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NATURAL HISTORY

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"NATURAL HISTORY" IS SENT
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NATURAL HISTORY

NORTH AMERICA

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The American Museum is indebted to all lands for their coöperation in the achievement of its aims, but in no continent has its work over the decades met with a warmer response or more generous support than in the North American homeland

JOURNAL OF THE AMERICAN
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NATURAL HISTORY

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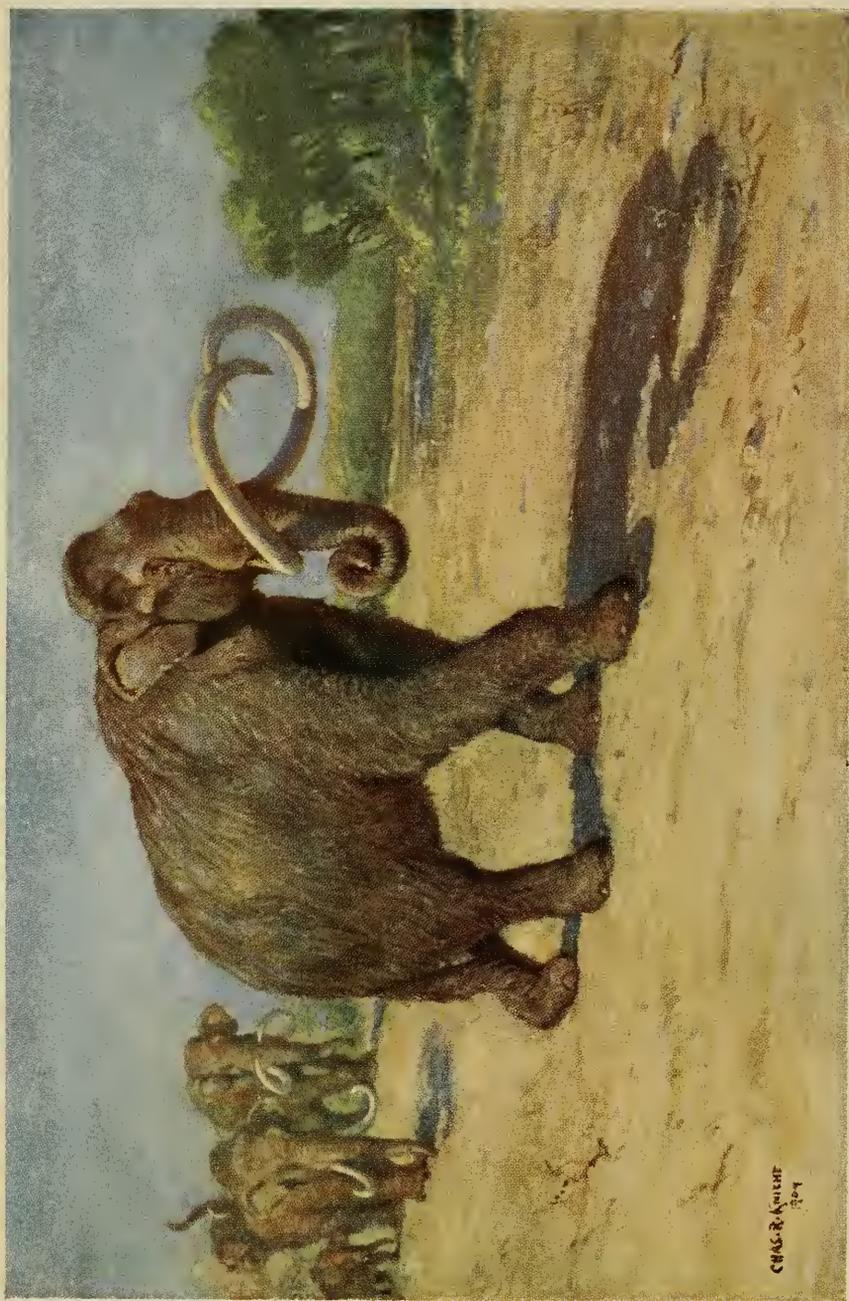
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THE JEFFERSONIAN MAMMOTH OF INDIANA (*PAELEPHAS JEFFERSONI*)

After restoration by Osborn and Knight; $\frac{1}{50}$ natural size



Group of American mastodons (*Mastodon americanus*) along the banks of the Ohio River, where these animals were first discovered in 1739. After restoration by Osborn and Knight

The Elephants and Mastodons Arrive in America

BY HENRY FAIRFIELD OSBORN

President of the American Museum of Natural History

FOREWORD.—Among the treasures of the American Museum is the unrivaled collection of skeletons and skulls of fossil proboscideans from Africa, the home of the race, from Asia, and from North and South America. Aided by the Morgan and Jesup funds, a large volume is being prepared describing the whole history of the elephant and mastodont families as far as known today. The present article is a sketch of these remarkable animals as they migrated, one race after another, into America, became naturalized and acclimated, enjoyed their lives here, and finally became extinct, the last survivor being the great mastodon of the eastern forests of North America.

THERE are few joys in life comparable with that which the naturalist experiences when one of his predictions or prophecies happens to be fulfilled. In 1900 I predicted that Africa would prove to be the cradle of the Proboscidea; in 1903 this prophecy was verified by British explorers in Egypt. Naturally eager to visit the scene of this discovery at once, I refrained until my British friends had fully described and published this and other discoveries and gained the world-wide reputation therefor to which they were richly entitled. I then asked President Theodore Roosevelt for an introduction to Lord Cromer, at the time Viceroy of Egypt, and through the generosity of President Jesup of the American Museum an expedition was fitted out, carrying as credentials a thoroughly

characteristic note from President Roosevelt to Lord Cromer. Unfortunately, I did not keep a copy of the note but, so far as I recall, it ran as follows:

January, 1907.

Dear Lord Cromer:

The bearer, Henry Fairfield Osborn, is a friend of mine keenly interested in palæontology who desires to enter the Fayûm district of Egypt. Any help which you may be able to extend to him or to his party will be greatly appreciated by

Yours sincerely,

THEODORE ROOSEVELT.

This brief and simple diplomatic message opened the doors of Egypt to the American Museum party. On our arrival at Sheppard's Hotel on the morning of January 23, a card was sent up announcing Captain H. G. Lyons, then director of the Geological Survey of Egypt, who thereupon as-

sured me that all the resources of the Survey would be placed at our disposal,—a camel caravan, a supply of the absolutely essential *fantasses* for carrying water, and, best of all, the guidance of a most intelligent and delightful member of the Survey staff, Mr. Hartley T. Ferrar. A personal caravan was also engaged. Thus, sixty camels strong, we wound our way past the pyramids of the eastern side of the Nile, skirted the fertile basin of the Fayûm, and struck southwest into the waterless desert until we reached the region that represented the ancient cradle of the elephant family. We at once set to work with a very superior force of Egyptian excavators from Kuft, under the direction of Mr. Walter Granger and Mr. George Olsen, two of the best fossil hunters of America, who stuck to their arduous post for nearly two months, until driven out by sandstorms and excessive heat. With their skilled aid, we soon discovered the burial sites of three of the early elephant dynasties; the MÆRITHERIUM, the abundant PHIOMIA, and finally the rare PALÆOMASTODON. The last-mentioned name is derived from the uncorrupted Greek words *παλαιός*, *μαστός*, and *ὀδόνς*, signifying “the ancient nipple tooth.” This name, applied by the able British palæontologist, Charles W. Andrews, recently deceased, has proved to be of literal significance, because we now have reason to believe that *Palæomastodon* may be the direct lineal ancestor of our true American mastodon (*Mastodon americanus*). Thus for the American Museum was disinterred a superb collection of small ancestral mastodonts, remote and humble relatives of three branches of the mastodont family—all of Upper

Oligocene time, estimated by some geologists as 3,000,000 years ago.

The Fayûm Expedition took place seventeen years ago. It aroused in the writer's mind the liveliest interest in these relatively small and primitive proboscideans, and a desire to compare them closely with the large proboscideans of France and South America, which were first described in 1806 by the famous Cuvier, also the wish to compare them with the proboscideans described and figured by the British explorers Falconer and Cautley in India between the years 1845 and 1847, and finally the hope to trace all these animals from their ancestral homes in Africa and Eurasia through their migrations to America.

TRAVELING INSTINCTS OF THE PROBOSCIDEANS

An insatiable *Wanderlust* has always possessed the souls of elephants as it has those of the tribes and races of man. Not only to overcome the changes and chances of this mortal life, but also to gratify their intelligent curiosity ever to explore afresh forests, pastures, fields, rivers, and streams, they have gone to the very ends of the earth and have far surpassed man in adapting their clothing and teeth to all possible conditions of life. Thus the romances of elephant migration and conquest are second only to the romances of human migration and conquest. Variety is the spice of elephant life, as it is of human life, and the very longing for a change of scene and of diet has been the indirect cause of what in scientific parlance we term *adaptive radiation*—the reaching out in every direction for every kind of food, every kind of habitat, in itself the *cause* of radiating or divergent evolution and adaptation. It is to this predisposition to local, conti-

mental or insular, and world-wide wanderings that we attribute the many branches and sub-branches which have been developed in this remarkable family. We may first enumerate all these branches and then signalize those that found their way to America and which form the chief subject of this article.

PROBOSCIDEA

Races I-X of the Mastodont Family: Mastodontidæ

I. THE MÆRITHERES, named from Lake Mœris of the Greeks. Small amphibious mastodonts of the North African rivers and lakes. See figure p. 9.¹

II. THE DINOOTHERES, implying proboscideans of terrifying size. Existed in Europe and Asia in Miocene and early Pliocene times.

III. THE TRUE MASTODONS, arising from *Palæomastodon* of the Egyptian Oligocene. Sparsely represented in the forest and lignitic deposits of Europe; first appearing in America in Upper Miocene time, becoming the giant mastodonts of the American forests at the close of the Ice Age. See figure p. 12.

IV. THE YOKE-TOOTHED MASTODONTS, OR ZYGLOPHODONTS. First known in the Miocene of Europe and leading into Borson's mastodon of the Upper Pliocene forests of Europe and Asia, close to the true mastodonts.

V. THE LONG-JAWED MASTODONTS, OR LONGIROSTRINES, springing from the long-jawed *Phiomia* of the Egyptian Oligocene and becoming the *Trilophodon* of Europe, migrating through Europe and Asia in the Miocene and spreading over Nebraska, Kansas, South Dakota, and Colorado in Pliocene time. See figures pp. 10 and 11.

VI. THE TETRALOPHODONTS, the name referring to the four ridge crests on the anterior molar teeth. First known from the Lower Pliocene of Eppelsheim, Germany, and of Pikermi, Greece; migrated across India, and entered America in late Pliocene time during the beginning of the Ice Age.

VII. THE SERRIDENTINES, named in allusion to the serrations on the outer and inner borders of the grinding teeth; medium-jawed. First known in the Miocene forest deposits of Europe; migrated to our southern states, Texas and Florida, and survived to the very close of Pliocene time. See figure p. 13.

VIII. THE BEAK-JAWED MASTODONTS, OR RHYNCHOROSTRINES, readily distinguished by the downward curvature of the tusks, similar to that in the Dinotheres. Of unknown European origin; first discovered in Colorado and California, and traced down into Mexico.

IX. THE NOTOROSTRINES, name signifying 'mastodonts of the south' because the animals are found chiefly in California and South America. Short-jawed, like the true mastodonts.

X. EXTREMELY SHORT-JAWED MASTODONTS, OR BREVIROSTRINES. First known species, the straight-tusked mastodont of Auvergne, Pliocene of France. The Brevirostrines migrated to India, reached western Nebraska in Middle Pliocene time, and survived in our southern states into the beginning of the Ice Age. See figures, p. 15.

Races XI-XVI of the Elephant Family: Elephantidæ

XI. THE STEGODONTS, named because of the resemblance of the toothed ridges of the grinding teeth to a series of roof-gables are more primitive than the true elephants. The Stegodonts have been traced from the Miocene of Europe into the forests of India and the East Indies to China.

XII. THE AFRICAN ELEPHANTS, OR LOXODONTS, distinguished by their lozenge-shaped grinders. See upper figure p. 18. Related forms attained gigantic size in southern Europe and in India, dwarfing into the diminutive species of the Mediterranean islands. See lower figure p. 6.

XIII. THE SOUTHERN MAMMOTHS (*Archidiskodon*, signifying ancient crested). First known in India, migrating westward into southern Europe, eastward by Bering Strait into America, where they arrived in early Glacial time, and gave rise to the imperial mammoth. See figure p. 20.

¹The series of illustrations throughout the article are all to a uniform scale, with the exception of the head-piece and tail-piece.

XIV. PARELEPHAS, signifying a collateral to the true *Elephas*. Mammoths of the temperate zone. First known in Europe, traced into America, where they arrived in mid-Glacial time, and gave rise to the great Jeffersonian mammoth. See frontispiece.

XV. THE WOOLLY MAMMOTH (the *Elephas primigenius* of Blumenbach). First discovered in northern Germany and in England. It crossed northern Asia, and arrived in America in late Glacial time. See figure p. 21.

XVI. THE TRUE ELEPHANTS (the *Elephas* of Linnæus), probably originating in northern Asia. First known in India early in the Age of Man, and giving rise to the recent species of India, Burma, and Ceylon. See lower figure p. 18.



African home of the primitive mastodonts.—The word "Proboscidea" as printed in 1900 and supplemented in the present map by the black dot (●) indicates the Fayûm Desert of Egypt, where these animals were discovered in 1903



Pygmy elephants of Malta and of the other Mediterranean islands, as restored by Leith Adams in 1870, namely, 1, *Loxodonta (Pilgrimia) mnaidrax*; 2, *L. (Pilgrimia) melitensis*; and 3, *L. (Pilgrimia) falconeri*, the smallest. $\frac{1}{10}$ natural size

So strong was the migratory impulse that only six out of these sixteen races of mastodonts and elephants failed to reach America. The Stegodonts (Race XI), one of these six groups of 'stay-at-homes,' were confined, according to the writer's theory, to the warm southern forests of India, to China, Japan, and the East Indies, when these islands were connected with the mainland. The true African elephants, or Loxodonts (Race XII), never left the African continent, although the somewhat closely related pygmy elephants of the Mediterranean islands (see lower figure on this page) and the giant straight-tusked elephants of India and southern Europe were great travelers. The true Indian elephant (Race XVI) never went beyond the confines of Asia, and its Asiatic ancestors still await discovery; their probable homeland was in the great northern plateaus and forests. The amphibious *Mœritheres* (Race I) were closely bound by their river habitat to Africa and thus far have not been recognized elsewhere. The *Dinotheres* (Race II), notwithstanding their long limbs and gigantic size, wandered only east and west in their European and Asiatic homelands. The 'yoke-toothed



Theoretic migration routes of the mastodont family from their center (●) in Africa to all of the continents excepting Australia. The cradle of the elephant family is still unknown



Actual migration routes of the long-jawed mastodonts (*Longirostrinæ*) and of the true mastodon (*Mastodontinæ*) from their actual center of origin in north Africa as indicated by their respective symbols. Note also the migration routes of the *Brevisrostrines*, *Notorostrines*, and *Rhynchorostrines*

mastodonts,' or *Zygalophodonts* (Race IV), never reached America and are not treated fully in this article.

The successive times of departure and arrival of the ten wandering races as contrasted with the 'stay-at-homes'

cannot be fixed exactly. En route from Asia to North America, they were all forced to come by way of the northern Bering Strait, then an isthmus. Some races, like the 'beak-jawed mastodonts,' are very rare and are as yet known only by a few specimens, which are of highly characteristic and easily distinguishable form and associated habit. All the arrivals were naturally subsequent to the early evolution of the sixteen races of proboscideans in the African and Eurasiatic continents. In some cases the migrations appear to have been very gradual; for example, the 'long-jawed mastodonts' (Race V), as represented by *Phiomia*, appear in the Oligocene of Egypt; they spread all over Europe in Miocene time, and were fairly abundant in Nebraska and Colorado in Pliocene time. At the other extreme are such instances of rapid traveling as that represented by the southern mammoth, which appears in the Upper Pliocene of Europe and in the advancing Ice Age of North America. Next in point of interest is the evidence of strong climatic preferences; it would appear that the south temperate and north temperate races of elephants sought corresponding and congenial life zones for their prevailing habitat, as do the Italians, the Germans, and the Scandinavians in the human migrations of our day.

Thus three kinds of mammoths are distributed on different isotherms, as indicated in the table herewith.

Proboscideans have always been fastidious in their feeding habits. Con-

sistent with their choice of similar isotherms conditioning the flora and fauna of their times, these clever animals coming from the Old World also sought out similar habitats in America, whether of northern or southern forests, savannas, stream borders, or more or less arid and desert zones. For example, we have proof of the arrival of Race X (the Brevirostrines, genus *Stegomastodon*) in the rapidly desiccating areas of western Texas and western Arizona, where they competed for food with other desert-loving forms, like the horses, the camels, and the armored glyptodonts (*Glyptotherium*) of South America. Superb adaptations to these different degrees of temperature, different kinds of food, and more or less moist or arid atmosphere appear not only in the tusks and in the grinding teeth (which are beautifully preserved in the fossil condition), but also doubtless in the unique shaping of the upper lip into the organ known as the proboscis, which gives these animals their ordinal name Proboscidea.

RACE I, THE MÉRITHERES, AND RACE II, THE DINOTHERES

THE MÉRITHERES (RACE I).—These are the oldest proboscideans known at present, the most primitive and diminutive. Their remains occur in the estuarine and fluvial sands of the primordial river Nile, which the German geologist, Blanckenhorn, named 'Ur-Nile.' The pair of enlarged upper and lower tusks abrade each other as in the hippopotami; were it not for the fact that these teeth are comparable to the pair of incisors

CLIMATIC TABLE

KINDS OF MAMMOTHS	EURASIA	AMERICA
XV. WOOLLY MAMMOTH	Boreal and circumpolar habitat	Boreal habitat and borders of glacial ice sheet
XIV. TROGONThERIAN MAMMOTH (<i>Parelephas</i>)	Mid-temperate regions	Mid-temperate regions
XIII. SOUTHERN MAMMOTHS	South temperate: <i>Elephas meridionalis</i>	South temperate: imperial mammoth (<i>Elephas imperator</i>)



Copyrighted by the American Museum of Natural History
Mærittherium on the borders of the primitive river Nile, now the Fayûm of Egypt.
 After restoration (1907) by Osborn and Knight; $\frac{1}{50}$ natural size

enlarged into tusks in all other proboscideans, and that the grinding teeth are also comparable to the grinders of all the higher mastodonts, we might question the relationship of these animals to the higher proboscideans, because their amphibious habits separate them so markedly from the other members of their order. They disported abundantly in the Ur-Nile but are not known to have migrated into Europe or to have left descendants.

THE DINOETHERES (RACE II).—Teeth, jaw fragments, and an astragalus of the *Dinotheres* had been found and described between the years 1715 and 1758, but it was not until 1828 that the famous lower jaw, named by Kaup in 1829 *Dinotherium giganteum*, was discovered at Eppelsheim, Germany. The *Dinotheres* appear abundantly in the Miocene of Europe and we are inclined to believe that they sprang from African ancestors, because one of these ancestors has recently been discovered.¹ As they are distinguished by sharply crested teeth and by a pair of huge down-turned lower incise tusks, it was long supposed that, like the *Mærittheres*, they too were amphibious in habit, but this hypothesis has been weakened by the discovery of a complete skeleton, which shows that these proboscideans had very tall

limbs, with high body proportions altogether different from those of the *Mærittheres* and of the existing hippopotami; in fact, all amphibious mammals have either short limbs or no limbs at all. Whatever their habits and special habitat, the *Dinotheres* attained gigantic size, as evidenced by the *Dinotherium gigantissimum* of Roumania. They reached India, but thus far there is no evidence of their having penetrated as far as China and still less of their having approached the American continent.

RACES V AND III. THE LONG-JAWED MASTODONTS AND THE TRUE MASTODONS

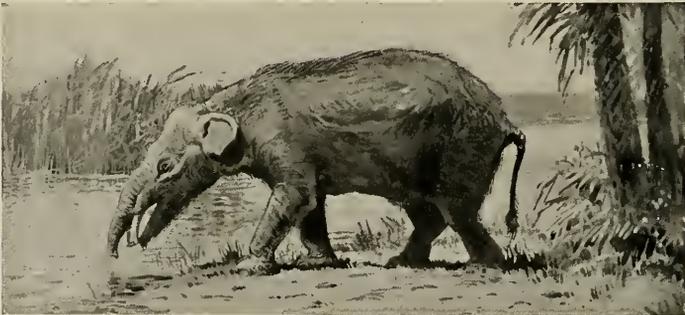
THE LONG-JAWED MASTODONTS (RACE V).—These animals derive their scientific name 'Longirostrines' from their extremely long and slender jaws, which far surpass in length those of any other land mammal thus far discovered. At the extremity of the lower jaw is a pair of shovel-shaped lower tusks, and there is no doubt that these tusks were used, after the manner of a trowel or spade, in the digging out and uprooting of plants. That this unique function gave these animals very great advantage over their rivals is demonstrated by the rapid spread of the Longirostrines eastward into India, thence northward into China and America, and all the while they were increasing in size and power until as a culmination the massive animal known as *Tri-*

¹This is *Dinotherium hobleji* from the east side of Victoria Nyanza, described in 1911 by the late Charles W. Andrews, of the British Museum, found in beds attributed to Lower or Middle Miocene age.

lophodon giganteus, discovered by Mr. Troxell in South Dakota, attains a height nearly equaling that of our giant American mastodon. It is difficult to believe that this giant springs from the relatively slender North African Longirostrine, to which the name *Phiomia* has been given in reference to the proximity of its former habitat to the Fayûm of Egypt, the *Phiomia* of the Greeks; yet when we examine minutely the horizontally placed upper and lower tusks of *Phiomia*, the long narrow grinding teeth harmonic with the long jaw, and the three crests of the intermediate grinding teeth, there can be little doubt that *Phiomia osborni* is a progenitor of the race that gave rise to the *Trilophodon angustidens* of Europe, to the *Trilophodon palæindicus* of India, and to the numerous long-jawed species recently discovered in South Dakota, Nebraska, and Colorado by

condition, hardly more complex than those of the Egyptian *Phiomia*, in which the jaw measures two feet six inches. To our mind, the Longirostrines relied very largely upon their superior and inferior tusks for the gathering in of food, which was rapidly masticated and readily swallowed because of its relatively succulent nature.

THE TRUE MASTODONS (RACE III).—The true mastodons of our American forests appear to have arisen from the diminutive *Palæomastodon* of the primordial river Nile. The reason these animals have left no trace of their 10,000-mile and 2,000,000-year journey from the Nile region to the forests bordering the Ohio and the Hudson rivers is that fossilization of forest-living fauna has always been rare. The ancestral *Palæomastodon* of the Nile region is itself very rare; in the American Museum collection there are



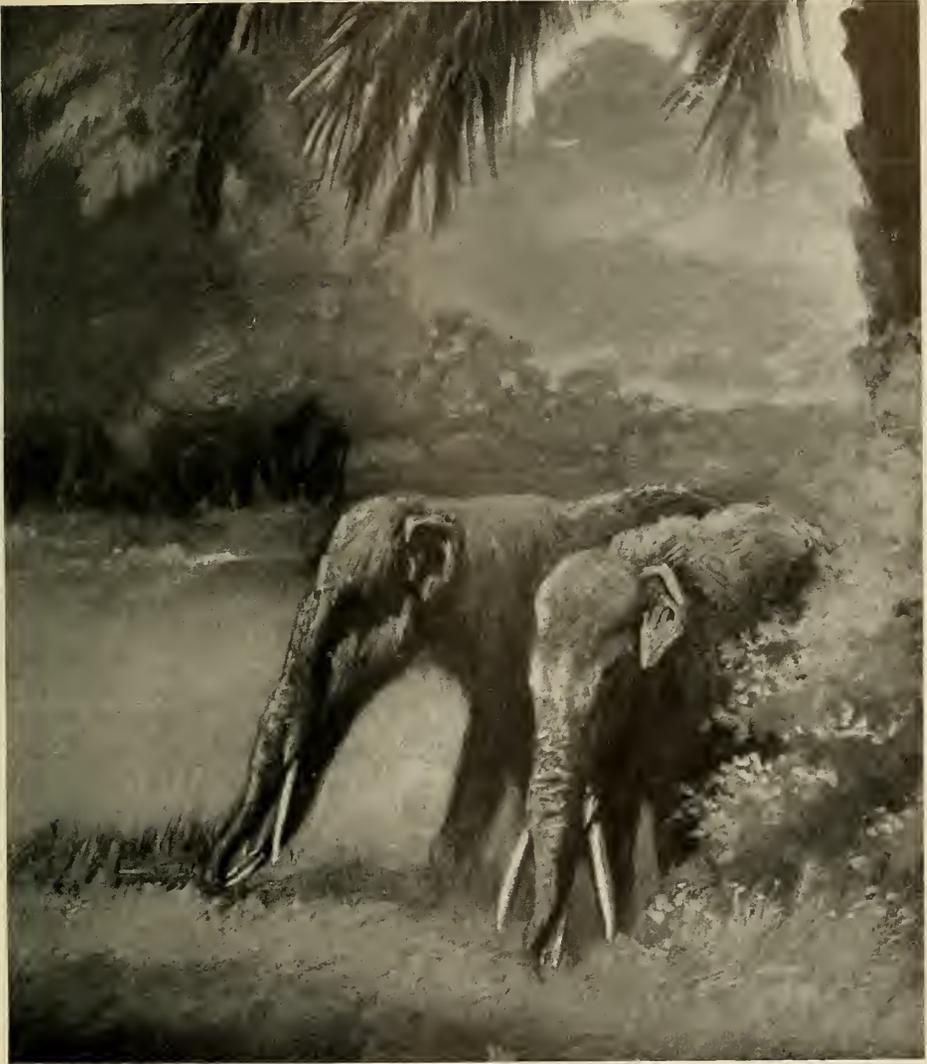
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Long-jawed mastodont (*Phiomia osborni*) on the borders of the primitive river Nile, now the Fayûm of Egypt. After restoration by Osborn and Knight; $\frac{1}{50}$ natural size

Prof. Erwin H. Barbour of the University of Nebraska, by Mr. Harold Cook of western Nebraska, and by Mr. E. L. Troxell mentioned above.

In these American Longirostrines the elongation of the lower jaw and tusks reaches the incredible extreme of six feet, seven inches in the species *Trilophodon lulli*. Jealous of her endowments, nature kept the grinding teeth of these animals in very simple

forty-eight specimens of the long-jawed *Phiomia* to seven specimens of *Palæomastodon*; not even fossilized teeth of this race were scattered in Europe to show the route. Thus, while the woolly mammoth left an overwhelming number of fossilized remains which were discovered in western Europe from the end of the eighteenth century onward, the true mastodon was first found on the banks of the Hud-



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Long-jawed mastodons (*Trilophodon giganteus*) from the Lower Pliocene beds of South Dakota. After restoration by Osborn and Knight; $\frac{2}{3}$ natural size

son (1705) and the Ohio (1739). The Ohio fossils were fully characterized by the great French naturalist Buffon as a distinct species belonging to the epoch of the elephants although Buffon did not give the animal a name. Johann Friedrich Blumenbach, who named the woolly mammoth *Elephas primigenius* in 1799, in the same communication placed the name OHIO-INCOGNITUM beneath the figure of the tooth of

the American mastodon. These animals now rival the mammoth, as the best-known of all the extinct proboscideans; thousands of teeth and jaws, as well as more or less complete skeletons have been found, chiefly in the Fourth Glacial swamps and marshes of our Middle and Eastern States.

In contrast with the long-jawed mastodons, the true mastodons are short-jawed. Their lower tusks are



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 True mastodon (*Mastodon americanus*) from the Pleistocene beds of New York. After restoration by Osborn and Knight; $\frac{1}{30}$ natural size

variable; the upper tusks curve upwards and inwards, like those of the elephants, and served for uprooting plants and for defensive and offensive purposes, while the proboscis was the main 'food getter' for the huge bodily frame.

RACES VI, VII, AND VIII. TETRALOPHODONTS, SERRIDENTINES, AND BEAK-JAWED MASTODONTS

THE FOUR-CRESTED MASTODONTS (RACE VI).—In 1832 Europe was greatly stirred by the discovery in the Lower Pliocene of Eppelsheim, Germany, of a mastodont with *four* instead of *three* ridge crests on its intermediate grinding teeth. Hugh Falconer based upon this character the appropriate name *Tetralophodon* (i.e. four-crested teeth) as distinguished from *Trilophodon*, the designation of the mastodonts with three ridge crests. In

these animals with four-crested teeth the jaws are not so extremely elongated for shovel and spade work as in the long-jawed mastodonts (Race V), but, by way of compensation, the grinding teeth became much more complex because they had to do far more work. While the back grinders of the long-jawed mastodonts remain very simple and never exceed four and a half ridge crests, the back grinders of the Tetralophodonts rise to seven and a half ridge crests and become adapted to their very long and arduous life work, culminating in the stage which the writer has named *Tetralophodon* (*Morrillia*) *barbouri*, after Dr. Erwin H. Barbour, the geologist and explorer, and the Honorable Charles H. Morrill, patron and benefactor of the exploration of the extinct life of Nebraska. The Tetralophodonts are in all coun-

tries very rare, yet we can trace their long migration through eastern Europe into India and China, until finally they arrive in Kansas and Nebraska. The jaws remain of medium length, the lower tusk is not as yet known; the upper tusk curves downwards and outwards.

THE SERRIDENTINES (RACE VII).—The Serridentines, or 'serrate-toothed mastodons,' have only recently, as a result of the investigations of the writer, become distinguished from the long-jawed mastodons, on the basis of the structure of the relatively few teeth found in ancient forest or lignitic

one member of this race succumbed and left his jaw to become a fossil on one of the ancient rivers of Mongolia, and here it was unearthed by the Third Asiatic Expedition in 1922 and subsequently christened *Serridentinus mongoliensis*. Eight thousand miles eastward and southward of this spot, which is in the desert of Gobi, the Americanized descendants are found in the marls near Santa Fé, New Mexico, and in the ancient river sands near Clarendon, Texas, in a formation of Lower Pliocene age. A beautiful restoration, made under the direction of the writer, from a nearly complete



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Serrate-toothed mastodont (*Serridentinus productus*) tree-browsing; as found fossil near Clarendon in northern Texas. After restoration by Osborn and Knight; $\frac{1}{50}$ natural size

deposits of France, Switzerland, and Austria. Yet these few teeth afford indubitable proof that these Serridentines are not to be confused either with the long-jawed mastodons (= *Trilophodon*) or with the medium-jawed mastodons (= *Tetralophodon*). They form a race of their own, to which the generic name *Serridentinus* has been given. En route to America

skeleton of a Serridentine of northern Texas is reproduced above. It shows the animal reaching for foliage with its proboscis, aided by a lower jaw with tusks of medium length, a jaw more elongate than in the true mastodons but less elongate than in the extremely long-jawed forms.

THE BEAK-JAWED MASTODONTS (RACE VIII).—The 'beak-jawed mas-

todonts,' technically known as Rhynchorostrines, are readily distinguished from all other mastodonts by the sharp downward curvature of the anterior portion of the jaw into a beaklike prolongation, in which are inserted two downwardly pointed tusks flattened on the sides. It was due to this unique adaptation of the jaw and tusks for uprooting plants and roots that Falconer in 1856-68 applied the name *Rhynchotherium* to the animal under the following circumstances: "At Genoa I saw a cast of a large lower jaw of a Mastodon from Mexico, with an enormous *bec* abruptly deflected downwards and containing one very large lower incisor. The beak is much thicker than in *M. (Trilophodon) angustidens* and larger than in *M. (Tetralophodon) longirostris*. You know that every one (Laurillard, Gervais, etc.) has insisted on the absence of the lower incisors from both of the South American species. The outline of the jaw resembles very much the figure in Alcide D'Orbigny's Voyage, described by Laurillard as *M. Andium*. The specimen is unpublished material and I was therefore only allowed to examine it very cursorily. The Genoese palæontologists had provisionally named it *Rhynchotherium*, from the enormous development of the beak, approaching *Dinotherium*."

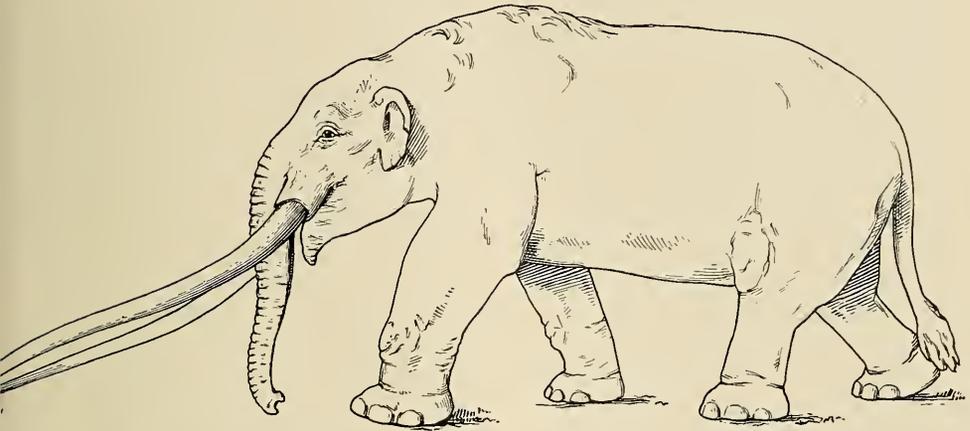
Very few remains of this 'beak-jawed mastodont' have been discovered, and it has required long study to work out the peculiar adaptations of the dentition, which consists of downturned upper and lower tusks and of very broad and simple upper and lower grinding teeth. Traces of the 'beak-jawed mastodonts' occur in Oregon, in Montana, in Colorado, and in California, but thus far the best-preserved jaws are those from Mexico, the region from which came the specimen that

the keen eye of Falconer first recognized as a beak-jawed animal quite distinct from the 'long-jawed mastodont' of western Europe.

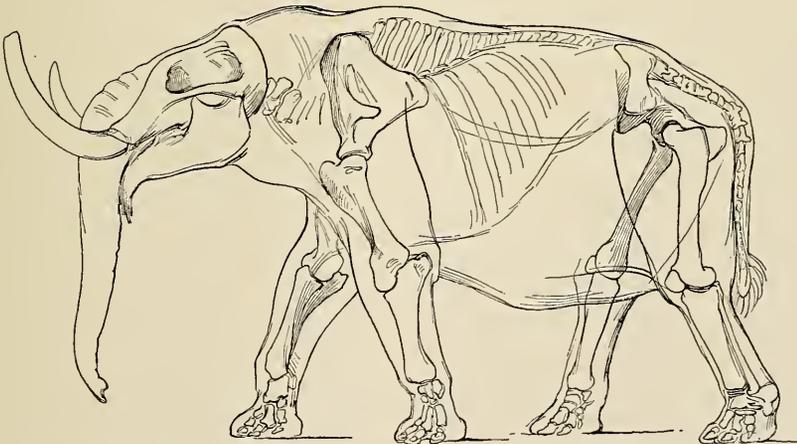
RACE X, THE SHORT-JAWED BREVIROSTRINES, AND RACE IX, THE NOTOROSTRINES

Races X and IX present a marked contrast to all the races preceding, in the shortening of the lower jaw and the disappearance of the lower tusks, which transfer to the upper tusks, the proboscis, and the upper and lower grinding teeth the whole function of collecting the food and of masticating it before it enters the long process of digestion and assimilation whereby the relatively feeble energy of plant life is transformed into the commanding energy of these proboscideans.

The back grinders, or third upper and lower molars, are, on the whole, the most characteristic part of the entire anatomy of these and other proboscideans, even more distinctive than the tusks. Many proboscideans resemble each other in the general shape of the superior tusks, which may display substantially the same curvature and shape in nine of the sixteen races which are here considered; this tendency is due to the fact that in all these races the upper tusks perform the same functions of offense and defense and are tools of great value in the uprooting of plants and small trees. It is true that there are in the tusks distinct differences of curvature and of diameter which become increasingly apparent as the animals attain old age, but the tusks of the young of the Indian elephants, of the woolly mammoth, of the Jeffersonian and of the imperial mammoths, of the African elephants, and of the Stegodonts are not readily distinguishable from the upper tusks of the true mastodonts nor from the two tusks of the short-jawed



Short-jawed mastodont of Auvergne, France, (*Anancus arvernensis*), highly characteristic of the Upper Pliocene of Italy, southern France, and Great Britain. After restoration by Osborn and Knight; $\frac{1}{50}$ natural size



Short-jawed mastodont of southern Arizona (*Stegomastodon arizonæ* Gidley), as discovered by J. W. Gidley in the San Pedro beds. After restoration by Knight; $\frac{1}{50}$ natural size

ances we are now considering, namely, the Brevirostrines, the European and American genera of which are illustrated on p. 15, and the Notorostrines.

Clearly to distinguish the sixteen races of proboscideans from one another we must study the back grinders with extreme care, and observe that these grinders are constantly changing their form to compensate for the gains and losses in the anterior grinders and in the upper and lower tusks. Thus, while the external appearance of the Brevirostrines and Notorostrines is not wholly dissimilar, the structure of the back grinders is radically at variance in the two races, and a very tyro in odontography could not fail to distinguish these grinders.

THE BREVIROSTRINES (RACE X).—Very early in their history the Brevirostrines began to lose their lower tusks with the rapid shortening of the lower jaws; in recognition of these changes, one of the first of these fossils found in France was termed '*Mastodon brevirostris*,' or 'short-jawed mastodont.' As in all other proboscideans, the two compensations were, first, a great increase in size of the upper tusks, which became excessively long and straight in the mastodont of Auvergne, France, and short and massive in the mastodont of Arizona (see figures, p. 15), and, second, a novel and complex mechanism which developed in the back grinders. The first step in this new food-grinding adaptation is seen in the Brevirostrine of Auvergne (*Anancus arvernensis*) and in its distant cousin of India (*Pentalophodon sivalensis*), namely, a twisting of the outer and inner grinding-tooth cones so that they *alternate on the inner and outer sides of the teeth*. Meanwhile in the Indian *Pentalophodon* five ridge crests are added to the teeth in front of the back grinders, and the crowns of the back

grinders are heightened. These two new devices in grinding-tooth construction were so successful that these animals increased in numbers in Eurasia and achieved their long journey to North America, where they first appear in western Nebraska, subsequently spreading southward into Texas and Arizona. The veteran palæontologist, Joseph Leidy, was so impressed with the complexity of these Brevirostrine grinding teeth that he thought the animal that bore them worthy of the name *Mastodon mirificus*, signifying the 'wonderful mastodon.' This complexity went on increasing by the addition and complication of the enamel foldings until the crown became a veritable labyrinth of dental tissue, well adapted to the hard grasses and tough woody fiber of the plants then becoming characteristic of the great American desert. It is by this condition of the teeth, ever growing more and more complex, that we trace these animals southward through the species *Stegomastodon (Mastodon) mirificus* of Nebraska into the *S. texanus* of Texas, thence into the *S. arizonæ* of the ancient playa lakes of Arizona, and finally into the giant *S. aftonix* of the First Interglacial epoch of Iowa.

Thus, this long and eventful journey from the Auvergne region of France and the Norfolk region of England, through India, into the American desert, was rendered possible only by the constant evolution and improvement of the grinding teeth until they attained the highest degree of perfection of their kind.

THE NOTOROSTRINES (RACE IX).—These animals take their name from the Latinized Greek word *Nótus*, signifying the south wind, that blew upon them as they left southern California, where their remains have recently been discovered by Mr. Childs Frick, and

journeyed southward along the Andes to the region now known as the Argentine. As discovered in Neogæa, or South America, it was appropriate that Cuvier should name one of these species *Mastodon humboldtii*, in reference to the travels of Alexander von Humboldt, and the other, *Mastodon andium*, commemorating the discovery of remains of this species on the slopes of the Andes.

In these Notorostrines the lower jaws are in process of abbreviation with corresponding loss of the lower incisive tusks, an abbreviation which does not go so fast or so far as in the extremely short-jawed Brevirostrines just described. The superior tusks contain a long ribbon of enamel on the outer side, and as the tusk rotates on its own axis, this enamel ribbon is carried around to the inner side in a corkscrew spiral form, a peculiarity not observed in any other proboscidean. This powerful tusk was so effective that, again following her principle of economy, nature kept the back grinders in a relatively simple condition in the species now known as *Dibelodon (Mastodon) andium*. In its sister form, *Cuvieronius (Mastodon) humboldtii*, named in honor of both Cuvier and von Humboldt, the upper tusks are of simpler upturned form, without the enamel ribbon, and the grinding teeth at once become more complex by means of the enamel foldings known as double trefoils.

RACES XII AND XVI, THE LIVING ELEPHANTS, AND RACE XI, THE STEGODONTS

THE LIVING ELEPHANTS (RACES XII AND XVI).—We now turn to the history of the elephant family, Elephantidæ, the second great division of the proboscideans, the two living examples of which are the true elephants of India belonging to the genus *Elephas*

of Linnæus, and the elephants of Africa belonging to the genus *Loxodonta* of Cuvier. We know nothing of the direct ancestral history, or of the immediate ancestors, of either *Elephas* or *Loxodonta*; this history still lies buried in the rocks of the great Eurasian continent north of India and in the vast unexplored strata of central Africa, but we look forward confidently to the filling in of these missing chapters in proboscidean history. As our knowledge stands at present, the Indian elephant suddenly appears fully formed during the Age of Man and the same is true of the African elephant. Attempts to establish the descent of the Indian or African races either from Race XI (the Stegodonts) or from Races XIII-XV (the Mammoths) will not stand the test of the higher criticism of palæontologists. Yet it appears certain that all the elephants sprang from ancestors like the Stegodonts.

THE STEGODONTS (RACE XI).—From Miocene to Pleistocene time, these very primitive elephants known as Stegodonts were dwellers in the tropical forests, extending from India and the East Indies to China. Differing from the mastodont family, the Stegodonts have a new kind of grinding tooth with multiple ridge crests, from which the grinding teeth of all the higher elephant races may have been derived, and it is not improbable that a certain branch of the Stegodont family wandered into northern Asia and was there transformed into some of the primitive members of the elephant family; such transformation certainly did not occur in southern Asia, where the Stegodonts have their own independent history that culminated in the prodigious and widespread Stegodontines, which left their fossil remains in the same deposits with the earliest of the mammoths. The best-known among these giant Stegodonts is the



Living African elephant (*Loxodonta africana*) in the forests of central Africa. After photograph by Carl E. Akeley; $\frac{1}{50}$ natural size



Courtesy of New York Zoological Society
Living Indian elephant (*Elephas indicus*) and living dwarf Congo elephant (*Loxodonta africana pumilio*) in the New York Zoological Park. After photograph by Elwin R. Sanborn; $\frac{1}{50}$ natural size

species *Stegodon ganesa*, named after one of the legendary deities of India. It is contemporary with a giant true elephant related to the African.

THE THREE RACES OF MAMMOTHS
(XIII, XIV, XV) WHICH REACHED
AMERICA

The name *Mammut*, probably derived from the Tartar *mama*, signifying earth, in allusion to the discovery of fossilized bones buried in the earth, properly belongs to the northern or woolly mammoth, *Elephas primigenius*, the primordial elephant. The term mammoth is used in the present article in a much broader significance to embrace three great branches of the elephant family. Two of them—the imperial mammoth and the Jeffersonian mammoth,—resemble the woolly mammoth in the architecture of the cranium and in the strong incurvature of the superior tusks, as greatly as they differ from this boreal elephant in the structure of the grinding teeth. The cranium rises into a high acute peak and the forehead is concave instead of being plane and flattened as in the African elephant, or prominent and domelike as in the Indian elephant (see upper and lower figures respectively, p. 18). There are many other features which unite the three races of mammoths among themselves and which separate them from the African and Indian elephants, but the one of paramount interest to us is that these animals were greater wanderers than either the Indian or African elephants and successively entered the American continent as follows:

The imperial mammoth (Race XIII), late in the Age of Mammals, early in the Age of Man.

The Jeffersonian mammoth (Race XIV), during the Age of Man.

The woolly mammoth (Race XV), late in the Age of Man, during the period of the last great glaciation.

THE IMPERIAL MAMMOTH (RACE XIII).—This majestic animal was discovered by Ferdinand Hayden, the exploring geologist, in Nebraska, and described by Joseph Leidy in 1858 as *Elephas imperator*, signifying the 'imperial elephant' in reference to the surpassing size of the grinding teeth and the impressive height of the animal. This designation has been more than justified by subsequent discoveries of remains of this gigantic animal in Nebraska, Kansas, Iowa, Texas, California, and Mexico, consisting of portions of teeth, skulls, and skeletons sufficient to establish the fact that the full-grown animals attained a height of 13½ to 14 feet, exceeding by 2½ feet the tallest of the existing African elephants and rivaled only by the gigantic straight-tusked elephant of India and western Europe known as *Loxodonta antiqua*.

The grinding teeth are readily distinguished by their surpassing size and by the relative paucity of the enamel ridge plates, which never exceed twenty in number; the ridge plates are very far apart and the enamel bands are broad, whereas in the woolly mammoth the enamel of the ridge plates is excessively fine, the grinding teeth are relatively small, and the number of ridge plates amounts to twenty-seven. It is in reference to this massive but primitive structure of the grinding teeth that Prof. Pohlig has named these animals *Archidiskodon*, signifying primitive ridge plates. The adaptation of these huge, coarse grinders was to tree-and shrub-browsing and the crushing of great masses of leaves and twigs; these imperial mammoths were therefore probably browsers, and with the reduction and disappearance of the western forests, they diminished in numbers and became extinct—the last of a noble line which traces its lineage



IMPERIAL MAMMOTH (*ARCHIDISKODON IMPERATOR*) OF NEBRASKA AND TEXAS. AFTER RESTORATION BY OSBORN AND KNIGHT; $\frac{1}{50}$ NATURAL SIZE



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WOOLLY MAMMOTH (*MAMMONTEUS PRIMIGENIUS*) OF THE RIVER SOMME, FRANCE, IN LATE GLACIAL TIME. AFTER RESTORATION
BY OSBORN AND KNIGHT; $\frac{1}{50}$ NATURAL SIZE

back to *Archidiskodon planifrons* in the Upper Pliocene of India and is related to the giant *Archidiskodon meridionalis* of the Pliocene and Lower Pleistocene forests of Italy, France, and Great Britain. In America *Archidiskodon* attained by far its greatest size, as majestically represented in our restoration (p. 21).

THE JEFFERSONIAN MAMMOTH (RACE XIV).—It has taken many years of study to disentangle the lineage of this great immigrant from that of the imperial mammoth on the one hand and that of the woolly mammoth on the other. With the aid of Prof. Hans Pohlig of Bonn and of Prof. Charles Depéret of the University of Lyons this lineage has been traced back to Germany, to southern France, and to Great Britain, and it is now a well established fact that the Jeffersonian mammoth came from smaller and more primitive ancestors which wandered in the forests and meadows of western Europe during the first half of the Age of Man. These European forebears replaced the ancestors of the imperial mammoth and were in turn replaced by great herds of the woolly mammoth that entered Europe in the closing period of the Age of Man. These animals are so distinct from either the imperial or the woolly mammoth stock that we give them the separate generic designation of *Parelephas*, in allusion to their development parallel with the true elephants of India. Whereas the European branch of *Parelephas* became extinct, the American branch flourished exceedingly in the temperate regions of the United States, and its fossil remains are far more numerous than those of either the imperial or the woolly mammoth; *Parelephas* also endured for a long period of time and underwent a considerable evolution in

respect to its grinding teeth, from an earlier stage which we have named *Parelephas jeffersonii* (see frontispiece), in honor of President Jefferson, to a final stage in which the third upper molar possessed as many as thirty plates and the third lower molar twenty-six.

Second only in size to the imperial mammoth, the Jeffersonian mammoth succeeded its imperial forerunner and survived the severe climate of the Fourth Glaciation, at the close of which it became extinct.

THE WOOLLY MAMMOTH (RACE XV).—Late in the Age of Man arrived the woolly mammoth (p. 21), closely related to the *Elephas primigenius* of the ancient steppes and tundras of western Europe. The first to make very close comparison between the west European and the American varieties of this boreal race was Dr. Hugh Falconer, who declared that while the same number of enamel ridge plates was present in the forms of both regions, namely, twenty-four in the last molar of each jaw, the American animals were in general characterized by still finer and more compressed ridge plates than those of western Europe. Thus we may distinguish one of our own forms as *Mammonteus primigenius americanus*, while in Indiana and in Alaska we find a type of mammoth with close-fitting enamel ridge plates to the number of twenty-seven and of such exceeding fineness that we have named it *Mammonteus primigenius compressus*. This adaptation of the grinding teeth for grazing habits was to enable the animal to feed upon the hard grasses which covered the tundras and steppes of the north during the summer season. Thus the woolly mammoth was chiefly a grazer, as proved by the stomach contents of frozen carcasses recovered from the ice in Siberia.

TABLE OF COMPARATIVE HEIGHTS OF CERTAIN
ELEPHANTS AND MASTODONTS

COMMON NAME	SCIENTIFIC NAME	HEIGHT
Imperial Mammoth	<i>Archidiskodon imperator</i>	13½ feet
African Elephant	<i>Loxodonta africana</i>	11 feet 4 inches
Jeffersonian Mammoth	<i>Parelephas jeffersonii</i>	10 feet 6 inches
Indian Elephant	<i>Elephas indicus</i>	10 feet
American Mastodon	<i>Mastodon americanus</i>	9 feet 6 inches
Woolly Mammoth	<i>Mammonteus primigenius</i>	9 feet 3 inches
Giant Longirostrine	<i>Trilophodon giganteus</i>	7 feet 9 inches
Small Mediterranean Elephant	<i>Loxodonta (Pilgrimia) mnaidra</i>	7 feet
Texas Serridentine	<i>Serridentinus productus</i>	5 feet 8 inches
Small Elephant of Malta	<i>Loxodonta (Pilgrimia) melitensis</i>	5 feet
Fayûm Longirostrine	<i>Phiomia osborni</i>	4 feet 5 inches
Young Congo Elephant	<i>Loxodonta africana punilio</i>	4 feet 5 inches
Smallest Elephant of Malta	<i>Loxodonta (Pilgrimia) falconeri</i>	3 feet
Fayûm Mœrithere	<i>Mœritherium andrewsi</i>	2 feet 1 inch

The woolly mammoth is relatively diminutive in size, not much exceeding nine feet and, despite the grazing adaptation in its grinding teeth, it shows its relationship both to the imperial and the Jeffersonian mammoths in two outstanding characters, namely, the extreme acuteness of the apex of the skull and the strong incurvature of the tusks, which completely cross each other in old age and no longer serve either for purposes of combat or for the gathering of food. Remains of the woolly mammoth are relatively rare in the United States but a few fine skulls have been recovered from Indiana and from Alaska, in which the acute apex, the concave forehead, the extreme flattening and deepening of the cranium and the tooth sockets may be observed.

We know little of the external appearance of the imperial mammoth; it was probably nearly hairless like the Indian and the African elephants. The Jeffersonian mammoth, we believe, was partly hairy, for it is characteristic of the north temperate region both of Europe and the United States. The northern mammoth of the Ice Age was both hairy and woolly and was perfectly adapted to the extremely severe climate of the Arctic Circle and of the borders of the advancing ice sheets. Both in their immense geographic range and in their extremes of adaptation to different climatic zones, these three branches of the mammoth family rank as the *facile princeps* among the mammals which ruled the Northern Hemisphere during the Age of Man.



Stegomastodon arriving in Arizona. Copyrighted by the American Museum of Natural History
After restoration by Osborn and Knight



Copyrighted by W. S. Taylor, 1912.

THE PRIZE OF THE WHALE HUNT

The Nootka of Vancouver Island, like the Quileute of the Olympic Peninsula, on the mainland to the south of them, are known as ardent hunters of the whale. Among both peoples a piece of blubber from the back of the animal was awarded to the chief harpooner. This was ornamented with feathers and suspended from a pole, as shown in this reproduction from a mural painting by Will S. Taylor that is one of the decorative features of the Northwest Indian hall, American Museum

Whaling of the Olympic Peninsula Indians of Washington¹

BY ALBERT B. REAGAN

NOTE.—The author of this article has not visited the Quileute Indians for some years, and it is not improbable that the practices herein recorded are now a thing of the past. This does not detract, however, from their interest and significance.—EDITOR.

THIRTY-SIX miles down the Pacific coast southeast of Cape Flattery is the Indian village of Quileute. It is situated on a point of land flanked by a giant forest on one side and the pounding ocean on the other. To the west of it is James Island in the shape of a giant lobster's claw reaching toward the setting sun. Southeast of it the hissing, seething surf beats against the world-foundation stones of the Giant's Graveyard.

In this village from time immemorial have lived the Quileute Indians, a coastal people that engage in whaling. The whale principally pursued is the California gray.

The aspiring whale hunter, especially the harpooner, must first obtain a knowledge of the sea folk-tales of the tribe, which are many and varied. These include the account how Kwatte, the creator god, the transformer and trickster, deliberately paddled his big dugout canoe toward the great whirlpool that was caused by Subbus, the whale, as, lying on the bottom of the sea, he drew the surface water down through his mouth. To the very edge of the great funnel Kwatte paddled the canoe. Its prow went forward and projected over the great hollow space above Subbus' mouth. For a moment it remained suspended there. Then it went down edgewise, right down through Subbus' mouth into his gigantic stomach, with Kwatte lying snugly in its bottom.

Then Kwatte set to work. He used the big canoe as a ladder, climbing to

its top in the huge stomach. With clamshell knives he cut at the inner linings and muscles of Subbus. From side to side he moved the canoe and cut and cut. The infuriated monster plunged and pitched in his death agony but he could not get rid of his enemy. At last Subbus made one powerful lunge, but in vain. Then he rose to the surface and floated there, dead.

The huge lifeless bulk drifted to shore. There the Indians found it and started to cut it up. As they began to remove the blubber, they heard someone talking inside the carcass:

"Be careful! You people will wound me with your knives. Don't hurt me! Ouch! Look out!"

A knife penetrated the body wall into the body cavity. Another thrust of the knife made a large hole in the great stomach. And Kwatte came up through this gash and stepped out on the beach.

We may turn at this point to another myth. It tells how in a wrestling match between the sea animals and those of the land, Bear threw Whale down and scratched him on the breast. These scratches are still to be seen on the fore part of the pectoral surface of the huge monster.

The Thunder Bird is represented as engaged in dreadful battles with whales. Once this bird, after killing the powerful ocean monster, was nearly robbed of its prey by a group of people who came to the scene and cut up the whale. But scarcely had they done so when it

¹Photographs by the author, supplemented by illustrations of objects in the Northwest Indian hall of the American Museum and by a photograph obtained from Mr. George Hunt.



The Thunder Bird bearing in its talons the Whale, which, though removed from its watery medium, is represented as still spouting. From a Nootka drumhead in the American Museum

began to rain, snow, and hail. The Thunder Bird, the flash of whose eyes is the lightning and the flapping of whose wings produces the mighty winds, came flying up in anger. Soon he caused great chunks of ice to fall. The people were scared. Some tried to flee, others concealed themselves under logs and rocks to escape the wrath of this god of the air. But all were stricken and turned to stone as was also the meat of the whale. Whoever visits the scene of their fatal gathering may view their remains, represented by the great blocks that form a ridge from one end of Beaver Prairie to the other. One may even see the ribs of the whale's carcass and its massive head.

When these myths and many others of a similar nature have been learned by the harpooner, he must undergo curious and weird ordeals. He must

bathe his body in the cold salt water of the ocean two or three times each night for several moons, beginning usually in the month of December before the whaling season opens. For the purpose he selects some rock that juts out of the water and around it he swims the hours away. He pretends that the rock is a whale that has come to the surface to get air and that he is attacking it. Then, in turn, he makes believe that he himself is a whale: he tries in every way to imitate a whale's motion, diving, coming to the surface, spouting, and the like. After a time he comes ashore from his whale-killing play and dries himself with a blanket or a bear skin. He then rubs himself with the twigs of a tree that his family has held sacred for generations. In doing so he must take care that the head of this body brush is pointing to the region

where the sun rises. His task completed, he must not throw the brush away heedlessly, as that would bring great misfortune in addition to shortening his life. While he thus rubs himself he prays to Se-kah-til, the mother earth, who especially aids whalers in their quest for the king of the sea. In addition to bathing, he also wanders about graveyards and secluded places at night. Often he gathers a number of human skulls and trails them behind him on a rope made of whale sinew, or practises similar gruesome rites.

While he is thus engaged out of doors, other members of the respective whaling crews are going through various incantations indoors to invoke the aid of the gods in the coming whaling season. They shake whale rattles and crawl and flounder around on the floor in imitation of the movements of a whale, especially those of a whale in

his dying struggles. The bathing and other rites they indulge in so that the whale may not detect them and also to gain the good will of the deities.

Thereupon a whaling canoe and the prerequisites for the whaling trip are secured. The harpoon and attached gear, a few buoys, a sufficient supply of paddles, and food enough for eight men—the complement of a canoe—are essentials in a venture on the deep that has for its object the killing of the largest animal of the seas.

The harpoon head is a piece of whale rib, or a flat piece of copper, iron, or steel, according to the hunter's choice. Attached to it are two barbs made of elk or deer horn, or of steel. These are fitted together very tightly and fastened in place by cords. The entire harpoon, including the barbs, is then covered with spruce gum to protect it and to aid in holding the parts in place.



Courtesy of Mr. George Hunt

The Nootka whale "house" is a more or less open structure, constructed of posts and poles. In it are many wooden figures of men and the skulls of whalers of the past; and here the chief harpooner was accustomed to engage in various rites that are a necessary preliminary to a successful hunt

When this gum is sufficiently hardened, the harpoon is scraped and ground until it is very sharp and will penetrate flesh easily.

To the barbed head of the harpoon is attached a lanyard from thirty to forty feet in length. This lanyard is made of whale sinew or cedar twigs or roots twisted into a rope. To make it still stronger, twine of whale sinew is wound



floats made of sealskin or of a seal's stomach were attached to a line fastened to the harpoon and prevented the wounded animal from seeking escape in the watery depths

very tightly around it throughout its entire length.

The staff is usually composed of two pieces of yew wood, which are spliced together neatly and firmly with bark or sinew. It is from eighteen to twenty feet in length, being thickest in the middle and tapering off toward each end. It is inserted in the harpoon head, and the end of the lanyard is fastened to a buoy.

Each buoy is a sealskin that has been taken off whole with the hair left inside, as in skinning small fur animals for market. The holes left by the removal of the head, flippers, and tail are tied up perfectly tight; and then the skin bag thus formed is inflated.

When the harpoon is driven into the whale, the barbs to which the lanyard is attached, penetrate the animal and

remain firmly fastened. The staff is then removed from the harpoon and put into the canoe. To the floating end of the lanyard is attached a long rope on which buoys have been fastened to keep the whale from sinking. Often as many as forty buoys are thus employed. The more buoys, the more difficult it is for the struggling monster to plunge beneath the surface, and the easier for the whalers to attack it with their spears and lances. The rope to which the buoys are attached is usually made of spruce limbs, which have been split into fibers and then twisted into rope.

The paddle of yew wood has a broad blade that tapers to a point; to the other end is fitted transversely a head-piece that is sufficiently long to enable the paddler to use it freely and comfortably as a hand-hold piece. Furthermore, the whole paddle is usually blackened in the fire and then polished with a vegetable compound. The canoe is a dugout that, with the exception of its prow, which is fashioned to represent the mythical river deer, is made from a single log.

When the whaling season arrives and all the preparations are completed, the weather being favorable, the whaling canoes are dragged to the beach in the gray of the early morning long before the blazing orb of day looks down into the valleys from the heights of the Olympic Mountains. There is wild excitement as the Indians haul the boats to the water's edge. The whale dancers go through their antics, shout and sing around their respective canoes as they carry the weapons of whaling out to them. In this ceremony the actors wear a black blanket, or one on which a whale has been painted. They also grease themselves with whale oil and wash their faces in it. They dance in imitation of a whale that is diving,

swimming, and floundering in his last efforts before dying.

At last the boats, with the hunting equipment and whale rattle, are launched. In another moment each of the crews is off, the man who has convinced his fellows that he has "bathed good" and that he "can catch the whale easy" being the harpooner. When they are out some distance from shore, the spouting of a whale may be seen. The crew in the boat nearest to it paddles swiftly but cautiously to the attack, while all chant in long-drawn-out crescendo to induce the whale to head toward the canoe or toward the



The harpoon with the lanyard attached is shown in the picture on the left. The barbs, made of pieces of antler, are visible at the base of the blade. Into the harpoon was inserted a long shaft similar to that depicted on the right, but this staff was withdrawn as soon as the whale had been struck. Among the Quileute, as Mr. Reagan points out, the shaft usually consists of two sections. The one here shown was obtained, as were the harpoon and lanyard, from the Nootka; these implements are on exhibit in the American Museum





Photograph by Albert B. Reagan

In a whale hunt of the Quileute many canoes may participate, each manned by eight Indians. The elongated neck and head of the mythical river deer is just visible on the prow of one of the canoes

shore. Usually, however, it submerges before they can reach it.

When it disappears, the whalers shake their rattles for a moment as they sing. Those in the foremost boat then cease singing and row their canoe swiftly over the water to the spot where the whale is likely to come to the surface again. Everyone now nerves himself for the attack as one of the hunters signals with uplifted paddle that the decisive moment has arrived. This news is transmitted in like manner to other canoes, and also to the shore. The spectators on James Island build huge bonfires on the southeast corner of the island if the whale is seen southeast of the village; and on the southwest corner if it happens to be seen southwestward of it. This is for the purpose of advising all the whaling canoes of the approximate location of the whale to be attacked.

The whale comes to the surface again, and the native navigator has not miscalculated the probable place of emergence; he seldom does. As soon

as the huge head makes its appearance, the action begins. With measured dip the paddles move the canoe noiselessly up to within a few feet of the huge creature that is unsuspectingly spouting on the surface of a quiet swell. The hunter hurls his harpoon with all his strength, while his men, ready for every danger, bend their energies to prevent the rope from tangling. The deadly weapon is driven deeply into the whale's body, and as quick as an eye-movement the harpooner draws out the harpoon stalk. The barbed points hold fast, and instantly the buoys and rope attached are thrown into the sea. The plunging of the wounded beast begins.

Quickly the whale goes down, drawing with him the lanyard rope of the harpoon to which are attached the seal-skin buoys. These go skimming along over the water like so many tops, while the canoes follow as rapidly as they can. Again and again the whale comes to the surface, and each time he is harpooned with deadly effect. The

fight may continue for hours, or it may be ended in a brief time. The monster may smash a canoe in frenzied fury, and it may also break the rope and escape. As a rule, however, its speed finally slackens, and the hunters, armed with their spears and lances, then finish their work at close quarters.

As soon as it is dead, the crew or crews attach a huge cedar-root rope cable to it and commence towing it ashore. As they thus tow, they sing day and night to keep the evil spirit, Ko-kwo-til, from alighting on it or taking possession of it, for "should it get on it, it would make it lean." They also sing songs to Se-kah-til, the mother earth, to aid them in bringing it ashore.

The whale is landed as high up on the beach as possible. When the tide recedes, all who are entitled to a share swarm around the carcass with long,

thick-bladed butcher knives and begin stripping off the blubber in blocks about two feet square. The saddle is considered sacred and is always the property of the hunter who first drove his harpoon into the whale, provided that the blow proved fatal. The other parts are divided and distributed according to an established rule, so that each individual knows just how much whale blubber or meat he is to receive. The cutting up of the whale is a merry and joyous occasion, for at such times the Indians invariably seem good-tempered. If some one gets more than he can use, the surplus is given to some less-favored friend, but it is assumed that there will be a return gift either of cash or something of equivalent value. The more unfortunate ones get a share of the meat by helping themselves.

After the skin is removed, the blubber is cut into strips and boiled



A group of Quileute Indians

Photograph by Albert B. Reagan

that the oil may be extracted, large iron pots now being used for the purpose. The oil is very carefully skimmed off with clamshells or thin saucers. The blubber is then hung up in the smoke of the fish house to dry. Before being eaten, it is some-



Photograph by Albert B. Reagan

One of the old-time Quileute whalers

times cooked for twenty minutes or more, but it is not unusual to eat it cold with dried halibut.

The extracted oil is used in eating potatoes, camas, dried clams, and boiled or dried fish, which are dipped into it. As receptacles for this oil the Indians use the stomach of the sea lion

or the seal and the whale's bladder and intestines, which have previously been inflated and dried for the purpose. The surplus oil is sold to or traded with other tribes, or is sold to logging camps or to traders for use as logging-skid grease and in general lubrication.

The skin of the whale is also considered very palatable and is usually given to the children. In fact, there is hardly any part of the animal that has not its uses for the coast natives.

The saddle is put on a pole supported at each end by a forked post, on which are hung the harpoons and lines used in the capture of the whale. It is also customary to stick eagle feathers in a row along its crest and in a bunch at each end of the pole. The saddle is then covered or sprinkled over with down. A vessel is placed underneath it to catch the dripping oil. Thereupon a "potlatch" (give-away feast dance) in honor of the whale's saddle is held, with the compliments of the harpooner who killed the whale. At this feast the participants always relate the story of the whale hunt and never fail to congratulate the host on his ability. Some one makes a speech, telling of the ancestral trait of the family or clan of the harpooner, of his past achievements, and the honor that others will bestow upon him. The ceremony is closed by a "vote of thanks," after which the guests carry home with them whatever is left of the saddle.





Kispiox, one of the Kitikshan villages of the Upper Skeena River of British Columbia. An impressive feature of the communities of this region is the line of carved poles in front of the houses

The Kitikshan and Their Totem Poles¹

BY LIEUT. GEORGE T. EMMONS

THE acknowledged cultural center of primitive life on the North Pacific Coast was about Dixon Entrance, where the Tsimshian of British Columbia, the Haida of Queen Charlotte's Islands, and the Tlingit of Alaska come together. Although speaking different tongues, yet through intermarriage, association, intermittent wars, and extravagant peace ceremonies, they formulated and recognized a common code of laws that regulated their intercourse with one another. Nevertheless, while they borrowed freely from one another, both in customs and industries, they ever retained their racial characteristics unimpaired. The Tsimshians, it would seem, are the latest comers to establish themselves in this region, and like the others, they are made up of different waves of migration, that have come presumably from the interior and scattered coastwise. They form three geographic divisions: the Tsimshian proper—dwellers on the seaboard,—

the Nishka of the Nass Valley, and the Kitikshan of the Upper Skeena, above the cañon, and it is of the last-mentioned that I write.

Their name signifies "Children of the Skeena," and they claim to be the parent stock from which the others have come. Their earliest tradition goes back to the subsidence of the flood, when their canoe landed on the north shore of the river, several miles below the mouth of the Bulkley. Because of its level expanse they called it Tumlaham, and around it many legends are woven. In time it became a great village, and the old man who told me the story said that so many were the people, and so loud was the noise of their voices, that geese passing in a flock overhead would become frightened and, folding their wings, would fall to the ground. Later the "Great Cold" came; snow continued to fall and the river was icebound far into the spring, when the salmon should have come to replenish the exhausted lar-

¹Photographs by the author.

ders of the Indians. Driven to desperation and resentment against the ice spirit, the chief soaked a dried salmon to make it appear as a fresh fish, and standing in his doorway, holding the fish aloft, reviled the cold, saying: "You are a weakling, you have no power. See the spring-run fish that I have taken." But this only incensed the spirit and, as the cold increased, starvation looked them in the face. Then one day a bluejay alighting over the smoke hole of a house dropped a fresh elderberry from its bill, a sign that summer had come somewhere. Thereupon the people left the village and scattered in all directions in search of food, which accounts for the other two divisions of the Tsimshian.

The country of the Kitikshan is practically included in the valleys of the Upper Skeena and its few tributaries. It is a land restricted in area and limited in resources. The flora is that of the semi-arid interior plateau, subject to long dry spells and inconvenient frosts even in midsummer. Spruce, cedar, jack pine, alder, and birch, but generally of small growth, represent the tree life. Of animals brown and black bear, mountain goat, and lynx are of common occurrence, but more important economically are the marmot and rabbit because of their abundance and the ease with which they can be taken. Caribou were found in the past but have almost disappeared since the introduction of firearms. Topographically, the land is peculiar in the isolated mountain masses of limited area that rise to great heights above the surrounding country, grim survivors of the leveling forces of earth shock, glacier, and pent-up water that are visible on every hand. The river is the artery of life of the country, and from it the people

draw their sustenance, represented by the salmon that run in from the sea each spring to seek the lakes for spawning purposes. It is also nature's highway, although a wicked water that takes its toll of life each season. It is said that in early days canoe travel was unknown and rafts alone were used for crossing at favorable points.

The country was practically unpenetrated by the white man until the Omineca gold excitement in 1867, when the Hudson's Bay Company established a post at Hazelton, and the people were released from the trade restrictions that had been put upon them by their neighbors of the lower valley, who had never permitted them to approach the coast nor to dispose of their furs to others than themselves. They lived by a narrow margin and, when abnormal conditions occurred, they were forced to sell their children to save them and themselves from starvation.

Each community was an independent band made up of two or more of the four totemic clans, that had come together through migration or intermarriage for mutual protection and social advantages. There was no central governing power either in the tribe or in the band. Each clan, or phratry, was a unit in itself, recognizing only the authority of its local chief but, in case of foreign aggression, all might band together and by common consent elect a leader for the emergency.

Their social organization was matriarchal and comprised the four exogamic clans, or phratries, in which all individuality was merged, the clan being physically, morally, and politically responsible for the acts of every member. Naturally marriage within the clan was impossible, and even a union with one of another tribe having a like

crest was not permitted. Under such a social system the children belonged absolutely to the mother's side, so the succession must follow in the clan. More often the maternal nephew was taken by the uncle at an early age, and trained by him for the succession, upon assuming which he must take the aunt to wife regardless of the disparity of years, for this assured her a home and position which otherwise she would have to forego, as neither the wife nor children could inherit from the husband or father. Such a marriage, however, did not prevent the nephew from taking other wives of his choice.

The four clans derive their names respectively from their principal crests: the frog, wolf, eagle, and fireweed; but they claim, assume, and use many subsidiary emblems that are displayed on their houses, poles, ceremonial dress, and household implements,—in fact on everything they possess. Their houses and personal names are clan possessions, referring in most instances to the crest. This is generally represented by the animal life of the country, but in addition are shown the strange forms of mythical animals that, it is believed, lived in early days and with which their ancestors had some connection, as well as natural phenomena, material objects, and—tracing relationship to the coast through migration and intermarriage—the figures of the killer whale, sea lion, halibut, and other ocean dwellers, which seem very much out of place stranded in this semi-arid country.

The people, while Tsimshian in language, organization, and culture, are necessarily hunters and trailmen due to their inland home, and a certain physical difference from the pure Tsimshian can be noticed in the slighter build and sharper features of

certain family groups, the result of constant marriage with their Babine neighbors. In manner they are dignified and quiet; they are absolutely honest, hospitable and friendly when known, although suspicious and taciturn with strangers. Pride, vanity, and oversensitiveness are their principal faults, and while cool-headed under natural conditions of danger, yet, when angry, they are as unthinking as children. I do not believe that they differ from ourselves in natural intelligence, only they have not had the opportunities to develop; but under more favorable conditions that have come to them in the opening up of this country by the railroad, they are becoming a useful and desirable population.

They live in permanent villages situated on the Upper Skeena and its tributaries. The houses, ranged in a single line, follow the trend of the shore with their gable ends facing the water. They are large, rectangular, barn-like structures, rather deeper than wide, built of spruce timbers, the smoke hole in the roof giving light and ventilation, and directly below it is the central fireplace. Communal in character, these structures housed many families, each of which occupied a fixed place around the walls, while the rear portion was occupied by the house chief.

The feature of these villages is the line of wonderfully carved tree trunks extending the length in front of the houses and separated from them by a broad roadway. While the totem pole is generally explained as a heraldic column, yet it stood for much more. Its erection was primarily a religious observance honoring the dead, for the only religion that entered into the life of this people was ancestor worship, with the death ceremonies and the feasts that followed for the honor and



The erection of a totem pole is primarily a religious observance in honor of the dead. Among the Tsimshian the curious custom prevails of placing on the pole a clothed wooden figure representing the deceased. The head and features are carved with rare fidelity, as the above example from the inland village of Kitwankool gives evidence. Rain and wind have torn to shreds the garments that once covered the jointed limbs of this effigy, which is seated on a chest containing the ashes of the man represented. The ceremonial neck ring of cedar bark, though damaged by the elements, still encircles the figure

spiritual comfort of the departed. These Indians had a firm belief in a future, and the food and articles cast into the fire upon such occasions were received in spiritual kind in a way that

it is difficult for us to understand. The pole was erected by the successor of the deceased with the assistance of the household, and it honored not only the dead but also the living, and the

descendants for all time. The family crest was shown at the top and sometimes also at the base and throughout the length of the pole, but generally the intermediate figures illustrated a legend, a hero tale of early life, or some important family happening.

The totem poles of the Kitikshan never form the entrance to the house as do some of those found on the coast, nor are they mortuary columns containing the cremated remains of the dead in recesses at the back. The Tsimshian place a portrait figure of the dead on the pole or over the grave, and among this people is found the only remaining evidence of this custom. The figure is a comparatively rude manikin jointed at the shoulders, elbows, hips, and knees, and fully clothed, so that little shows; in contrast to the other parts of the body, the head and features are carefully carved with great skill to represent as nearly as possible those of the dead.

The most striking example of this custom occurs at the old, more inland village of Kitwankool, now practically deserted, where on an old totem pole, some ten feet above the ground, is placed the figure of a young man seated on a chest containing his cremated remains. The face is very lifelike. The figure has been clothed but the elements have left only shreds of the body covering, the headdress, and the ceremonial neck ring of cedar bark. Again, at the village of Kitzegukla, below Hazelton, there is a most realistic figure of a man, seated in a chair over his remains, within a small grave house fitted with windows. In one hand he holds an old flintlock musket, such as used to be sold by the Hudson's Bay Company, and in the other, outstretched, are the bullets with which he was killed. The face,

of carved cedar, weathered to a pale brown, approximating the complexion of this people, is so lifelike, and the pose of the clothed, seated figure, so natural, that the first glance through the window gives one quite a shock.

The totem poles of the Kitikshan differ in several respects from those of the coast tribes. They are slighter—possibly from the smaller tree growth of the country—and below Hazelton, where the finest examples are found, they are more elaborately and completely carved throughout their length. From there, north, they are cruder and plainer. The finest and most intricate examples of carving are found at Kitwankool and Kitzegukla. The elements have obliterated most of the colors with which they were originally painted, but, moss-covered and weatherworn, they have lost nothing in dignity as they stand out against a background of dark-green spruces or distant snow-clad mountains.

Every pole tells a story, even if only the clan crest figure is shown, for the acquisition of this is the beginning of history when the clan took its place as a social and political body. House or family crests illustrate important happenings, generally individual in character, and often connected with the animal world, recalling a time when animals by removing their coats could assume human forms and intermarriage with them was not uncommon. The Bear, Wolf, Beaver, Frog, Owl, and Thunderbird are most in evidence on the poles in all of the Kitikshan villages, and while somewhat conventionalized to accommodate their shape to the restrictions imposed by the cylindrical tree trunk, they are very true to form although the characteristic features may be unduly accentuated.

The most artistic piece of work,



KITWANKOOL, FROM CENTER OF VILLAGE LOOKING NORTH

Kitwankool ("People among the Narrows," from its location at the entrance of a narrow valley between steep hills) is the most primitive of Kitikshan villages, owing to its isolated inland position between the Skeena and the Nass rivers and the unfriendly attitude of the inhabitants toward strangers. The villagers have uniformly resented the attempts of whites to settle in their midst and have refused to accept any reservation at the hands of the government. Today, with changed economic conditions, the scarcity of game and of fish and the necessity to seek work in other fields, the village is practically deserted except during the winter, when the people return en masse to celebrate the death feast and the potlatch. At such times the old house walls resound with the beat of the drum and the weird chants that tell of the glory of the past and the hero deeds of ancestors whose exploits are recorded on the totem poles



KITWANKOOL FROM NORTH END OF VILLAGE, LOOKING SOUTH AND EAST

Kitwankool, which lies to the west of Kitwanger and other river settlements of the Kitikshan, consists of a long row of typical old communal houses, gray, somber, and weathered. In front of these, standing at all angles, is a most wonderful forest of elaborately carved, slender totem poles, some of which show traces of color while others are moss-covered. These poles stand out against a background of deep green spruces and distant snow-capped mountains, making a picture that few have seen and none, having seen, could forget.

Among the poles of this village is that on which is represented the figure of a man seated on a chest containing his ashes. This curious effigy, of which a nearer view is presented on page 36, is seen in its larger setting, in the above photograph. The height of the pole may be visualized by the fact that the effigy itself is some ten feet above the ground.



THE MEDICINE MAN

While missions and schools have wrought great changes in the life and habits of the Kitikshan, yet the superstitions of the past still hold in thrall some of the older people, and the practice of the shaman has not entirely disappeared. The care of wounds and simple complaints was understood, and such minor afflictions were treated by older women with simple remedies, but severe and continued sickness was attributed to evil spirits that entered the body and stole the spirit—the essence of life—without which the body must die, or to the action of those who possessed witch power.

The shaman was relied upon to capture and restore the escaped spirit, or to detect the witch. Individuals of either sex might be shamans. The dress of a shaman consisted of a waist robe or apron, a small square of black-bear skin on the back, a crown of brown-bear claws or rope of woven red-cedar bark, a neck charm of bone, and finally a globular rattle of wood



KUN-LAK-GEHLT AND HER DAUGHTER

The ceremonial dress of the Kitikshan was much the same for both sexes, and was that of the other Tsimshian and coast people. It is traditionally believed that the blanket woven of the wool of the mountain goat originated with the Tsimshian, but as far back as 1880 no evidence of its manufacture could be found among this people. The waist robe, originally of deerskin, was later made of a blanket and ornamented with puffin bills and the dew-hoofs of deer. The headdress, *Amhaloid*, with the small wooden mask in front generally representing the family crest, was the insignia of the chief and was highly valued. The older woman in ceremonial attire is a chief, the younger woman similarly clad is her daughter.

The primitive garb of the woman of the Northwest Coast north of Vancouver Island was a blanket robe of sea otter, marmot, or other smaller fur-bearing animals, or of dressed caribou or deerskin. With the advent of traders, wool blankets took the place of furs, and then followed cotton dresses



At Kitzegukla, on a totem pole that in other respects is not remarkable for its carvings, appears this exquisite figure of a grouse and her young,—one of the best examples of Kitikshan art. Note the dog, with a pack fastened on his back

faithful to nature in every detail, is that representing a grouse and her young as if suddenly startled, on an otherwise crude pole at Kitzegukla. The most natural figures are those completely carved on top of the poles, for all of the others are more or less in relief as they are merged at the back of the pole,—a rounded tree trunk or one hollowed out to decrease the weight in handling. A very interesting pole at Old Kitzegukla, with four figures, one above the other, tells four stories that are totemic or otherwise connected with the early history of the Kish-hasht clan, when all of the Kitikshan lived together at Tumlaham.

Of the Great Horned Owl (*Gweek-gwu-nook*), which is represented at the base, there are many legends, relating principally to the theft of children. One of these tells how in the winter season, when the great barnlike communal houses were untenable, and the people had moved into low, log, moss-chinked shelters, a little boy kept the household awake with his crying until the father said that the Great Owl would get him if he did not stop, and after a little the door was heard to open and close, when quiet reigned. In the morning the child was missing but the crying voice was heard as if in the distance. The father took his bow and arrows and went in search and, as he followed the trail, a Grouse flew up. He was about to shoot it when it said, "Do not shoot and I will tell you of your lost boy, but first paint red about my eyes." This he did (which accounts for the color which ever since has marked the Grouse) and the bird said: "How nice I look! Now go right ahead to the Owl's nest in the big spruce and you will find your boy." The father did as he was told, but the Owl had fed the little boy on snakes

and frogs that in turn had eaten through his stomach so that he shortly died. In the fall of the year the Owl, appearing as an old woman, came to the crossing of the river and was recognized through singing of the lost child. The father told the children, who were playing on the bridge, to remove some boards and lay dead sticks in their place. Then they called to the Owl to cross and, in attempting to do so, she fell into the river and was drowned.

The figure immediately above the Owl represents Pighish (the Property Woman), a mythical being, part human and in a way associated with the Land Otter. She carries a crying child on her back. Only one without fault is able to see her, and when the crying is heard, he must follow as the sun goes around four times, and coming to her, must seize the child. Thereupon the mother will plead for its return, agreeing to grant any wish, or with her copper-armed nails she will scratch his face; the preservation of the healed flesh brings great wealth to the possessor. This legend is known up and down the coast and in early days a member of the family obtained great riches from a meeting with this being.

Next in order is a small figure holding a bucket within a circle representing the sun. This tells the story of Kuke-shan, a child of the sun, a great moose hunter, who was ever thirsty. He traveled always at great speed for long distances, hunting moose, but he took only the paunch and the blood that was boiled down to a thick broth, and when he returned, his wife had many baskets full of water that he emptied immediately. Once she neglected to fill the baskets and, as he returned, she heard him shouting for water. In her confusion she answered "No water?" and, grabbing the baskets,



A totem pole at Old Kitsegukla, the carvings of which tell in ascending order the stories of the Great Horned Owl, of the Property Woman, of Kuke-shan, who, a child of the sun, is shown within the great disk, and of the Mountain Goat

ran to the spring. But without water he could not live on earth and was at

once carried up to the sun, where he stands with his bucket of blood, which he spills on those who look at him, causing fatal sickness.

The last figure is that of the Mountain Goat and illustrates one of the oldest of the family legends. Across the river from Tumlaham is an isolated precipitous mountain known as Steep Sides, where in the fall after the salmon season the Indians hunted the Mountain Goat. The flesh was eaten, the heavy pelt served for bedding, the fine wool was spun into a thread and woven into blankets, the horns were fashioned into spoons, and the heavy leaf fat melted and run into cakes for winter food. One fall a young hunter after killing many goats caught a kid and, taking the red paint with which he used to color his arrow for good luck, painted the horns and face of the kid to honor it. Thereupon he set it free. The following spring two strangers, dressed in white blankets, appeared in the village and, as was the custom, were entertained by the chief. At the feast, when dried salmon, goat's meat, and dried berries were placed before them, they made no attempt to eat, but after they had left, some children playing beyond the village saw them on their hands and knees eating grass like animals.

Their purpose in coming was to invite the people to visit them but without giving the location of the village to which they offered to guide them. The following morning the villagers assembled and, led by their visitors, crossed the river. Ascending the mountain, they reached what appeared to them to be a broad expanse, with large feast houses and many people all in white robes. But this was all a delusion. They were under the spell of the mountain. The

broad expanse was a narrow rock shelf; over the precipitous sides were platforms of broad planks and the white-clad villagers were Mountain Goats. After the feast the hosts began a weird dance and sang: "I am shaking my hoofs over the mountain-side," and the people saw the rocks open and close, and were puzzled.

When night came, they were given sleeping places on the outer portion of the platforms while their hosts took the inner side, all except the hunter who the previous year had caught and painted the kid. To him came a young man whose face was painted in red, and asked him to share his sleeping place with him, which was next to the wall. During the night the Goat hosts pushed all of their sleeping guests off into space and they were killed. When the young hunter arose, his friend took off his own boots, which appeared as hoofs, and told the hunter to put them on, for then he would be able to descend the steep shelves by jumping from one to another without fear. When the Indian youth reached the plain below, he found the crushed remains of all of his friends, and in this way the Goat people had avenged the death of their people by the hunters.

The legend of a chief's daughter who was carried away by the Frog lover is common to the whole Northwest Coast and is told here as elsewhere. Le-gam-ksh, the daughter of the chief of the Kan-ha-da, at Kitwankool, was strictly guarded, as was the custom among the aristocracy, but it became known that a strange young man had been seen with her for several nights. No trace of him could be found in the morning, only a little frog was noticed in the house. Later the daughter was missing, and the only trace discoverable was her footprints, leading to a near-by

spring. Some years later two little Frogs appeared at the door of the house, croaking very loudly. The chief wanted to know what was their trouble, but no one could tell until an old woman who understood the Frog language was found. She said that their mother had sent them to borrow an awl for use in sewing moccasins. This was given them, also some sinew thread, and as they left, they were followed to the very spring to which the lost daughter's trail led so many years before. So the chief knew that she was still alive and sojourning with the Frog people and he proposed to drain the spring to recover her. A ditch was dug but it was found, as the course of the water was followed, that it led to a lake far beyond. The Indians kept on and, when they reached the lake and the water commenced to fall, the Frog people begged the woman to loosen her hair and float down the stream, and they all clung to her and her flowing hair, singing the family death chant. The totem pole representing the figure of a woman with Frogs on it and three Frogs below illustrates and perpetuates this happening in the early life of the family.

At the northern end of the village of Kispiox is a tall pole of the Lagh-Ke-boo clan, representing at the top the Bald Eagle of the coast holding a human figure by the head, and below four other figures each grasping the legs of the one above. Coming out of the base of the pole is the forebody of the Bear, the emblem of the clan. This is purely a story pole illustrating the adventures of Gwa-skeek, which is likewise the name of the pole. Gwa-skeek was a gambler and in play lost everything to an opponent. Then he went into the woods and during his wandering came to a salmon stream



This totem pole serves to recall a myth common to the entire Northwest Coast, namely, that of the elopement of a chief's daughter with her Frog lover



Gwa-skeek, enveloped by the skin of the Bald Eagle, is shown at the top of the pole with wings spread in flight, bearing seaward the five victims of his revenge. Near the base of the pole protrudes the body of the Bear, an emblem of the Lagh-ke-boo clan

and, when he took the fish, their scales turned into the valuable coppers. Throughout the three years he lived there, he ate the bark of the devil's-club to bring him luck, and then, doing up the coppers in bundles, he returned to his village and challenged his former opponent to play again, finally winning

all his belongings. But before he could leave, the whole family of his opponent turned against him, made him fast to a plank with spruce gum, and pushed it out in the water. He drifted about for some time but finally grounded in front of a strange village.

The chief had him brought ashore and tried to release him from the plank but to no avail until seal oil was used. Then, free, he became the chief's guest. Early every morning one of the household would rise, put on the skin of an Eagle that was hanging on the wall, and flying up through the smoke would go out to sea and catch a seal, which was shared by all of the villagers. Then the chief said to his guest: "It is your turn to provide a seal, but when you fasten to it, do not try to rise, but let it take you down under the water at first." Gwa-skeek was successful.

After Gwa-skeek had practiced sufficiently, the chief told him to get into the Eagle skin and to go to the village of those who would have killed him, but to act cautiously and to seek the chief, the uncle of the one with whom he had gambled, and, when he had seized him by the head, to rise very slowly. This Gwa-skeek did and, as the chief was lifted from the ground, one of the nephews caught hold of his feet and then in turn each of the other three nephews caught hold of the one above until the Eagle man rose with all five and, flying out to sea, dropped all into the water, drowning them.

About the middle of the village of Kispiox is a house of the Lagh-ke-boo clan, with a round hole over the doorway, and directly in front is a carved pole showing a human figure at the base, above it a round hole with four small figures, then a standing figure of a man, above which is a Wolf, and finally another Wolf, the clan emblem,

surmounts the pole. The crude human figures are named Weden-ba-bah (legs apart). The designation of the pole is Wil-na kak (through the hole). This pole illustrates the story of a man, Ye-a, who with his family was camping by a lake in the valley above the village. The Beaver people captured and drew him into the lake, where he was found by his three sons and his daughter. When he saw his children, he commenced to cry. They pushed some small trees out to him, but instead of taking hold of them, he would turn and dive and, as he went down, his flat beaver tail would strike the water with a great splash, and he would come up farther out. He told them that he could never come home again but would always live with the Beaver people. So the family took the Beaver for emblem and entered their house, just as the Beaver does, through a round hole. When a potlatch was given by this household some years ago, the guests entered the house through the round hole above the door as if going into a beaver's hutch. The round hole on the pole represents the entrance to the Beaver's house and the four small figures the four children of the lost father.

With the totem poles on the farther side of the roadway in front of the houses crest figures are placed on platforms. At Kispiox, before the house of the Kish-hash chief, is a distinctive house-crest pole representing a mythical Snake of great size that was taken by a member of the family in early days after it had killed many of the people; and on either side of it are two well carved and painted figures representing a Killer Whale and the mythical Bear under Water. A large painted figure of this Bear resting on a raised platform, appears in front of another house located about the middle of Kispiox.



This pole tells the story of a man who was captured by the Beaver people and made one of them. His descendants adopted the Beaver as their emblem and some years ago, when the family gave a potlatch, the guests crawled into the dwelling through the round hole above the doorway as though they were entering a beaver hutch.

The head and forepaws are those of the Bear; the high dorsal fin is that of the Whale.

In the village of Kitwangach on a raised platform is a very remarkable animal figure known as How-how, a



In the upper picture, taken at the village of Kispiox, are shown two crest figures carved in wood, flanking a pole representing a mythical Snake. The figure on the left represents the Killer Whale, that on the right the mythical Grizzly Bear under Water, a marine monster. In front of another house in Kispiox is the figure shown in the lower photograph. Its head and forepaws are those of the Grizzly Bear under Water but the upthrust dorsal fin, perforated with a circular hole, is that of the Killer Whale

creature that after terrorizing a portion of the river was finally killed by a member of a family of this village and hence became a family crest. It

resembles no animal known to this section but, judging by the tail, might be a mountain lion that had wandered over the mountains to the coast.

The Night Chant

AS REPRESENTED IN THE NEW NAVAJO GROUP AT
THE AMERICAN MUSEUM

By P. E. GODDARD

Curator of Ethnology, American Museum

THE third of the series of "habitat groups" in the Southwest Indian hall was opened with a reception on Wednesday afternoon, the nineteenth of November. This group represents certain phases of the life of the Navajo, the largest tribe of full-blood Indians in the United States, numbering 30,000 individuals.

There have been Catholic churches and missionaries in the Southwest since 1610 and Protestant missionaries for the past fifty years at least, but until recently the Navajo remained unaffected. Even now the great majority is untouched by direct Christianity. For them the forces of nature are powerful and endowed with personality. The sun, lightning, mirage, rain-clouds, rainbows, and winds are the subject of song and are addressed in prayer. In addition there are personal divinities with definite names and attributes. These gods and goddesses in former days visited the Navajo whenever they could be of assistance to them and came also to join in their festivities. Times have changed, and now Navajo men wear masks to represent these gods, but they represent them as a viceroy would a king. For the time being the masked man has some of the powers and personality of the god himself.

Religious activities among the Navajo are mostly systematized into definite ceremonies lasting nine days. Each of these has a long myth telling how the songs, prayers, and rites of the ceremony were learned from the

supernatural ones after many and long journeys made to their abodes by a traveler ages ago. This information is passed down from the master or priest to disciples, who learn by receiving oral instruction and by assisting in the ceremonies. Such a ceremony is held for a sick or ailing individual, who pays the priest and his assistants and feeds all those who help in the rites or attend as spectators.

Viewed from another angle, however, the ceremonies appear as art as well as religion. The mythical narratives have high literary value, characterized as they are by vivid descriptions and much human interest. The songs and prayers use repetition to produce symmetry and balance, and they abound in figures of speech and imagery. The masked gods are actors who present the dramas of the golden age when gods and men mingled freely. In the medicine lodge many elaborate paintings are laid on the floor, by sprinkling powdered materials of the required colors. These pictures also portray supernatural events of mythical times generally connected with the origin of the ceremony. On the final night there is not only a drama in which the gods appear, but there is much rivalry in group dancing, clowns divert the audience, and magic is practised to entertain and impress the spectators.

To illustrate ceremonial life in the newly installed Museum group, the Night Chant was chosen. This is a favorite observance among the Navajo

THE MEDICINE
LODGE

Ceremonial paintings like that laid on the floor of the lodge must be completed in one day and removed by sundown. One of the Indians is shown putting the finishing touch on the medicine bag carried by a Hunchback God. Just beyond the opposite arm of the cross is seen another Hunchback God. The House God is represented in the extreme foreground, and the corresponding figure seen faintly between the far arm of the cross and the blanket-covered doorway is the Talking God. Other gods and goddesses are seated on the cross itself. The bowl in the center represents a bottomless lake



THE SCENE OUTSIDE
OF THE LODGE

The patient for whose healing the painting in the lodge has been made, is seen to the left enveloped in a blanket. Behind him is the god Fringe Mouth shaking his rattle to drive out the disease. The naked youth in the background is a novice undergoing an initiation rite. At the moment, he is being whipped by a goddess, after which the Talking God, standing close by, will sprinkle him with corn meal. Characteristic features of the pastoral life of these Indians are seen to the right of the group, while the costumes and silver ornaments of the figures in the foreground illustrate present-day dress



and the necessary information was available in a Memoir of the Museum written by Dr. Washington Matthews, who learned much of the ceremony and was recognized by the Navajo as a priest of the rite. A panel divides the group into two sections: a medicine lodge with its interior exposed is on the left, and a scene outside of the lodge is depicted on the right. Two ceremonial events are shown in this open-air scene. Just outside of the medicine lodge stands the patient and behind him one of the gods, Fringe Mouth. This diety, dressed and painted according to the ritual, is driving away the disease with the aid of a rattle. In the background a youth is being initiated. Until this time he is not supposed to know that those appearing as gods are not the real supernatural beings. He is whipped by a goddess and then is sprinkled with corn meal by the Talking God, the dean of the divinities, who is standing close by. After this, one of the gods un.masks that the novice may see that he is only a Navajo acquaintance.

It is in the medicine lodge that the more important events take place. Here the dry paintings are made on several different days. Each painting must be completed in one day and removed by sundown. The painting shown in this group represents two logs in the form of a cross whirling sunwise on a bottomless lake. This lake is supposed to be near the place where the San Juan River joins the Colorado. The lake itself is represented by a bowl of water in the center. From this four corn stalks grow out in the angles formed by the logs. These corn plants are painted in the four colors which the Navajo associate with the world quarters: white with the east, blue with the south, yellow

with the west, and black with the north.

Sitting on the ends of each arm of the cross are pairs of gods and beyond the ends are other divinities, one for each point of the compass. At the east, near the blanketed exit of the lodge, is the Talking God carrying a squirrel skin as his medicine bag. Opposite, at the west, is the House God, the constant companion of the former. At the other ends, north and south, are Hunchback Gods, associated particularly with mountain sheep. Almost completely surrounding the picture is a Rainbow Goddess, on whose hand has been set a vessel containing a medicine.

There is a series of songs relating to this sand picture which must be sung over it. While the occasion for holding the ceremony is always the indisposition of an individual, blessings are sought for the entire community. The most important of these blessings are plentiful crops and sufficient pasturage, which are dependent on frequent rains. Hence rain is the thing asked for in the songs. Health and general prosperity are also sought by the vocal songs and prayers, the dry paintings, enacted dramas, and pantomime.

When the picture is completed, the patient is seated on the painting and parts of it are applied to him for his healing. Other individuals may help themselves to what remains and the residue is carried out and properly disposed of.

While the ceremonies of the Night Chant are of principal interest in the group, other phases of Navajo life are included. Their pastoral pursuits are suggested by the sheep that are being driven from the dance ground by a young woman and her dog. The

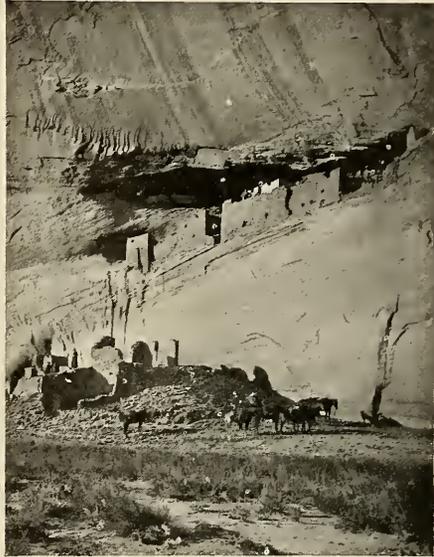
Navajo women own the sheep and, with the help of the children of both sexes, herd them. Goats usually run with the sheep, partly as a protection against coyotes, which they fight off, and as a source of meat that does not reduce the supply of wool. The horsemanship of the Navajo and the type of their horses is shown at the extreme left beyond the range of the illustration. The costumes of the figures, particularly those in the foreground, with their colored velveteen upper garments and their silver ornaments, illustrate present-day dress, while the Navajo blanket appears both in the indoor and outdoor scenes.

The setting chosen is Cañon de Chelly in the heart of the Navajo country. The walls of this cañon reach a height of eight hundred feet in places and are of red sandstone beautifully shaded and here and there deeply stained. White House, a noted cliff ruin, is included in the painted background but beyond the angle of the lens. It was in this cliff house that many of the rites of the Night Chant were imparted by the gods to the Navajo who, it is believed, introduced the ceremony.

Howard McCormick painted the landscape, arranged the setting, and had oversight of the lighting and the many details of the construction. Mahonri M. Young, from notes and studies made in the Navajo country, modeled the human figures, colored them, and arranged their spacing and grouping.

In addition to the expert work of the department of preparation, in carrying out the larger features as well as in making and placing the vegetation and

accessories, the execution of such a group requires the aid of many skilled workers belonging to the Museum's forces: carpenters, plasterers, painters, metal workers, and electricians. All the work must be done in full coöperation with the artists, who also must collaborate in order to produce a



THE WHITE HOUSE OF CAÑON
DE CHELLY

Of white dawn the house is made and of
yellow twilight,
Of dark cloud the house is made and of male
rain,
Of dark mist the house is made and of female
rain,
Of grasshoppers and fertile pollen;
Where dark mist watches the door
And rainbow's trail is the road,
Where high stands the jagged lightning,
Where high stands the male rain.

picture all of the elements of which, whether faithful rendering or artful illusion, give the spectator the feeling of witnessing Navajo life in the Navajo country.

A Bird Trickster Outwitted

HOW THE YELLOW WARBLER CIRCUMVENTS THE COWBIRD

BY CHARLES MACNAMARA

ONE of the most widely known facts of natural history is that the European cuckoo never builds a nest of its own, but deposits its eggs in the nests of other birds, there to be hatched, the young cuckoo throwing out the legitimate nestlings to perish on the ground so that it may enjoy the whole of the food supplied by the infatuated and unsuspecting foster parents. This parasitic habit is not confined to one species; it is practised by most, if not all, of the cuckoo family of the Old World. But, with the exception of a little-known South American species, it does not extend to the cuckoos of the New World, and the two species that reside in eastern North America in summer build nests for themselves—albeit very poor ones—and virtuously rear their own young. Nevertheless, our bird population is not without its cheats. In this country the cowbirds, cousins of the American blackbirds and the starlings, and totally unrelated to the cuckoos, have hit on the same disreputable plan as the Old World cuckoos for avoiding the cares and anxieties of parenthood.

Cowbirds are found in both North and South America, and their habits appear to be much the same on both continents. The best-known species is *Molothrus ater*, common in summer time in the pastures of the Eastern States and Canada. It usually feeds on the ground in small flocks among the horses and cattle, whence it derives its popular name. It is a stoutly-built thick-beaked bird about four-fifths the size of a robin. The male is glossy black

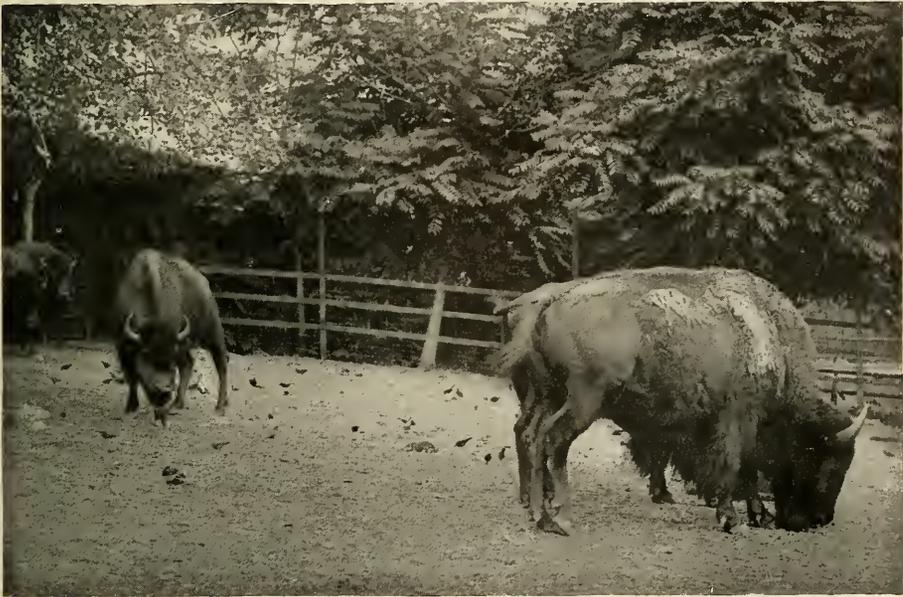
with coffee-brown head, neck, and breast, while the female is ashen brown, darker on the back and lighter beneath. Our cowbird doubtless accompanies the cattle for the sake of the insects that the tramping of the animals disturbs from the sod, and for the flies and other pests that always frequent a herd. In *The Voyage of the Beagle* Darwin describes the same habit as evidenced in another species, *Molothrus niger*, on the plains of Uruguay. North American Cowbirds followed the buffalo herds on the great plains, and before the white man cleared the forests and introduced cattle, they were probably scarce in the eastern woodlands, although a few of them may have frequented swampy places, where they are sometimes still to be found associating with red-winged blackbirds.

From the fact that several females are often seen flying around with one male, it is supposed that cowbirds are polygamous. As they build no nests, but deposit their eggs in the nests of others, there is no particular need for them to pair. It is curious to see a female cowbird looking for a nest in which to lay. One day last summer I was sitting on the veranda of my home in this little Ontario town,¹ when I caught a glimpse of an unfamiliar bird in the maple tree before the door. I was pretty well acquainted with all the birds living along our street: robins, wrens, vireos, warblers, sparrows, phœbes, and others, but this was none of them. A second better view showed

¹Arnprior, regarding the bird life of which Mr. Macnamara contributed an article to the issue of NATURAL HISTORY for May-June, 1923.

it to be a gray-brown female cowbird that was a long way from her usual beat. Her actions were amusing. As she hopped from branch to branch, craning her neck and turning her head, no screen actress could have better "registered" an anxious search. Most manifestly she was looking eagerly for

nest, the cowbird follows a different practice. It monopolizes all the food, and causes the death of the other nestlings by starvation, and long after it has left the nest and could easily fend for itself, it continues to follow its poor dupes around and importune them for food. A small neat chipping



Photograph by G. Clyde Fisher

Before the white man's cattle took over the grazing lands of the bison, the cowbird (*Molothrus ater*) was the *buffalo* bird, being found often in company with this animal. The above picture, taken at Bronx Park, indicates that the ancient association is easily reestablished

something, the something being, of course, a bird's nest. I lost sight of her in the next tree, and although there were many birds nesting in the vicinity, apparently she found no suitable place anywhere near to deposit her white egg with the brown speckles, for I did not subsequently see a young cowbird in our neighborhood. And a young cowbird is always conspicuous: the difference in size and appearance between it and its foster parents is usually very striking. While the cuckoo actually throws the rightful young out of the

sparrow devotedly feeding a large gawky young cowbird is a pathetic sight. Apparently cowbirds never lay more than one egg in the same nest. Instinct tells them that one of their young is all that any pair of birds can attend to at a time.

Cowbirds impose on many different birds, mostly those smaller than themselves, but it is said that even species as large as towhees and kingbirds do not escape the infliction. Vireos and chipping sparrows are perhaps the most frequent victims. But although most



Photograph by Arthur A. Allen

A yellow warbler (*Dendroica aestiva*) on its nest

species accept the changeling egg without hesitation, there is one bird that often detects the fraud and has devised an ingenious way of circumventing the impostor. This is the yellow warbler, *Dendroica aestiva*. With his greenish-yellow mate, this dapper little bright-yellow bird usually builds in a shrub a few feet from the ground. The nest is well constructed of fine roots, withered grass, horse and cow hair, and shreds of fibrous bark, with an inevitable trimming of down from poplar or willow catkins. The normal nest is about three inches high, but once in a while you come across one

that is noticeably taller, measuring perhaps four or five inches in height. Investigation will show that the cup of this nest is no deeper than usual, and that the additional height is made up of an extra thickness in the bottom. If you probe into this heavy base, you are almost sure to find a cowbird's egg embedded in it. The warblers, returning some fine day and discovering a strange repulsive egg in their little home, disposed of it by the elaborate method of building another story to their nest, and burying the unwanted egg in the basement, sometimes even immuring part of their own clutch at

the same time. If after a first egg is thus disposed of, another one is laid in the nest, the operation may be repeated. The second egg is covered over as was the first, and the walls of the nest are again raised.

that not one egg but two were buried in its base. The white shells are discolored and the brown speckles on them have turned black, but the eggs are unmistakably those of a cowbird.

Why the warblers do not simply



Photograph by Charles Macnamara

A yellow warbler's nest found in a garden at Arnprior, Ontario.—It was built of typical materials, but was nearly twice as high as the ordinary nest of this bird. Photograph about one-half natural size.



Photograph by Charles Macnamara

A vertical section of the yellow warbler's nest shown intact in the photograph on the left. The extra height is in the base of the nest, in which two eggs of the cowbird are embedded

Such a nest is shown in the accompanying photographs. It was found during the winter in a barberry bush by Liguori Gormley of Arnprior, Ontario, a keen bird student, who, noticing the unusual height of the nest—about five inches—suspected that it enclosed a cowbird's egg. On parting the fibers in the bottom, he discovered the upper egg, and kindly brought the nest to me. After photographing it intact as it was collected, I sectioned it with a razor, and was surprised to find

throw the intruding egg overboard it is hard to say. It cannot be that they are too small. The house wren is smaller than the yellow warbler, yet it readily empties a nest of eggs, and even of young birds. The warbler's method is curiously indirect and seems to us to involve much needless work. But then they have no efficiency experts to teach them how to avoid unnecessary motions, and the course they take, however devious, must be the line of least resistance for them.

Dogs of the Labrador Indians¹

By FRANK G. SPECK

Professor of Anthropology, University of Pennsylvania

MUCH attention has been directed to the use of dogs for transportation in the Arctic and Antarctic regions. The Eskimos have long been regarded as the originators of dog transportation in North America; but the question of the

Montagnais and Naskapi, comprising a total of about 3000 individuals, whose hunting grounds range between James Bay and the Gulf of St. Lawrence. For a number of years I have been engaged in research work among these tribes, undertaken on behalf of various museums.



A typical hunting dog of the Montagnais

origin of similar practices among the Indians of the Far North has not been previously approached. This statement applies particularly to the tribes of the Labrador peninsula, who use dogs extensively for the transportation of their valuable cargoes of fur and provisions in their winter wanderings. A recent study of the institution of dog-driving among these tribes has led to the conclusions herein presented. The tribes dealt with are those speaking Algonkian languages and known respectively as the Mon-

There rests in my mind little doubt now, after a survey of its distribution, that not only the practice of using dogs for transport in winter, but to a large extent even the dog stock itself, have been derived by the Montagnais of the southern part of the peninsula, through contact with the French Canadians. If this conclusion is correct, it warrants the assumption, to which the situation existing in other Algonkian groups lends color, that the earlier ancestors of the present tribes did not have suitable animals for hauling before the time of their contact with the dog-driving Eskimos in the Hudson Bay and the Labrador region, and later with the Canadians in the St. Lawrence area. We may, however, leave this assumption to become more evident as the variations and innovations of dog utilization are indicated farther on in the article.

The Montagnais have several types of dog. First to be mentioned is a small, decidedly vulpine race: the prominent, pointed, up-standing ears, the pointed nose, the silky hair, and whitish belly are characteristic. In color, dogs of this race are brown, reddish, or white and gray. They have a light delicate step, a trim graceful figure, and an amiable disposition. *Mahì-*

¹Photographs, with the exception of those noted, by the author.



Montagnais hunters and members of their families at Lake St. John, with a sled dog and two hunting dogs.—When puppies are born, a method of ascertaining whether they will become good forward trailers is to lift them up by one ear. If the puppy thus tested cries, it is a bad sign. If he is quiet, the Indians feel confident that he will become a good hunter.

The names borne by these hunting dogs are often interesting. They furnish a registry illustrative of an unquestionably early stage of native culture: *Negwutsàc*, "Squirrel," applied to a handsome little beast of hardly fifteen pounds, with delicate legs and a light chestnut-brown hue; *Shoje*, which seems to have no meaning; *Ntòhum*, "My Hunter"; *Kavàbchit*, "Whitey"; *Tanè*, "Where?"; and the like

kan atùm, "wolf-dog," is the term by which they are known among the Indians of the Lake St. John and the Gulf of St. Lawrence region. These, considered the real Indian dogs, undoubtedly represent the original strain. They serve only as trailers, for their scent being keen and their actions quick, they make excellent, intelligent hunters. The hunting dog constitutes a decided type, one that appeals to human interest because of its historical background as well as through its individuality. About thirty years ago there were no dogs other than these among the Lake St. John Indians; and they did not "train." The toboggans were drawn by the

men, dogs running alongside or behind, constantly on the alert for the scent of game.

When, in traveling, these dogs scent the tracks of game, they are off after the animal, quietly taking the trail unless it is very fresh, in which case they yelp and howl. It is then that the big sled-dogs make an uproar. Often the latter have to be quieted by force, even having their mouths tied shut with thongs.

The driving animals, in contrast to the breed just described, are ordinarily big hardy beasts, with broad heads and short hair. Usually their features indicate affinity with the European dog races, but occasionally some mix-

ture with the Eskimo husky is evident. This infusion is not surprising, for we know that trade with the more remote Indians, the Naskapi or "heathen," who are in direct contact with the Eskimos, has brought the husky



A Naskapi husky at Seven Islands, Gulf of St. Lawrence

breed into the interior among the Montagnais. I have seen on several occasions true types of the Eskimo breed of dog tied up near the camps and houses of the Lake St. John band, some of which had been brought in by Chief Joseph Kurtness. Some of the sled dogs, or "train" dogs, as we

may call them from the common French term *chiens qui traient*, show a wolf strain in their bushy tail, long muzzle, oblique eyes, and savage disposition. The large train dogs are known in the native tongue as *mistâ-tum*, "big dog."

The breed of dogs used for sled-driving by the Montagnais of Lake St. John and from there to the St. Lawrence and eastward generally as far as Seven Islands, is a mongrel shaggy beast, prevailingly dark brown, of a rusty, worn hue, or black, with a slight admixture of white.

There is a great difference between the train dogs of the Lake St. John Indians and those of Lake Mistassini. At the latter post the animals are almost of the pure husky type, and the technique employed in harnessing and driving them is strictly Eskimoan. Here the four or five animals are harnessed by the leather strap loop over the neck and shoulders, one dog before the other. The lead dog is master of the team; the driver uses a whip to guide the animals, and the commands are the same as those used by the Labrador Eskimos (*huit*, go; *ā*, stop; *auq*, right; *rr*, left). The Mistassini



Photograph by W. H. Hauser

When these puppies grow up, they, in their turn, will pull the laden sleds of the Naskapi. The picture was taken at Seven Islands



Photograph by J. G. Rousseau

A dog team of the Naskapi at Seven Islands.—The built-up sled, which is coming into more general use along the trade paths in place of the toboggan, is shown in this photograph

people, who are one of the divisions of the Naskapi, employ the toboggan for dog transportation, not the built-up sled of the Montagnais. The latter has more resemblances to the sled of both Eskimos and Canadians. The Mistassini carry on some trade in dogs with the other bands, getting not less than thirty dollars for an adult animal. Chief Kurtness, of the Lake St. John tribe, some years ago secured two puppies from Mistassini Indians, paying twenty-two dollars for them.

As an instance of what these fine animals are expected to do, the chief just alluded to on one occasion came down from Lake Chibougamou with two dogs and provisions enough for man and beasts. On the way he gathered from traps two lynxes and two foxes weighing an additional one hundred pounds. He left Chibougamou at 7 A.M., stopped and camped at 2 P.M., left camp the next morning before 6 A.M., stopped again at 2 P.M., started the third morning at about 7

A.M., and arrived at Lake St. John late that afternoon, a distance of almost two hundred miles. The huskies run for a while, then trot to rest themselves, taking each gait according to their own inclination. It is very hard to make them change pace when they do not want to. In short, dog-driving among the Mistassini people is a distinct Eskimo analogy, if not an outright acculturation.

As regards the technique of dog transportation among the Montagnais, on the other hand, an European origin is convincingly suggested not only by the breed of the large dogs and their individual names, but in many details of harnessing and management. The sleds consist of two side pieces, shod with wooden or iron runners and connected by rounds. A pair of shafts is bolted by rings to the front end of the side pieces, and between the shafts, tied firmly to them, is a stuffed leather collar. If two or more dogs are used, the front ones, arranged in tandem,



To break a path the Indian walks ahead of the dogs, treading on the soft snow with his broad rounded snowshoes of the Montagnais type

pull on traces attached to their collars. On the coast of the Gulf of St. Lawrence westward of Esquimaux Point this is the method of harnessing, but eastward on the entire coast the more Eskimo-like "span" attachment is found. Jenness attributest the tandem attachment wherever found, even among Eskimos, to European contact. The big dogs often appear with their tails cut off. The reason for this amputation is to prevent the driver being "hit" in the face when he rides close behind the beast. The words of command are given in Canadian French. *Pareille* means "turn left;" *icitte*, "turn right;" *hooa* (whoa), "stop;" and the universal *marche*, "go." The Athapascans of the Canadian Northwest use *marche* and *whoa* similarly, but *eun*, "right," and *ja*, "left."

When traveling in the bush on his constant wanderings, the Montagnais hunter usually runs ahead of the dogs to break the trail with snowshoes. The dogs go much better if there is a man ahead of them. In fact, even a little hunting dog keeping ahead of a

train dog will often prove such an incentive to the harnessed animal that he will do almost anything in his power either to reach the little one or keep him from gaining. Ordinarily a dog train on the move is anything but tranquility. The animals are constantly falling off the beaten track into soft snow, where they lie helpless until hauled out by the driver. When pulling through burnt country, which of course is very extensive in the high interior, they constantly become tangled, or get a leg over the shaft or line. This incites the driver to shouts and commands, which, however, seldom upset his sense of humor, provided he is not suffering from hunger. Hunger, I might add, is about the only misery of the bush life that cannot be met with good humor.

As the trail winds over hills, and through the openings of the spruces and balsams, the dogs tug away, suiting their pace to the going. Should a dog become over-tired on an upgrade or because the snow is too soft, he may lie down with an appealing look.

Such behavior, if the driver be not in sympathy with it, brings forth a yell of *lâche*, in the Canadian-French patois, "coward," and, if further incentive is necessary, a pelting with lumps of snow. So between untangling, trotting on the smooth good trails, tugging slowly on the grades or soft places, and occasional rests, the day passes. When a halt is made, the dogs stretch flat on their bellies and bury their muzzles in the snow. They eat snow quite frequently, this being, in fact, their only method of getting a drink. They are, nevertheless, no worse off than their masters in this respect, for in winter the Montagnais when in the bush obtain all their water by melting snow. This drink is referred to as *shîshebanabui*.

When the grade is downward and the trail is smooth, the hunter may let his dogs pass him. Then quickly by a twist of the foot he will remove the wide rounded snowshoes of the Montagnais type, throw them on the load, and himself squat on the laden sled or toboggan, encouraging his dogs by "*Marche! marche da' toi!*" The bobbing brown bodies pulling in the trace, the crunch of the iron or wooden runners—wood being used in the spring when the snow is more soggy,—the thick bush gliding by at about eight or ten miles an hour contribute memorable impressions to one's life with the northern Indians.

Should it be necessary to pass another team on the trail, the moment is a critical one. The dogs of the two caravans, if not held in check, will engage in battle. By a tacit understanding one man leads his animals to one side, holding the lead dog by the collar. Then a curt command is given in French "*Passe!*" and with muffled growls, and bristles

erect, the dogs of each sled resume their way. Generally, if both the drivers are Indians, they stop and converse, but in either case, the dogs have to be held.

The feeding times are in the morning and evening, but sometimes, if food happens to be short, only an evening meal is supplied. The Lake St. John Indians do not feed their dogs frozen fish as do the Crees and Eskimos, for they have not an abundant supply. Whatever is left from the Indian repasts is given to the dogs. This is invariably meat and bone. To one unaccustomed to northern dog-wolves,



A Montagnais and his dogs resting on the trail

chien-loups as they are called by the "habitants," it is astonishing at first to observe the rapidity and apparent ease with which the beasts break up and swallow tough bones, bones being their favorite diet.

It is the general opinion among the Indians of this particular region that caribou bones make their dogs sick. They claim that these bones are indigestible. And yet I suspect the true objection is to be found in their superstition. It is their belief that the game animals are sensitive to ill-treatment of the parts left over after the flesh has been eaten. The spirits of the animals resent in particular the ignominy of seeing their bones fought over, crunched, and devoured by dogs, because the dog, an animal like themselves, has turned traitor to his kind and, living with man, aids him in following their traces and bringing them down. Accordingly, for a hunter to allow his dogs to eat the bones of game he has killed is regarded as a sure source of bad luck in his hunt. So all through the north one sees the bones of game animals treated with some form of regard. Especially are the skulls of the bear and beaver cleaned and hung up among the branches of a tree to satisfy the spirits of their kind, that they may be induced to continue the submission of their spirits to those of the hunters. Among these nomads the whole theory of success in life's pursuits, no matter what they may be, lies in a concept of soul conquest.

In the mythology of the north we find one interesting example of speculative theory as to how the dog came originally to be the companion of man

and so different in disposition from the wild creatures of the bush, who regard with feelings of terror both human beings and fire. Not among the Labrador tribes, however, but across the St. Lawrence in Maine, among the Penobscot, is the following version related: The mythical hero, whose name is translated as Deceiving Man, just before the appearance of human beings in the world, called the different animals of the forest to assemble before him and to show him what their conduct would be when man appeared in their midst. The various animals were questioned by the hero. The moose, when asked what he would do, declared that he would take to flight. The red squirrel threatened that he would carry a man into the nearest tree and gnaw his head off. At that time the squirrel was as big as the moose, but after this threat he was seized by the hero, who stroked him until he shrunk to his present size and became harmless, though, to be sure, little subdued in spirit. The other beasts went away angrily, shaking themselves and saying that man would be too poor. Finally one animal stood forth and offered to live with man, sharing his poverty. It was the dog. Then the hero, after thanking the dog, spoke to the others, and ordained that those who went off shaking themselves should henceforth hold in fear not only man but the dog as well. Since that time man and his canine companion have continued in their hunting partnership. Their close relationship not only on the hunt but in the other activities of life in the American *taiga* is well exemplified among the Labrador Indians.

The Snowy Owl in Its Northern Home¹

By ALFRED M. BAILEY

Of the Colorado Museum of Natural History

WE were making our way slowly under the precipitous walls of Cape Lisburne, through the piled-up sea ice which crowded the frozen Arctic in northern Alaska. For days we had traveled without a sign of wild life other than an occasional track of *p'shukok*, the Arctic fox, or the faint prints of a lemming wandering aimlessly across the tundra, but early this particular morning the keen-eyed dogs saw a black object perched upon a high pressure ridge out on the broken ice field. I could not imagine what the dark-colored bird might be, so detouring between the hummocks, we slowly made our way in its direction. It soon took to flight, however, its broad expanse of wing gleaming dark in the bright light of the Arctic spring day, its shadow moving grotesquely from one ridge to another as it sailed swiftly away. My Eskimo companion said "*upik*," and then I knew that my black-appearing bird was the snowy owl, his white plumage black against the sun, and especially so when contrasted with the high lights of the glittering ice pinnacles. Later, we had occasion to note these owls many times on our journey down the coast, but at no time did the contrast seem so noticeable as when we were among the broken ice fields off Cape Lisburne.

The snowy owl is usually classed by ornithological writers as a bird that is abundant in the northern regions, but from my experience, and from what I am told by natives and traders of the Arctic coast, its numbers are not great, —just a few birds scattered here and there across the vast extent of tundra,

their abundance presumably being dependent on the food supply. This dependence, however, does not seem to hold true always, for on a twenty-five day trip inland for caribou, my companion, Mr. R. W. Hendee, saw but three owls, notwithstanding the fact that ptarmigan were exceedingly abundant in the country traversed.

During the summer of 1921, we saw birds at points along the entire Arctic coast of Alaska, from Demarcation Point, the boundary between Canada and Alaska, to Cape Prince of Wales. They were very shy, rarely allowing one to come within rifle range; in fact, one could scarcely approach within identifying distance.

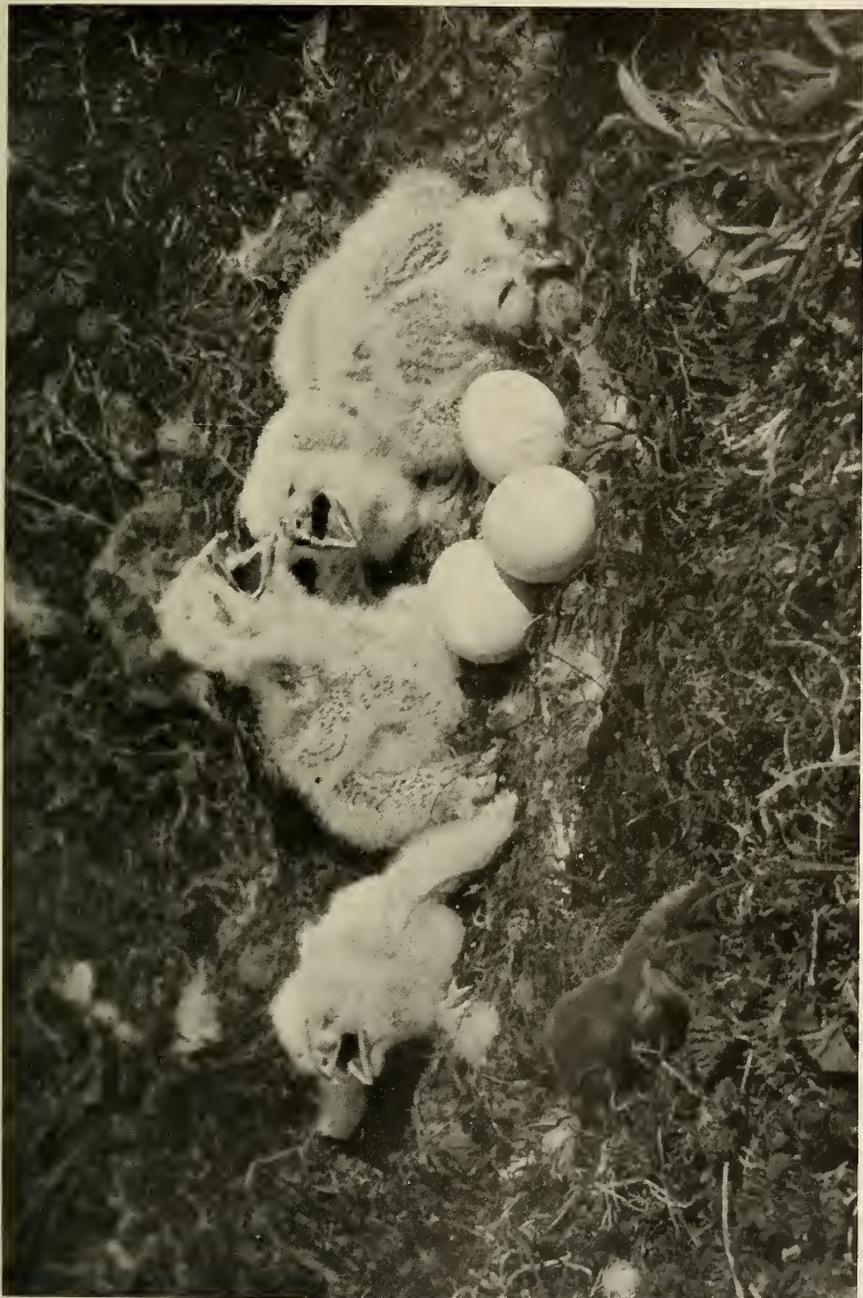
At Wainwright, our winter headquarters near northernmost Alaska, these birds proved very scarce during the fall and winter. During the spring months, April and May, they seemed to congregate along the coast, often far out on the sea ice; then, soon after the leads opened, more birds appeared, the Eskimos claiming that they were catching crippled eiders, which were rather numerous in the vicinity of the native villages.

Few ornithologists have found nests of the snowy owl, so when Mr. Frank Dufresne volunteered to show us a nest which he had "staked" upon the tundra back of Nome, we considered ourselves fortunate. A few miles of rolling tundra, literally dotted with small lagoons, and covered with moss, grass, and waving fields of "Alaska cotton," separate the gold-bearing sands of Bering Sea from the foothills, and here, as soon as the winter snows

¹Photographs by the author



ANXIOUS PARENTS FLYING OVERHEAD



FOUR UNGAINLY OWLETS—THE OBJECTS OF SOLICITUDE



A field of "Alaska cotton"

have melted, numerous Arctic birds congregate to raise their families. In such a setting we found the home of the snowy owl, where an abundant bird life would supplement the food supply of the growing young. The nest was on a ridge that rose from the tundra; it was a mere depression in the moss, scantily lined with willow leaves. Anvil Mountain and the other foothills were half a mile away, their sides still snow-seamed, but on the tundra plants were growing luxuriantly. In the nest there were three addled eggs and four typical little owls, ungainly and homely, with their eyes tightly closed against the brightness of the northern light. As subjects for a photographer they were most unsatis-

factory, for they huddled together with faces hidden, looking like so many pieces of cotton.

If the young failed to show action, however, the adults made things interesting enough. At our approach they had soared to a distant mound, where they perched for a time, but soon the male, a beautiful white specimen, started sailing overhead, uttering his hoarse *who-who*. Occasionally he was joined by his mate, and against the light blue sky as a background, they offered an attractive target for our camera. Unfortunately, Arctic light is rather poor for speed pictures. The male bird would sail with the wind, and then circling, would dart within a few feet of us, his wings whistling and

talons outstretched. He dropped from the sky on folded wing with marvelous speed, and time and again I caught myself dodging his onslaught, but he seemed to give most of his attention to my bewildered Airedale, who crouched in the grass with a slit ear, not knowing from where the attack came.

We left the nestlings for a few days, but revisited them on June 24. The weather had turned very warm and clouds of mosquitoes rose from the grass and circled over the panting, helpless young. Each little fellow had his eyes closed to the merest slits because of the bright glare and, fringing the eyelids of each, were rows of mosquitoes. On this occasion the old birds were not so fierce but now and then sailed anxiously overhead, and subsequently alighted on a distant tundra hummock.

The snowy owl feeds, I believe, to a greater extent upon small mammals than upon birds, for although only a few ptarmigan feathers littered the

nest, there were several rodents (*Microtus*) awaiting consumption. Later, I saw owls with ground squirrels in their talons, and specimens which we collected had been eating lemming and mice. The owls take also many ptarmigan in the course of a season, and for that reason are persecuted at every opportunity, no doubt justly. Mr. Dufresne told me that several other pairs of these owls had been nesting in the adjoining foothills but that their nests were always broken up by the prospectors as soon as found. Locating several pairs of nesting owls in the vicinity of Nome would prompt an ornithologist to declare them "fairly common breeding birds," but Mr. Dufresne told me that the following year he failed to find a nest, so instead we shall have to place the status of the snowy owl as irregular; [it may be fairly common at points along the Arctic coast one season where it will be absent the next.



The tundra near Nome as it appears in June

The Coastal Prairies of Southern Texas

AN ORNITHOLOGIST'S PARADISE

By LUDLOW GRISCOM

Assistant Curator of Birds, American Museum

EVER since taking a brief trip to Corpus Christi several years ago I had planned to revisit a region which gave indications of being extraordinarily rich in bird life. This plan was quickened by the investigations of Mr. T. Gilbert Pearson, president of the National Association of Audubon Societies, who rediscovered the whooping crane and found many breeding colonies of rare and little-known water birds in the vast uninhabited coastal prairies and lagoons stretching south from Corpus Christi to the Mexican border. His kindly interest and friendliness prompted him to provide me with the necessary information and letters of introduction, and shortly after Christmas, 1923, I was on my way south, fortunate in the companionship of Mr. Maunsell S. Crosby, an experienced amateur field ornithologist and a member of the American Museum.

A series of peculiar conditions combines to make this extreme southeastern corner of Texas a veritable paradise for the bird lover. Approximately in the latitude of Miami, Florida, it has an almost tropical climate, except for occasional "northers," which swoop down with great suddenness, bringing chilly reminders of a higher latitude, though frost is very rare. As a result, a distinctly tropical vegetation flourishes in the richer soil around Brownsville, where the Rio Grande supplies a certain amount of irrigation. A small number of tropical birds here reach their extreme northern limit, and occur nowhere else in North America. On the other hand, numerous breeding

species of the southern United States reach here their approximate southern limits. Two groups of species are irregular visitants to the region in winter, and for similar reasons. One group, wintering chiefly in the tropics, lingers this far north in mild seasons. Another, hardier group rarely occurs as far south in winter, reaching so low a latitude only in seasons of exceptional severity.

The plains and prairies of the central United States are a dividing line between a distinctly eastern and a western bird fauna. In the Brownsville region these plains and prairies have narrowed to relatively few miles, resulting in the mingling of western, eastern, and prairie types. A considerable number of western or Sonoran species, therefore, here reach their eastern or southeastern limits. This narrowing of the continent causes a similar convergence of migration routes. Numerous eastern species, disliking to cross the Gulf of Mexico on their way to their winter quarters in Central America, are forced to pass through the Brownsville region twice annually, and the path of migration of several Rocky Mountain or western species extends as far east as the open arid country that they favor. Add to the foregoing analysis that lonely beaches, extensive fresh and salt lagoons, vast coastal prairies, heavily wooded watercourses, stretches of cactus scrub and desert, and fields and plantations occur in close proximity to one another, and we can see why more than 350 species of birds have been

recorded in a small area, where relatively little exploration has been attempted and almost no continuous observation has been undertaken. There is no doubt that more varieties will be detected, and new stations for rare species will be found, as more remote sections are visited by competent naturalists. Brownsville might well hang out a sign reading, "All tastes satisfied here."

The reader will now readily understand the eagerness with which two naturalists looked out of their Pullman windows early on the morning of January 3, 1924, as the train was just entering the territory of the great King Ranch. The alternating pine woods and cypress swamps of the day before had disappeared, and an unbroken expanse of flat prairie stretched away to the horizon in every direction. The cheerful and light-hearted negroes had been replaced overnight by Mexicans, whose wattle huts had the charm of relative novelty; the adobe houses in the Mexican sections of the few towns had a distinctly Spanish atmosphere. One missed the trees, the frequent water towers being a poor substitute aesthetically, but the compensation lay in a vastness of sweep and the immensity of space, which a rolling and wooded country cannot convey. A brilliant sun burned in a cloudless sky, the air was warm and balmy, and the prairie grass rippled before the wind like the waves of a copper-colored sea.

After a breakfast at Kingsville, the headquarters and the administrative center of the King Ranch, we embarked upon a most remarkable train ride. There had been a good deal of rain the preceding fall, and thanks to the impermeability of the Texas soil, the prairies were dotted with ponds and sloughs in every direction. During a

five-hour journey we found every one of these ponds covered with ducks of many species, grebes and coots, while killdeer plover, yellowlegs, and black and white stilts with incredibly long red legs, bobbed and probed on their margins. The passing of the train was a well-known daily event, which had long since ceased to arouse the slightest interest. Many did not bother to fly, and from the rear platform we could have hit them with stones, or shot the legal limit of twenty-five before the ride was concluded.

About two hours south of Kingsville the railroad passed through a low range of sand hills, which are regarded by the residents as an important frost barrier. After this the prairies became dotted increasingly with patches of "chaparral"—a low scrubby growth of mesquite, huisache, and other trees, most of them thorny and prickly. A large number and variety of hawks were the outstanding features of this section. At our approach a flock of wild turkeys rushed madly away into the nearest scrub, and an occasional white-necked raven or caracara flapped by looking for carrion. About one hundred miles south of Kingsville the train leaves the King Ranch and enters a more fertile section, where there is plenty of timber. Between Harlingen and Brownsville the country is settled, fields and plantations alternating with orange and grapefruit groves.

At Brownsville we were fortunate enough to find Mr. R. D. Camp, federal and state game warden, just returned from a tour of duty. An enthusiastic conservationist, he now devotes his entire time to protecting the wild life, and has succeeded in gaining the respect and support of the leading citizens of the huge area in

which single-handed and alone he is doing his best to enforce unpopular game laws. In recent years his summers have been spent in the lonely work of guarding remote colonies of terns and egrets on desert islands in the Laguna Madre. He rendered us invaluable assistance through his knowledge of the best localities for rare and unusual birds, particularly when his duties permitted him to accompany us as guide. One conference was sufficient to plan out a schedule of trips, which was put into effect immediately.

In southern Texas, the tenderfoot (and any northerner or easterner is regarded as a tenderfoot) must be prepared for endless encomia on the wonders of the country and for tales of blood and violence! Apparently so many tourists have visited the region, looking for signs of Mexican revolutions, gunmen, and other evidences of unsettlement that all outsiders are regarded as thirsty in these respects, and with a somewhat naïve courtesy your supposed wants are generously supplied. In Matamoros across the border, every imperfection in a concrete wall is caused by a rifle bullet; a defective cornice is invariably due to a shell; and this street and that have run with gore. A glance at the powdery white dust, ankle-deep over everything, is sufficient to convince one of the improbability of any such phenomenon. One hears much of little "arguments" between "perfect gentlemen," which end fatally for the less able debater. The visitor's scepticism must not be voiced, as it would give the greatest offence. If this fine point in deportment is observed, the country is yours, and everyone goes out of his way to help you and to further your aims, with an open-handed hospitality

and friendliness which I have never found excelled anywhere. Without such generous assistance we could not have seen so much in so short a time.

Perhaps the most impressive feature of the bird life about Brownsville was the slight extent to which the birds were affected by man and his works. A half hour's observation at daylight the next morning on the platform of the railroad station, while we were waiting for the train to Point Isabel, yielded nearly twenty species of birds, including white-fronted geese, several species of ducks, and two snowy white American egrets—an experience which it would be hard to duplicate.

The train for Point Isabel proved to be a Ford truck made over to look like a train, and we staggered and lurched out of town over a sinuous track. About five miles out we left the scrub country and emerged on the coastal prairies, stretching away to the Laguna Madre, intersected with numerous smaller lagoons, some fresh and some brackish. The train obligingly stopped in the middle of nowhere, at the nearest point to one of these lagoons. The region is known locally as "Jackass Prairie" (pronounced Perrairie!) because donkeys and mules have run wild there. The only inhabitants are a few wretched Mexicans, who make a precarious living catching the jackasses and selling their hides in Brownsville.

A lonely and desolate region, immense, hot, and thirsty, but a paradise for birds! The lagoons were covered with white pelicans and ducks. Geese of four kinds were occasional in flocks. Terns and gulls hawked over the waters or the marshes, which were the feeding grounds of numerous herons, and we were fortunate in finding three of the rare snowy egrets. Sandpipers and plover of various kinds swarmed

on the flats. The prairies were covered with meadowlarks, pipits, and savanna sparrows. Lines of long-billed curlew streamed away in front of us, whistling harshly, their wings bright cinnamon beneath when raised in flight. They are as large as chickens, and have curved bills six or more inches long. In an arid patch of cactus and yucca, we found some pretty black-throated sparrows, a sage thrasher, and some curve-billed thrashers,—western species here reaching their eastern limit. A total of eighty species on a trial trip in an unfamiliar country!

Another interesting trip was that made to some wild scrub country about fifteen miles north of Brownsville, where we camped out for a weekend. Water, that vital essential, is often provided by what is known locally as the *resaca*. The turbulent Rio Grande in time of flood is ever changing its course, and the term *resaca* (literally surf) is used to designate a former course of this river. Some *resacas* wind for miles through the country and are filled with water. As a result, the most luxurious vegetation of the region grows on their banks. Glossy green ebony trees and other tropical varieties form almost impenetrable masses of thorn and prickly, as luxuriance is measured by density and not by height. These *resacas* are the chosen haunt of many species of birds, including some of the tropical ones, and no trip to southeastern Texas is complete unless several visits are paid to them. Here gorgeous green jays skulked through the underbrush, the handsome Derby flycatcher called harshly from a conspicuous perch, and an occasional Audubon's oriole flashed across an open space. Shy and gentle white-fronted doves walked around in dense cover, and in the very thickest growth of

all lived the secretive chachalaca, only representative of a group of tropical game birds, the name of which is an imitation of the loud, harsh, cackling cries with which birds of this species greet the dawn in chorus.

A climb of fifteen feet out of the *resaca* brought us to the cactus-covered desert plain, where walking was necessarily a very cautious and careful proceeding. Here were road runners, an eccentric cuckoo which runs away instead of flying, great cactus wrens, the shy Sennett's thrasher, and the pretty little verdin, a gray bird with a bright yellow head. A burrowing owl bobbed and blinked at us from the entrance of its burrow, and near by we flushed some chestnut-bellied scaled quail. A flooded pasture was full of ducks, and I saw more blue-winged teal there in one day than I had seen in ten years' field work in the Atlantic states. The flats were covered with shore birds, and a flock of white-faced glossy ibises were probing in the mud with their long bills, honking like geese. Filled with a fearful "mulligan" distilled by Camp from the "innerds" of some wild ducks, we rested somewhat fitfully under the stars on ground as hard as iron, devoured by seed ticks, and listening to the plaints of a screech owl and some Merrill's parauques—a tropical goatsucker.

Thanks to the courtesy of Mr. Caesar Kleberg we were his guests for a day at Norias Ranch, the southernmost property of the great King Ranch, containing about half a million acres. He is an ardent conservationist, and takes great pride in the incredible abundance of game on the section administered by him. A herd of pronghorns and thousands of wild turkeys are perhaps his most cherished possessions. So flat is the prairie that a

lively and ambitious Ford was quite independent of roads, and we rushed over parts of the estate where game was to be expected, watching the head cowboy shoot galloping coyotes from an auto with a rifle at 250 yards, scarcely ever missing his mark. We saw 14 kinds of ducks, 3 kinds of geese, hundreds of curlew, at least 100 quail, and a flock of stately sandhill cranes.

Our final trip was in search of the whooping crane, which Mr. Pearson had found the preceding year in the northern half of the King Ranch; his host, Mr. Richard M. Kleberg, had assured him that it had wintered there regularly. It is now one of the rarest of North American birds, and there had been no winter or breeding records of it in many years. It is one of our most magnificent birds,—pure white, with black-tipped wings, and standing $4\frac{1}{2}$ feet high, with a wing expanse of 8 feet.

The northern part of the King Ranch is a huge tract of prairie containing about a million acres. It is divided into sections, which are subdivided roughly into different pastures. However, a pasture may be a hundred square miles, fifteen or twenty miles from the ranch house, and to count the cows that range over it may necessitate a week's absence! Mr. Richard M. Kleberg kindly invited us out to Laureles Ranch, and was a most courteous and attentive host, affording us every possible facility. He, too, was an enthusiastic conservationist, and was quite proud of having whooping cranes on his property. The ranch house is thirty miles east of Kingsville in the middle of the lonely prairie, but it has electric light, running water, a special guest house, a piano, and many other unexpected conveniences and luxuries.

There were special quarters for the Mexicans and their families, and a school was provided for the children.

The next morning we started off in a Ford for the Laguna Larga, a shallow body of fresh water about ten miles farther east. Here, a mile from shore, we discovered four stately whooping cranes feeding in the shallow water, while geese, ducks, and shore birds were visible in every direction. It was impossible to approach any nearer the whooping cranes at that time. In the afternoon we took a sixty mile drive, going entirely around the lagoon. The wetter prairies were covered with geese, the lesser snow goose being particularly handsome and conspicuous in flocks of hundreds. In what are called the Shin Oak Prairies we saw hundreds of the sandhill crane, which is a foot smaller than the whooping crane and of a uniform grayish brown. This, too, is a rare bird; it is rapidly decreasing and has already become extinct in most of the eastern part of the United States. I do not believe a greater number of these cranes could be seen in any other part of North America today. At the south end of the Laguna Larga we again found the four whooping cranes, and this time were able to stalk them to within 250 yards. The long plumes of the secondaries cover the black wings in repose, and the birds appear pure white except for the patches of bare red skin and the black streaks on the head and the long black legs. These four birds were very wild and shy, and the ducks which we scared up by our approach gave them the alarm. With long necks fully extended the cranes stood more than five feet high; shortly after our arrival they flew away with steady powerful strokes of their great wings,—a picture no nature lover could ever forget.

In spite of renewed investigations in Saskatchewan, and the discovery of two breeding pairs, there is not the slightest evidence to justify the hope that a hundred individuals of this magnificent bird remain alive. Three-quarters of its former breeding range is now given over to cornfields, and its conspicuousness and size will make its migrations a peril, even if it is safe in its present winter and summer haunts. On the coastal prairies of southern Texas, however, it, as well as many

other kinds of waterfowl and game, will be safe as long as the great ranches remain intact. Their owners enforce the laws, and hundreds of square miles are unvisited by a human being from one year's end to the other. Let us hope that these conditions will continue, as the majority of the natives are hostile to laws restricting the taking of game. They cannot realize that its incredible abundance is due to local conditions which do not prevail in most parts of the continent.



The Whooping Crane Group in the American Museum:—This stately bird has been brought to the verge of extinction. Until the recent discovery of a few survivors in southern Texas, there had been scarcely any records of the occurrence of this bird in the United States for decades, and the breeding grounds of the few remaining individuals were not definitely known. Yet at one time the whooping crane must have been relatively plentiful. In December, 1811, on the Mississippi, Nuttall witnessed a migration of this species assembled in a "mighty host. Their flight took place at night, down the great aerial valley of the river . . . The clangor of the numerous legions passing along high in the air seemed almost deafening . . . and as the vocal call continued nearly throughout the whole night without intermission, some idea may be formed of the immensity of the numbers now assembled on their annual journey to the regions of the south."

The Hoop Snake Story

WITH SOME THEORIES OF ITS ORIGIN

BY KARL PATTERSON SCHMIDT

Assistant Curator of Reptiles and Amphibians, Field Museum of Natural History

ONE of the most persistent and widespread snake myths in the United States tells of a large serpent which takes its tail in its mouth and rolls like a hoop. It is further reputed to have a poisonous sting in its tail, which is launched at its enemy from the rolling position. This story has come to be associated with various snakes in different parts of the country. My interest in the story was aroused during a stay in Louisiana, where I could gather eyewitness testimony regarding one of the "hoop snakes" (*Abastor erythrogrammus*) and the "stingin' snake" of the genus *Farancia*. It appears that the supposed habit of rolling like a hoop is an elaboration of the more fundamental belief in a snake with a poison sting in its tail.

My first impression was that this must be one of the universal snake myths, and I thought of the familiar "snake" bracelet or finger ring, in which the head of the snake meets the tail. On inquiry, however, there appears to be no classical or European analogue of the American hoop snake story.¹ Herodotus, the earliest source of some still current misinformation concerning reptiles, is not the fountainhead of this legend, and it does not find place in Pliny, whose voluminous Natural History would surely have included a story so much in his own vein, had he known of it. My search of possible European sources was

slight, but it gave no clue to a European prototype of the hoop snake yarn.

Turning to American sources, our search is at once rewarded by finding references to the horn or hoop snake in early accounts of travel in this country.² These accounts may speak for themselves. The earliest is in a letter dated 1688 that was written by John Clayton to the Royal Society of London:³

"There is another sort of deadly snake, the Red-Snake; I once narrowly escaped treading on the back of one of them. They are of an ugly dark brown Colour, inclining to red; their bellies are of a more dusky white, with a large streak of vermilion Red on either side; this too is of the Viper kind, but is not so short, but its tail is more taper and small. The Horn snake, is as they say, another sort of deadly snake; I never saw any of them unless once, shortly after my Arrival in that Country, which I cannot attest to being the Horn-Snake, for I could not distinctly view it, being in a thicket of sumach; it was perched up about two feet high in a Sumach Branch, its Tail twisted about the Shrub, and about a quarter of a yard stood bolt forward, leaning over the forked branch thereof: I could not see the Horne, with which it strikes, and if it wounds, is as deadly as the Rattle-Snake's Bite. The Gentleman that was with me told me it was the Horn snake; but being in hast, and on

¹The Midgard serpent of Norse myth, a sea monster represented as encircling the earth, could not, in the opinion of the writer, have had a bearing on the hoop snake story.

²For a list of volumes which were searched for mention of the hoop snake, I am indebted to Dr. A. H. Wright of Cornell University.

³Force, P., *Tracts relating to America*, Vol. III, No. 12, p. 44. Washington, 1844.

Horseback, and the Snake in a Thicket, I could not see the Horn; but had I thought I should never have seen more of them, I should have took a little Pains to have been better satisfied. This I think may not improperly be referred to the Dart Snake.”

Here are a number of elements that go to make up a typical snake story. A description of the mud or rainbow snake (it is impossible to be sure which is meant); a “horn snake,” with the horn in its “front,” apparently one of the tree snakes, or possibly a black snake; and not least, the abundant excuses for not making a more thorough investigation.

The next account is that of Robert Beverly, in a *History of Virginia* published in London in 1722.¹ He writes: “They have likewise the Horn snake, so called from a sharp horn it carries in its tail, with which it assaults anything that offends it, with that Force, that as it is said it will strike its tail into the But end of a Musquet, from whence it is not able to disengage itself.”

In this short note are two distinct additions that are familiar in later accounts: first, the transference of the horn to the tail; and second, the characteristic of striking with such force as to remain fast in the object struck. No mention is made of the horn being poisonous,—an oversight which is supplied by our next reference.

Alexander Hewatt, writing in 1779,² describes the fangs of the rattler and other genuinely poisonous snakes; he then goes on to say: “The horn snake is also found here, which takes his name from a horn in its tail, with which he defends himself, and strikes

it with great force into every aggressor. This reptile is also deemed very venomous, and the Indians, when wounded by him usually cut out the part wounded as quickly as possible so as to prevent the infection spreading through the body.”

In this account the name of “Horn snake” is reënforced, and the quality of venom added. This is the only reference to a belief in stinging snakes on the part of the North American Indians which has come to my attention. It would be highly interesting if these legends should be found in North American Indian folklore, and in that case my hypothesis, subsequently stated, of an African origin could be discarded.

The next account in our list is supplied by one J. F. D. Smyth, in 1784.³ As this is the first account—I had almost said authentic account—which introduces the “hoop,” I shall quote it in full. Referring to a stay in western North Carolina, he writes:

“While I was at Sawra Towns, one day a little lad of Mr. Bayley’s came to acquaint us that he had killed a horn-snake, which being a curiosity that I was extremely desirous of observing and examining with particular attention, I accompanied him to the place where he said he had left it; but when we arrived there, to my great disappointment, it was not to be found. He assured me that it must not have been quite dead, and had recovered so much as to be able to crawl from the spot on which he had left it, and had secreted itself somewhere among the leaves.

“However, everyone, and all the inhabitants, with the greatest confidence asserted, and avowed their

¹Beverly, Robert. *History of Virginia*, p. 261. London, 1722.

²Hewatt, Alexander, *Historical Account of South Carolina and Georgia*, Vol. I, p. 87. London, 1779.

³Smyth, J. F. D. *Tour in the U. S. A.*, Vol. I, p. 263-65. London, 1784.

having seen such snake, though very seldom.

"They represented them to me as the most formidable and direful foes in existence to the human race, and to all animation; poisonous and fatal to a degree almost beyond credibility.

"He is described as something resembling a black snake, but thicker, shorter, and of a colour more inclining to dark brown. He never bites his adversary, but has a weapon in his tail, called his sting, of a hard horny substance, in shape and appearance very much like to a cock's spur: with this he strikes his antagonist, or whatever object he aims at, when he least expects it, and if it penetrates the skin it is inevitable and sudden death.

"So very virulent is his poison that it is reported, if he should miss the object he pointed at, and should strike his horn through the bark of a young sapling tree, if it penetrates into the sap or vital parts, the bark or rind will, within a few hours, swell, burst, and peel off, and the tree itself will perish.¹

"As other serpents crawl upon their bellies, so can this; but he has another method of moving peculiar to his own species, which he always adopts when he is in eager pursuit of his prey; he throws himself into a circle, running rapidly around, advancing like a hoop, with his tail arising and pointed forward in the circle, by which he is always in the ready position of striking.

"It is observed that they only make use of this method in attacking; for when they fly from their enemy they go upon their bellies, like other serpents.

"From the above circumstance, peculiar to themselves, they have also derived the appellation of hoop snakes."

¹What may be an indirect reference to the account of Mr. Smyth appears in Charles M. Walker's *A History of Athens Co., Ohio*, p. 97, Cincinnati, 1869: "Early travellers mention the hoop snake, stinging with their tails, and so malignant as to cause the death of a green tree if struck."

This account may be considered the first in which the hoop snake myth appears in full flower. It is to be noted that the hoop snake story is added to that of the horn snake. It is difficult to avoid the conclusion that some village genius has invented the hoop snake and blended his creation with the horn snake, the reputation of whose venomous tail sting was a really current snake "myth."

In a *View of South Carolina*, by John Drayton, published in Charleston in 1802, appears a list of the snakes of South Carolina that includes the horn snake. Robert Mills, in *Statistics of South Carolina*, 1826, also mentions a species under this name.²

John Lee Williams, in a *View of West Florida*, published in 1827,³ lists various snakes and writes: that "... a livid looking mud asp, that has sometimes been mistaken for an eel, has in several instances proved fatal to those who expose themselves by wading in muddy creeks." This looks very much like a reference to the horn snake under a new name, for this snake really lives in mud and its sides and belly are a "livid" red.

The single case of scepticism on the part of a person mentioning the horn snake that has come to my attention in works of the nature thus far quoted is that of J. H. Hinton. In his *History and Topography of the United States*, published in London, 1832, he writes⁴ that "The accounts of the deadly venom of the Horn-snake being without actual attestation by fact, are considered as unfounded."

There is no doubt that this list of references to the hoop snake could be much extended. I have not examined

²Mills, Robert. *Statistics of South Carolina*, p. 102. Charleston, 1826.

³Williams, John Lee. *View West of Florida*, p. 28. Philadelphia, 1827.

⁴Hinton, J. H. *History and Topography of the United States*, Vol. II p. 185. London, 1832.

current sources, for there is no difficulty in gathering any number of contemporary accounts of the hoop snake and the horn snake from alleged eyewitnesses, especially in any one of the southern states. These accounts are not to be confused with yarns spun for the misinformation of the traveler. If one expresses doubt, he runs real danger of seriously offending the narrator; and the stories are attached to perfectly definite and well-known species of snakes, which are greatly dreaded and shunned. The first specimen of the "stingin' snake" that I collected, I brought in alive to a camp in Louisiana, and I had difficulty in convincing my camp mates that it was not by virtue of occult power over snakes that I escaped the predicted death. I had already gathered accounts from a considerable number of eyewitnesses, of the death of various animals from the sting of the "stingin' snake," and when I confronted my informants with the living source of their fears, they were forced to make the difficult choice between their traditional belief and the evidence of their eyes and of common sense.

In the locality in question (Natchitoches Parish), it was *Farancia abacura*, the horn snake or mud snake of other sections, to which the stinging powers were attributed. There was no hoop snake story current in this section of Louisiana. Only one family, which had come from Georgia, knew of it. All the members of this family would have been glad to take oath to having seen the veritable hooping of the hoop snake in their native state. They apparently referred their experience to the rainbow snake (*Abastor erythrogrammus*), which in many parts of the South is known as the "hoop snake."

Both of these snakes lend themselves well to their legendary rôles. They are large, brilliantly colored serpents, which because of their habits are very rarely seen, for they burrow in soft mud or soil in wet localities, or frequent swampy areas which are sparsely inhabited. The terminal scale of their tail is considerably enlarged and is spinous or horn-like, so that the examination of a dead snake, the only kind ever examined, lends apparent support to the theory of a sting. Further support is derived from the actions of the living snake, though it is doubtful if the authors or bearers of the "stingin' snake" stories ever observed the reptiles alive. When held in the hand, the mud snake (which is the more familiar to me) coils around the hand, and explores or feels about with the tip of the tail with sufficient force to give a considerable prick, though I doubt if even a large snake would penetrate the skin with its tail spine. This is the normal, or slightly modified, habit of constricting snakes in general, which attempt to tuck the tail beneath a coil or otherwise secure a purchase for it, to enable them to constrict.

An account by T. G. Dabney,¹ who was a good observer both of snakes and of human reactions to them, illuminates the problem of explaining the many eyewitness accounts. He writes, concerning a specimen which was brought to him:

"It had just been killed, but had enough vitality for tail movements. It was carefully carried on a fire poker to the porch for good light. The poker was pressed on the tail, which set up a lively oscillation, and the observer distinctly saw a sting, protruded and withdrawn 'in a flash,'

¹*Copeia*, No. 73, p. 73. 1919.

but saw no repetition of the exposure. A dissection showed the tail vertebræ descending in a diminuendo to the fine pointed extremity of the tail, and no place for a 'sting.' This shows that we are very likely to see what we expect to see, when snakes are involved; and the average person is prone to accept first impressions, and any extravagant statement about snakes, without any inclination to verify, or disprove them."

The most pronounced development of a tail spine in snakes that has come to my notice is that of some of the blind burrowing snakes of the family *Typhlopidae*. Living specimens held in the hand make the same exploration with the tail spine, which is very sharp, as I have described above in the case of the horn snake. Mr. Herbert Lang, leader of the American Museum Congo Expedition, informs me that the African natives believe that the tail of these burrowing snakes is used as a sting, and that these snakes are relatively abundant in Central and West Africa. It seems a plausible hypothesis, therefore, that the stories of stinging snakes were brought from Africa by the negroes imported as slaves. The transfer of this reputation from the burrowing snakes of Africa to American burrowing snakes offers no difficulty to anyone

familiar with the permutations and combinations of popular names for animals.

The habit of the common black snake of eastern North America of gliding along at great speed over the tops of bushes, without descending to the ground, may have a bearing on the origin of the belief in the hoop snake's rolling method of progression. Where the horn snake and rainbow snake do not occur, there seems to be a tendency to identify the hoop snake with the black snake or blue racer.

The only remaining hypothesis for the origin of the stories of the stinging snake and the hoop snake that has come to my attention rests on the comparison with scorpions. Scorpions do have a veritable sting in their tails, and they do advance with the sting raised over the back "in the ready position of striking." The remoteness of the scorpions from snakes in zoölogical classification seems to offer little difficulty to the popular imagination. In the same section of Louisiana where I collected my first hoop snakes, I heard repeatedly about "stingin' lizards." My informants thought they had scored a clear triumph against my scepticism when they showed me scorpions to prove their assertion that there *were* "stingin' lizards" that really could sting!

The Social Wasps—*Polistes* and *Vespa*

AN INVITATION TO CLOSER AQUAINTANCE WITH THE HORNETS
AND THEIR RELATIVES

By WILLIAM M. SAVIN¹

SOcial wasps of the genus *Polistes* are comparative strangers to most persons although there is a wide, even if superficial, acquaintance with their near relatives of the genus *Vespa*, commonly known as hornets and yellow jackets. The nests of *Vespa* consist of several combs built one beneath the other and enclosed by a protective envelope. The nests of *Polistes*, on the other hand, have but a single comb, oblong or more or less circular, the cells of which are exposed to view. The nests of *Vespa*, often comprising several stories, accommodate as a rule a larger number of tenants than do the single-story dwellings of *Polistes*. A large nest of *Polistes annularis* contained about 1500 cells; one of *Vespa germanica* had about 14,000 and the huge nests of *Vespa maculata* have many more.

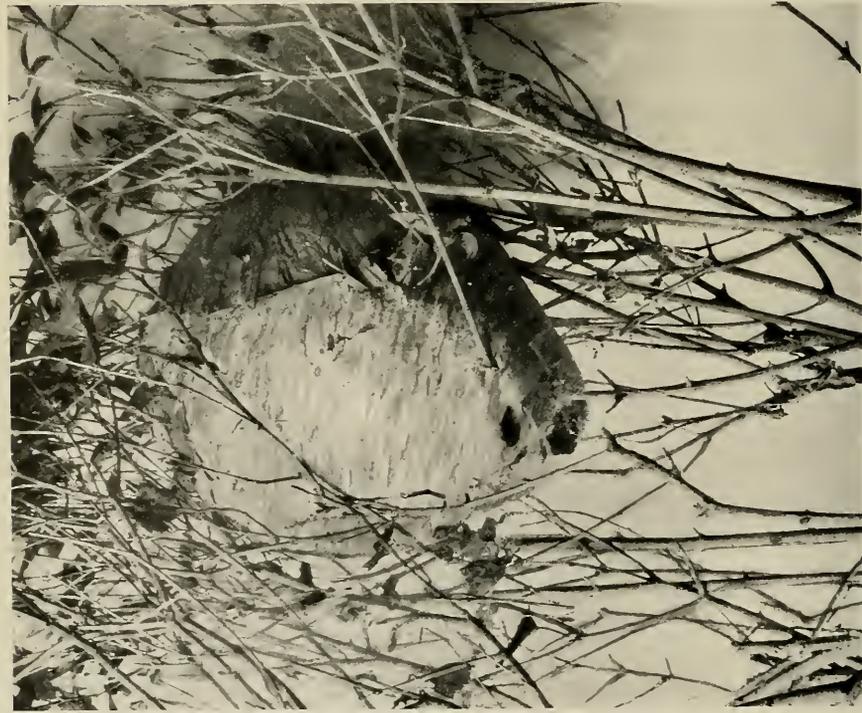
While the nests of *Polistes* are always constructed above ground, those of certain species of *Vespa* are located in hollows excavated in the earth. As a rule it is the short-cheeked forms that in North America and Europe dwell in the ground while the long-cheeked species build aerial nests. One of the large European species (*Vespa crabro*), which constructs its nest in hollow tree trunks and like places, made its appearance in this country in recent years. A colony of this wasp established itself on my place in New Jersey, occupying a bird house on a tree near a driveway. As the wasps created consternation among the neighbors, some one destroyed not only them but an opportunity for studying them.

To construct their nests many of our social wasps use paper made from small pieces of wood taken from old unpainted buildings, weather-beaten fence boards, and many other sources of supply, but *Vespa crabro* uses fresh wood. After being chewed into a pulp and mixed with saliva these scrapings are applied to the nest. It has been suggested that the idea of making paper from wood pulp was first conceived by human beings as a result of their observing the social wasps.

A colony of *Polistes* is usually started by a single female in the spring and, in temperate regions at least, it endures only until the fall. In similar fashion a *Vespa* community is begun by an overwintered queen. In both genera the queen first lays the foundation of a few cells and deposits in each of these an egg. She is obliged to forage for the larvæ that are hatched from these eggs but, when these larvæ finally pupate and emerge as adult workers, they relieve her of her miscellaneous duties by assuming in their turn the task of enlarging the nest and of feeding their younger sisters, while the queen confines her activities to supplying the eggs. The workers are imperfectly developed females. Only late in the season are eggs laid which produce males and fully developed females.

Save the new generation of females, all the members of the colony, including the old queen, die off at the approach of cold weather in the autumn, although there is record for southern United States of some unmated males

¹Illustrations from photographs by the author.



THE ENVELOPED NEST OF VESPA

This nest was found on a privet hedge. The paper covering of the nest (shown in its entirety on the left) was cut away to reveal the combs within. The wasps reverse the human method of construction, building their pendent nests from the roof basementward. The covering consists of many layers, with air pockets between. At the top of the nest here shown were eleven layers; at the right near the top, nine; over the remainder of the nest, only seven. The relatively greater number of layers above is perhaps due to the necessity for protection against the rain



THE EXPOSED NEST OF POLISTES

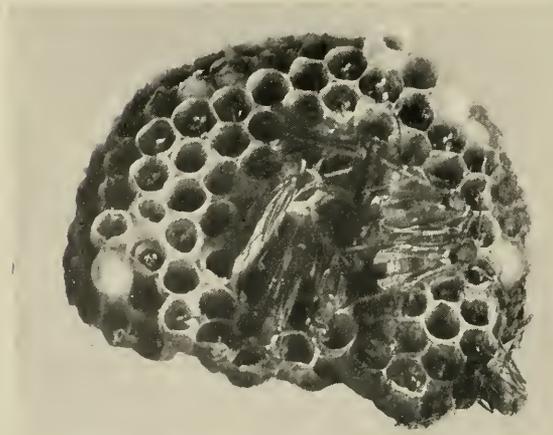
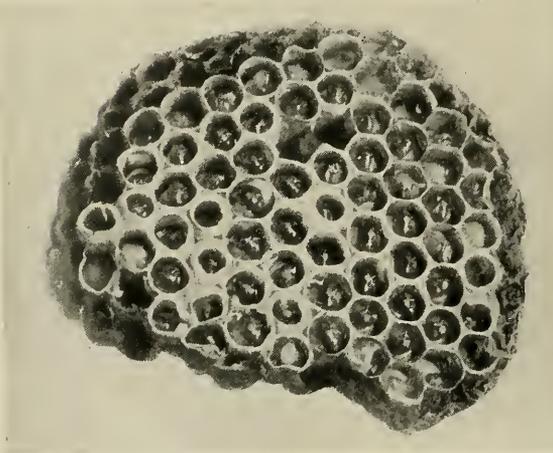
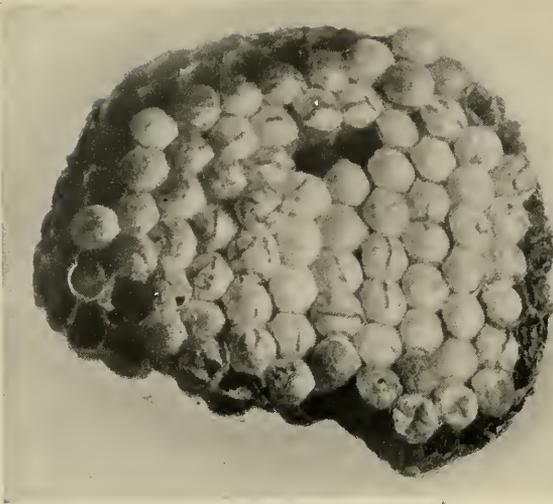
This nest was attached to an aster growing in a field. It was made secure by a gluey saliva which is also used for water-proofing the nest

A NEST OF POLISTES
DETACHED FROM
ITS SUPPORT

This nest, turned face upward, contained 135 cells. In each of the seventy cells covered with silken caps (top-most picture) was a pupa or a larva about to pupate. Many of the peripheral cells contained larvæ that had not yet spun their covering.

The silken caps were removed with a razor and the inmates of the cells exposed (picture in middle). In the topmost cell thus uncovered was a larva which set about spinning a second cap for its cell. Only about two-thirds of the exposed pupæ attained the adult stage.

The status of the colony three weeks later is shown in the lowest picture. Only six of the larvæ that occupied the outlying cells spun a covering and none of these emerged. The larva, previously referred to, that spun a second covering after the first had been sliced off reached maturity, as the conspicuous emergence hole in its silken cap gives evidence. Several adult wasps may be seen resting on the nest



of *Polistes* living over until spring.¹ The females hibernate and start new colonies the following year. In contrast to the social bees, which use honey and pollen as food for their larvæ, the social wasps supply their young with morsels of insects they have captured.

The nests of *Polistes* are usually in buildings although sometimes the wasp chooses a site in the open and attaches her nest to the branch of a tree or shrub. It has been suggested that *Polistes* at times appropriates old nests constructed by wasps of a previous year, and it is an established fact that these wasps will build new cells along the border of old nests. Social wasps are provident in using the cells of their own nest more than once, for after the occupant of a cell emerges as an adult the little compartment is cleaned and thereby made ready for the reception of another egg.

The nest depicted on p. 83 was found in a meadow and was attached to an aster over which twined a hog peanut (*Falcata*) partly concealing the nest. Within fifty feet of the site chosen was a rail fence which would have offered more ample protection, but the wasp apparently preferred the open.

As the *Polistes* wasps make their nests waterproof, it matters little where they locate them. These wasps may be seen walking over the nests and it is likely that in so doing they apply a gluey saliva for the waterproofing. The nests are smooth, somewhat shiny, and slightly sticky.

The nest shown on p. 84 was taken on August 26 and contained 135 cells. Seventy of these had been covered with silk by the larvæ preliminary to

pupation while a number of those along the periphery of the comb were open and contained larvæ. To ascertain whether the pupæ would develop normally under changed conditions,



When resting, the social wasps commonly fold their wings and this attitude is the one usually assumed also in death. The above photograph shows one of the species of *Polistes*, a genus readily distinguished from the familiar *Vespa* by its more slender waist. In disposition it is more gentle than the belligerent yellow jacket and, as the present article indicates, its nests with their living contents may even be transferred to the collector's home for observation, without undue risk of being stung. Photograph about natural size.

the silken coverings of seventy cells were cut with a razor, thus exposing the inmates. That these might be better observed the nest was inverted, so that the cells opened upward, as shown on p. 84 instead of maintaining their normal downward position.

From time to time during the next three weeks the wasps emerged from the cells. They were puzzled and seemed to have no idea as to their duties. Most of their time was spent

¹Brimley caught males of *Polistes* from November to March at Raleigh, North Carolina.

in walking over the cells and examining them. They made no attempt to fly away but after a few days they invariably wandered from the comb and failed to return to it, other wasps, as they emerged, taking their places. They would crawl up the wall of the room and, when the nest was held near one of them, she would return to it as though she were recovering some valued possession. This confusion was doubtless due to the fact that the nest had been moved to an unnatural location and not to the uncovering of the pupæ.

Not more than ten adult wasps were on the nest at any one time. Occasionally I would move them about with tweezers but they showed no resentment. They had had no nourishment and it is just possible that this may have so weakened them that they were not interested in anything about them.

On one occasion the nest was taken into another room and placed in the direct sunlight, whereupon all the wasps became very active. The nest was then placed out of doors in a strong sunlight and a few of the wasps flew away.

About one-third of the exposed pupæ died, and, as the workers supplied no nourishment to the larvæ, all of these also perished save six that were so far advanced that they spun their silken caps, but even these six failed to survive through the pupal stage. A larva (one of the seventy insects that were deprived of their silken coverings) spun a second canopy by way of replacing the one removed. It later emerged as a wasp.

The colony-forming habit of certain insects such as *Polistes* is one of the most interesting of the many fascinating phenomena of entomology. To be sure, it has been intensively studied by others, but there is much joy in seeing for one's self. That *Polistes* offers a favorable opportunity for such observations is evident from the facts that their nests are easily accessible to us (not underground, for example); that their activities are not under cover, as are those of the honey bee; and, not the least, that their temper is so mild that they and their nests may be safely taken even into our own homes, as is shown by the experiments to which I have just referred.



It looked as if "All the king's horses and all the king's men" could never make anything out of such a heap of scraps as this—the broken fragments of a vessel long buried in the ruins of an Indian village on Long Island. But a little patience and a pot of glue transformed chaos into shapeliness

Humpty Dumpty Outdone

A HEAP OF BROKEN POTTERY THAT TOOK SHAPE AS A BEAUTIFUL JAR

By ETHELYN G. NELSON

CATALOGUE No. 20-4571 described it as "200-sherds from other vessels," and the location was given as Pit 63, Trench 8, General Diggings, Port Washington, Long Island. It was, moreover, just as uninteresting a boxful of broken pottery as this description suggests. The sherds, spread out upon the work table in the laboratory, did not gain particularly in interest, but shed large quantities of Long Island dirt, later to be transferred to the hands—perchance to the faces—of those who handled the specimens. Anyone but an archaeologist would have incontinently dumped the whole lot into the nearest

garbage can and been thankful to rid himself of the mess.

But there was an attempt at decoration, in the form of incised lines, on a number of the sherds, and it was therefore deemed necessary to sort over the lot in the interests of that awesome thing, SCIENCE. Presently it was noticed that a few of the larger pieces looked as if they might be fitted together, and the archaeologist spent a little time following up this idea, with a view to ascertaining how many of the plain sherds it might be necessary to keep. He succeeded in matching up three considerable rim groups, which appeared to belong to two, perhaps



THE BOWL RESTORED

Piecing sherds together into a pot like this is easier, perhaps, than trying to reconstruct in imagination the life of those who first made and used it. The vessel, so crude and sharply contrasting with our modern ware, was no doubt an expression of the maker's highest endeavor. In fancy we see it, with pointed base sunk in the sand and steam rising from its mouth, as the Indian owner, with baby strapped to her back, lifts from the camp fire hot stones and drops them into it until the water boils to cook her food. The quiet of the Long Island shore, now disturbed by the constant whirl of the restless automobile, was then broken only by the lap of the waves or the tread of moccasined feet. Dome-shaped, grass-covered huts, now replaced by stately residences, then answered all the needs of the people and left undisturbed the wooded landscape. The arrow sped from the bow to furnish food for the pot without breaking the calm. But though we may mend the jar, which has lain crushed in the earth three hundred years or more, we cannot restore to Long Island that idyllic peace—and perhaps would not if we could

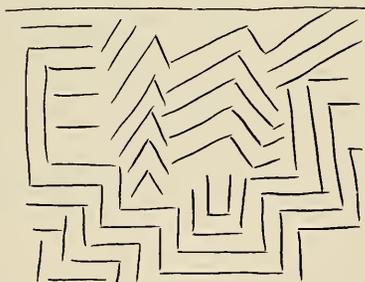
three, different vessels, and then turned the job over to the writer and awaited the result before the final discard.

Then the exciting game began. Do you recall how in the days of your youth you spent hours in putting picture puzzles together? The fascination comes again when mending a much broken piece of pottery, even when it is only a dirty old cooking pot from Long Island, guiltless of the artistic coloring which belongs to the vessels of the Southwest. You search and search for long minutes, and are about to give up in despair and declare that not another sherd will fit anywhere, when suddenly—ecstatic moment!—a piece slips into place and another section is on its way, leading to the discovery of various other small pieces which will fill in the crevices. And so one keeps on and on with almost the enthusiasm of a treasure hunter.

It did not take long to disclose the fact that most, if not all, of the sherds belonged to the same vessel. The in-

cised decoration differed on opposite sides of the rim and the thickness of the ware was very unequal, which had made it appear that two different specimens were present. Link after link was joined, until by noon of the second day a complete contact had been made around the body of what was developing into a large jar, presumably of Algonquin Indian manufacture. Only a few such pieces are in possession of the American Museum and it added zest to the adventure to know that a valuable specimen would be the outcome of our labor.

About this time Mr. Hoover, the preparator, became somewhat excited and undertook to fit in the many small pieces which might or might not compose the bottom portion of the jar. He was so successful that almost every one of the sherds found a place. It now remained only to fill the few vacant places with plaster and a fine conical vessel appeared where before had been but a heap of ugly sherds.





Photograph by B. E. Parke

PINES AND HEMLOCKS

The beautiful trees of Cook Forest, some of which were standing before William Penn conferred his name upon the forest wilderness that is now the state of Pennsylvania, deserve to be preserved, constituting, as they do, one of the few areas of primeval woodland to be found east of the Mississippi

Cook Forest

A TRACT OF PRIMEVAL WOODLAND THAT SHOULD BE
PRESERVED FOR ALL TIME

BY THOMAS LIGGETT

MUCH less than a century ago, from Minnesota to Maine the northeastern United States had many millions of acres of the best forests the world has ever known. Conifers and deciduous trees of all species natural to this region flourished here and the various types of wild life—whether fin, fur, or feathers—were abundantly represented. So bountiful was the supply that our forebears and many persons still living thought that it was inexhaustible, and the waste and extravagance of which they were guilty are comparable to those of the Prodigal Son. Now we, like he, must fall back on husks.

As illustrating the waste and lack of forethought,—walnut, now worth more than mahogany, was used for such base purposes as barn floors and stalls for cattle; oak, capable of being made into the finest products, was split for fence rails; cherry and birch, now nearly approximating mahogany in value, were popular fire woods. Hemlock was cut by many millions of feet; the bark was stripped and the trees were left in the woods (sometimes two and three deep as in the “big slashing” Forest County, Pennsylvania), to rot or burn and render the soil useless for reforestation purposes for many years to come. White pine, the best of the conifers, was cut and rafted to market. From ten to twenty dollars per thousand feet, board measure, was realized for timber that would today bring in the market \$200 per thousand as pattern wood.

So great and complete has this destruction been that today a grove of the original hemlock, the most beautiful of the conifers, or a grove of the original white pine, the most stately and spectacular of these trees, is a sight that repays one for taking a journey of many miles, and wherever such groves exist, they should be preserved for the

recreation and pleasure of the coming generations.

In northwestern Pennsylvania, sixteen miles from Brookville and Clarion, both of which are on the “Lakes to Sea Highway,” is what is known as “Cook Forest,”—a tract of 8200 acres on which is the largest body of old white pine conveniently located for the tourist and motorist to be found anywhere in the northeastern United States. In fact, it is the opinion of the writer that it has on it more of the old-growth white pine than is standing on all of the combined tracts of New England. In addition to the white pine there are stretches of as fine hemlock as ever grew and all of the deciduous species native to the region, including the various oaks, maples, birches, beech, cherry, ash, hickory, and walnut, as well as old cucumber trees, the fruit of which the early settlers were accustomed to put into a bottle of whiskey as a cure for all ills. Here grow also numerous wild flowers, ferns, and laurel. Wide stretches of rhododendron make of the woods great bouquets and garlands of beauty. No fire has ever occurred on the tract to mar its attractions.

On this property there are many spots that are both unusual and spectacular. It is a place not only recreational but educational. It has been well said that by keeping our people more closely in touch with nature we build a finer type of citizenship than is attained when they are surrounded uninterruptedly by the man-made environment of a city. This being true, it is the more important that spots such as Cook Forest should be preserved. Lord Ashfield, chairman of the London Underground Railway system, sees in the automobile, good roads, and opportunity through them to get out and see the beautiful in nature, some of America's greatest antidotes to



Photograph by B. E. Parke

AN ORIGINAL STAND OF HEMLOCK

Formerly hemlock was so plentiful that, according to the wasteful methods then prevailing, the bark was stripped from the trees and the denuded trunks were left to decay in the forest, or to serve as tinder in the path of some devastating fire. Today the preservation of a stand like this is a matter of far-reaching importance

Bolshevism, and if this claim be valid, how important it is that Cook Forest and similar tracts should be available for the use of the people!

A group of men, organized as the Cook Forest Association, with headquarters at 331 Fourth Avenue, Pittsburgh, and at the Franklin Trust Building, Franklin, Pennsylvania, are endeavoring to have the people, by popular contribution, raise a fund with which to buy this property from the Cook family, the members of which have thus far, both patriotically and altruistically, at much financial sacrifice to themselves, saved these trees; and then by deed of gift, with the proper regulations and restrictions embodied therein as part of the consideration, convey it to the commonwealth of Pennsylvania to be kept and preserved for the use of all the people. To have the commonwealth purchase it, is impossible. Neither the nation nor any state has thus far purchased *timber* but only cut-over land for reforestation purposes and, in any event, it is best that the state should hold it under the above-mentioned regulations and restrictions guaranteeing that these

trees shall survive.

Cook Forest will become a game sanctuary where wild life may thrive and be seen in its natural environment. On some abandoned farms scattered over the property game food could be planted in furtherance of this object. A trout stream known as Toms Run, which flows through the property for five miles, and the Clarion River, a branch of the Allegheny, which forms the frontage of Cook Forest for seven miles, offer opportunities for fresh-water life.

Excellent accommodations for the visitor are provided by Cook Forest Inn, which is the old Cook Homestead and its associated buildings, put to use by the Cook Forest Association. Already capable of accommodating about fifty people, it might in time become the nucleus of even more extensive quarters for guests.

Located as Cook Forest is within easy reach of so many millions of people—overnight from New York via the Pennsylvania Railroad, or from Chicago, by the New York Central—its preservation is a matter of interest, not only to Pennsylvania but to the whole northeastern United States.



Photograph by B. E. Parke

A section of Cook Forest along the Clarion River



Alert, yet motionless as a bronze statue

“The Sprite”

A REVIEW OF ERNEST HAROLD BAYNES' STORY OF A RED FOX¹

BY G. CLYDE FISHER

ALL lovers of animals will be delighted to learn that Ernest Harold Baynes has put another of his stories into book form. Its predecessors, *Polaris, The Story of an Eskimo Dog*, and *Jimmie, The Story of a Black Bear Cub*, are splendid tales, but *The Sprite, The Story of a Red Fox* is an even more masterly production. The reason is not far to seek,—Mr. Baynes loved The Sprite best of all his wild animal companions, and he has given us the intimate biography of a friend, yet has avoided humanizing his subject. Without being over-sentimental, his account makes a strong appeal to our sympathy.

It begins with the babyhood of The Sprite and paints a wonderful picture of his life during the two years that he was a member of the Baynes'

household. The following paragraphs of the preface may be quoted for their revelation of the author's rich response to the interest and beauty of wild life:

I wish it were possible to tell you what I feel about foxes—the sensations which come when I see one in the open. I hold my breath; my clothes feel too small for me; I can hardly speak. It is much the same feeling that I should have were I suddenly to come upon a fairy. There is such beauty in his form and coloring—such grace and poetry in his motion—such mystery in his coming and his going. I have never known anyone to describe successfully the movement of a fox. Perhaps it is one of those delicate things which words will not describe. At times it might be simulated by a ball of tawny fur blown swiftly along, close to but not quite touching the ground; at others by a puff of reddish smoke, at one moment seen distinctly, then melting softly into the landscape. It is subtle as the passing of the shadow of a cloud across a field of waving grain.

¹*The Sprite, The Story of a Red Fox* by Ernest Harold Baynes. With many illustrations from photographs by Louise Birt Baynes and the author, and an Introduction by Dallas Lore Sharp. Published, 1924, by The Macmillan Company.

And think of such beauty coming into one's life in the person of a fox that loves you. It is an experience as rare as it is beautiful, and we are deeply grateful that it has been ours. If anyone else has had such an experience I have never heard of it. For nearly two years, The Sprite, a wonderful specimen of his race, as his photographs will show, was a guest in our home. Part of that time his wife and babies were also guests. Usually he came and went as he chose, and he made for himself a place not only in our hearts, but in the hearts of our neighbors.

It is with mingled feelings that I undertake to tell the story. There is joy at the thought of trying to write it, and regret in the realization that I cannot do it justice. At the very outset I am aware that I cannot convey to my readers the peculiar joy which The Sprite brought to us. But if I can make them love him, and other foxes for his sake; if the love I create is strong enough to save even a few foxes from bitter struggles and death in the steel traps—from the indignity of adorning the thoughtless, I shall have done as much perhaps as I can hope for.

The tale is a true one, and for that

reason is a valuable contribution to animal psychology, but its scientific worth is not its greatest claim to distinction, nor is the vividness of the author's language. The special fascination of the story is not scientific or literary at all, but purely human. We are told much to arouse our interest in the fox and, as is inevitable, we learn much about the story-teller, who has done so much for animals.

Mr. Baynes is a dependable naturalist who sees straight, and who writes with a "pen which not only accuracy governs but imagination inspires."

The book is illustrated with many superb photographs by the author and Mrs. Baynes, and the Introduction was written by Dallas Lore Sharp. It is a worthy addition to the literature for young readers, and grown-ups who still have the heart of youth will enjoy it no less.



Waking up with a yawn

NOTES

EXTINCT ANIMALS

MR. BARNUM BROWN, associate curator of fossil reptiles, American Museum, returned to this country on the "Aquitania," January 1, after five years spent in continuous exploration, chiefly in southern Asia, in the islands of the Mediterranean, and in Greece. He left the Museum April 16, 1919, with the immediate object of exploring the Siwalik Hills of India, as already reported in *NATURAL HISTORY*. After most successful exploration in all the levels of the great Siwalik formation, dating from the Middle Miocene to the early Pleistocene, he journeyed to Burma and reconnoitered some of the classic localities along the Irrawaddy River, first made known through the explorations of J. Crawfurd in 1826. The formations extend from Upper Eocene into Middle Miocene times and, while they are scattered and do not yield fossils superior in quality, they afford a most interesting vista of the kinship between the Upper Eocene life of Burma and that of Mongolia to the north-east, and of the Middle Miocene life of Burma as an outlier of the Middle Miocene zoölogy of India. All this exploration was conducted under the generous patronage of Mrs. Henry Clay Frick.

The fossils which have arrived from India are in superb condition and not only include a considerable number of forms new to science but also more perfectly preserved specimens of some of the known forms than have hitherto been available. These finds greatly amplify and extend our knowledge of the mammalian life of India in Tertiary times. Mrs. Frick has recently added to her previous generous gift a contribution sufficient to complete the preparation and exhibition of these superb Siwalik animals.

During his trip Mr. Brown contracted a very severe jungle fever, which threatened his life, and he was saved only through the constant and intelligent nursing of Mrs. Brown, who attended him throughout his illness.

Upon recovering, he went to the Mediterranean islands and remained especially on the island of Samos, where he procured a collection of mammalian fossils representing the Lower Pliocene period of time in the eastern Mediterranean region. He then returned to Athens, where permission to send these fossils to the American Museum was obtained,

chiefly through the aid of Mrs. Mary White Tsiouras. Afterward he journeyed to Macedonia, where he made a reconnaissance and discovered a number of fossil localities; he also worked in the caves of the island of Kalymnos. Before returning to America, Mr. Brown traveled through Europe, visiting chiefly the museums of Italy, France, Belgium, and Great Britain, and made arrangements with several of these institutions for future interchange of material.

Upon arriving at the American Museum Mr. Brown was warmly welcomed by the members of the palæontological staff and conducted to his new office on the top floor of the Asiatic hall, facing Central Park.

In the March-April issue of *NATURAL HISTORY* will appear an account from Mr. Brown's own pen of his field experiences in India.

DR. SANTIAGO ROTH, chief of the palæontological department of the Museo de La Plata in Argentina, died August 4, 1924. Doctor Roth was born in Switzerland but emigrated to the Argentine about fifty years ago and for some time was engaged in collecting for the Swiss museums. A fine collection of Argentine fossil mammals made by him is now in the Zurich Museum. He took an active part at that time in the discoveries of fossil human remains associated with the extinct Argentine mammals and in the controversies that raged over the problem of their antiquity. Subsequently, on the founding of the great natural history museum of La Plata, he was placed in charge of the palæontological collections and held that position for nearly thirty years, devoting himself to the care of these collections and to field work and researches upon Argentine fossil mammals and the stratigraphy of the formations in which they are found. His studies upon the Pampean and underlying formations and upon the Notoungulata, extinct hoofed animals of South America, are his most important contributions to science. He wrote equally well in German and Spanish and the high quality of his work made him a much respected figure in South American palæontology. The American Museum is indebted to his good offices for a valuable series of casts of South American fossil mammals received

as an exchange. Among these are the skeletons of *Macrauchenia* and *Toxodon* in the hall of the Age of Man.—W. D. MATTHEW.

FOSSIL MAMMALS FROM ST. PETERSBURG, FLORIDA.—In March, 1924, while the guest of Mr. Walter W. Holmes, of St. Petersburg, Florida, I visited the site of the old Indian village, where a great series of human skeletons, pottery, and other remains have been excavated by the Smithsonian Institution under direction of Dr. J. Walter Fewkes. Doctor Fewkes very courteously showed us the excavations and discoveries, and discussed the prospects for future archaeological research in Florida.

In this connection Mr. Holmes showed me a small plaque that he had picked up on a hunting trip in the outskirts of the city, and that had impressed him as being of a very curious and unusual pattern. I recognized it as a plate of an armored edentate, probably *Chlamytherium*, and at his suggestion we went out to look over the locality and see if other fossil remains could be discovered. We were fortunate in finding many fragments of fossil bone.

After I left for the north, Mr. Holmes continued the search at this site and at other points that seemed to be promising, and made a considerable collection, fragmentary but representing a dozen or more mammalian species, for the most part extinct, besides crocodile, turtle, fish, and even a few bird bones. His finds include:

Elephant (<i>Elephas</i> cf. <i>Jeffersonii</i>)	fragments of teeth
Mastodon (<i>Mastodon</i> cf. <i>Americanus</i>)	" "
Horse (<i>Equus complicatus</i> ?)	teeth, vertebrae, and foot bones
Tapir (<i>Tapirus</i> sp. indesc.?)	teeth
Deer (<i>Odocoileus</i> sp.)	teeth, limb, and foot bones
Pocket gopher (<i>Geomys</i> cf. <i>floridanus</i>)	lower jaw
Wood rat (<i>Neotoma</i> sp.)	" "
Hare (<i>Lepus</i> cf. <i>floridanus</i>)	" "
Tusked deer (<i>Smilomeryx holmestii</i>)	tusk and upper molars
(new genus and species)	
Bison (<i>Bison</i> sp.)	teeth and foot bones
Raccoon (<i>Procyon</i> sp.)	teeth and parts of jaws
Opossum (<i>Didelphis</i> sp.)	parts of lower jaws
Giant armadillo (<i>Glyptodon</i> sp.)	scutes
Giant armadillo (<i>Chlamytherium</i> sp.)	scutes, part of tooth
Armadillo (<i>Dasybus</i> sp.)	scutes
Turkey (<i>Meleagris gallopavo</i>)	part of leg bone
Alligator (<i>Alligator</i>)	limb and foot bones, vertebrae, scutes
Turtles (<i>Terrapene</i> ?)	fragments of shells
Turtles (Trionychid)	" "

In addition to these finds, there were shark and ray teeth as well as fish spines, which still await determination.

¹Identified by Dr. Alexander Wetmore, to whose courtesy the American Museum is indebted for many identifications of fragmentary fossil birds.

This is a Pleistocene fauna, comparable to the fossil fauna found at Vero, west of Palm Beach, where fossil human remains were also secured. Whether these human remains from Vero were really of the same age as the fossil fauna of that locality has been questioned, and Mr. Holmes's intention is to make a very careful and critical search at the St. Petersburg site, so that if any traces of man should be found associated with its extinct fauna, the exact occurrence may be examined and fully recorded. Whether or not any human remains are discovered, it will be of advantage to know more about the extinct mammals, which include at least one of interest, a tusked deer, not hitherto found in the Pleistocene of the New World, although primitive ancestral types (*Blastomeryx*) existed in the Western Tertiary.

Mastodons and mammoths, horses and bison, tapirs, deer, opossums, and raccoons, are found in Pleistocene formations all over the country, and the last five animals still survive,¹ although the tapirs are limited to Central and South America and the bison is nearly extinct. Glyptodonts were predominantly South American, and in North America have been found only in the Southern States westward to Texas and in Mexico, while fossil remains of Chlamydothères have been located only in Florida, Brazil, and Argentina. Armadillos still live in South and Central America and Mexico, and range into southern Texas. Fossil armadillos have been found in Florida but nowhere else in the United States.

The absence, in Mr. Holmes' collection, of camels, ground sloths, peccaries, and other animals listed as found at Vero may indicate that the St. Petersburg fauna is of later age geologically, or more probably is an accident due to the small number of animals thus far secured.—W. D. MATTHEW.

RUSSIAN EXPLORATION NEAR TURGAI, TURKESTAN.—Dr. Serge d'Oldenbourg, perpetual secretary of the Académie des Sciences de Russie, in conveying to Prof. Henry Fairfield Osborn the diploma signaling his recent election as a corresponding member of the Academy, writes that an expedition sent out by that organization is continuing with great success excavations in the region of Turgai, where the type of the giant *Indricotherium* (close relative of *Baluchitherium*) was secured.

¹The domestic horse is, of course, an importation from the Old World and the reference by implication to the horse as one of the extinct animals applies not to this familiar beast of burden but to the fossil horses found in America.

M. Bajarunas will soon render a report of these new excavations.

Meanwhile the department of palæontology, of the American Museum, has received from the Academy a number of valuable casts of the limb and foot bones of *Indricotherium*, a rhinoceros slightly exceeding in size the type specimen of *Baluchitherium grangeri* found in Mongolia and described in a recent number of NATURAL HISTORY.¹ The American Museum is also indebted to its sister institution in Leningrad for a fine skull and many parts of the skeleton of the extremely primitive reptile known as *Pariasaurus*, from the Northern Dvina River. The Museum has sent in exchange for the *Indricotherium* casts a fine cast of the skull of *Baluchitherium* and is now negotiating with the Leningrad museum for the balance of the very ancient skeleton of *Pariasaurus*.

BIRDS

DR. ROBERT CUSHMAN MURPHY, assistant director of the American Museum, sailed on Thanksgiving Day for South America, where he is devoting three months to field work. His expedition was made possible through the generosity of the following five friends of the Museum: Mr. James B. Ford of New York, the Misses Case of Weston, Massachusetts, Mr. Charles H. Taylor of Boston, Mrs. Zechariah Chafee of Providence, and Mr. F. Gilbert Hinsdale of Mattapoisett, Massachusetts.

Doctor Murphy's first objective was the Third Pan-American Scientific Congress, which convened late in December at Lima, Peru. Mrs. Murphy, who is accompanying her husband, attended the meetings of the Second Conference of Pan-American Women, in session at the same time.

Following the meetings in Lima, it was the plan of Doctor Murphy to proceed to Ecuador to resume his ornithological and oceanographic field work from the point where he had discontinued it in 1920. The former investigations were made along some seven hundred miles of the Peruvian coast and are described in Doctor Murphy's book, *Bird Islands of Peru*, just issued by G. P. Putnam's Sons. This is a work of popular geographic character which explains the causes behind the unparalleled abundance of marine life along the coast of Peru, and describes the modern guano traffic of that country, said to be the greatest of all industries based upon the conservation of wild animals.

¹Issue for May-June, 1923, pp. 208-28.

The coast of Peru is washed by the northward-flowing Humboldt Current, which is somewhat analogous to our Gulf Stream except that it carries cold instead of warm ocean waters. At the northern end of the country, or just south of the Gulf of Guayaquil, this oceanic stream departs from the continent and flows westward across the equatorial Pacific. At this point the relatively heated tropical water of the Ecuadorean coast begins, and stretches northward toward the Bay of Panama. The temperature of the sea is so much higher than that of Peruvian latitudes that the life of these two regions is almost totally different.

Doctor Murphy and Mr. Van Campen Heilner, who was scheduled to join him in Ecuador about January 1, 1925, plan to work in small craft from the port of Guayaquil to the Colombian border, visiting each of the Ecuadorean ports, recording ocean temperatures along lines perpendicular to the shores, and gathering data on the rate and direction of the oceanic circulation. They will also make collections of the small organisms that inhabit the waters, and will study the marine fishes and fishery methods of Ecuador. Moreover, they will make a collection of sea birds and determine the northern limits of the ranges of the many species of water fowl which appear to be more or less exclusively confined to the cool waters of the Humboldt Current.

THE WHITNEY SOUTH SEA EXPEDITION.—The director of the American Museum has received a cordial letter from the Governor of the French possessions in Oceanica, thanking the Museum for a recent donation of birds to the Museum of Papeete and commending Mr. Rollo H. Beck for his conduct of the Whitney South Sea Expedition. A translation of this letter is appended:

To the Director of the
American Museum of Natural History
SIR:

In your letter of August 15 you kindly informed us that you were sending to the Museum of Papeete nineteen specimens of Polynesian birds, mounted at the museum in New York.

With the same steamer came your shipment, in excellent condition; and for it we express our full measure of gratitude.

These birds which you have presented to our museum will be placed in a special exhibition case, with a label indicating that they are the gift of the museum in New York, and that they were collected by Mr. Rollo H. Beck.

We hope some time to complete this little collection. It already includes several speci-

mens which today are very difficult to procure and our Société d'Études Océaniques will take great interest in receiving the publications dealing with the ornithological discoveries made in our islands by the Whitney Expedition.

In closing, we wish to assure you that we have always been highly pleased with the perfect courtesy shown by Mr. Rollo Beck during his stay among our islands.

Kindly accept, Mr. Director, this assurance of my distinguished consideration.

THE GOVERNOR OF THE
FRENCH POSSESSIONS OF OCEANICA.

ERRATUM.—In alluding to the election of Mrs. Walter W. Naumburg as a member of the American Ornithologists' Union, mention was made (NATURAL HISTORY, November-December, 1924, p. 722) that this distinction had been conferred previously upon only two other women. The number should have read four, Mrs. Olive Thorne Miller (deceased) and Miss Althea R. Sherman having been omitted inadvertently.

MAMMALS

NED HOLLISTER, since 1916 superintendent of the National Zoological Park at Washington, D. C., and one of the world's foremost mammalogists, died on November 3, after an operation. Mr. Hollister had experienced ill health at times during the past few years but hardly any of his friends realized that his condition was so critical. His death was an unexpected shock to all who knew him, and natural science has suffered a great loss.

Mr. Hollister was born November 26, 1876, at Delavan, Wisconsin, where he was educated and began the study of zoölogy, which was to become his life work. His first important zoölogical field work was for the Bureau of Biological Survey. From 1902 to 1909 he made investigations in Texas, New Mexico, Alaska, British Columbia, Washington, Oregon, California, Utah, Nevada, Louisiana, and Arizona. In 1910 he was appointed assistant curator of mammals in the United States National Museum, and his connection with the Smithsonian Institution lasted until his death.

Other field work included the exploration of the Mount Robson region of British Columbia and the adjoining area of Alberta in 1911, and the Altai Mountains, Siberia, and Mongolia in 1912, which he visited as a member of the Smithsonian-Harvard Expedition.

Mr. Hollister's work always received the favorable attention that is given to expressions of authoritative opinion. He was one of the

organizers of the American Society of Mammalogists and, under his guidance as editor, the *Journal of Mammalogy*, the publication of the Society, assumed an important position among publications devoted to the study of mammals. Mr. Hollister issued many papers. In addition to more than one hundred minor articles on zoölogical subjects, he wrote important larger works, such as "The Birds of Wisconsin" (1903); "A List of Mammals of the Philippine Islands" (1912); "Mammals of the Alpine Club Expedition to the Mount Robson Region" (1912); "East African Mammals in the U. S. National Museum" (Vol. I, 1918; Vol. II, 1919; Vol. III, 1924). Fortunately for natural science, Mr. Hollister had completed the report on the large African collections a short time before his final illness deprived the world of his services, and the last volume of the report had issued from the press before his death.

Progress and constructive activity marked Mr. Hollister's term of office at the National Zoological Park. No effort was spared to improve living conditions for the animals under his care and he brought to his work a nature which was in full sympathy with his charge. The number of visitors to the park increased steadily and reached a total of 2,400,000 for the last year. The collection of animals within the park became greater in number and in scientific interest than ever before.

Mr. Hollister belonged to many scientific societies and held many honors conferred by these societies. He was a fellow of the American Association for the Advancement of Science, a member of the Biological Society of Washington (president, 1921), of the American Ornithologists' Union, of the Washington Academy of Sciences, of the American Society of Mammalogists (editor), and of the Cosmos Club, and an honorary member of the Sociedad de Estudios Biológicos of Mexico.

Mr. Hollister's likeable personality made him many personal friends, who will mourn his untimely departure. The loss to the American Society of Mammalogists is especially great, since he occupied such an important rôle in the Society, not only as editor of the journal but as an active and moving spirit in every enterprise of the organization. Finally, the whole field of natural history regrets the passage of a man of whom so much that is good may be written and so little that one could find to criticize.—
H. E. ANTHONY.

NOTEWORTHY ADDITIONS TO THE ASIATIC MAMMAL COLLECTIONS.—The great plans of the American Museum for the appropriate exhibition of Asia's magnificent fauna in the newly erected hall have attracted wide attention. The splendid series of Indian mammals presented to the Museum by the Faunthorpe-Vernay expeditions and those of the more

than 8000 feet, offer it a natural protection. Yet some years ago even such wary game was in danger of being wiped out by reckless shooting parties. Since then the government has taken a keen interest in the preservation of the herds and as a result they have again become more numerous.

Doctor Vail, provided with letters of



Courtesy of Dr. C. E. Vail

"Pillar Rocks" near Kodia Kanal, Madura District, India, where the Nilgiri tahr is to be found

northern region collected by the Asiatic expeditions of the Museum are gradually being rounded out.

Dr. C. E. Vail, a surgeon of the American Presbyterian Mission Hospital in southern India, when passing through New York, was inspired by President Henry Fairfield Osborn to secure a group of one of the more interesting mammals of which the Museum was still in need.

The Nilgiri tahr or, as sportsmen often call it, the "Nilgiri ibex" (*Hemitragus hylocrius*) is one of the few wild goats occurring in the tropics. It frequents the hill ranges of southwestern India, from the Western Ghats, Nilgiris, and Anamalais, practically to Cape Comorin. The picturesque, precipitous mountain fastnesses, which attain altitudes of more

introduction from the Museum, received the most cordial aid of the district forest officer, Mr. Saw, and was able to secure his quarry, but only after undergoing the severe hardships necessarily experienced in tramping about the haunts of the tahr.

Through the blackness of night he and his guides followed the edge of cliffs that seemed impassable in daytime. Often they had to hang on for dear life with both hands and both feet. Only gradually can one acquire assurance for such dangerous climbing. But even then there is the constant anxiety lest one dislodge loose stones under foot. Should a boulder suddenly slip and leap down, one may lose his hold, or, at the least, its crashing may startle the game. Yet, after laboring over the craggy walls, what a glorious

feeling to reach camp on the higher levels! One takes a few hours' rest, and wakes to see, appearing through the lifting mists and dazzling in the early sunlight, the vistas of tree tops and ranges of hills, with rolling grass country beyond.

Once a fatality was avoided by a hair's breadth. In their hurried flight the goats loosened a rock six inches in diameter. It came leaping down to the very place where but a moment before the party had been.

Through his persistence and marksmanship Doctor Vail secured four specimens. One of them, a splendid old male, has horns almost fifteen inches in length, which come close to being the best ever recorded.

The Nilgiri tahr is the only species of tahr having a short coat of rather uniform length. The tahr that lives in the mountains near Muscat, in southeastern Arabia, strangely enough, is more closely related to the Himalayan species than to that of the Nilgiris, having a harsh, shaggy coat much elongated on the nape, withers, throat, and parts of the limbs. But though much smaller in size than the Himalayan species, it has longer horns, rather less knotted, and in this respect, at least, resembles more closely the Nilgiri tahr.

Another gift from Doctor Vail is a remarkably large black Nilgiri hill monkey, *Pygathrix (Presbytiscus) johni*, the largest yet received. Doctor Vail hopes that in his spare time he may add to the Museum's Indian material some further specimens that may prove of equal value.—H. LANG.

FISH

A NEW TOP MINNOW FROM BRITISH GUIANA¹ is described by Mr. G. S. Myers in a recent number of the American Museum *Novitates*. The Pœciliidæ, or top minnows, include some rather pretty forms, prized highly by persons interested in aquaria for their ornamental and hardy qualities. Their fine health in captivity and generally long life under artificial conditions are undoubtedly due to their natural liking for quiet stretches of water. Although some of these fish occur near the shores of the sea, most of them live in brooks, or in the calm waters beneath overhanging branches along the banks of larger streams, or in the practically stagnant pools of swamps and their ditches. Fishes of

this family are of great importance in mosquito control.

The six fishes from British Guiana belonging to the new form *Rivulus mazaruni* were found as virtual captives between the rocks in one of the puddles left by the subsiding floods at Mutusi Hole, a rapid of the Mazaruni River. At this romantic spot, travel is greatly impeded, much time being lost in hauling the boats across the dangerous places. Thus, during a halt, the writer, on his way to the interior in 1922, had a chance of securing these specimens. It seems rather surprising that *Rivulus mazaruni* is apparently the first fish described from the Mazaruni River, a great western affluent of the Essequibo River, into which it flows, together with the Cuyuni, about forty miles from the mouth of the main stream.—H. LANG.

MR. JOHN T. NICHOLS, associate curator of recent fishes in the American Museum, has contributed the article on "Zoology" to *The Americana Annual*, 1924,—a digest of current events that is issued each year in continuation of *The Encyclopedia Americana*.

A MARINE COLLECTION FROM THE ARCTIC

In the summer of 1924, Captain Robert A. Bartlett accompanied the revenue cutter "Bear" on her cruise to Bering Sea and the adjacent Arctic Ocean, his purpose being to secure scientific data which would be of interest in connection with the further exploration of far northern waters. Whenever opportunity offered, he used a dredge, and by its means made a collection which he has since presented to the American Museum. The specimens are mostly invertebrates, especially crustaceans, mollusks, ascidians, and the like. Many of these are new to the collection of the Museum, which has had comparatively little material from the region. After a preliminary sorting it was found that the collection of invertebrates comprises 375 lots, each lot containing from one or two to many specimens each. Several species of fishes were also included,—sculpins, the snake blenny (*Lumpenus*), spotted kelp blenny (*Stichæus*), *Aspidophoroides guntheri*, eel pouts, post-larval gadoids, etc. Dr. F. Johansen of Ottawa, at present engaged in a revision of the fishes of the Arctic Ocean, found this material of much interest when visiting the Museum recently.

¹"A New Pœciliid Fish of the Genus *Rivulus* from British Guiana." *Novitates*, Amer. Mus. Nat. Hist., No. 129, 1924, pp. 1-2.

EDMUND OTIS HOVEY

A signal tribute has been paid to the memory of Dr. Edmund Otis Hovey, late curator of geology and invertebrate palæontology, American Museum, in the adoption of the following Resolution, an attractively printed copy of which was presented to the American Museum. It will be appropriately framed and permanently placed in the office of the curator of the department of geology

THE DEATH OF EDMUND OTIS HOVEY HAVING BEEN ANNOUNCED AT THE MONTHLY MEETING OF THE BOARD OF TRUSTEES OF FIELD MUSEUM OF NATURAL HISTORY, HELD OCTOBER 20, 1924, THE FOLLOWING RESOLUTION WAS ADOPTED AS A TESTIMONIAL OF HIS SERVICES TO SCIENCE AND MUSEUM PRACTICE.

THE BOARD OF TRUSTEES OF FIELD MUSEUM OF NATURAL HISTORY HAVE LEARNED WITH DEEP REGRET OF THE DEATH OF DOCTOR EDMUND OTIS HOVEY, FOR MANY YEARS CURATOR OF GEOLOGY OF THE AMERICAN MUSEUM OF NATURAL HISTORY.

DURING A LIFETIME DEVOTED TO MUSEUM SERVICE, DOCTOR HOVEY DISPLAYED TO A REMARKABLE DEGREE COMBINED QUALITIES OF A MASTER AND OF AN INTERPRETER OF SCIENCE. NOT ONLY WERE HIS CONTRIBUTIONS TO SCIENTIFIC KNOWLEDGE MARKED AND VALUABLE BUT HE WAS EQUALLY CAPABLE IN MAKING THEM OF PUBLIC INTEREST. HIS WORK OF MUSEUM INSTALLATION, TOO, WAS CHARACTERIZED BY ORIGINALITY AND EFFECTIVENESS. HE WAS A LEADER IN DEVISING NEW METHODS OF MUSEUM DISPLAY AND A PIONEER IN SUPPLEMENTING SYSTEMATIC COLLECTIONS WITH EFFECTIVE GROUPS. HE WAS ALSO A PLEASING AND AUTHORITATIVE WRITER AND AN ENTERTAINING AND INSTRUCTIVE LECTURER. IN HIS OCCASIONAL VISITS TO FIELD MUSEUM, DOCTOR HOVEY WAS ALWAYS READY FOR THE EXCHANGE OF IDEAS, BEING FREE TO GIVE OR RECEIVE WHATEVER VIEWS HE BELIEVED MIGHT ADVANCE THE CAUSE OF MUSEUM REPRESENTATION OR AID IN THE GENERAL DIFFUSION OF KNOWLEDGE.

TO OUR SISTER INSTITUTION AND DOCTOR HOVEY'S BEREAVED FAMILY, THE BOARD OF TRUSTEES EXTEND THEIR SINCERE SYMPATHY AND HAVE ORDERED A COPY OF THESE RESOLUTIONS SPREAD UPON THE RECORDS OF THIS INSTITUTION.

STANLEY FIELD,
PRESIDENT

D. C. DAVIES
SECRETARY AND DIRECTOR

EUROPEAN ARCHÆOLOGY

EOLITHIC ORNAMENT AND ART.—An extensive review of Hugo Obermaier's *Fossil Man in Spain* was published in the issue of NATURAL HISTORY for November–December, 1924, and, in view of this fact, Mr. J. Reid Moir, who contributed the leading article to the same issue, has asked that the following letter be printed in the magazine:

To the Editor of
NATURAL HISTORY,

Sir,—

In the English translation, just published, of Prof. Hugo Obermaier's book *Fossil Man in Spain* (Yale University Press for Hispanic Society of America), I notice that, on page 9, the following statement appears—"But some among them—Boucher de Perthes, Dharvent, Newton, Thieullen, and J. R. Moir—went further, and proclaimed the existence of Eolithic ornament and art."

This, so far as I am concerned, is entirely incorrect. I have never "proclaimed" a belief in the existence, in any form, of Eolithic

ornament and art, nor do I consider that evidence which would make such a belief inevitable has, at present, been discovered.

In view of the fact that, in all probability, Professor Obermaier's book will be widely read in America, I think it to be necessary to make the above correction.

Yours faithfully,

J. REID MOIR

"Tertiary Man in England."—In the Note on J. Reid Moir's "Tertiary Man in England" contributed by Sir E. Ray Lankester to the issue of NATURAL HISTORY for November–December, 1924, there is a typographical error that gives a different significance to one of the statements from that which the author had intended. The sentence, which finds place on p. 654, should read:

This latter had a molluscan fauna, in many respects identical with that of the deposits distinguished by the name "Pliocene."

As originally printed the word "marine" was substituted for "name."

RECENT GATHERINGS AND EVENTS

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE held its seventyninth meeting at Washington, D. C., from December 29, 1924, to January 3, 1925. As usual a number of valuable papers—the result of research in many different branches of science—were presented; those contributed by members of the American Museum staff included the following:

"The Significance of Insect Sounds" by Dr. Frank E. Lutz; "The 'Retrograde Metamorphosis' of the Sirenidæ; Experiments on the Functional Activity of the Thyroid of the Perennibranchs" and "The Integumentary, Pulmonary, and Cardiac Modifications Correlated with Increased Cutaneous Respiration in the Amphibia" by Dr. G. K. Noble; "The Classified Continuation Card Catalog of *The Bibliography of Fishes*" and "The Distribution of the Oilfish, *Ruvettus pretiosus*, in the Pacific Ocean, as Shown by the Peculiar Hook Used in Its Capture" by Dr. E. W. Gudger; and "Pottery of Northeastern Asia and Northwestern America" by Dr. Waldemar Jochelson.

To the great regret of those attending, Prof. Henry Fairfield Osborn was unable to deliver his announced address on "Factors in the Evolution and Phylogeny of the Proboscidea."

Dr. Frank E. Lutz and Dr. Clarke Wissler were the official representatives of the American Museum at the gathering, and Doctor Wissler attended also the two-day conference

of the National Research Council on problems in human migration, at which he had an opportunity of presenting the results of the investigation he has been making, in association with Dr. Louis R. Sullivan and Dr. Milo Hellman, into the question of race crossing and heredity.

DR. FRANK M. CHAPMAN represented the American Museum at the Conference on Outdoor Recreation, which was held in Washington on December 11 and 12.

DR. CHARLES D. WALCOTT, secretary of the Smithsonian Institution, represented the American Museum at the annual reception and exhibit of the current work of the Carnegie Institution of Washington, held on the evening of December 11.

THE YOSEMITE MUSEUM.—The cornerstone of the Yosemite Museum,¹ in Yosemite National Park, was laid on November 16, 1924, and on the same day the new administration building was dedicated.

NEW MEMBERS

Since the last issue of NATURAL HISTORY the following persons have been elected members of the American Museum, making the total membership 8039:

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¹For a more detailed Note regarding this projected museum the reader is referred to the issue of NATURAL HISTORY for September-October, 1924, p. 621.

WILLIAM ERIC FOWLER, ERNEST T. FRANCK, AMOS TUCK FRENCH, E. R. GRANT, HARRY K. GRIGG, J. W. GUTMAN, HOWARD S. HART, FREDERICK ROWLAND HAZARD, W. W. HOFFMAN, T. C. HOLLANDER, MAURICE HOOPES, NORMAN S. HOPE, EDWIN C. HYMAN, ROBERT HATFIELD IRONS, GEORGE B. JOHNSON, MAX S. KALLMAN, GEORGE L. KUMPF, S. FERRY LAUCKS, HENRY D. LINDSLEY, SOLOMON LOWENSTEIN, CHARLES MARX, ROBERT W. MAYNARD, JULES NEHRING, HAZARD OKEY, SCHUYLER L. PARSONS, H. GALLATIN PELL, TIMOTHY NEWELL PFEIFFER, WM. PAUL PICKHARDT, FREDERICK PUTNAM PLATT, THEODORE ROSENWALD, CLINTON L. ROSSITER, H. S. ROWLEY, EDWARD WHEELOCK RUNYON, LIONEL SCHUSTER, W. C. SPRUANCE, REGINALD H. STURGIS, SPENCER TURNER, D. D. VAN MATER, ERNEST ALAN VAN VLECK, GILBERT C. WOOD; MASTER ROBERT BENDHEIM, MASTER NORTON SKINNER; HARLEM ACADEMY.

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THE MARCH-APRIL ISSUE

In the next number of *Natural History*, the reader, instead of having his interest concentrated on a single continent, will be given an opportunity to range over a wider field, making acquaintance with interesting phenomena the world over. Mr. Barnum Brown, leader of the Siwalik Hills Indian Expedition of the American Museum, will tell of his experiences in collecting fossils under the burning sun of the Orient. Dr. E. W. Gudger will contribute an article on "Cats As Fishermen," dispelling the illusion that all Toms and Tabbies are afraid of the water. There will be an article by Mr. Herbert P. Whitlock on "Mimicry of Minerals" and one by Dr. Robert H. Lowie on "A Women's Ceremony among the Hopi." Prof. William T. Shaw will present some of his field observations of the hoary marmot and Mr. Frank Levy will tell how he trained a falcon. The reader will be made acquainted with two-headed snakes through an article by Mr. B. T. B. Hyde. The value of palæontology will be emphasized by Dr. William D. Matthew. Through an article by Dr. F. E. Lutz a better conception will be had of the significance of some of the insect groups recently installed in the American Museum.

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AUTUMN AND SPRING COURSES OF POPULAR LECTURES

Series of illustrated lectures, held in the Auditorium of the Museum on alternate Thursday evenings in the fall and spring of the year, are open only to members and to those holding tickets given them by members.

Illustrated stories for the children of members are told on alternate Saturday mornings in the fall and in the spring.

MEMBERS' CLUB ROOM AND GUIDE SERVICE

A room on the third floor of the Museum, equipped with every convenience for rest, reading, and correspondence, is set apart during Museum hours for the exclusive use of members. When visiting the Museum, members are also privileged to avail themselves of the services of an instructor for guidance.

THE AMERICAN MUSEUM OF NATURAL HISTORY has a record of fifty-five years of public service, during which its activities have grown and broadened, until today it occupies a position of recognized importance not only in the community it immediately serves but in the educational life of the nation and in the progress of civilization throughout the world.

Every year brings evidence—in the growth of the Museum membership, in the ever-larger number of individuals visiting its exhibits for study and recreation, in the rapidly expanding activities of its school service, in the wealth of scientific information gathered by its world-wide expeditions and disseminated through its publications—of the increasing influence exercised by the institution. In 1924 no fewer than 1,633,843 individuals visited the Museum as against 1,440,726 in 1923 and 1,309,856 in 1922. All of these people had access to the exhibition halls without the payment of any admission fee whatsoever.

The **EXPEDITIONS** of the Museum have yielded during the past year results of distinct value. The collections made by Mr. Arthur S. Vernay in new areas of Burma, Assam, and Siam, and by Mr. Barnum Brown in southern Asia and the Mediterranean region of Europe; the studies of Andean avifauna pursued by Dr. Frank M. Chapman in Chile; the excavation of fossil sites in Florida and Texas by Dr. William D. Matthew; the extensive survey of Polynesian bird life conducted by the Whitney South Sea Expedition; the work pursued in selected faunal areas of Ecuador by Mr. G. H. H. Tate; the field observations and collections made in Panama by Dr. Frank E. Lutz and Mr. Ludlow Griscom; the underwater studies of reef life at Andros Island carried out by Dr. Roy W. Miner; the notable journey of Dr. G. Clyde Fisher and Mr. Carveth Wells to Sweden and Lapland; and the preparations made for the continuation of the brilliant work of the Third Asiatic Expedition during the coming five years—these (and the list might be extended) are among the notable achievements of the past twelve months.

The **SCHOOL SERVICE** of the Museum reaches annually about 7,000,000 boys and girls, through the opportunities it affords classes of students to visit the Museum; through lectures on natural history especially designed for pupils and delivered both in the Museum and in many school centers; through its loan collections, or “traveling museums,” which during the past year circulated among 433 schools, with a total attendance of 1,247,914 pupils. During the same period 598,132 lantern slides were loaned by the Museum for use in the schools as against 440,315 in 1923, the total number of children reached being 5,407,525.

The **LECTURE COURSES**, some exclusively for members and their children, others for the schools, colleges, and the general public, are delivered both in the Museum and at outside educational institutions.

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The **SCIENTIFIC PUBLICATIONS** of the Museum, based upon its explorations and the study of its collections, comprise the *Memoirs*, of quarto size, devoted to monographs requiring large or fine illustrations and exhaustive treatment; the *Bulletin*, issued since 1881, in octavo form, dealing with the scientific activities of the departments, aside from anthropology; the *Anthropological Papers*, recording the work of the staff of the department of anthropology; and *Novitates*, devoted to the publication of preliminary scientific announcements, descriptions of new forms, and similar matters.

For a detailed list of popular and scientific publications with prices apply to:

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DEVOTED TO NATURAL HISTORY,
EXPLORATION, AND THE DEVELOP-
MENT OF PUBLIC EDUCATION
THROUGH THE MUSEUM



MARCH-APRIL, 1925

[Published April, 1925]

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NATURAL HISTORY

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The Invertebrate Number

Beginning with the number for May-June, 1925, NATURAL HISTORY for a period will be issued by various departments of the Museum, thus giving an opportunity to present to our readers in each case a series of articles emphasizing a special field of natural history.

The May-June number will appear under the editorship of Dr. Roy W. Miner, curator of lower invertebrates, and will be devoted in the main to these humble creatures, which constitute biologically so large a proportion of the animal kingdom. Often these creatures are of minute size and relatively unknown to many people.

Mr. Frank J. Myers will introduce the reader to those strange inhabitants of fresh-water pools known as rotifers, the animals with "wheels in their heads," too small to be seen except with the aid of a microscope, but so numerous that a drop of pond water may contain hundreds of them. Prof. Ulric Dahlgren, of Princeton, will describe the organs of hearing among some of the lower forms of life, especially the katydid, which have "ears in their shins." Mr. Herman Mueller, the expert glass blower of the Museum, will initiate the reader into the marvelous process of glass-blowing, by means of which one of the most interesting Museum groups, representing a half inch of pond bottom with its associated life magnified one hundred times, is now being constructed. Dr. Willard G. Van Name will show how in that strange group of animals, the ascidians, evolution appears to have taken a step backward. Dr. E. W. Gudger will describe some curious habits of the hunting spiders. Mr. William M. Savin will picture the remarkable moth, *Pronuba*, and its strange relationship to the flowers of the *Yucca* plant. Mr. Barnum Brown, who has just returned from a five years' journey to the Far East, will relate some of his interesting experiences in Burma, in connection with which he has brought back many striking photographs, a selection from which will be reproduced. Dr. Roy W. Miner will tell how the tiny coral animals of tropical seas gradually build up immense coral reefs to become islands fit for the habitation of man.

There will be a series of duotone illustrations depicting exhibits in the Darwin hall, noteworthy because of their beauty and faithfulness to nature.

It is hoped that in this or a subsequent number, Dr. W. K. Gregory may review Professor Osborn's new book entitled *Impressions of Great Naturalists*. This will be supplemented by a short article by President Osborn on "The Born Naturalist." The May-June number will contain also a vivid description of the animal life and vegetation of a cactus desert of the Southwest, contributed by De Lancey Verplanck.



WHERE A SHORT DISTANCE WAS A LONG WAY

In the Upper Siwaliks near Siswan an elephant skull weighing a ton was found in a place accessible only to men on foot. So that the skull might be carried out, borne on poles to the cart awaiting it a mile beyond, the winding stream bed along which the porters struggled with their load had to be filled in wherever unevennesses occurred

Glimpses of India*

INCLUDING AN ACCOUNT OF THE FIELD EXPERIENCES OF THE SIWALIK HILLS INDIAN EXPEDITION OF THE AMERICAN MUSEUM

By BARNUM BROWN

Associate Curator of Fossil Reptiles, American Museum

IN the days of clipper ships, when traveling was arduous, voyagers returning from the Far East were wont to bring back marvelous stories of the countries visited: religious rites, fakirs, gorgeous pageantries; things so different from western experience that none could hear without wishing to see. None of the tales were more startling than those coming from India.

Many of the early descriptions savor of the *Arabian Nights*, for India is typical of the East, where time moves slowly. Today is like yesterday or the day before in rural parts; hence the contrast so vivid to westerners. One may still see the same conditions that surrounded the great Mogul emperors, even back to the days of Gautama Buddha, whose cult has long since moved eastward.

We of the American Museum staff have long cherished the hope that some day our halls would be enriched from India, and the Museum explorations in China and Mongolia made it increasingly more important that we should have a representative collection of fossils from the famous Siwalik Hills of India, and the lesser known areas of Burma. The generosity of Mrs. Henry Clay Frick made these hopes possible of realization, and it was with keen satisfaction that I received the appointment from President Osborn to carry on work in these regions.

Calcutta, where I hoped to establish

relationship with officials of the Geological Survey of India, was my immediate objective, but Bombay is the first port of call from the west, and the rail journey of 1500 miles separating these great ports saves time and gives an opportunity of seeing the central part of this vast empire, remnant of ancient Gondwana land.¹

One unacquainted with India through a personal visit may think the term "empire" grandiloquent, but no other word can adequately encompass this vast area, with its 300,000,000 people, more diverse in race, religion, and language than combined Europe.

A few hours in Bombay afford time for little more than a hasty visit to the Museum of the Bombay Natural History Society, which is doing such admirable work in India, and a drive to the Towers of Silence, the Parsi place of the dead. A considerable part of the population is made up of Parsis, whose tenets are not to pollute the elements fire, earth, or water; wherefore the dead are placed in towers, to be disposed of by vultures. It was a happier thought to watch the evening strollers, the women draped in multi-colored toga-like *saris*, as brilliant as the flowers they cast upon the waters.

At first it is rather startling to learn that you must carry your bed every-

¹For a map of the ancient land masses that subsequently united to form the Asiatic continent, the reader is referred to p. 134 of the article "The Discovery of an Unknown Continent," by Henry Fairfield Osborn, *NATURAL HISTORY*, March-April, 1924.

where, on railway journeys and in most hotels. Wherever you go, there are countless servants, but none to do your bidding unless under personal hire. No white sahib may carry even a small package; indeed few want to where service is so cheap, and reduced railwayfaresandhotel charges are provided for servants. If your stay is long enough, by process of elimination you acquire a good retinue—cook, personal servant, and the like, *ad lib*.

Midway between Bombay and Calcutta in the Central Provinces lies the favored hill station, Jubbulpore. It was here that so long ago as 1828 a British officer, Captain (later Major General) Sleeman, first discovered dinosaur bones in India. This deposit, of middle Upper Cretaceous age,

has been examined subsequently and many bones have been recovered, chiefly those of large sauropods, which are of more than passing interest from the fact that their placement indicates that the life of these giant reptiles was here prolonged to a later geologic date than is evidenced by discoveries in other parts of the world. The American Museum was enriched by representative specimens from this horizon.

The rail journey across central India is not attractive in views, nor

does one sense the density of the population in the country traversed. Most of the inhabitants cultivate the soil, but there are neither fences nor single houses to mark individual ownership. Villages upon villages, unpretentious in appearance and of monotonous occurrence; temples far and near!

As we cross the Vindhya Mountains, not made up of peaks and jagged scarps, but harder remnants that have resisted erosion on a long, stable surface, we begin to sense the great time periods involved, and nature's influence on this passive people; whose fate it is to be born, to live, and to die in unchanged caste. From these mountains came many of the diamonds that give luster to history and fable. The "Great

Mogul," the "Orloff," the "Koh-i-noor," the "Pitt," all came from India.

Mr. Guy E. Pilgrim, head of the palaeontological department of the Geological Survey, was away on field duty in the northern states when I arrived in Calcutta, but a letter bade me join him in camp on a date that gave ample time to investigate along the way.

Calcutta as a municipality is no more distinctly Indian than New York is American. There are parts



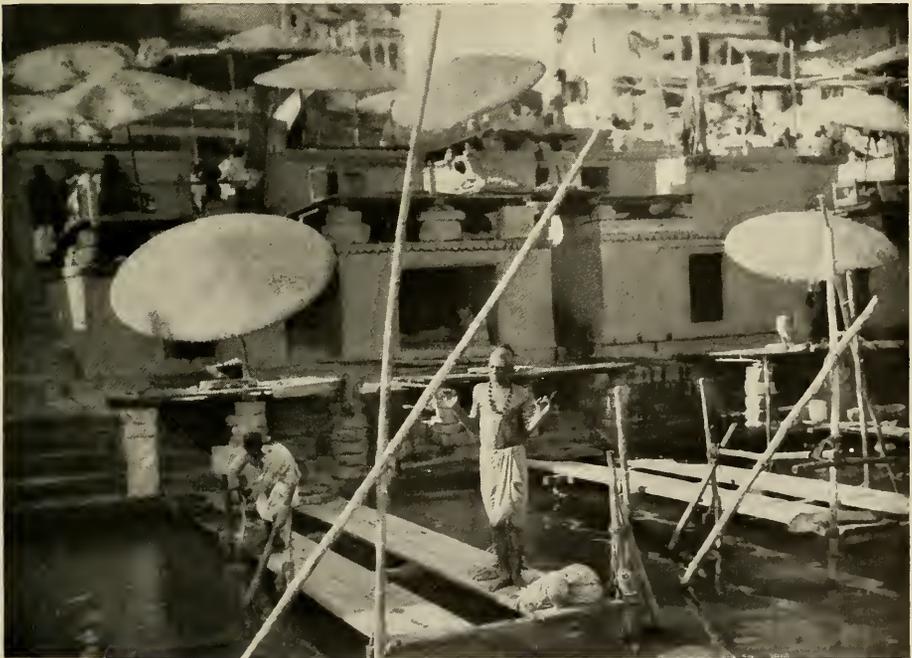
Mr. Brown and his Mohammedan leader, locating the next camp.—Faithful as a right hand, punctilious as a major, solicitous as a mother, Abdul Aziz smoothed many a hard way for his master

purely British and parts purely Bengali, but there is little of admixture. A vibrant stir and a quickening pulse make one realize that here is the commercial center of India. The Hooghly River is filled with shipping; there are broad avenues and beautiful edifices. You pass down Clive Street, with magnificent bank buildings to right and to left, a dense moving crowd on either side; suddenly you stumble over a huge bull lying on the sidewalk chewing its cud leisurely, oblivious of the hurrying throng, and you remember that you are in the Hindu country of the Sacred Bull.

Northwest of Calcutta in the provinces of Bihar and Orissa, a night's ride by rail, lie some of India's extensive coal fields, Carboniferous and Permian in age. Overlying them are broad exposures of Triassic sand-

stones, where early Survey workers found remains of labyrinthodonts, fishes, and dicynodont reptiles. Near Asansol my search was rewarded by the discovery of bones representing most of the forms already described and some not heretofore known.

No part of India holds so much of historical interest for the traveler as the Punjab, that northern province drained by the five great tributaries of the Indus, and the United Provinces watered by the Ganges. It was in the latter region on the banks of the Rohini, not far from the present city of Gorakhpur, that Gautama Buddha was born between five and six hundred years before Christ. A few monuments and building basements made by his faithful followers are still to be seen at Sarnath, near Benares, and at Taxilla, near Rawalpindi; but here



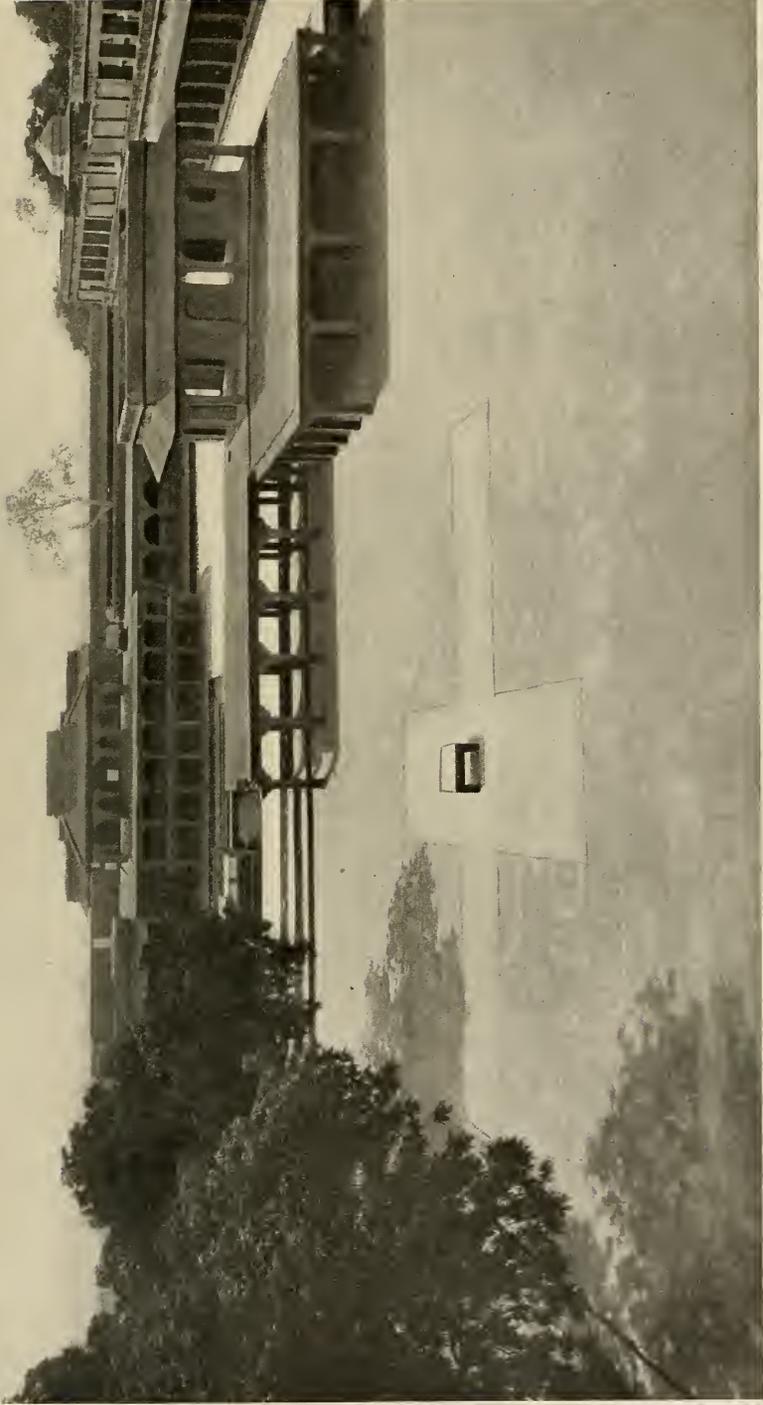
A section of the waterfront in Benares.—The ascetic in the foreground stands all day with hands uplifted, his face to the sun. Another, in front of him, remains prostrate, venerating the sacred river. Bands of pilgrims arrive constantly and the river front always presents a festal appearance



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"PEARL OF THE ORIENT"

Neither photographs nor words can adequately portray this greatest of monuments, the Taj Mahal, tomb of Mumtaz, wife of Emperor Shah Jahan. It is a fitting and perfect expression of a great love for a woman



Copyrighted 1925 by Barnum Brown

AUDIENCE HALL AND QUEEN'S APARTMENTS AT FATEHPUR SIKRI

In every detail this palace of Akbar, the Great Mogul, is as perfect as when constructed and abandoned more than three hundred years ago. From the bench in the foreground the emperor played *parehisi*,—his board, the pavement; his figures, slave girls

Buddhist temple bells no longer tinkle in the evening breeze.

Benares is on our way, and to visit it, is worth a long journey, even if one is not a pilgrim of the faith. To the Hindu, Benares has come to mean as much as Mecca means to the Mohammedan. We do not quarrel with the Hindu belief by saying Benares beggars description. Criticism is rather of the ignorance of the great mass of people who venerate the idols instead of treating them as symbols, as their faith teaches. The British long ago put



A human ant in the Himalayas.—With enormous weights balanced over the hips, the hill people trudge over mountain trails at elevations where walking is an uncomfortable exertion for a white man. One day Mr. Brown met a man carrying a pine log twelve feet long, squared eight by twelve inches

a stop to the practice of throwing baby girls to the alligators and burning widows on the funeral pyres of their husbands, but the burning ghats are always alight, for it is the desire of all Hindus to die and be burned here, their ashes to be scattered over sacred Mother Ganges. Golden temples;

myriads of stone temples; masses of people bathing along the river and drinking the water, while now and then a half-charred corpse floats by,—such is Benares. A holy man sits on a pier all day, dipping up water with one hand, pouring it out with the other; another sits cross-legged on a bed of spikes. You look through a temple door and see a woman pouring milk over a lingam, the symbol of Siva; another anoints it with oil; still another drapes it with flowers. One leaves Benares without regret.

Agra, Delhi, and Lahore were cities of great importance during the Mogul periods, as they are today, and the marble buildings, mosques, and mausolea scattered through this section bespeak the splendor, wealth, and achievement of their builders. No monument in existence surpasses the Taj Mahal at Agra, mausoleum of Muntaz, wife of the Emperor Shah Jahan; it is a lacework conception in marble, perfectly executed.

The palace in the fort at Delhi conjures up the thought of its great splendor when inhabited by emperors. Delhi, the present winter capital of India, is the seventh city of its name, and in the environs one may drive through forty miles of city potter's field. Mausolea and mosques in close proximity; cities of the dead and dead cities!

A few miles away lies Fatehpur Sikri, peopled by the ghosts of yesterday; a unique city of red sandstone buildings created and abandoned by Akbar more than three hundred years ago, but still in a perfect state of preservation as though the court had left but yesterday.

Simla, in the middle Himalayas, 8000 feet above the sea, is the summer capital, where duplicate copies of

important government papers are kept, so that only the personnel needs to shift, finding in either capital the data for conducting uninterruptedly the state business. Not until a summer is spent on the plains does one appreciate this advantage of migration. The higher Himalayas rise to the north in cold grandeur, but lack the majestic peaks seen farther east. Rickshaws and ponies take the place of carriages, while heavy loads are carried by the hill people,—an admixture of Tibetans and Nepalese. One marvels at the weights carried. Boxes, bales, huge building timbers, even pianos are transported by one man. Nothing seems to daunt these sturdy human ants.

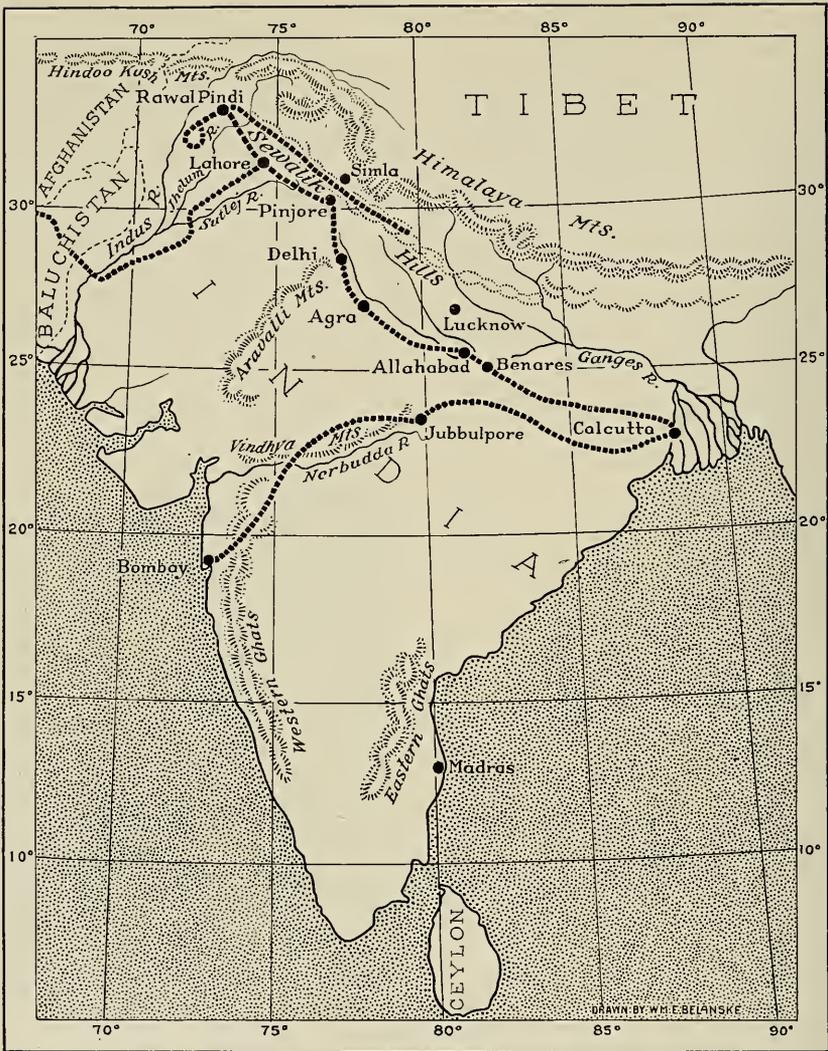
After a seventy-mile ride over low mountain ranges I joined Doctor Pilgrim in a government bungalow at Hari Talyangar, in the Bilaspur hill state. It was a pleasure to meet this distinguished gentleman who has done so much to unravel India's later geologic history. His hearty coöperation was assured, and it was of greatest importance to my work to be guided by his experience in determining characteristic rocks and their faunas, and to map out areas to be examined.

The journey across central India and along the lower ranges of the Himalayas affords a wonderful insight to its geology, the outstanding features of which are at once apparent. Briefly the Indian region may be analyzed as three distinct units: (1) a triangular mainland plateau named by the Indian geologists "the Peninsula"; (2) the mountainous region which borders it on the west, north, and east, called "the Extra-Peninsula"; and (3) the Indo-Gangetic Plain separating the two former areas. Stratigraphically and physiographically the first two divisions are entirely unlike.

(1) Since the Cambrian Period the Peninsula has been a stable land mass which has suffered but little disturbance in the great earth revolutions that have occurred from time to time. It is this part that is thought to be a fragment of a former continent called Gondwana land, which extended across the present Indian Ocean, uniting the Malay Archipelago with Australia and western Africa. Mantles of terrestrial deposits were locally distributed over parts of this area during the periods succeeding the Cambrian, and toward the close of the Cretaceous the south and central part of the Peninsula was covered by a thick series of lavas called the Deccan Traps. From the absence of craters and the horizontally-bedded sheets of material, it is evident that the eruptions came through fissures and cracks made by the movement of great earth blocks. Along the coast near Bombay the Traps reach a maximum thickness of nearly 10,000 feet and they encompass an area of 200,000 square miles, but formerly they covered an area estimated to be not less than 500,000 square miles.

Throughout the Peninsula most stratified rocks lie in a comparatively horizontal position, while mountain eminences are merely harder remnants of the surface that have resisted erosion. The rivers are shallow waterways meandering to the sea.

(2) The Extra-Peninsula, the Himalayan region, in contrast, is composed chiefly of marine deposits representing all the great geologic periods, including and succeeding the Cambrian; a comparatively weak, flexible area of the earth crust that has undergone an enormous amount of upheaval and compression during late geologic periods. All strata show high angles of dip, and extensive thrusts and faults



Map of India, showing the route of the Siwalik Hills Indian Expedition of the American Museum

attest the enormous strain to which these rocks have been subjected. The mountains are mighty serrated folds with deep transverse gorges; the rivers, rushing torrents. No less than nine of the great Himalayan peaks reach a height of more than 25,000 feet, Mount Everest, 26,002 feet, being the highest in the world. At one point in Kashmir the Indus rushes through a narrow defile between precipices 20,000

feet in height, while the river bed is only 3000 feet above sea level; thus this stupendous gorge is 17,000 feet, more than three miles, in depth.

(3) Between the Peninsula and the Extra-Peninsula lies the third great Indian feature, the Indo-Gangetic Plain, a sagging part of the Peninsula, or possibly an enormous rift fronting the Himalayas and filled in with river clays and silts that have been borne

down from the mountains by rivers tributary to the Indus and the Ganges. The abrupt termination of the foothills and the transition to far-reaching level plains in some parts of the Punjab, is startlingly sudden.

It is in this foothill region of rapidly accumulated deposits that our chief interest lies. Here and in the inlying Salt Range were preserved the remains of the varied Miocene, Pliocene, and Pleistocene vertebrate faunas.

Having just spent a year in Africa, sometimes near the equator, I rather pooh-poohed the suggestion that a white man could not work in the open the year round in India, so much farther north. Doctor Pilgrim, however, insisted that some parts of the Punjab were hazardous for a white man in summer, especially along the Indus, so I planned to spend the remaining winter months and early spring in the Bugti section of Baluchistan, and afterwards take up the Siwalik subdivisions in succession, reserving those of the highest elevation for the hottest weather.

I again proceeded across the northern part of India to Jacobabad, near the Bugti country, where first were found bones of the gigantic Miocene rhinoceros, *Baluchitherium*.

One always writes ahead for the use of a bungalow, and from the Sibi district came word not to leave for the field until I had seen the commissioner. Arriving at Sibi during a durbar I met the nawab of the Bugtis, who at first gave reluctant permission to work in his territory, provided I took a large armed escort. This agreed to, he later flatly refused responsibility. A year before an American oil geologist, with his party, had been murdered in his territory by raiding Pathans, for which the nawab was assessed 50,000

rupees, and he "didn't care to pay for another one."

I was loath to give up this part of the plan, but official correspondence with the government elicited no better results than permission to carry on the work at some future date. An expedition at the moment involved too many possibilities of a political nature.

Britain's suzerainty in India is held largely by her military administration, and her absorption of the borderlands is slow but sure. Highways and railways are built and maintained with military forethought. The borders of Afghanistan and Baluchistan on the northwest have long been the scene of conflict, for these untamed people do not take kindly to the assimilation process.

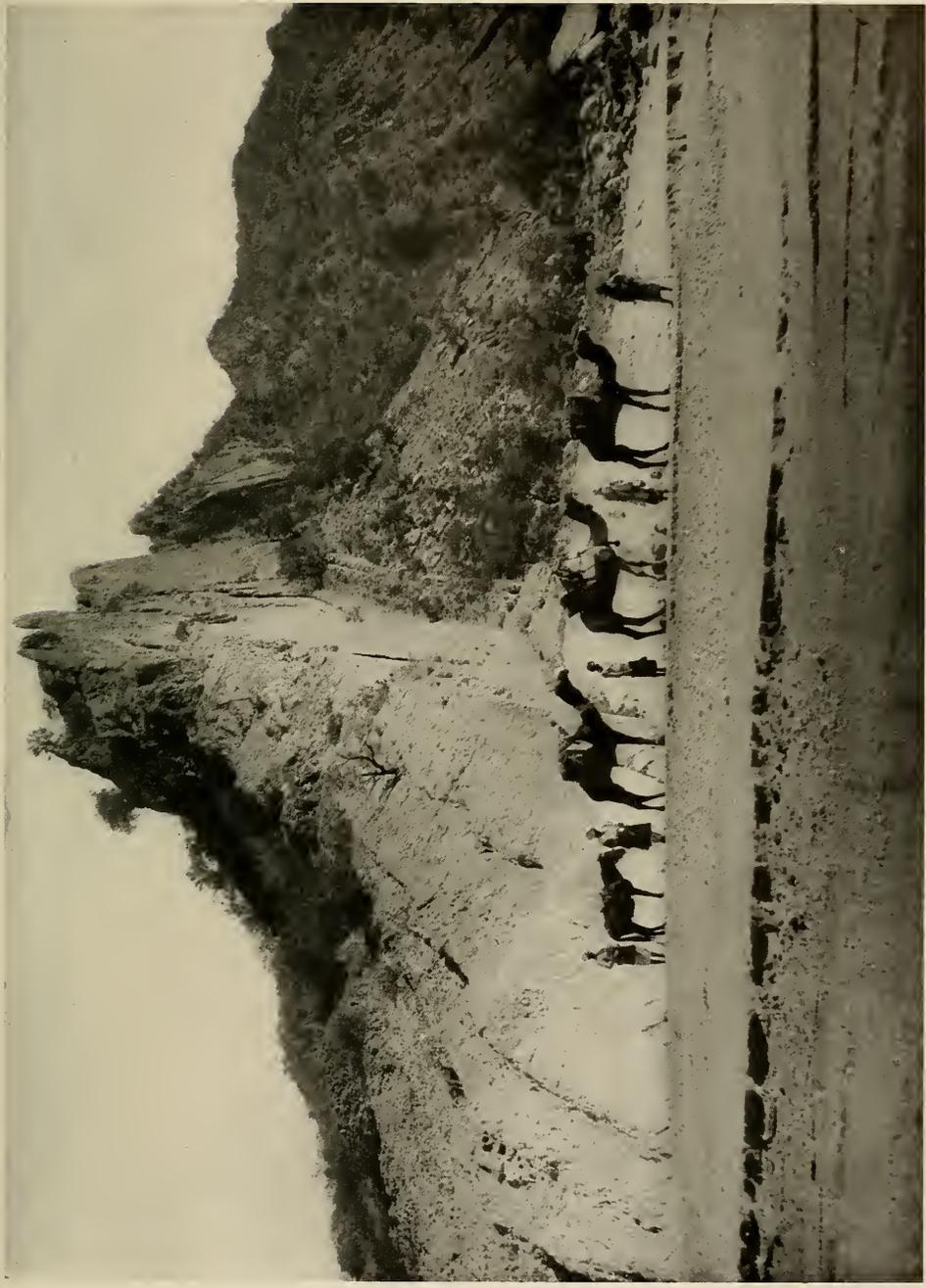
Jacobabad was long a frontier station, but now the military have moved westward, and the surrounding country is under irrigation, with ditches fed by the Indus. Magnificent neem trees contrast with the sandy desert outside, and the crops show the great possibilities of irrigation. Fat sheep and cattle and swift Arab-bred horses were a welcome sight after the underfed animals of other parts. Even the people reflect their improved condition, aside from the fact that the Baluchis and Afghans are more virile than the central Indian peoples. Temperature charts kept over a long period at this point record a usual maximum summer heat of 129 degrees. It is one of the hottest places in the world, although at the time of my visit in March it was delightfully cool.

Back I traveled to the northern sections; from Rawalpindi it was but a short distance to Chakwal, where a camel caravan was gathered for my three journeys to the Lower and Middle Siwalik exposures of the Salt Range.



THE MARKET PLACE IN JACOBABAD

The distinguished British general, John Jacob, for whom the town was named, spent many years quelling anarchy in the Upper Sind, built the Residency, and here lies buried under a massive tomb



THE CARAVAN OF THE EXPEDITION IN THE DILJUBBA RUKA PASS

For many miles east and west the range can be crossed only at this point, where the rock strata stand on edge

The Chakwal region was then suffering from an epidemic of bubonic plague. At such times the villagers scatter to the country, living along the trails wherever shelter is afforded.

As one journeys southeastward, the trail winds through cultivated lands, and through the pass of the Diljubba Ruka Hills, where several hundred feet of variegated marine rocks underlying the Siwalik strata are exposed. At

River, a second well-known area of Middle Siwalik exposures near Dhok Pathan.

The weather had now become excessively hot, and I was grateful to be permitted to live in a government dak bungalow, an institution worthy of mention. Throughout India, and to some extent in Burma, various government departments, such as the Police, Public Works, etc., have built bunga-



A large *Mastodon* skull in situ.—Specimens of this size were guarded from the natives night and day

Hasnot the broken country assumes a lighter orange-buff color, and in the surrounding exposures have been found many fossils of Middle Siwalik age. The ground had been worked over not long before, and fossils were not nearly so numerous as they doubtless were originally. However, skulls and jaws were obtained, chiefly of the smaller forms. Satisfying myself that this area had little more to offer, I proceeded northward a hundred miles to the Soan

lowlands at points convenient for the traveler. Some are fine, costly buildings, furnished throughout and, where use demands, frequently comprising from one to six complete separate suites. By arranging beforehand any civilian may obtain permission to occupy one of these suites for a limited stay at a regulated small charge, usually one rupee per day (about thirty cents).

Some of the best fossils were found at Dhok Pathan, including horse and



The big mastodon skull starts west at last.—It took four bullocks and twenty-one men fourteen days to “worry” it to the railway, sixty miles away

Mastodon skulls, the latter presenting no inconsiderable difficulties to transport. Camels are wonderful beasts for carrying loads up to six or eight hundred pounds, but a fossil elephant or *Mastodon* skull far exceeds their capacity. Due to the rough country two of these skulls were exceedingly difficult to bring out, each requiring four bullocks to pull, and twenty-one men to push the cart in which it was conveyed after a road had been made for several miles.

The only oil so far produced in India, a limited supply, comes from the Orbitoidese measures underlying the Lower Siwaliks at Khoar, a few miles northward.

Further search at Dhok Pathan added nothing new to the collection, which now included most of the known species, and I proceeded southward to the Lower Siwalik exposures at Chenji. These strata are predominantly reddish in color, and very broken, with fossils most abundant in two upper zones stratigraphically several hundred feet apart. Vertebrate remains, however,

are found occasionally down almost to the point of contact of these strata with the underlying marine beds. The strata gradate into overlying Middle Siwalik sandstones without sign of interruption in their deposition. Few of the species are common to the overlying sandstones, but after some little experience in the field one can readily distinguish the two horizons although there are no lithological characters to separate them.

The natives cultivate patches all through the exposures and they rather resented the activities of a Sahib who went out to find fossils himself; consequently a guard had to be placed over every large specimen that required more than a day to excavate. No matter how rugged or difficult the place, I would soon see spectators perched on the high peaks, where they would remain for hours. In spite of explanations the natives could not understand why bones were collected for a museum. When asked one day what they supposed the Sahib did with



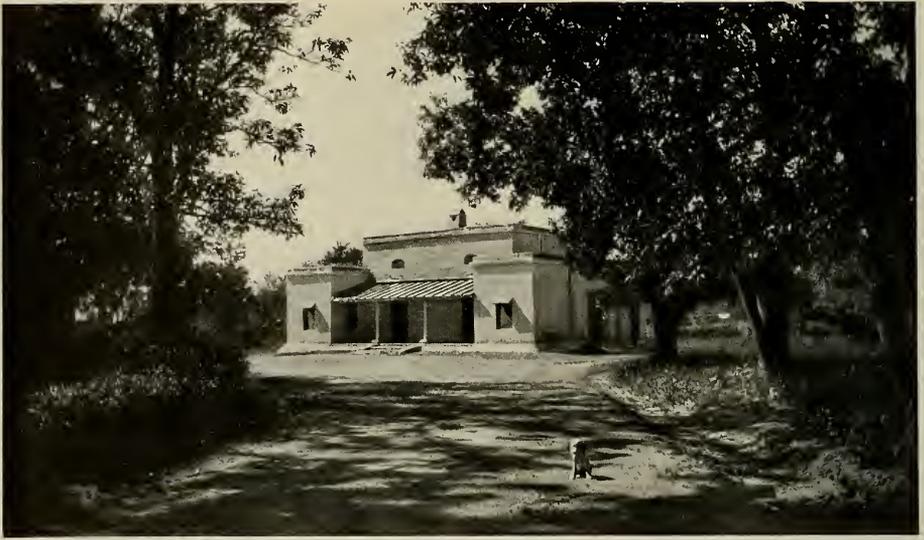
LOWER SIWALIK BEDS NEAR CHENJI

In appearance the Lower Siwaliks are not unlike bad lands in other parts of the world but are easily distinguished by their reddish appearance and fossil remains from the overlying Middle Siwaliks. Every available level place, even in this wild region, is cultivated



TOP OF THE UPPER SIWALIK BEDS AT SISWAN

Toward the close of the period represented by these beds there was accelerated elevation of the Himalayas, marked by predominant bowlder and conglomerate strata clearly shown in this photograph. Few fossils are found in these strata



Public Works Department bungalow at Chandigarh.—In the early days of British administration, a departmental officer required a cumbersome outfit of tents and caravan with two complete equipments, so that whenever one camp was abandoned, another might be in readiness for him. Now fine bungalows are built at convenient points

these bones, they replied that he pounded them up for medicine—a prevalent use of fossils also in parts of China.

Having completed this part of the program, I proceeded by rail to the Upper Siwalik exposures in the Ambala district, near Kalka. It was in this area that Siwalik fossils were first found, and for many years thereafter fossils from the three divisions of the Siwaliks were grouped under the same time period, without recognition of the significance of evolutionary development in various genera.

One may better appreciate what this means from the fact that taking the places of maximum thickness of each member, the three subdivisions total 20,000 feet of sediments,—strata that are especially difficult to classify and correlate on lithological characters without the aid of fossils. This enormously thick mass of strata does not, however, represent the same time

period that an equal thickness of rock would denote elsewhere. The deposition of the beds was more rapid than that traceable in almost any other part of the world. Especially is this true of the Upper Siwaliks, where hundreds of feet of material are composed chiefly of bowlders rapidly accumulated during a period of elevation of the Himalayas. The thickness and character of the beds are explained by the height and broken nature of the mountains from which they were derived, in conjunction with the excessive rains which fall during the monsoon periods, when every water course is a muddy torrent. Micaceous material from disintegrated schistose rocks forms a large percentage of the entire Siwalik series.

The Upper Siwalik beds usually form the outer range of the Himalayas as distinct low ridges parallel to the main range, or at intervals as part of the outer flanks of the range extending from

Baluchistan to Assam. They are not, however, fossiliferous throughout their extent. One of the historic type localities is on the railway to Simla, near Chandigarh, where I made headquarters in a dak bungalow, collecting on either side along the foothills for a distance of seventy-five miles.

In the Upper Siwalik fauna elephant remains are most numerous, with those of hippopotamuses a close second, the occurrence of which gives a clew to the climatic condition of this area when the animals were alive. In other parts of the world numerous skeletons, or at least associated bones of the same individual, will be found in parts of a formation where favorable for their preservation. It was with the hope of finding such material that I spent a year and a half searching in the Siwalik measures of India, but, though isolated bones were found in numbers, during all this time only one incomplete skele-

ton, that of a camel, was secured in the Upper Siwaliks.

The faunas of the different Indian horizons are represented in the collection of the Siwalik Hills Indian Expedition of the American Museum by skulls or jaws of most of the known species and by several new species; the collection is especially rich in skulls and jaws of elephants and horses.

One of the most striking specimens is an enormous tortoise with leg bones the size of a large rhinoceros. It is incomplete, but the clean bone of the existing parts weighs no less than eight hundred pounds.

During the expedition in India two car loads of fossils were collected and despatched to the American Museum, after which another part of my program was undertaken. This was to collect fossils in the Eocene-Pliocene beds of Burma, an account of which would require another article.



Elephant skull found at Siswan in a hard sandstone concretion of the Upper Siwalik beds.—Mohammedan masons are helping to remove the matrix



THE TIGER SWALLOWTAIL, ONE OF THE NEW INSECT GROUPS

A photograph gives but a faint notion of the beauty of the exhibit with all of its natural color. Usually both sexes of this butterfly are largely yellow but frequently, especially in the South, the female is dark, as in the case of the one flying near the center of this group

The New Insect Groups in the American Museum

By FRANK E. LUTZ

Curator of Entomology, American Museum

TO show insects in an appropriate setting without having the setting swallow up the insects,—that was the problem.

An early departure from a "Noah's Ark" exhibit—insects pinned two by two, male and female, in endless array—was made when the inflated skins of caterpillars in all their sausagelike unnaturalness were glued on dried leaves. Then artificial leaves were substituted for dried natural ones and finally wax caterpillars were made so lifelike that they seemed to be eating the wax leaves upon which they rested.

But a spray of leaves does not picture the whole environment of even a leaf-eating insect. "Habitat groups" were highly desirable.

We undertook years ago to show the huge nest built by one of our local species of ants, *Formica exsectoides*. We constructed a nest about three feet in diameter, and the fact that these ants live in open woodland is indicated to the visitor who knows plants by the ferns and other characteristic vegetation surrounding the nest, but these tell little to the visitor who does not know plants. Furthermore, without a background there is nothing to bring out the fact that the home of this ant is in the hill country. Incidentally, much labor in carefully posing a hundred or more ants was largely wasted because they can scarcely be seen.

With respect to the number of biological points illustrated, one of the most successful groups ever constructed (at least of those without a

background) is that of the seventeen-year cicada, made under the direction of Mr. Grossbeck, then assistant in our department of entomology. It shows that there are two races of this interesting insect, a large one and a small one; that the immature life is spent underground; that sometimes, especially in damp places where leaves lie thickly, a clay "chimney" is built over the exit from the earthy nursery; that the wonderful change from a wingless digger to a winged creature of the free air takes place while the insect is clinging to a tree trunk or other vertical support; that the female lays her eggs in punctures which she makes in small branches, although her young must drop from there to the ground; that these punctures so weaken the branches that they are eventually broken off by high winds; that a fungus destroys many of the adults, eating off their abdomens; that the largely useless English sparrow also feeds on cicadas; and so on.

But even the cicada group is a diagram rather than a picture—instructive but not particularly pleasing to the eye. It was not until we hit upon the idea of confining the view of a group to that obtained through a relatively small opening in the front of a case that we were able satisfactorily to show insects in appropriate settings without having the settings swallow up the insects. We can now present real pictures of insect life. However, these pictures are expensive to make and space is limited. What determines our choice of subjects when we



A GROUP ILLUSTRATING THE LIFE HISTORY AND HABITS OF THE BALTIMORE BUTTERFLY



THE PLEBIAN CABBAGE BUTTERFLY, AN IMMIGRANT FROM EUROPE



THE JAPANESE BEETLE

This group shows a peach orchard being devastated by thousands of beetles whose ancestors reached this country not more than ten years ago. Such an increase in numbers was possible because of the absence of parasitic insects which prey upon the beetle in Asia



THE MONARCH BUTTERFLY

The monarch is known also as the milkweed butterfly because of the food habits of its banded caterpillar. The red and black adults fly about apparently unafraid of enemies, and in the autumn go south for the winter



LADY BEETLES, INSECT FRIENDS OF MAN, EMERGING FROM HIBERNATION ON A MOUNTAIN TOP

have half a million different kinds of insects from which to choose? Let us glance at those which have already been put on exhibition.

The life history of the Baltimore butterfly (*Melitæa phaëton*) was selected as the first subject to be shown by this new method. The picture is a moist meadow in early summer, a landscape so difficult to represent that it was a real test. A very slight "group license" was taken in order to exhibit all stages from the eggs—yellow when freshly laid, red when about to hatch—through various sizes of spiny caterpillars and the unprotected pupa to the dainty adult bearing the colors of Lord Baltimore. But, conspicuous in the center of the foreground, is a rather tight mass of dead leaves still clinging to a weed stalk. It is the main point of interest because, in the preceding autumn, several dozen young caterpillars, brothers and sisters, had fastened those leaves together with silk spun from their mouths and had passed the winter in that thatched hut. Such a family hibernaculum is unusual.

We talk of "cabbages and kings" even in entomology. Standing next to the meadow of the Baltimore is a neglected cabbage patch in which an early immigrant from Europe, our now common cabbage butterfly (*Pieris rapæ*), has made itself at home and we shall come later to the "monarch."

The European cabbage butterfly was accidentally brought to America at about the time of our Civil War and, though but a medium-sized butterfly with a naked caterpillar, it started an invading march that has not only pushed our native cabbage-eating butterflies almost out of existence—at least, as far as our garden patches are concerned—but has cost our gardeners many hundreds of thousands of dollars.

Why it should have been so successful we do not know; but certainly its success would have been even greater had it not been for parasitic insects which attack it and keep its abundance within at least reasonable limits. Cocoons of some of these parasites are shown in our group just as they were spun after the parasitic larvæ had left the caterpillar which they had killed. The various stages in the life of the butterfly are also shown and the observant visitor will note that some of the adults (the females) have one more spot on each front wing than the other adults (the males).

The tiger swallowtail (*Papilio glaucus*) is the most gorgeous of our Northeastern butterflies when it is in its yellow clothes. This yellow is always worn by the males and, in the North, usually by the females; but sometimes in the North and often in the South the female puts on a dull dark-brown or blackish dress. Why this change we do not know; but our group shows both forms of the adult. It also shows the curious and rather luxurious caterpillar on its favorite food plant, wild cherry. "Curious," because of the pair of eye-like spots on its thorax and the pair of "horns" that may be thrust out or withdrawn, apparently depending upon whether the caterpillar wishes to frighten an intruder or not. "Luxurious," because of its habit of making a hammock upon which to rest when not feeding. It does this by spinning a sheet of silk so tightly over the top of a leaf that the leaf is bowed.

Then we have the monarch (*Danaus archippus*). Instead of enduring our northern winters, these butterflies gather in great flocks in early autumn and leisurely migrate to the South. Part of such a flock, ready to begin

the migration, has been on exhibition for some time in a large case at the entrance to the hall of insect life. Next spring a few individuals return to start a new generation. The caterpillars, banded with black and green and having a pair of threadlike appendages at each end of the body, feed upon milkweed and are there rather conspicuous objects, apparently unafraid of enemies. The newly formed pupa is indeed a beautiful object and has been aptly described as "a green house studded with golden nails." This "house" darkens as the inmate takes on the adult coloration of red and black. Man has come to associate red with danger. Whether or not this be the reason that man believes red to be a warning color in nature, the theory is that the monarch adult is distasteful to birds and by its color warns the birds not to try to eat it.

We have another butterfly that is about the size of the monarch and has almost identical red and black markings. It is believed that birds find it quite edible and the theory is that its color, "mimicking" that of the monarch, is for the purpose of deceiving the birds into thinking that it is distasteful. At any rate, the mimic is an interesting insect and we hope to exhibit its life history in a habitat group before long.

The Baltimore group showed a family winter quarters, and its meadow habitat tested our method of exhibition because of its flatness and the danger that the small insects would be lost in the abundance of vegetation. Monarch butterflies gather in flocks and go south before winter comes. Adult lady beetles also gather in numbers for the winter but they huddle together under bark, or in a rocky crevice, or in some other protected place. In the

mountains of our West these numbers are often immense, the insects flying long distances to congregate on some mountain top. It has been my good fortune on several occasions to see these beetles coming out of their winter sleep aloft and I wanted others to get a picture of this stirring sight. Could we show the beetles swarming over the rocks and still give the impression that these rocks are the top of a peak?

Each visitor looking at our group of lady beetles on a Colorado mountain can judge of our success and each one seeing these beetles should remember that lady beetles are exceedingly beneficial to mankind and, indeed, to all the higher animals. As larvæ and as adults, except for a few renegade kinds that we shall exhibit later, they spend their lives eating the plant lice or scale insects (as the case may be) that are so destructive of vegetation.

Not all insects are pests. In the cabbage patch we show a parasitic insect that is helping to keep the European cabbage worm in check, and our country has thousands of kinds of insects which guard our fields and forests against an undue increase in the native insects that feed upon our plants and trees. This is the "balance of nature," and insects are largely balanced by insects.

But man, with his commerce, is continually upsetting this balance, as was the case when a Japanese beetle (*Popillia japonica*), now known to us as *the* Japanese beetle, came to the vicinity of Philadelphia, in the earth about the roots of some imported Japanese shrubs. The presence of this beetle in America was first discovered in 1916. Now, lacking its insect enemies that held it in check in its original home, it has increased to

almost unbelievable numbers and is extending its range in the United States. Our latest habitat group shows these aliens in a peach orchard and the exhibit gives at least a faint notion of the menace this beetle represents.

These are the insect habitat groups that have been installed within the last two years. Our idea of a relatively small window restricting the view has been a success. Thanks to the skill of Messrs. Burns, Jansen, and others

working under the direction of Mr. James Clark, the groups are natural and beautiful pictures, and the aim of the department of entomology has been to make each one show interesting features of natural history,—something that is either a striking biological phenomenon or of economic importance to man. In this way the exhibits are truly both beautiful and instructive, and our insect exhibition hall is becoming a hall of insect life.



Reproducing the Rockies in order to show lady beetles emerging from a winter sleep on a mountain top.—At the left Mr. A. A. Jansen is shown painting the background, and at the right Mr. E. J. Burns is seen working on the rocks that form the mountain top in the foreground. Note in each case the small sketch model of the proposed exhibit. See also the illustration of the completed group, page 132

Old-Time Range of Virginia Deer, Moose, and Elk

BY GEORGE BIRD GRINNELL

THE former abundance of North America's big game is hardly realized today. Accounts of the enormous numbers of buffalo and other game make little impression on us. We who have never witnessed anything with which we can compare what is described, cannot picture the scenes.

Scattered writings of recent years contain many interesting references to former game plenty; but besides these, buried in old books of travel and discovery, are other accounts, even more interesting, which to many of us are unknown. Then, too, hidden away in the memories of a few living men, are recollections of game plenty seen with their own eyes, which have not been recorded.

Of the big-game hunters and field naturalists of the present day, who must go far in order to put in practice their skill in hunting or in the use of the rifle, or their observation of big game, not a few, I think, will feel an interest in these random notes about some of our game animals.

Naturalists and outdoor men feel keen regret at the passing of the wild things, so beautiful and so admirable under natural conditions. The disappearance of the wild creatures from most of the land is a loss—a loss in beauty and a loss to civilization, which they benefited in many ways. Yet fortunately some of them are being preserved and will no doubt endure for generations; and in the national parks and forest reserves of the United States and Canada, the children and grandchildren of those

who used to hunt them may continue to see examples of many of our most splendid forms of wild game.

WHITE-TAILED DEER

Notwithstanding the pursuit to which it has always been subjected, the familiar Virginia deer still persists in many thickly settled regions. Where it is provided with proper range and protection, it does well and increases. Occasionally it is even propagated in semi-domestication for food.

Formerly abundant from the Atlantic Coast to the Rocky Mountains, Mexico, and California, its range on the Atlantic seaboard has of late years extended far to the north and east. It was long supposed that it had not inhabited Nova Scotia until introduced there about 1888. Recently, however, some remains of this animal were found in two widely separated prehistoric shell heaps, and the bones were identified by anatomists of the Geological Survey of Canada, which identification, it is understood, was later confirmed by Dr. Gerritt S. Miller, Jr., of the United States National Museum.

A point of interest in connection with this species is that it was perhaps the first of our big-game animals in behalf of which serious efforts at protection were attempted. Nearly sixty years ago the Hon. Clinton L. Merriam, of Locust Grove, Lewis County, New York, became greatly interested in the deer of the Adirondack region, which were being destroyed in great numbers. At the time wolves and panthers still existed in the Adirondacks and killed

many deer, but the chief slaughter was wrought by the residents. During the deep snows of winter, when the deer found it hard to get about, these residents chased them with dogs and, following the dogs on snowshoes, killed the defenseless animals with clubs. Driving deer into the water with dogs in summer and killing them while swimming, was then—and for many years afterward—a recognized method of hunting.

In his efforts to lessen the destruction of these animals, Mr. Merriam appealed to the New York Association for the Protection of Game, and in a letter written in March, 1869, to Royal Phelps, its president, Mr. Merriam urged the introduction of a number of amendments to a game bill then before the New York Legislature. Among other things, these amendments provided for a bounty on wolves, the closing of still hunting December 25, prohibition of trapping deer, and the imposition of a heavy fine for each offense when a railroad received as freight venison killed in New York after January 15.

While at the time Mr. Merriam's efforts did not accomplish great things in the way of further protection of deer by law, they did much to educate the people of the Adirondacks and the general public. He vigorously agitated the question of the protection of the local deer, and, I think, was the first man who took active steps to save the Adirondack deer. In one form or another, most of his recommendations were later incorporated in the laws of New York.

In that year (1869) Mr. Merriam estimated that the deer in the Adirondacks numbered 5000 and he feared their early extermination there. Today it is believed that there are 50,000

deer in the region, and that during the hunting season of 1918, deer to the number of 15,000 were killed.

MOOSE

The range of the moose extends, with some interruptions, from the Atlantic to the Pacific but the animal is chiefly represented in Canada. It was, and is, more or less abundant in Nova Scotia, New Brunswick, and Maine, in the District of Gaspé, and on the north side of the St. Lawrence River, abundantly as far east as the Saguenay and, formerly, east of that, almost or quite to the Godbout River, according to the relation of Father Albanel. It was formerly found in great numbers in New Hampshire and Vermont, and the Reverend Nathan Perkins, who in 1789 made a trip to the new settlements in that state, wrote "Moose plentiful on ye mountains over against Jericho, Essex, and Colchester—people hunt them—eat them in lieu of beef—and get their tallow. Bears and wolves plenty." They were found occasionally in the Berkshire Hills of Massachusetts. In the Adirondack region they were well represented, the last one apparently having been killed there in 1861.¹ They occurred in the northern peninsula of Michigan and in Wisconsin, are still found in Minnesota, and again in the Rocky Mountains from northern Wyoming—one was killed near the North Platte River—northward in suitable situations, and become very abundant and very large in Alaska.² The Yellowstone Park has long been known as one of the southernmost points in the Rocky Mountains where moose were abundant, and only a

¹Efforts to reintroduce the moose in the Adirondacks have not been successful nor did the animals do well in the Corbin Preserve in New Hampshire. Those placed there have disappeared.

²There is a moose head from Alaska in the Field Museum of Natural History at Chicago, the antlers of which measure more than six and one-half feet in spread.

dozen years ago the Hon. George Shiras 3d discovered that they were extraordinarily plentiful in the valley of the Yellowstone River, just where it comes out of the mountains and enters Yellowstone Lake.

Their extraordinary number in primitive times is indicated by the report of Nicolas Perrot, who says that in the winter of 1670-71 the Saulteur Indians "secured more than two thousand four hundred moose in an island called Isle des Outaouas,"¹ which extraordinary catch of game was made only with snares. Such snares were nooses of rawhide set in openings in a sort of fence made of trees and poles loosely planted in the ground; the animal, running its head into the noose, pulled up the post to which the line was tied and dragged it along, until finally the post struck some resistant growth, the line was held fast, and the moose was choked to death. In other places, and at other times, the Indians killed moose with guns or arrows, but in winter, when the snows were deep, they pursued them on snowshoes and dispatched them with lances. This method, according to the *Jesuit Relations*, was practiced everywhere in the country of the moose.

Moose adapt themselves readily to changed conditions and still flourish in parts of eastern Canada which are sparsely populated. In recent years they have greatly extended their range in the Northwest Territories and Alaska, and are now common in the delta of the Mackenzie River. They pay little or no attention to the signs of civilization and, unless overhunted and driven away by lumbering operations, tend to hold their own in point of numbers. The settlement of many portions of Canada will be gradual and

¹Manitoulin Island.

we may expect to see the moose an inhabitant of the northern part of North America for many years.

ELK

The elk had the widest distribution of any of our large hoofed game animals. In one form or another it was found from the Atlantic to the Pacific, and from latitude 59° in western Canada south into Arizona and New Mexico. From the St. Lawrence River and Quebec on the northeast it extended south at least as far as North Carolina and Georgia, and from there westward it was very abundant.

The *Jesuit Relations*, speaking of the country along the St. Lawrence River, contain frequent references to "wild cows," "a kind of cow that appears to have some affinity with ours," and so on. Elk are commonly spoken of; but this is the French *élan*, which is, of course, the elk of Europe and the animal which we Americans call by its Indian name, moose.

A passage in the *Jesuit Relations* for 1646, by Fr. Hierosme Lalemant describes in the following language four species of deer found in the valley of the St. Lawrence between Quebec and Montreal:

There is found here a species of deer, different from the common ones of France. Our French call them "wild cows," but they are really deer; their branching horns have no likeness to the horns of our oxen, and their bodies are very dissimilar, and of much greater height. These animals go in troops; but, to assist one another, during the winter, they follow one after another, the first ones breaking the way for those that come after; and, when the one which breaks and opens up the snow is tired, it places itself last in the beaten path. The deer in France do the same in crossing a river, when they happen to be in a herd. According to report, these animals hardly stop in one place, continually travelling within these great forests. The Elks do the contrary; though they walk together, they

observe no order, browsing here and there, without straying far from the same shelter. This is what prompted, some days ago, a Savag^e who wished to become sedentary, to say that the Elks were French, and that other sort of roving deer, Algonquins; because the latter go to seek their living hither and thither within these great forests, and the French are stationary, tilling the earth at the place where they make their abode. Besides these deer, there are two other species—one of which is similar, or which has much likeness, to our deer of France; the other of which is believed to be the Onager or wild ass of the Scriptures.

The description of the "wild cows" with their branching horns, their height much greater than a domestic cow, and their method of breaking a way through the snow can only, it seems, apply to the wapiti. The elks spoken of are our moose. The species of deer "which has much likeness to our deer of France" may very well be the Virginia deer, while the "Onager or wild ass of the Scriptures" is the caribou. This name was applied to that species by Sagard, *History of Canada*, 1636, p. 750, and by La Hontan.

From what we read in the *Jesuit Relations* it seems, then, that the wapiti must have been abundant in the open country along the St. Lawrence River down below Montreal. Hind in his *Labrador Peninsula* quotes a statement that the elk (wapiti) persisted on the Saguenay until 1823, when the last survivors were killed by the Montagnais Indians.

The wapiti was not in old times an inhabitant of the dense woods, and may never have been abundant in the heavily forested New England hills, though it was no doubt found in open valleys. At certain points in New York it did occur, and in abundance. La Hontan in a letter dated May, 1687, describes the process by which

the natives drove *cerfs* (La Haye, 1703) or harts (London, 1735) into a pound, and gives an engraving which shows the animals being forced into an enclosure. This occurred somewhere near Lake Champlain.

Major William Austin Wadsworth had for many years at his home in Geneseo, New York, two pairs of elk antlers which, it is believed, were taken somewhere in the Mohawk Valley, perhaps near the junction of the Mohawk River with the Hudson. These antlers, Major Wadsworth told me, came from Col. Walter S. Church, a good part of whose life was spent near Albany and west of that city, and Major Wadsworth believed that they were taken somewhere in that general region. Colonel Church presented the antlers to a relative of Major Wadsworth, when the latter was a youngster, perhaps between 1850 and 1860. Colonel Church was born probably between 1810 and 1820.

Dr. C. H. Merriam in his *Mammals of the Adirondacks* presents traditions of the occurrence of elk in that region and mentions the discovery of antlers there. He is inclined to doubt the accounts given by De Kay of elk having been killed there between 1830 and 1840, for he could find no Adirondack hunters, however aged, who knew of such happenings.

Many years ago I was told of the finding of a pair of elk antlers which had been recovered from the bottom of a small pond in central Vermont. A note of the discovery was published in *Forest and Stream*, March 11, 1899, Vol. LII, p. 185.

According to McAtee, elk were found in historic times in or near what is now the District of Columbia. About the year 1775 Bartram speaks of them as being at the heads of certain rivers

of North Carolina and Georgia. Until after the Civil War they persisted in Pennsylvania, and it is believed that the last one was killed in that state in 1867.

As the country became thickly populated and communities pressed farther and farther westward, the elk, of course, retreated before them. Nevertheless, in Michigan there were elk certainly as late as 1874, and probably well into the decade between 1880 and 1890. In 1870 there were elk in Iowa, where I saw them, and in northern Minnesota they lasted almost to the beginning of this century. When the Union Pacific Railroad was built through Nebraska, elk were abundant on the plains, and in 1868 they were killed within sixty-five or seventy miles of the city of Omaha, while in 1873 they were abundant on Cedar Creek and on the Loups, and were found at the head of forks of the Loup River as late as 1880.

In these modern days we read of the elk as found only among the mountains and the timber, and some young people may think of it as a mountain animal—one that dwells in the forest. As a matter of fact, the elk of old times was quite as much an animal of the open country, the plains, the high plateaus, and the naked bald hills. If alarmed, it plunged into timber or thickets, but it loved the open.

Some years ago, when the establishment of a game reservation for wild birds and animals in Nebraska was being discussed, some naturalists expressed doubt as to whether the elk could live on the plains. In other words, the fact that the elk is naturally an animal of the open land and not merely of the densely forested country, had been entirely overlooked or forgotten by some of the men of today. Yet in my youth the whole of the

western plains was a resort for elk, which lived in part also in the timber and willows along the river bottoms. In the Yellowstone Park today elk are found in the open, which is where they feed and live; but, if frightened, they run into the timber or the brush, where their enemies lose sight of them and they lose sight of their enemies.

Up to about 1890, great herds of elk collected each winter on the bare rolling country of the central plateau east of the Continental Divide and in the eastern foothills of the Rockies. This country was high and cold, but was exposed to the wind and was largely free from snow. The elk would come down from the high mountains, where the snow lay deep, seeking the warmer broken country, where the soil was exposed and food accessible. Practically all the elk in the southern and southeastern portions of the Yellowstone Park and in the Wind River Mountains came out to this open country to winter, and for a few years after the white settlers began to arrive, they were little disturbed.

For the elk of the farther western plains and the foothills of the Rocky Mountains, the high, open valleys and meadows, and the high, bald hills of the Continental Divide were a great summer range. Thither they went in spring from their wintering grounds below, the bulls in bands seeking the highest points, to get away from the flies and mosquitoes while their horns were growing; the cows, in groups, also went to the high country, but not so high as the bulls, had their calves there, and then again collected in loose herds, which kept together until early autumn.

The region which is now the Yellowstone National Park has long been under observation, and the migratory

movements of the elk in that section have for many years been well understood by some naturalists. Early in September, depending somewhat on the first advent of cold and snow in the high regions, the elk began a movement from summer to winter range,—a general migration, in which all moved down from the high mountains. Very rarely a few animals delayed their departure too long and were snowed in and forced to winter on the heights and often to starve. I recall many years ago learning of a few bulls that were so caught in the Hayden Valley and stayed there all the winter, some or all of them dying of starvation.

The elk from the Continental Divide in the Yellowstone Park country had regular migration routes which followed down the different rivers and came out either on the lower country of the plains or on the open wind-swept spaces of the high central plateau. The elk on the east and north sides of the present Yellowstone Park moved east down the Yellowstone River as well as Clark's Fork, both branches of the Stinking Water, now called Shoshone River, and down the Grey Bull and Wind rivers. Some of these elk, when they reached the plains, went as far east as the Bighorn Mountains, and wintered in their foothills.

West of the Continental Divide a part of the elk followed down the Madison River toward the Three Forks of the Missouri and wintered in that lower country. Those to the south of the Continental Divide—the Heart Lake, Lewis Lake, and Shoshone Lake country—migrated southward along Snake River, part of their number passing over the Divide between Snake River and Green River at various low points, following down tributaries of the Green River, and thence working eastward to

the wide flats and bad-land country of the Red Desert, and east and south of that. In various sheltered spots in this plateau country, which extends for many miles east and west, elk wintered in great numbers. They were found by thousands in many places of limited area where food was abundant or near which it was accessible in favorable weather.

Many years ago, while traveling in September through the country south of the Yellowstone Park, I saw the beginnings of the individual migration southward of the elk. From all the hills along the valleys through which we rode were trails in the snow showing where single elk had passed during the night, all the trails converging toward what represented the easiest way through the country, and at last making a well-beaten road.

The number of these individual trails, plainly visible everywhere and through the glasses often traceable for a long distance up the mountain-sides, was very great, and all the trails headed in one direction,—southward for the lower country where food was plentiful, the snow less deep, and where for unnumbered generations the elk of this part of the Rocky Mountains had spent the winter.

In early days I used to be much at my ranch near a part of this wintering ground, and not infrequently rode through Bates' Hole, where there were thousands of these elk. There they remained until the approach of spring, when the snow had melted, the worst cold had passed, and the early spring rains had begun. By this time the bulls had shed their horns, and in May they began to drift back toward the higher country and were often seen. The bulls moved by twos and threes, and the movement was slow; they followed up

the snow as it melted, feeding on the old grass, for as yet the new growth had not begun.

Before 1890, however, a movement of cattlemen had started from the country of the lower plains. Many of the ranges there had been stripped of much of their herbage and the cattle no longer did as well as formerly and were moved either north to Montana or into the higher country to the west, which up to that time had been more or less free from cattle. Before this a few sheep also had been brought into this upper country and, with the gradual influx of cattle and sheep and people, there came to be some interference with the winter range of the elk. Soon after this, too, people from east of the mountains and from Colorado learned of some of these wintering grounds and began to come up in the late autumn to kill elk and load up their wagons with meat for the winter. This movement spread very rapidly, and in a short time so many meat hunters came to the particular country just spoken of that all the elk that wintered there were killed off, and the next year there were none at all—to the great disappointment and surprise of the hunters who came up for their meat.

Meantime, the Yellowstone Park country had been surrounded on the north, west, and east by ranches. Settlement on the south side came somewhat later. At first there were

only a few prospectors looking for gold on the tributaries of the Snake River, but the stories they took back brought into the country a few settlers, some of whom cut hay there for their cattle. So long as these settlers were but few, they obtained what meat they needed from the passing elk herds and did not interfere with the migration, but after some years the settlers had so increased that they put up fences which barred the ancestral migratory road of the elk to the south. Then began the starvation of elk about which of late years we have heard so much. It is obvious that the destruction caused by this starvation has far exceeded the killing by all classes of hunters.

While the elk spend their summers in an absolutely protected area, they must leave it when the heavy snows come. The park is a rectangle straddling the continental divide, and surrounded by fenced ranches, beyond which the elk cannot pass. They are shut up in a territory where there is not enough food for them, and so in winters of heavy snowfall they must starve. I believe that the number of calves born each year after the animals have gone back to their summer range exceeds the winter's loss, and that the elk herds are slowly increasing, but in the area they occupy their food is not increasing but is growing less. The future of these elk is, therefore, entirely uncertain.

Cats as Fishermen

By E. W. GUDGER

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SOME months ago I published in NATURAL HISTORY an article on "Dogs as Fishermen," and at the time the editor asked me if I could not prepare a similar article on "Cats as Fishermen". As it happened, I had a considerable amount of data on hand. To this other accounts have been added and the present article is the result.

My readers, who have watched puss after a rain daintily picking her way down the sidewalk or across the street, may be pardoned some feeling of surprise on reading the heading of this article. And yet is it not a truism that cats and goldfish do not flourish together even in the "best regulated households?" Unless it be catnip, there is nothing on the earth or in the waters under the earth for which cats have such a violent fondness as for fish. Undoubtedly some of the readers of NATURAL HISTORY have had that calamity happen which almost inevitably comes to pass when puss, left alone in a room with a bowl of goldfish, gently inserts a hooked paw and deftly abstracts one of the finny inhabitants. However, retribution sure if not swift sometimes overtakes the purloiner, and the poet Gray has celebrated in verse the demise of such a cat. In trying to remove the goldfish, puss overreached herself, fell into the glass vase and, unable to get any foothold on its smooth high sides, was drowned. Gray notes that she rose eight times and succumbed to the ninth sinking—her ninth life presumably being extinguished under water.

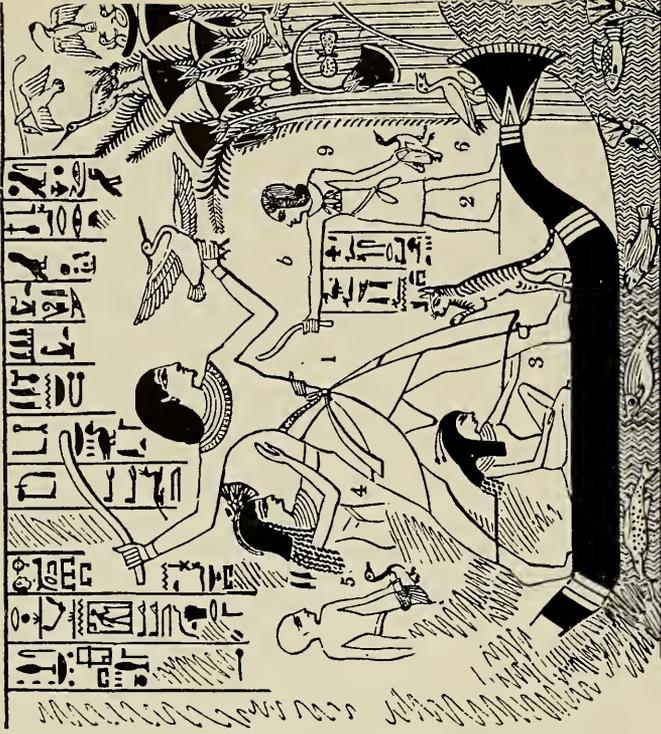
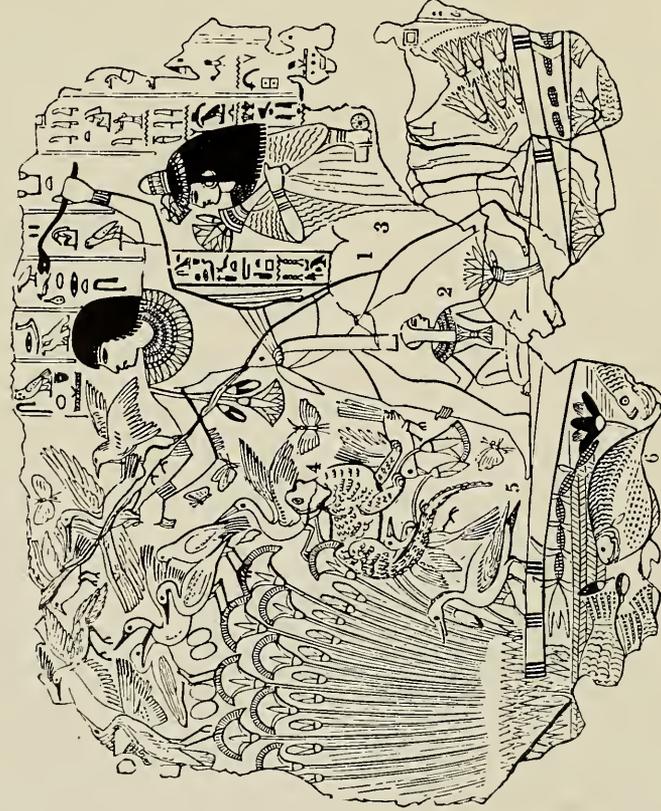
An inclination for fishing on the part

of an animal which normally shows a most marked antipathy to getting wet, would seem to be a reversion to primitive habits. That a similar habit existed in an earlier period of the world's history we have reliable information. On the Egyptian monuments and tombs are found representations of cats accompanying their masters on fowling expeditions and engaged in retrieving birds from the water. Such an activity today would be thought wonderful since the feline race in these later times seems almost entirely to have lost this ancestral faculty. However, we shall see that among cats both wild and tame retrieving still prevails in some cases and in certain countries. Indeed tame cats frequently bring back to their masters the rats, rabbits, birds, lizards, and even snakes which they have caught. Charles St. John in his delightful *Sketches of the Wild Sports and Natural History of the Highlands* (London, 1878, p. 47), tells of three cats, known to him, that hunted for game which they always brought home. But let us proceed at once to the more interesting accounts of fishing by cats.

I.

FISHING BY WILD CATS

The wild Felidæ certainly find their sustenance in part in crayfish, crabs, and fishes, denizens of the waters—not merely feeding on those cast up on the shore, but fishing for those actively swimming. This is probably an ancestral habit, as noted above, for, as will be shown later, it is practised today by certain wild cats (using the term in a wide generic sense) and is a



THE CAT AS A RETRIEVER OF WATER BIRDS

It would appear probable that the cat was occasionally employed in Ancient Egypt for retrieving. Although Sir I. Gardner Wilkinson, from whose *Manners and Customs of the Ancient Egyptians* the above illustrations are reproduced, voices doubt whether a cat "could be induced, on any consideration, to take the water in quest of a fallen bird," the number of instances, presented in this article, of cats, both domestic and wild, that brave the water in their pursuit of fish, gives assurance that the above pictures record real happenings.

In the illustration on the left the cat is depicted seizing a bird in a thicket of lotus, while its master, poised in the boat, is about to use his throw-stick upon another bird victim. In the picture on the right the cat is represented as though pleading to be let out of the boat into the thicket

habit reverted to, under suitable conditions and provocation, by our common house cats.

SOUTH AMERICAN WILD CATS

Practically all these cats feed on fish, as specific instances quoted below will show. Indeed, William Swainson (1838) says that the (South) American tiger cats are more aquatic than those of any other continent and that they live largely "upon the boundless profusion of fish which swarm in its numerous and majestic rivers." In particular he names the jaguar as an expert fisherman.

Azara in the Spanish edition of his book on the Paraguayan quadrupeds (1802) alleges that Maregrave and Piso say that the South American jaguar prefers fish to flesh. This, if true, would be our oldest reference to wild Felidæ eating fish, but it is certainly erroneous. I have gone minutely through both the 1648 and the 1658 editions of their *Historia Naturalis Brasilæ* and cannot find one word as to the food of the jaguar. I find, however, that Azara takes this statement from the volume on Quadrupeds of Buffon's *Histoire Naturelle*, and hence the latter is fundamentally responsible for the error. The oldest record, then, seems to be that in Azara's book (page 93), where he says, according to the English version (1838), that:

It is very generally asserted in these parts, that the jaguar frequently goes into the water a little way, and there discharges some saliva, which attracts the fish, which greedily snap at it, when the jaguar, who is very fond of them, by a stroke of his paw, tosses them on the bank. Various persons have assured me that they have seen them fishing in this way and have collected the fish which they have thrown out; for they do not devour them immediately, but wait until they have caught sufficient for a meal.

We are fortunate in having next an eye-witness account from Rengger (1830), a Swiss naturalist who spent eight years in Paraguay. He states that:

Regarding the manner in which the Jaguar provides himself with fish, many tales are told in Paraguay. For example, it is said that he is able to charm the fish by the froth of his saliva or by beating with his tail upon the surface of the water. A very intelligent huntsman, to whom I am indebted for many noteworthy observations and much good advice in my travels, gave me a better account, and my own observation proved to me later the veracity of his assertion. On the approach of a storm one sultry summer evening, as I was returning home in my boat, my companion, an Indian, noticed a Jaguar on the edge of the stream. We drew nearer and hid ourselves under the overhanging willow trees in order to observe his actions. He was sitting crouched on a projection of the shore, where the water was running rather more swiftly, the usual habitat of a preying fish, known in the country as Dorado. Unswervingly he directed his glance at the water, swaying forward from time to time as if he wished to gaze into the depths. After about a quarter of an hour I saw him make a sudden blow with his paw and throw a large fish on to the land. Thus he fishes in the same way as our domestic cat.

The next reference to the fishing proclivities of the jaguar is in La Cordière (1832), who tells us that the jaguars of Brazil and Guiana visit the seashore at night and from overhanging rocks reach down thorny paws and hurl out on land the fish and crabs, which they then eat at their leisure.

Roulin (1865) records an experience of a native boatman of his in 1824 on the upper Orinoco. A jaguar and her kittens had been seen at a small rapid, where the mother caught fishes ascending it. She distributed the fishes until the hunger of all was satisfied and then allowed the kittens to try their skill also at the fishing. This they did in most charming imitation of her.



The Decisive Moment.—The ocelot, on the verge of action, like a trigger about to be snapped, awaits the approach to the surface of the unsuspecting catfish. Reproduced from a picture by J. W. Audubon

Other and similar reports have emanated from travelers in South America, who, however, have gotten their accounts from the Indians. Very interesting is the incident related by that accurate observer, Herbert M. Smith (1879), in whose narrative we again note the use of the tail. Smith tells us:

The spotted Jaguar belongs here [on the rivers of Brazil] of right; he is a fisherman as well as a hunter, and, though he often wanders on the highland, you never find him far from water. The Indians have a curious story about his fishing. The Jaguar, they say, comes at night and crouches on a log or branch over the water; he raps the surface [of the water] with his tail, gently, and the *tambakis*, or other fruit-eating fish, come to the sound, when he knocks them out with his paw. I do not take it upon myself to say that this story is true, but I have heard it from all sides, and from persons who aver that they have seen the fishing.

R. Stewart Clough, writing of the habits of animals in the Amazon region, makes a similar comment regarding the jaguar, which, he says, "may often be seen engaged in piscatorial exercise, as he draws his tail backwards and forwards in the water until approached by his finny prey, when with lightning speed his sharp-clawed paw grasps the prize."

Caspar Whitney (1912), who has had wide experience in travel in South America, speaks several times in his book, *The Flowing Road*, of the jaguar's "scooping" fish out of the water with a swift forepaw, and says more in detail:

In the Rio de la Plata, just off Buenos Aires, is an island where at one time several jaguars lived and thrived practically off the fish they caught. There was no other life on the island and never any evidence of the beasts visiting the mainland, which, so far as distance is concerned, was entirely possible, because the

tiger is a strong, bold swimmer, and minds no river of South America, not the widest, if he wishes to reach the opposite bank. He is a patient, unerring fisherman, watching for long periods from some vantage point, which may be either a fallen tree trunk extending into the stream, or at the bank's edge, until a victim draws within reach, when with a lightning blow he hurls the fish out on to the bank.

NORTH AMERICAN WILD CATS

First of all Audubon and Bachman (1851) in their delightful work on North American quadrupeds figure an ocelot crouching on a tree trunk extending over a pool, and eagerly watching a catfish in the clear water below. The cat is evidently waiting for the catfish to come further out where he can reach it. Unfortunately there is nothing in their text to explain the incident depicted in their figure, which is reproduced herewith.

Adams (1870) reports that settlers in New Brunswick, Canada, told him that many persons had watched the

Canada lynx and had seen it catch fishes in brooks in similar fashion. Elliott (1883) in his great monograph says that the bay lynx is not afraid of water but seeks the streams in quest of fish and frogs.

EUROPEAN AND INDIAN WILD CATS

The preceding accounts all allege that these great cats simply "scoop out" their prey with a rapid flashing paw, but J. Bowden (1869) asserts that the Norwegian wild cats dive readily into the water in pursuit of rats, and, since fishes are better food, presumably for them also. At any rate, they are said to "go in all over."

In another part of the world, however, there is a wild cat whose menu is made up to so large an extent of fish that he is called "the fishing cat." This is the *Felis viverrina* of India. The first account of it that I have been able to trace is in Mivart (1881), who quotes it from Buchanan, pre-



Although this cat (*Felis viverrina*) eats, it is said, other things besides fish, nevertheless fish form so large a part of its diet that it well merits the name "fishing cat." Reproduced from *The Cat* by St. George Mivart

sumably Francis Buchanan, afterwards Buchanan-Hamilton, author of *Fishes of the Ganges*. I have made a careful search through all the works of this writer, but have nowhere found any reference to the "fishing cat," whose portrait is herewith reproduced from Mivart. Statements similar to those of Mivart are made by all the other writers on the mammals of India; each repeats the other but not one gives his source. Probably all the statements are ultimately taken from Buchanan-Hamilton's manuscript notes.

It is presumably *Felis viverrina*, whose habitat extends into the Malay Peninsula, to which White (1912) refers in these words:

The fisherman cat is found here. We kept one for a time and studied its methods of plunging into the large tray of water and securing the live fish at a single pounce, with both forepaws, putting its head under the water and bringing it out in its mouth.

Furthermore, Simson (1886) in his charming account of hunting in eastern Bengal, tells us that the tigers on the islands in the lower Ganges and Brahmaputra, during times of inundation, when other food is scarce, eat fish, turtles, young crocodiles, and large lizards—in fact, anything on which they can get their paws. And it seems not improbable that they *catch* these fish, since they are not infrequently forced, through the flooding of the land, to take refuge in trees. Corroboration is the earlier record by Walter Elliott (1839), who was told by the Bheels of Kandaish that during the monsoons, when the country is flooded and food is scarce, tigers eagerly eat frogs.

II.

FISHING EXPLOITS OF THE HOUSE CAT

There is now to be presented a large mass of evidence relating to the fishing

proclivities of our common house cat, *Felis domestica*, for puss does not confine herself to "grabbling" for goldfish but really "goes a-fishing." These accounts readily fall into five groups: first, where Tabby or Tom merely accompanies the fisherman, hoping to share in the catch; secondly, where puss seeks a stream or pond by herself and catches fishes by the scooping-out process; thirdly, where the cat goes in "all over" to catch the prey that is in full retreat; fourthly, where she brings the fish home as the evidence of her prowess; and lastly, where she trains other cats in fishing.

However, before beginning our categorical account there is to be set forth a manner of fishing in which the cat does not even get its feet wet. Flying fish, disturbed by the motion of a vessel, will spring out of the water and, attracted by the lights on the vessel, will frequently come aboard if her bulwarks are not too high. In this connection Ross (1868) says that an officer on an Australian packet told him of a ship's cat that would watch for hours on a windy night, awaiting the flying fish that would thus come aboard.

Dr. Gordon Stables (1874), the well-known authority on domestic animals, gives a more detailed account and goes Ross one better by alleging that the cat himself supplies the attracting light—from his eyes! His lively recital reads thus:

On dark nights in the tropical seas, he [the cat] used to perch himself on the bulwarks aft, and bend his glittering eyes downwards into the sea. He never sat long thus without a flying fish, sometimes two, jumping past him or over him, and alighting on deck. Then Tom would descend and have a delightful supper, and if not fully satisfied [would] resume his seat and continue the sport. Tom must have gained his knowledge from experience, al-

though the success of his method of fishing is easily explained. It is well known that these fish always fly towards a light, which is therefore used by the sailors to catch them. The cat required no other light save the glimmering of his two eyes, which in the dark shone like a couple of Koh-i-noors.

CATS THAT ACCOMPANY FISHERMEN

Under the first category, wherein the cat merely goes along hoping to share the spoils, I am able to present a personal experience, for which I am indebted to Mrs. Paul Bucher, of the information division of the New York Public Library. Mrs. Bucher says:

In the years shortly after 1890, I and various members of my family used to go fishing in Kensico Reservoir. On one occasion, as we stopped at the keeper's house to engage a rowboat we were observed by the tiger-marked cat belonging to the keeper. Evidently the presence of fishing poles and bait cans aroused high hopes of fresh fish, for the cat scampered after us to the shore of the reservoir and jumped into our boat before we were seated. We were out on the water in the boat for several hours, with a fair catch of small fish such as perch and sunfish. During this time the cat seemed perfectly at home and very much interested in any movement of the fishing lines. When the fish were lifted from the water, she would hang over the gunwale with outstretched paw, in what frequently seemed a precarious state of balance. She received a number of the smaller fish as caught and made short work of devouring them. We learned later that she had been accustomed to following fishing parties for several years.

Stables gives the following interesting account of a tabby that "was a curious specimen of the feline fish catcher."

Her master was a disciple of Walton's. With eager and joyful looks, pussy used to watch him taking down the rod and fishing-basket, sit singing beside him while he looked to his tackle, and rub herself against his leg while he prepared the invariable sandwich, as much as to say 'Don't forget a morsel for your puss, she likewise is going a-fishing.' Then she would trot by his side all the way,

as proud as Punch, to the distant streamlet. Anxiously she would watch the skimming fly, squaring her lips and emitting little excited screams of delight, whenever a fish rose to nibble. Then, when a trout was landed, pussy at once threw herself upon it and despatched it.

A writer in *The Angler's Note Book* under the *nom de plume* of "March Brown" (1880) tells of an old fisherman on the Tweed known personally to him, who had a cat that always accompanied him when he went fly-fishing. This cat was evidently a good sportsman, for:

When . . . a fish was hooked . . . her eagerness could not be controlled, and so soon as the captive was in shoal water in sprang puss up to her shoulders, and fixing her claws firmly in the fish brought it to bank, when with a caress from Donald she again took her place behind him till another trout was on the line and the sport repeated.

In this connection the readers of NATURAL HISTORY will recall the accounts in my previous article, "Dogs as Fishermen," of canines which went a-fishing with their masters and in similar fashion would help bring the hooked fishes to land.

CATS THAT FISH FOR THEMSELVES

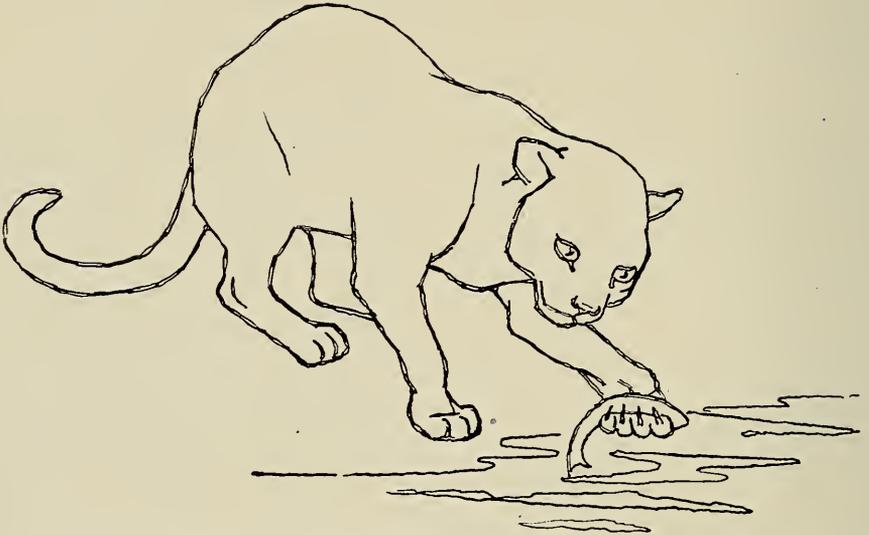
Before taking up, under our second category, the quoted accounts of cats which fish along the banks of streams, I fortunately can give a first-hand account related to me by Miss Annie Smith of Bronxville, New York, of cats fishing along the seashore. Miss Smith writes that:

About 1898 my father took his family in the late fall for a short visit to the seashore at Asbury Park, New Jersey. One frosty night in October, he came in and asked us to go down to the seashore for a most unusual sight, that all the cats in Asbury Park were gathered on the seashore a-fishing. When we reached the shore, we found quite a crowd gathered watching the cats fishing with very great luck.

It was a bright moonlight night, cold and very still. The ocean was rather calm and

each small wave that broke on the shore brought with it myriads of small fish—'white-bait'—chased inshore by larger fish. The former were very slender fish, white and silvery. They sparkled and flashed in the waves before these broke on the beach, and afterwards they were easily seen and pounced upon by the stray cats left homeless and hungry by the cottagers who had closed their summer homes and had returned to the city for the winter. The cats had no hesitation in wetting their feet, so intent were they on getting the fish.

White's *Natural History of Selborne* (1851). In Roxburghshire a fine cat lived near a mill. When grinding ceased and the water was cut off, the mill pond began to fill up, and the stream below, supplied now only by the leaks in the dam, ran shallow and left in difficulties the fishes which had come up during the flood. "And so well acquainted had puss become with this circumstance, and so fond was she



This drawing, supplied by Mr. E. H. Forbush, shows that the domestic cat does not confine its depredations to the goldfish bowl

For three successive nights the little fish appeared, driven inshore by their enemies, and each night the cats were there, to a Tom intent on their fishing, and the audience of the genus *Homo* was also there taking in this most unusual and interesting occurrence.

We now come to a number of accounts which merely recite the fact that cats following the course of a stream will hook out unwary fishes and eat them. These, lacking, in the main, points of particular interest, will be briefly considered.

The first of these incidents is from Jardine's footnotes in his edition of

of fish, that the moment the noise of the mill-clapper ceased, she used to scamper off to the dam, and, up to her belly in water, continued to catch fish like an otter." Two other accounts, very similar to this, are also given.

The next incident is from Adams (1870), who had it on good authority that in a household in County Cork, Ireland, there was a cat that regularly repaired to a brook, where it was frequently observed capturing small fish.

In the volume by Stables from which citation has been made, that author

recites a number of instances of cats that fished along the banks of streams and in shallows. The best of these accounts is of a cat that seriously diminished the number of salmon in the stream which he patronized.

Gibbey was a noted fisherman and a daring and reckless poacher, so much so that the gamekeepers threatened to kill him, whenever they could catch him. They did not mind, they said, his taking a good clean sea trout occasionally; but the beast fished in season and out of season. In fact, Gibbey found the spawning time much more convenient than any other. When the salmon came up the shallows to spawn in thousands, all wagging under his very nose, and to be had for the mere lifting out, he couldn't stand that. "Tam tint his reason a' thegither" and played terrible havoc among the poor fishes. It was not so much what he ate that the keepers grudged; but he was in the constant habit of carrying away large fish to hide for future use; and as he generally forgot where he had put them, he still went on hiding more.

Accounts are given by Wier (1889) of a cat that would take an eel out of a pail of water, and of others that would fish in shallow streams. And Lane (1903) tells of a cat that made her living almost entirely by catching fish along the banks of a near-by stream. It will be recalled in this connection that similar actions by dogs are recorded in my paper previously referred to.

Most interesting of all accounts of this kind is one related by "March Brown" from a personal experience, already alluded to. The cat of which he speaks, for a while threatened to spoil his fishing. His boatman had collected a large number of minnows for bait and had placed them in a "well," or enclosed spring of cold water, two or three feet deep. Things went along uneventfully for several days but presently the minnows began to disappear. The "well" was then watched one night and the mystery solved:

At the well-side stood puss, the favorite of the household; with arched back and extended paw she took her prey. When an unfortunate minnow approached the surface, sharp was the dash made by puss, arm and shoulder were boldly immersed, and straightway the victim lay gasping on the bank; fishing in this manner she soon captured half-a-dozen, and was then driven away; from that evening the well was always covered with a net, which scared puss into enforced honesty.

Mr. E. H. Forbush quotes in his valuable monograph (1916) the observations of several correspondents in Massachusetts who saw cats fishing for trout in streams that are low in summer or for smelts and eels in shallow tide pools along the seashore. He gives also a figure, reproduced herein, showing a cat "flipping" out a fish with a paw the claws of which are unsheathed for action.

I now have the pleasure of giving an unpublished observation which has come to me first-hand from the observer himself, Mr. Herbert Lang, associate curator of African mammals in the American Museum. The incidents related occurred at Öhringen, Württemberg, Germany, about 1889.

We boys often used to fish in a small lake behind our house. One evening a friend of mine discovered our old gray cat sitting on one of the many stones which emerged from the water where it was shallow. Watching her intently we saw her make a dash, and, sure enough, she had caught a fish. Later on, and for several years thereafter, two or three other cats came to fish, but only during the summer months and just before dusk. At this hour a great number of fish were playing about the stones among the green mosslike algae. The cats always sat on their haunches bent somewhat toward the water, as immovable as if carved of stone. But suddenly a paw would shoot out and a fish be caught, to be taken into the mouth or landed on the stone. Though the cats sometimes missed their aim, it seldom took them more than twenty minutes to get their fill. Four fishes, each about two or three inches long, was the maxi-

mum we ever saw any one catch. Heads and tails were not consumed. When opportunity offered, the same cats would also steal much larger fishes out of pails. These they usually attacked in the neck region.

These incidents are all very well and really do not overstrain one's credulity, but will the cat, with a dread of water amounting to a veritable hydrophobia, leap into the water, swim, and dive for its prey? Are the accounts previously given final or do they lead up to a series of diving episodes? Let the following accounts be the answer.

DIVING CATS

The first incident to be given is related by John McDairmid (1830). The chief occupation of the cat mentioned therein was hunting in winter and fishing in summer:

Her custom was to dern [*sic*] herself by the side of a pool . . . and when a trout rose at the shallowest part of the water, she immediately sprung on it. . . . These exploits cost her many a ducking, but her patience was equal to this and more, and what with exercise and the frequent use of the cold bath she acquired all the hardihood of a wild cat, though she retained her docile habits when at home.

The next account in this category is from Scales (1831) and is both very interesting and very much to the point.

Many a time and oft have I watched puss . . . watching on the brink [of the fish-pond] for its finny inhabitants, and on their appearing at the surface darting on her prey, and in spite of the wetting and ducking she encountered, bringing them in triumph to the pond's edge, and regaling [herself] on the delicious fare. This sport, I believe, she continued in the enjoyment of till the day of her death. . . . The pond was . . . completely a cockney pond . . . therefore before puss could gratify her taste, a plunge was to be taken which was sufficient to make the stoutest cat's heart tremble.

In the same note is an account of another cat (known to Scales), which used to dive after water rats in a pond. This was the cat's constant practice for nine or ten years—till his death. As he never ate the rats, it is evident that his motive was pure sport.

The next account of a cat swimming and diving for fish is that by John Dixon (1854), who writes:

A friend of mine . . . tells me he well remembers a cat at Aberford Mills, that was a regular fisher in the little rivulet there, (the Cock). So soon as the wheels were stopped, and the mill race once again placed, puss might often have been seen, generally at noon, swimming and diving about in pursuit of her finny prey. It was not exactly "bobbing for eels," but "tickling trout," that was most to her fancy, and when these grew scarce, smaller fry in the shape of minnows, were made to suffice; "better sma' fish than nane."

Stables says that he has dozens of accounts of cats diving and fishing, and gives a few striking ones. These nearly all relate to millers' cats, which, he alleges, almost invariably take to the water in pursuit of prey. One interesting account reads as follows:

I know an instance of a cat bred and reared at a flour mill. It was a universal custom with this pussy to watch by the dam-side, where she might have been seen at any time either in winter or in summer. She used to run along the edge of the water in full tilt after a trout until it stopped; then, seeming to take aim for a few seconds, she would dive down like an arrow from a bow, and never failed to land the fish.

Of another cat at a mill in Aberdeenshire he relates that she was "an excellent swimmer and fisher, and as fond of the water as an Irish spaniel."

When fishing, she did not confine herself to any one portion of the stream, and whether deep or shallow it was all one to puss. The boys, too, of the neighborhood, were not long in finding out, that, by whatever part of the rivulet they saw the miller's cat fishing, there they would find trout in greatest abundance.

Stables (1876) also tells of a certain cat that was fond of eels and always managed to provide for herself. Another cat, white in color, was one day seen walking along some distance away, with what was apparently a black band or necktie around her neck. On closer inspection it was found that the supposed band was an eel, the head of which was in her mouth. Of yet another feline he writes, "I have, myself, watched a cat by the banks of a stream until I have seen him dive into the water, and emerge almost immediately with a large trout in his mouth."

Lane (in the work previously cited) speaks of an old friend and neighbor of his, who in his youth lived in Dumfriesshire near the Annon River, in which he was accustomed to fish and bathe. He was generally accompanied by his cat, which was pure white, except for a black smudge covering the face, head, and ears. This marking gave the cat a most sinister appearance and led to his being called Beelzebub. On one occasion, when his master was bathing, Beelzebub sprang into the water, swam to him, climbed on his shoulder, and was thus borne ashore. Lane concludes:

Ever afterwards the cat was observed to visit the river on his own account, and swim after the small fry, driving them into shallow water, catching and making a meal of them, and never seemed troubled with the natural aversion generally felt by cats to water, but would plunge boldly in and swim about like a dog.

At this point I again have the pleasure of giving an unpublished first-hand observation, which was communicated to me by Miss Maurine Pickett of Little Rock, Arkansas. The incidents she relates took place in 1921 when she and her family were

living in Bloomingdale, Indiana. We shall let her give the account in her own words:

My small brother, Marion, was accustomed to fish in a little branch [brook] that ran through our pasture. One day he put a six-inch catfish and two smaller sunfish in a puddle about four inches deep, at the outlet of the milk trough from the dairy. Some time later he went back to look for his fishes, but they were not to be found. Tom, our cat, was sitting near by, washing his face and wearing the expression of having just "eaten the canary." Now Tom was an ordinary large white cat with green eyes and the usual fondness for mice and milk. But Marion suspected him and took steps immediately to prove his guilt. Accordingly he ran to the branch with line and bait. When he caught another fish, he brought it to the puddle and called Tom. Tom watched the fish intently for a few moments, then he thrust his paw into the water, caught the fish, and held it, just as he would a mouse, until he could get it in his mouth. He enjoyed this fish very much and did not seem to mind getting his face and paw wet.

Marion was delighted with the experiment. For several days he spent most of his time fishing for Tom and watching him catch the fishes out of the puddle.

As Tom's appetite for fish was cultivated, he learned to associate Marion's trips to the branch with pole and bait, with the fish in the puddle. When Marion would start to the branch, Tom would follow. The fishing "hole" was about eight feet across and was probably eighteen inches deep in the center. Tom saw that in this hole fish like those he had taken from the puddle were swimming about. He watched them for a few minutes, waiting for one of them to become quiet, then he dived about two feet out into the water, caught the fish with his paw, got it into his mouth, and swam back to the bank, reaching the same point that he had left. Every hair was dripping, but Tom didn't care. As soon as he had disposed of that fish, he caught another in the same manner.

The next day Tom went with Marion to the branch again. He caught his fish and swam like a veteran. After that it was not necessary to go fishing with Tom—Tom went by himself. He learned also how to catch frogs along the marshy places at the

edge of the branch. Almost every day for the rest of the summer we would see Tom coming from the branch with his fur all parted from being wet. This daily plunge kept his coat very white and clean. He was known in the neighborhood as the diving cat. We don't know whether he became too popular or what happened. At any rate, a few days before we left Indiana for Arkansas, Tom disappeared and we haven't heard of him since.

CATS THAT BRING BACK FISH TO THEIR MASTERS

In the article "Dogs as Fishermen," previously referred to, I have shown that in some parts of the world dogs act as aids to their masters by driving the fish into nets, and that some even bring their catch to their owners. Cats do not seem to enact the former rôle, but some, like dogs, have acted as purveyors for their masters. We shall now briefly consider some of these cases.

First of all, F. O. Morris (1860) tells of a cat that used to bring home eels and other fish caught in a pond near by. Charles H. Ross (1868) gives us two very concise accounts. He says that a Mr. Moody of Jesmond, near Newcastle upon Tyne, had in 1829 a remarkable fishing cat which he had owned for a number of years, and which "caught fish with great assiduity and frequently brought them home alive. Besides minnows and eels, she occasionally carried home pilchards, one of which, about 6 inches long, was once found in her possession."

Mr. Ross's second account is quoted from the *Plymouth Journal*, an English publication, of June, 1828, in which it is stated that:

There is now at the Battery, on Devil's Point, a cat, which is an expert catcher of the finny tribe, being in the constant habit of diving into the sea and bringing up the fish alive in her mouth, and depositing it in the guard room for the use of the sailors. She is now seven years old, and has long been a useful caterer. It is supposed that her pursuit of

the water-rats first taught her to venture into the water, to which it is well known Puss has a natural aversion. She is now as fond of the water as a Newfoundland dog, and takes her regular peregrinations along the rocks at its edge, looking out for her game, and ready to dive for it at a moment's notice.

Fennell (1874) records that a cottager in Wiltshire had a cat which would dive and catch trout, and these the cat would bring to her mistress as she would captured rats or mice. Furthermore, Stables, in the two works listed in the bibliography at the close of this article, reports this habit as being characteristic of a number of cats. One carried home an eel. In another case a fisherman lost a fine salmon through the breaking of his line. Next morning the fish with the hook in its mouth was found on the doorstep alongside the household cat.

Several of the authors cited (particularly Stables) note that cats that develop the fishing habit are mainly millers' cats. These cats, domiciled at mills to keep down the plague of mice and rats, catch water rats as well as house rats and presently develop the habit of going into the water after their prey. In this water they will find fish, their best-loved food. Suppose, then, that a cat in trying to catch a water rat makes a misplay and catches a fish—in this may not improbably be found the beginning of the habit of deliberate fishing.

CATS THAT TRAIN OTHER CATS

Furthermore, a cat thus self-trained may in turn train another cat. So relates Ross, in speaking of the cat previously referred to. ". . . she also contrived to teach a neighbor's cat to fish, and the two were sometimes seen together watching by the river side for their prey. At other times they were seen at opposite sides of the river, not

far from each other, on the lookout for game."

Stables makes the general statement that cats not only learn to swim and dive but teach their young to do so, and he avers that this interesting practice has been transmitted in certain families of cats even to the third and fourth generation. Here it may be recalled that in my previous article on "Dogs as Fishermen" it was recounted that a fishing dog was trained by being taken out with an older and trained dog, and that another dog trained her puppy so well that he became a better fisher than his parent.

Speaking specifically of a miller's cat which was an expert fisher,

Stables gives the following charming account:

This cat not only fished herself, but taught her children to do so. The way in which she managed this was very amusing, and shows how extremely sagacious feline nature is. When the kittens came of sufficient age she would entice them down some fine sunny day, to a part of the stream, where the water was very clear and shallow. Here the smaller trout-fry and minnows would be gambolling; and, making a spring, pussy would seize one of these and bring it out alive. After letting it jump about for some little time, to amuse the kittens and attract their undivided attention, she would kill and return it to the stream, jumping after it, and playing with it in the water to entice a kitten in. Thus in course of time, the kittens could all swim and fish, and rivalled even their mother in quickness and daring.



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The Mimicry of Minerals

By HERBERT P. WHITLOCK

Curator of Mineralogy, American Museum

BETWEEN the perfectly formed crystal developed to ideal proportions and free from distortion, and massive bodies which do not possess any outward token of crystallization, we find among minerals a wide range of examples of molecular architecture which are known as crystalline aggregates. Many of these mimic the forms of animate nature, producing fanciful shapes of great diversity and beauty.

Water, which is so common a substance that few of us realize that it is really a mineral, furnishes us with an admirable instance of the wealth of exquisite patterns produced by crystallization. Where water vapor is cooled slowly to just the point of freezing, its molecules are drawn together to form little flat six-sided crystals familiar to anyone who has looked closely at snowflakes. With somewhat more rapid cooling of the air the minute nucleus of the snow crystal becomes the center of intricate branching and starlike forms of wonderful symmetry. Where water vapor consolidates on a cold sheet of glass, for instance a windowpane, the water crystals grow much more rapidly, and interlacing patterns of rods—produced by one tiny crystal forming against another—or branching, fernlike forms result. Lastly, where dripping water is consolidated by the cold, the rounded shapes of icicles, resulting from the quick solidification of a liquid, give no outward evidence of the inward ordering of their molecules, although this arrangement is the same that has produced the snow crystal and the window frost.

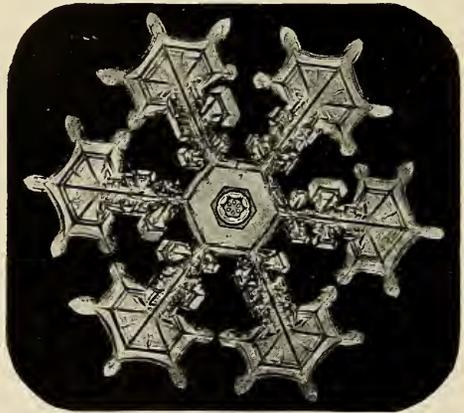
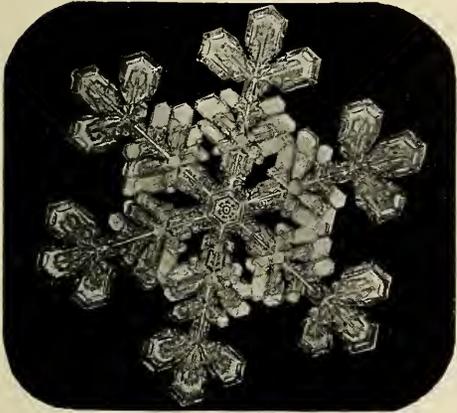
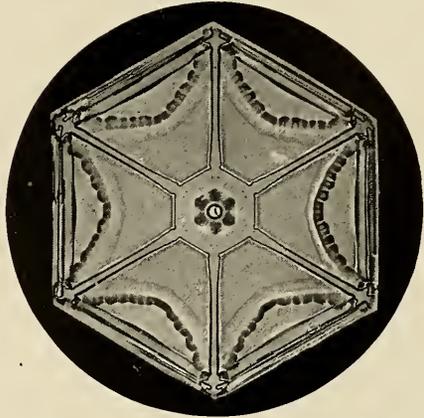
The knowledge how window frost is produced enables us to understand the meaning of the so-called *dendritic* structure, assumed by a number of minerals. Such minute and intimate crystal groupings as are to be seen in moss agate bear a very close resemblance to the delicate tracery of the vegetable world, and at first glance we are almost forced to the belief that they are in reality fossil plants. However, we have but to compare them with the frost designs that the touch of winter leaves upon our windowpane to realize their true nature.

Sometimes the long-drawn-out prisms of a mineral will group themselves in masses, suggesting a bundle of sticks or the slender fluted columns that distinguish some kinds of architecture. From the latter resemblance this kind of grouping has been called columnar structure. Or again the long thin rods, which are in reality prismatic crystals, interlace to form a netlike structure with angular open spaces. This kind of structure may be seen in some varieties of the minerals rutile and cerussite.

Crystals seem to have a tendency to attach themselves to a support by one of their extremities with the result that their greatest length is directed outward. A crystal of slender prismatic habit will usually project from the rock to which it is affixed in much the same way that an iron filing sticks out from the magnet that attracts it, and if the crystal happens to be flat and platelike, it will very often be found fastened by its edge. Needle-like

or hairlike crystals attached to a projecting point will tend to radiate from this point as a center and will assume a structure like a tuft of hairs.

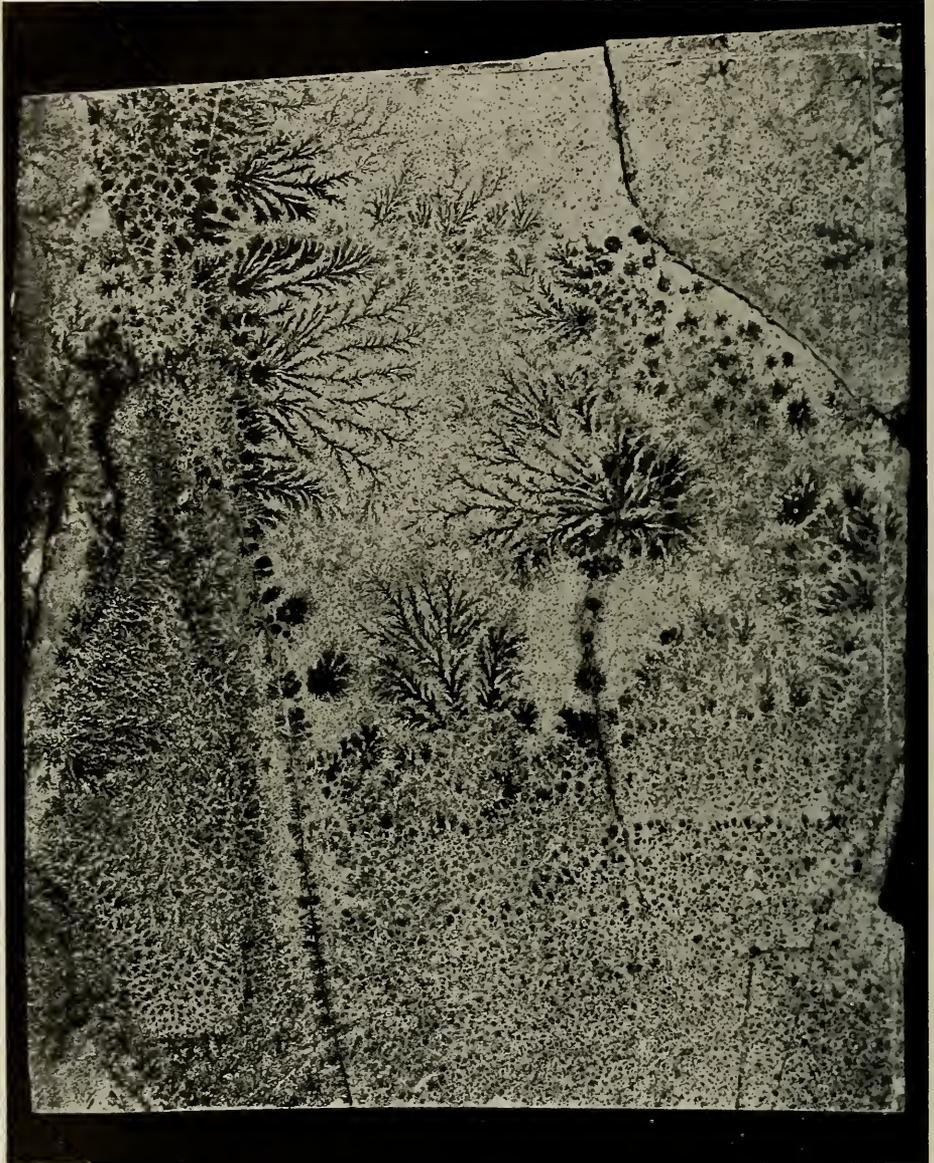
more perfect as the radiating prisms that form it are more thickly grouped. An excellent instance of the perfect roundness assumed by these "mineral



The tiny six-sided plate (upper row) which, under conditions of slow crystallization, is typical of snow, with a somewhat more rapid cooling of the air becomes the center of intricate, branching, and starlike forms of wonderful symmetry (lower row)

A number of minerals furnish examples of this grouping. Perhaps the most striking illustration is to be found in the radiating crystal aggregates of the mineral natrolite, which from a center thrust out their glistening white needles sometimes an inch and a half or more in all directions. As it usually happens that the length of these needle-like prisms is fairly constant, the outer surface of the group assumes the shape of a ball, the outline of which becomes

balls" is found in the mineral wavellite, which takes on forms that remind us of the familiar fluffy seed balls of the dandelion. Occasionally the radiating structure has for its nucleus a single small fragment of a mineral, such as a fragment of quartz or a minute crystal, and the conditions are such that crystals are freely developed in all directions around this center. In this way the concretionary balls of the mineral pyrite are produced in slate,



Crystalline Aggregate of the Mineral Pyrolusite (Manganese Dioxide).—This structure, which is called dendritic, is formed in the same way as window frost, which it closely resembles

and when these are cut in sections through the centers, they constitute the beautiful and remarkable objects that are known as pyrite "sunbursts."

The mineral hematite often crystallizes in flat hexagonal plates. Some-

times these platelike crystals attach themselves to a projecting point in overlapping piles in much the same manner that the petals of a rose are fastened to its calyx. The fanciful name of "iron roses" has been given to



NATROLITE

Long slender silky needles of the mineral natrolite radiating from a central nucleus suggest a fluffy seed ball of the dandelion. Wavellite is another mineral that assumes forms of this type



The flat platelike crystals of hematite sometimes bunch themselves in forms resembling the petals of a rose

these groupings. When the plates are more thickly packed together, a variety of curious and interesting crystal structures result, such as the crested aggregates of the mineral barite and the sheaflike bundles of the mineral stilbite. The flat crystals of calamine, a silicate of zinc, tend to group themselves in rounded ridges, notched at the crest where the angular edges of the crystals emerge from the group. From a fancied resemblance to the notched comb of a rooster, this grouping has been called "cockscomb" structure.

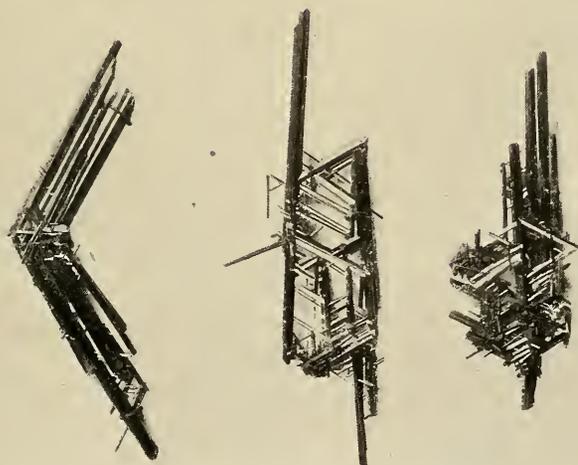
Frequently among minerals the crystal individuals are so crowded together that no single crystal has a chance to develop its regular and characteristic

outline, or to assume with its neighbors a distinctive group or aggregate. Such a structure, made up of packed-together crystal units, may resemble, when broken, a lump of sugar or a mass of common table salt made solid by moisture. Because they are made up of masses of coarse or fine grains, we call such structures massive and characterize them as "coarse granular" or "fine granular," each of the "grains" being a tiny crystal lacking the outward form it would have had if it had been permitted a free and unobstructed growth.

We have touched upon some of the more significant examples of crystal structure and have endeavored to ex-

plain how nature operating through the inflexible laws of crystallization has out of inorganic matter fashioned the intricate shapes which often suggest the forms of life. We have opened the door to this fascinating maze of form and color only a little way, and have permitted merely a glimpse at the wonders within. To draw a comparison from the animate world, the relation between crystalline aggregates and

the individual crystals that compose them is outwardly much the same as the relation between a compound flower and the separate florets that make up its intricate form. And just as in the realm of plants we find countless shapes among compound flowers, so in the mineral kingdom the varied forms assumed by groups of crystals continually excite our wonder and admiration.



Long thin crystals of rutile (titanium dioxide), which group themselves in masses, suggesting the slender columns characteristic of certain types of architecture

Eclipses

AS INTERPRETED BY THE AMERICAN ABORIGINES

BY HERBERT F. SCHWARZ

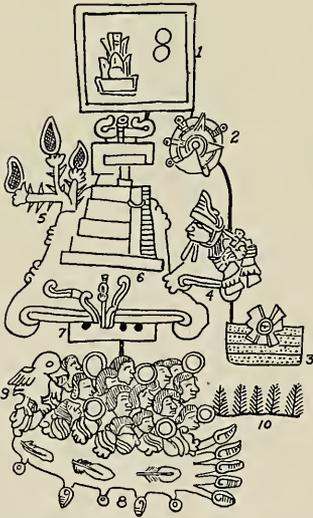
Research Associate in Hymenoptera, American Museum

WHEN New Yorkers poured out of their homes in the early morning of January 24 and hastened to the upper sections of the city and to the suburbs to await the eclipse, they were confident to a man that they could rely on the predictions of the astronomer. Watch in hand, they knew that the celestial mechanism, more dependable than the contrivances run by man, would perform its predestined functions on the scheduled minute.

Contrast with this mental preparedness, the utter unexpectedness of such a phenomenon among savage peoples. Without any warning, the orb of day, the source of their light and warmth and cheer, is invaded by a dark monster that nibbles its way deeper and deeper into the heart of the sun, which shrinks before the assault. At length the

sinister antagonist has overpowered it, obliterated it; and only a ghostly radiance remains of the blazing majesty that previously no man dared look upon. Nor is the sense of awe and bewilderment much less when there is a similar obscuration of the moon.

Again and again among primitive peoples the devouring monster is given a definite designation. The Indians of the Cape Flattery region of Washington, who, it is said, have named many of the constellations after such creatures of the sea as the whale, halibut, skate, and shark, further reflect their maritime culture in their explanation of eclipses, which they look upon as the attempts of a fish like the "cultus" cod, or *toosh-kow*, to eat the sun or moon. The moon, they say, is made of a jelly-like substance such as fish enjoy—a morsel presumably as palatable as the green cheese moon of nursery tale days. According to Cherokee myth it is a great frog up in the sky that tries now and then to swallow the sun or the moon. And these people add "Everybody knows this, even the Creeks and the other tribes." Apparently, however, the Creeks have another explanation for the celestial phenomenon, for according to Daniel G. Brinton these Indians were wont to thrash their dogs during an eclipse and, when they were asked for an explanation of their behavior, they replied that "The big dog was swallowing the sun, and that by whipping the little ones they could make him desist." Certain of the Caribs of the West Indian region attributed eclipses to their devil, Maboia, who seeks the destruction of the sun and the moon.



Analysis of Mexican Record, showing occurrences of the year Two Reed, 1507. The figure marked (2) represents an eclipse of the sun, and (3) an earthquake. Reproduced from *Ancient Civilizations of Mexico* by Herbert J. Spinden, to which the reader is referred for an explanation of the other figures

To drive off the spirit of evil that threatens the light of the world unenlightened man relies on noise. Even in seventeenth century England we come upon this quaint bit of advice: "Imitate not the wild Irish or Welch, who, during eclipses, run about beating kettles and pans, thinking their clamour and vexations available to the assistance of the higher orbs." Throughout aboriginal America similar methods of combating the foe in the heavens were widely employed. James Adair, writing of an eclipse that occurred in 1736 while he was sojourning among the Cherokee, says that "During the continuance of it, their conduct appeared very surprising to one who had not seen the like before; they all ran wild, this way and that way, like lunatics, firing their guns, whooping and hallooing, beating of kettles, ringing horse-bells, and making the most horrid noises that human beings possibly could." Sometimes even fire-arms were employed to drive off the celestial aggressor.

Although indiscriminate noise—the louder, the better—was usually deemed effective, there is an interesting instance to the contrary reported by Joseph Gumilla, a Spanish missionary who visited the tribes along the Orinoco in the first half of the eighteenth century. During a lunar eclipse, he tells us, the married men of the Otomacs, snatch up their arms, rush about, yell discordantly, fit their arrows to their bows as a sign of indignation, and in turn command and entreat the moon not to die. But when in spite of all their efforts, its light becomes less and less, and they come to realize that the moon is deaf to their appeal, they rush to their homes and upbraid their women folk for not exerting themselves in bewailing the infirmity of the moon.

The women, however, give no evidence that they grasp what their husbands are saying and do not answer so much as a word. The men, seeing they can accomplish nothing by force, change their tone and begin to supplicate their women to weep and wail so that the moon may recover. The entreaties of the men are all in vain. Thereupon they proceed to the distribution of gifts, which conquers all resistance on the part of the women. The men part with their gaudy ornaments; each gives the best he has,—some beads of glass, others necklaces of monkeys' teeth, and similar finery dear to the feminine heart. Then the women go out to salute the moon and in mournful tones address supplications to it; and as this function takes place at the time when the moon is about to recover its light, a little while after they have urged their request, the luminary is again whole and clear. Then the Otomacs heap thanks upon their women, whose lamentation, according to their notion, moved the moon to compassion and persuaded it not to die.

This conception of the moon as ill and threatened with impending death has its counterpart in other regions. Among the Tewa of the upper Rio Grande Valley, for instance, when there is an eclipse, the luminary is referred to as dying.

Another interesting instance reported by Gumilla from the Orinoco region is to the effect that the Indians at times of eclipse seize their agricultural implements and begin vigorously cultivating their fields under the impression that the moon is showing its anger because of their lazy ways. "But," adds the Padre, "as soon as the moon has recovered its light, they return to their houses . . . and think no more of sowing or of cultivating the soil. . . ."



The solar eclipse of August 7, 1869, as recorded by Lone Dog, a Dakota chief, on his buffalo robe. The sun is painted black, the stars red. From "Picture-Writing of the American Indians" by Garrick Mallery

Allusion has been made to the belief that eclipses are caused by some monster of the sky bent on the destruction of the sun or the moon, or again that the waning light of the luminary affected is due to its infirmity and approaching death, or finally that the bright disk is withdrawing in anger, refusing to shine for an offending people. There remains yet another common conception, namely, that sun and moon are hostile to each other and that an eclipse is the time when they come to blows. Thus the Arawaks among whom E. F. im Thurn sojourned, shouted and yelled in order to separate the celestial combatants as they grappled with each other.

Reference may be made at this point to a myth, widespread among the Eskimo.¹ It is the belief of this people that moon and sun are respectively brother and sister who parted in anger. According to Franz Boas, who reports the legend from Cumberland Bay, it is the brother who is pursuing his sister through the heavens, and this is the prevalent conception and the one depicted in the mural of the Northwest Indian hall, American Museum. The tale, however, has its variants and, as reported by Lucien M. Turner from the Ungava District, Hudson Bay Territory, it is the sister who, armed with a brand from the fire, pursues the brother, the sparks streaming from her torch becoming the stars. Turner adds that, when an eclipse occurs, sun and moon are supposed to meet.

¹This myth and its variants are very widespread. They are found from the Pacific Northwest to Greenland. A close analogue occurs among the Cherokee. A variant, but with all the essential features preserved, has been reported from British Guiana.

A myth, obtained by Walter E. Roth at first-hand from the Pomeroon Arawaks, explains a lunar eclipse as due to the moon's falling asleep in the path of the sun and being overtaken before it can get out of the way. To warn the slumbering moon of the approach of the sun these Indians make the usual din. Furthermore, they abstain from taking food under the impression that those who eat at such times are changed into the animal or plant of which they partake.

The belief in a pursuit of one celestial body by the other was not confined to the New World. Citation may be made in this connection of an eclipse myth as recorded by William T. Olcott in *Sun Lore of All Ages*.

The primitive natives of the Malay Peninsula . . . regarded the Sun and Moon as women and the stars as the Moon's children. A legend relates that the Sun had as many children as the Moon, in ancient times, and fearing that mankind could not bear so much brightness and heat, the Sun and Moon agreed to devour their children.

The Moon retended to thus dispose of hers and hid them instead; but the Sun kept faith, and made way with all her children. When they were all devoured, the Moon brought hers out from their hiding-place. When the Sun saw them she was very angry, and pursued the Moon to kill her, and the chase is a perpetual one. Sometimes the Sun comes near enough to bite the Moon, and then men say there is an eclipse.

Just as in the Old World a battle in the war between the Medes and the Lydians was stopped, according to Herodotus, by a solar eclipse, so in the New, tradition tells us, a war between the Mohawks and the Senecas was averted through the timely obscuration of the sun. The alleged event is associated with the eclipse of June 28, 1451.

Whatever doubt there may be as to the authenticity of this pre-Columbian happening, it is certain that, in the

Western Hemisphere as in the Eastern, eclipses had their part in shaping the course of history. With the exception of the conspiracy of Pontiac, there was perhaps no concerted effort of the Indians that was better planned and organized, or calculated to present a more formidable obstacle to the encroachment of the whites, than the movement headed by Tecumtha. Yet that movement, dependent upon the coöperation and unity of purpose of many tribes, probably could not have made such headway if the interest of the Indians in the preservation of their native life and ways from the corrupting influence of the foreign race had not been kindled to fever heat by the fanatical zeal of Tecumtha's brother, the shaman Tenskwatawa, who exercised an extraordinary influence not only over his people, the Shawano, but even over relatively remote tribes. Yet his hold upon the savages had not been established without opposition and in the beginning the Miami and even the chiefs of his own tribe looked askance at his growing prestige. At this time of wavering, when perhaps the course of events might still have been turned, he effectually silenced all opposition by proving to the satisfaction of doubters and scoffers that he was a man inspired. He had learned that an eclipse of the sun was to take place in the summer of 1806 and, as the time approached, he boldly asserted that on a designated day he would prove his spiritual power by blackening the face of the sun. When at mid-day the eclipse occurred, the frightened redmen one and all proclaimed him a true prophet.

The shaman Smohalla, one of the most extraordinary characters the red race has produced, gained a reputation as a prophet through consulting an

almanac in which the occurrence of different eclipses was forecast. He failed, however, to reckon with the circumstance that the dates of these celestial events are not constant from year to year, and after the expiration of the period covered by the almanac, his astronomical predictions came to an inglorious end.¹

Yet in taking advantage of the credulity of his tribe, the Indian medicine man was but following the example set by the discoverer of America. In the gloomy days of February, 1504, when Columbus, deserted by many of his mutinous followers, lay ill in Jamaica, and the Indians, incensed by the inhuman treatment from which they had suffered, refused to be cajoled or threatened into delivering food, the Admiral thought out a way of gaining mastery over the savages. He knew that on the twenty-ninth of the month would occur an eclipse of the moon. Summoning the chiefs a day before the event, he announced to them that God was angry because of their failure to assist the Spaniards, that He was about to punish them with famine and other calamities, and as a sign of His intention He would give them a warning not to be mistaken, nothing less than the obliteration of the moon as it sailed through the sky.

When the eclipse came to pass as predicted, Columbus withdrew but, returning just before the emergence of the moon, announced that he had interceded with the Deity on behalf of the Indians and that God, being magnanimous, had determined to forgive them. When thereupon the moon struggled out of the shadow and little by little regained its splendor, the victory of Columbus was complete.

¹The Ghost-Dance Religion and the Sioux Outbreak of 1890," by James Mooney. Fourteenth Annual Report, Bureau of Ethnology.

The Value of Palæontology

BY W. D. MATTHEW

Curator of Vertebrate Palæontology, American Museum

A FEW men, a mere handful scattered among the millions of civilization, devote their lives to collecting and studying fossils. A larger number take a more casual interest in the results of these studies. The vast majority have never heard of fossils or ask indifferently, "Why should anyone waste his time upon such useless studies?"

This is the answer:

In the first place, what are fossils? They are the teeth or bones or shells of animals found buried in the solid rock. Centuries ago these were noticed by ancient writers, who wondered how they got there. Some thought that they were creatures half-formed and left unfinished when the creative day was ended. Others thought that they were a mere *lusus naturæ*. But in time everybody had to admit that they were remains of real animals which had been buried in the rock when it was soft sand or mud and preserved, sometimes very perfectly, when it hardened into rock. Then it was discovered that many of these fossil remains were of animals more or less unlike any that exist today. It was found, moreover, and has since been confirmed by such overwhelming proofs that none save the veriest ignoramus would venture to challenge the statement, that each formation had its own peculiar kinds of fossils, different from those in the overlying rock strata and from those that lay beneath, as well as unlike anything that now exists. One could recognize a certain formation wherever it showed up at the surface

of the earth by the fossils that it contained. Here was a very practical use for palæontology. It was a great aid, oftentimes indispensable; to the geologist in identifying and mapping the successive geological formations. With its aid he could trace the probable extension and depth beneath the surface of the formations containing coal or oil or other useful minerals, and the great mining industries of our modern civilization depend largely upon this sure foundation for their success and vast expansion.

But there is another aspect of palæontology which adds not to our wealth but to our knowledge of the world we live in. These fossils, remains of animals that have lived in past ages but no longer survive, are the records of the history of life. We collect and study and compare them so that we can reconstruct these extinct animals, so that we can find out, as far as may be, just how they differed from those that preceded and from those that succeeded them, how they lived and to what environment they were adapted. Our aim is to reconstruct the history of life during the vast periods of time that have elapsed since the first rocks were formed.

Current history is but a passing phase, a stage in the march of events, past, present, and future. We cannot follow present events without becoming keenly interested in the past, which explains the present, and in the future, which we can predict more certainly if we have an adequate knowledge of the past and the present.

The more we know of these, the more clearly can we discern the laws that govern the orderly progress of events, the more definitely and positively can we perceive what is to come, at least in its broader outlines. Herein lies the great fascination of historical studies: in the attempt to synthesize and arrange the infinite multiplicity of events great and small, to find the underlying causes to whose interaction they may be ascribed, to test and prove the soundness of our theories by bringing them to bear upon other groups of events, above all to apply the acid test of fulfilment of our prophecies, the confirmation of our theories by new discoveries and forthcoming events. To read the future is the dearest wish of man and it can be done in so far as his knowledge and understanding of the past show whence we have come and whither we are going.

But history in the ordinary sense of the word deals with but a limited portion of the past of man. The world in which we live has a far wider scope and its history extends backward through enormous periods of time in comparison with the few thousands of years covered by recorded human history. In these dark ages of prehistoric time vast and complex movements and changes have gone on, whose final results we see emerging from obscurity into the bright light of history. From the study of these results we can infer a great deal as to the causes that brought them about, but aside from this indirect evidence we know of the history of life only what we can learn from the rocks and the fossils preserved therein, which constitute our records of the prehistoric ages.

From these fossil records, the "documents" of earth history, it has been possible to build up a great and splen-

did science, secure and fixed in its massive foundations and its broader lines of structure, more doubtful and speculative in some of its lighter tracery and ornamentation. Those who, through field work and study, have been able to add brick by brick to extend and amplify its solid basis, who have learned the laws of its architecture and aided in building up its superstructure, who have at times been privileged to add some bright pinnacle or favorite cornice to its glittering towers—these men have come to love their science beyond all else. It is their home which they have helped to build, and its beauty and symmetry, its noble and appropriate proportions, and its perfection of detail fill them with an ever-growing admiration and affection.

Do you wonder that the palæontologist, absorbed in contemplation of his splendid edifice, walks a little apart from the ways of men; that the little personal affairs and interests of the fleeting present which make up the world of his fellows, seem to him but gewgaws and trifles of no importance? His field of vision embraces the whole of life. His time scale is so gigantic that it dwarfs to insignificance the centuries of human endeavor. And the laws and principles which he studies are those which control the whole great stream of life, upon which the happenings of our daily existence appear but as little surface ripples.

Preëminent among the laws which govern the architecture of our world of life is evolution. To the zoölogist the law of evolution appears as a theory, an explanation of the world of nature that lies about him. It is the only theory that really explains it, and it fits all the marvelously complex details of adaptation, the perfections and likewise the imperfections of structure

of every animal and plant so perfectly and accurately that few or no zoölogists can question the theory, however they may dispute about the precise method of its action.

To the palæontologist, however, evolution appears not as a theory but as a fact of record. He does not and cannot doubt the gradual development of diversely specialized races from a common ancestral stock through a long series of intermediate gradations, for he has before him all these stages in the evolution of the race preserved as fossils, each in its appropriate place in the successive strata of a geologic period. It is not a matter of deduction but of observation, at least in those races of animals whose fossil record has been discovered; for the rest it is a matter of obvious inference. Concerning the causes and methods of this evolutionary process he finds wide room for discussion; but of the fact, of the actuality of it, he can have no doubt. Evolution is no more a theory to the man who has collected and studied fossils than the city of New York is a theory to the man who lives in it.

But, in truth, evolution is only one aspect of the order of nature, of the relations of cause and effect, of continuity of space and time, which pervade the universe and enable us to comprehend its simplicity of plan, its complexity of detail. The palæontologist, engaged in adding year by year to the mass of documents which record the history of life, in deciphering their meaning and interpreting their

significance, has no more occasion to doubt its continuity and orderly development than the historian has to doubt the continuity and consecutive evolution of human history, or the student of current affairs to doubt that the events of today will result in the conditions of tomorrow.

We have much to learn concerning the details of these great natural laws, their mode of operation, the manner in which the changing environment has influenced the course of development of all living beings, and of the nature of life itself. But of all this there is no more solid and direct evidence than that furnished by the records of the past which are found in the rocks, provided we keep ever in mind their necessary incompleteness and the comparatively slight and oftentimes superficial examination and study of them that has thus far been possible.

Such is the value of palæontology. It provides an essential part of the evidence for scientific study of the rocks, which has made possible the huge expansion of the mining industries upon which our modern material civilization is so largely based. Its higher value lies in adding to our knowledge and aiding in our comprehension of the world we live in, in tracing the past history of life and finding in it the explanation of the present, in observing the ordered progress of evolution under natural law from the beginnings of the world down to the present day, in helping us to discern through a better knowledge of the past what may be the course of future events.

The Marmots of Hannegan Pass

By WILLIAM T. SHAW

Professor of Zoölogy, State College of Washington

THIS morning, as I was coming down the trail from Hannegan Pass¹ over the alternate patches of slide rock and snow, my attention was sharply attracted by a furry object moving in an odd sort of way, on an old grass-grown moraine below. My first thought was of some trapped animal writhing in the agony of the grip of steel. On closer examination, the object proved to be two young marmots in a friendly bout. They were very deliberate and grotesque in this brotherly contest, very bearlike in their manner of attack. It was a playful sort of private affair; with the rest of the family complacently holding aloof at the front door across a log.

What a shot!

My camera was always eagerly operated in response to such an invitation, and while it was being rigged, I became aware of the shrill whistle of a marmot up the north slope of the pass, yet did not get the significance of the situation nor realize my opportunity until everything was ready and I began more carefully to study the surroundings. Soon a marmot was seen progressing down one of the rock slides, marmot fashion. She was not at ease but was evidently suspicious as she made her way toward me though still three hundred yards away. As she approached, it became evident that she must be the mother of this little brood, for only a mother would take such a risk.

If I was to make good use of my opportunity, I must keep her from

home, for once there, the young family would be under her direction if not direct command, so I acted accordingly. On she came by stages, flourishing her tail occasionally as these marmots are wont to do, and finally stopped beside a den in the midst of some yellow flowers, *Mimulus* I think they were. She was not still long, but roamed restlessly, and once or twice left some fine footprints in a near-at-hand snow bank. Gaining confidence, she came on and soon cantered over to a bowlder under which was a hole, as was the case beneath most of the rocks of size, which seem to serve equally for sunning, lookout, and retreat. Thinking she might make a dash for the home den, I went over to frighten her away. Down went the old mother marmot under the big sheltering rock, only to reappear as soon as my back was turned. I had looked back and seen a young marmot viewing the situation from his front door, complacently ignoring my camera, which was carefully focused at the rear of his back porch. The mother showed much concern and appeared so persistently at the entrance of her retreat that I decided to focus on her, with one leg of the tripod within a very short distance of the hole which she occupied. I had not long to wait. In a few moments, from my place of vantage behind some red heather, I saw her clearly, squarely in the focus area, ready at a moment's notice to dart back into concealment. Feeling sure she had done her part and was likely to hold her pose, I pressed the release bulb firmly and forcefully and could

¹A pass in the northern Cascade Mountains of Washington, between the headwaters of the Nooksak and the Chilliwack; elevation, 4962 feet.



Photograph by William T. Shaw

The mother marmot, photographed as she cautiously surveyed the landscape, ready at the first suspicious sign to dart back to safety

hear the shutter register clearly and distinctly while there was not a tremor of the animal. What an exposure!

Once more I returned to the family residence and focused again on the back door, which was the choice from the standpoints of lighting and composition. And now began a prolonged wait. The little fellows appeared at long intervals, their bodies like round fluffy balls, their faces sooty but gray-nosed, with bright little shiny black eyes and orphan-like, droopy-cornered mouths. But they came up singly, therefore would not make companionable groupings, and something better might be had by waiting.

I had begun my vigil at eleven in the morning. Not until four o'clock did the marmots appear for the evening

pasture. First one ventured forth, then another; but always at the front door. Finally the sun had swung into the camera so I reset the apparatus, this time shooting down so as to obtain a comprehensive view of the front door, now in the shadow, with the earthen dooryard still nicely flooded with afternoon sunshine. One little fellow, the big brother of the family, came out, surveyed the country, and lounged over with such an air of characteristic abandonment that I could not resist the temptation to release the shutter for one lone figure (see p. 171). Next two,—and then to my astonishment five fair little woolly heads looked about over the great amphitheater of their mountain birthplace. It was all new to them, perhaps their first or

second day out from the great warm nest below. This time they saw me and, young as they were, darted in unison at the noise of the shutter. I had grave fears for the result!

Once more the mother came close and presently whistled a long shrill whistle, which sent the little ones pell-mell into the den.

Just to the right of Hannegan Pass, looking west, is a knob, behind which the sun now began to settle, throwing an ever-quickly-lengthening shadow over the flower-carpeted cirque, and soon the spot on which I was focusing was merged into the shade of the mountain. But I continued to lie there, watching the little family of marmots, which had reappeared, as they nibbled their first meal of grass. Earnestly they worked at it, slowly nipping, or squirrel-like holding bits

of vegetation in their paws, or rising bearlike on their hind feet as they ate.

Out over the meadow the mother was similarly engaged, for the quiet of evening was drawing on. In anticipation of coming night she gathered a great mouthful of dry vegetation from the ground and carried it roughly grasped to the den,—not neatly tucked in her mouth as is the case with ground squirrels and chipmunks when building nests. Evidently she meant to repair this wayside den for the night.

At six o'clock I left them, but at seven, from the distance, I could see them still cropping grass. In the evening light, they looked like little gray-backed bears with intensely sooty faces and breasts.

Next morning they were still about the den, the mother with them but, as I set out to visit them again, I saw her



Photograph by William T. Shaw

The temptation to release the shutter for one lone figure was irresistible

once more leave on one of her wanderings of wide range. Perhaps she was heading for the hill slope of succulent grass by the banks of snow.

Ascending one of the many great cañons of the Cascade Mountains, one comes to the thinning out of the forest, and here is the home of the hoary marmot. On the steep-sided, snow-patched, fir-walled sides of these cañons one sees fan-shaped banks winding down in ever-increasing talus slopes from the summit. Far distant, they appear gray and earthen; the binoculars reveal them as granular; a contact view shows them as they are: sloping masses of liberated, disintegrating, crumbling slabs of granite or basalt, augmented from time to time by shattered slabs that in their turn have broken from the faces of the cliff wall. Here and there a living tree springs from their desolation; a dead tree, moldering, has strewn its brown decay over their jagged surface; and everywhere about their base and sides is the greenest verdure of grass and blossoming shrub and stately forest tree. Everywhere, passages lead to a

forbidden mysterious inner region, a safe retreat for many a little mountain mammal. These "slides" of desolation have their life. The marmot in all his stately dignity stalks bearlike or canters lumberingly from rock slab to jagged point or flattens out luxuriantly in the sun on one of his high outstanding sentinel rocks, asleep to all appearances except for two wonderful black eyes, ever keenly watchful of the cañon side. His is the hoary majesty of the mountain rock slide!

Although the marmots love these stony fortresses for certain good reasons, finding shelter in them from bears and bobcats, they have resorted in many places to the grassy bottoms of the slides and, tunneling into the hidden crevices of an old flower-covered moraine, have established a colonial home.

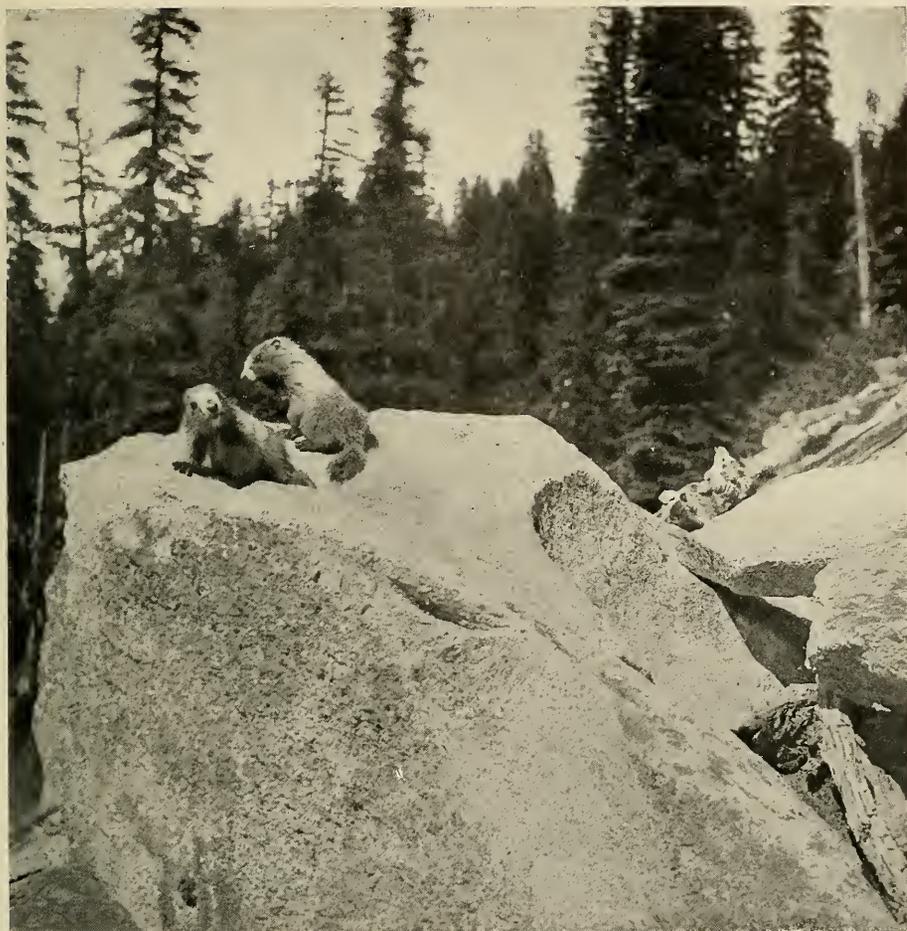
The animal known as the marmot, woodchuck, or ground hog, is widely distributed over temperate America, though represented by different species or kinds. The Cascade hoary marmot (*Marmota caligata cascadenis*), is an alpine merging into an Arctic form. Few mammals among those inhabiting elevations from four thousand feet to the limit of vegetation, are more noteworthy. It is a great ponderous rodent, much larger and heavier than a common cat, differentiated from others of its group by having a very light region of fur on the back, especially over the shoulders. Occasionally individuals are found in a characteristic dark phase; sometimes such animals are almost black (see picture herewith). Probably more than any other mountain mammal, the hoary marmot dominates its particular landscape.

Riding into one of the headwater cirques of some mountain stream the horseman is met by a long-drawn whis-



Photograph by William T. Shaw

A marmot standing erect like a pygmy bear. This dark phase was found on the headwaters of the Suiattle River on Glacier Peak, Washington



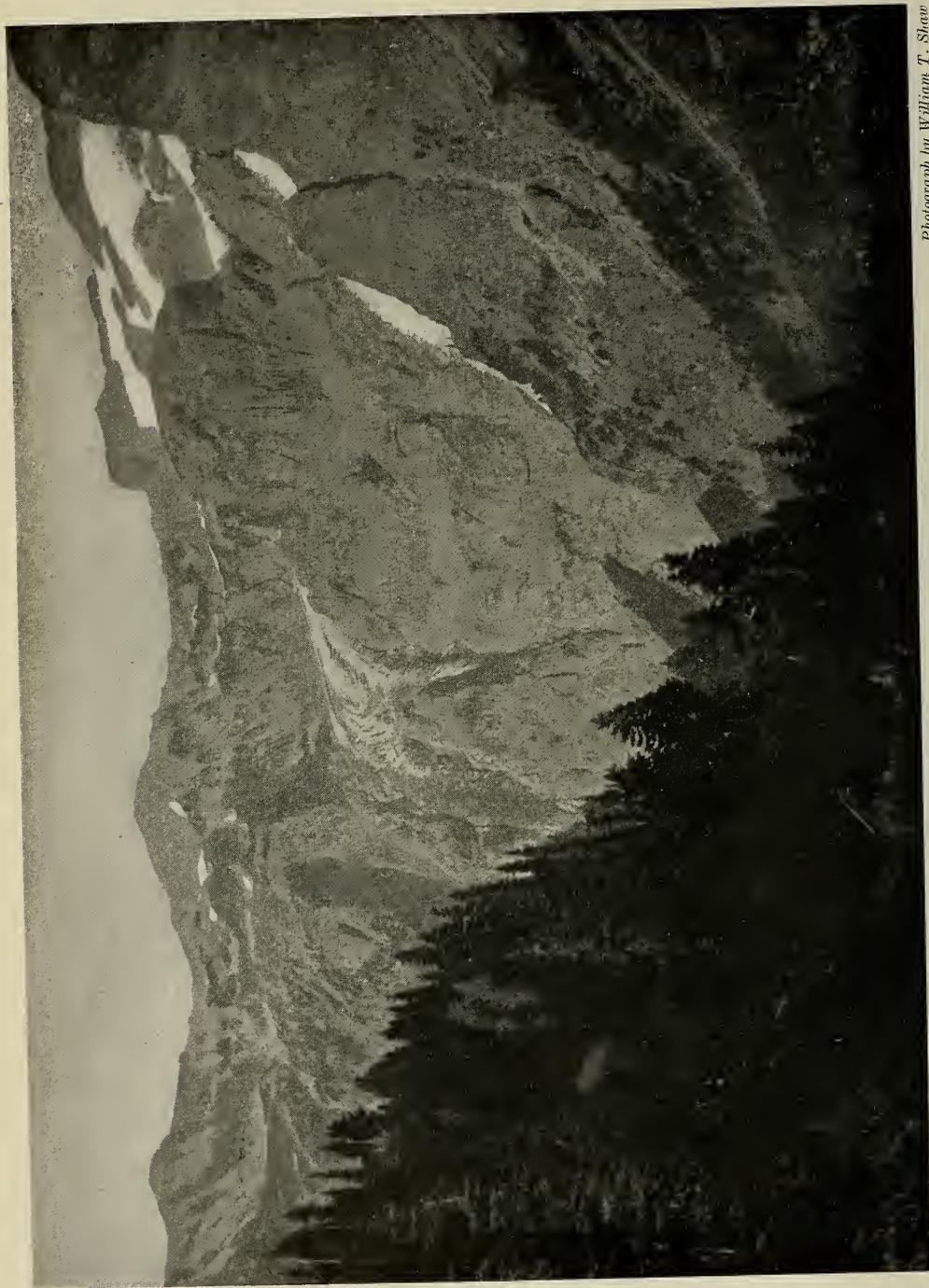
Photograph by William T. Shaw

Idling away time on a sunny boulder

tle, very human in its sound and weird in its effect. Presently this call is answered by another, perhaps nearer or again more remote. Soon the landscape becomes populated with marmots, standing erect like pygmy bears among the flowers about their den or lying upon some rock on the hillside. They never tire, lazily watching a passing pack train or any new unusual sight. Perhaps, if their surroundings were less congenial, they would not spend so much time in this way,—but what is time to a marmot! They dearly love the sunlight and will sprawl for

many lazy hours, flat, ruglike, on the warm face of a slab in the rock slide, frequently not changing their indolent position even if others in the colony are giving the call of danger.

Like most terrestrial rodents of similar nature they are ever watchful of the enemy. No rock slide but has some great boulder higher than another; few burrow entrances but have mounds of earth lifting above the grass. Should an eagle suddenly swing around the shoulder of a cliff, instantly a sun-basking sentinel from his point of vantage whistles with



PUYALLUP HEAD, MOUNT RAINIER, WASHINGTON
Here the eagle and the wild mountain goat are at home

Photograph by William T. Shaw



LYMAN LAKE AND GLACIER, WASHINGTON
The foreground is typical of the home of the Cascade hoary marmot

Photograph by William T. Shaw

piercing intensity and from innumerable lookout rocks and mounds mammal forms appear watchful and alert.

The hoary marmot is a hibernating mammal, appearing late or early in the spring according to altitude and amounts of neighboring snow. At Reflection Lake, Mount Rainier, on July 16, one year, an old female marmot was observed on a rock slide and with her was a litter of young, apparently just fresh from the den. She seemed very uneasy at sight of a passing stranger and, finding one of the youngsters which had wandered too far from home, deliberately picked it up with her teeth and carried it as a great Saint Bernard would a basket. The little creature was apparently held by one hind foot, and swung from side to side as the mother came cautiously down over the rocks.

The feeding range of the marmot is the neighboring wild grass-grown flower garden. The animal is quite truly diurnal.

On the broad grassy slopes of extensive mountain-sides are often found colonies of hoary marmots. On these green inclines great mounds occur, here and there. From below they look like sod-bound banks of earth; from above like a rostrum or platform, and to some extent they serve the same purpose. These rostra are many yards apart, and often the dens are connected by paths of sufficient width to afford a trail for the human foot. So nearly free are these paths from the slippery huckleberry stems that they afford relief from the ever-present strain of uncertain footing on the dewy mountain slope.

The course of these paths is often influenced by the boulders which lie scattered through the vegetation. It does not follow a straight line from

one den, or it may be one hole, to another, but zigzags through the heather and huckleberries so as to include as way stations the near-by rocks. A boulder only a few inches high gives the marmots the advantage of a view above the plant growth, and assures them of the peace of the mountain-side or warns them of impending danger.

Few sounds of the mountain glen are more memory-abiding than the wonderful air-piercing whistle of the hoary marmots, animals so aptly called whistling Jacks by the sheep men. *Cheer, cheer,* comes the call from the distance, faintly carried from far down the crag side. A mighty ice crag breaks, groaning, roaring, thundering; and we are reminded of the instability of a mountain moment. Tense wind, storm-pressed, plays strange music through the bony skeletal fingers of the bleached ghost trees long since fire-swept. But it is the shrill staccato cry of the whistling Jack that stirs up a thousand memories, every one eternally tied to wild, weird, high-mountain scenes.

Yet, is the voice of this splendid mountain mammal for itself alone? Surely a hundred little creatures must give heed to its warning and scamper to friendly shelter, indulging in bright-eyed peeps from many a shelving rock.

Once, on the headwaters of the Saint Andrews, we were lying at noonday among the slab rocks of a granite slide, viewing with the binoculars the white form of a goat on an opposite cañon wall. At the moment two great eagles drifted through the pass from the Puyallup head (see p. 174). Instantly it seemed all the marmots in Saint Andrews shrilled their piercing whistle of alarm. Whether or not *Oreamnos* took this warning for himself we do

not know, but he at once resumed his cliff-face journey.

Once again in the cañon of Hindoo Creek by the shadow of Mount Aix, I heard this wonderful call given as if for the entire cañon side. Most of the summer day had been spent beside a great lookout rock of a "slide," waiting for a wary old marmot. From time to time he or perhaps some of his race would send up from the cavernous depths beneath, a series of piercing, hysterically uttered calls, as if to tell me that my presence was quite well known though not at all appreciated. *Cheer, cheer, cheer*, in a running succession at first; then the call would die down in frequency and volume, and finally cease. Here and there a cony, the little haymaker of the mountains, would take his rock-tip station and speak to me inquiringly. Then a more venturesome one would slip out into meadows bordering the rock slide and bring in a bundle of freshly snipped hay. A chipmunk would appear here, a rock squirrel there, until presently

the quiet scene was animated with little rodent forms. From the cañon side, far-distant, lone sentinels still gave their desultory calls. Suddenly! So suddenly that I still stood wide-eyed when it was over and past, a great swift shadow shot over the slide with the swish of a falling pine, but in the thrilling action of that ill-planned moment the whistler sentinel had seen and heard, and from that instant the cañon from crag to crag fairly crackled as with an electrical charge, high-pitched and piercing,—above, below, wherever a shaggy marmot stood; and in that moment of shadow and shrieking cry, the rock slide became as deserted as if swept by death. Completing the rocket-like plunge of that powerful, wing-driven bolt from the crag crest, an eagle struck in the blueberries and heather,—a moment too late! Safe, under the sheltering rocks of that cañon side, was a very frightened little "haymaker," a very much frightened little "haymaker," that was all,—thanks to the warning of the big hoary marmot.





Mishongnovi, one of the villages where the *Majau* ritual was performed in September, 1916

A Women's Ceremony among the Hopi*

By ROBERT H. LOWIE

Associate Professor of Anthropology, University of California

AMONG the Hopi Indians of Arizona, the women play a less conspicuous part in native ritualism than do their brothers and husbands, nevertheless certain elaborate ceremonies are conducted very largely, though not entirely, by female members of what might be called religious organizations. One of these societies, the *Mámajauhtö*, performs the *Majau* rite, the public portion of which I was able to witness in September, 1916. Fairly detailed notes regarding the entire ceremony as practised at the village of Walpi¹ have been published by Dr. J. Walter Fewkes and Mr. A. M. Stephen, while the variant celebrated at the pueblo of Oraibi has been treated at length by Mr. H. R. Voth.² Though my own

observations were purely casual and limited to the proceedings of a single day, they were made in another village, Mishongnovi, and accordingly, meager as they are, have a supplementary value.

The *Majau* is a festival of nine days' duration, the major part of which period is spent in an underground chamber, where an elaborate altar is constructed by the priesthood and prayer offerings are made. These prayer offerings are deposited in springs and other sacred spots. At Oraibi the ceremony was specially associated with the Lizard clan,—that is, the chief functionaries, both male and female, belonged to that group. In Walpi, where the ritual has been discontinued, owing to the leader's conversion to Christianity, the former head priestess was of the Snake clan, which is regarded by the Hopi as somehow related

¹"The Mam-zrau'-ti: a Tusayan Ceremony." *American Anthropologist*, O. S., Vol. V, 1892, pp. 217-45.

²"The Oraibi Marau Ceremony." *Anthropological Series*, Field Museum, Vol. XI, No. 1, 1912.

*Photographs by the author

to the Lizard division. In that village, however, according to Fewkes, some of the male participants belonged to other clans, such as the Mustard and Water-house (Cloud) clans. At Mishongnovi I learned that Cucuñiqwa of the Chicken-hawk clan was the principal male performer, being designated as *Majau'-muñwi*, *Majau* chief. Unfortunately I have no record of the affiliations of the woman leader; in the neighboring village of Shipaulovi she is of the *Qálö* (Sun's Forehead) clan.

In 1916 the members first entered their kiva (or subterranean ceremonial chamber) on September 15, but in accordance with traditional usage not this day but the one following was reckoned as the initial day of the *Majau*. I was told that they were using the kiva ordinarily associated with a men's fraternity called the *Wöwötcim*: in token of their occupancy an emblem of feathers was put on the

roof of the chamber. For several days preceding the final dance the men of the village went on a rabbit hunt. It is not certain that these trips had a ritualistic significance, but it was said that the hunting on September 21 was connected with the ceremony. On the evening of September 19, I was subsequently informed, the women of the society danced in the plaza for a short time, but as I was unfortunately not forewarned, I was not present.

On the 23d the final public solemnity was celebrated. A line of about twenty women and girls left the kiva and proceeded in single file to the Mishongnovi plaza. Some were old, others hardly more than two or three years of age. While some were clad in blankets of native make, others wore garments bought at the trader's store. The members, one and all, were carrying in each hand a wooden slab tipped with a wisp of grass. Proceeding to the center



Interior of kiva.—On the wall may be seen the Hopi symbolic design representing rain clouds and descending rain

of the square they formed a ring and intoned a low song, at the same time rhythmically moving their slabs up and down. These objects, which are called *majau'-vaho*, are decorated with symbolic designs, some of them representing clouds and rain, others corncobs, and so on. After a while the dancers, who hitherto had merely swayed their

The last woman to leave the kiva differed from the rest in being dressed in masculine apparel. She was differentiated also by the fact that she carried on her back a painted wooden board with a bow and arrows above it. My informant told me that this woman had been chosen for her special office on the preceding night. Instead



Walking in single file from the kiva to the plaza, the performers enter for the celebration of the dance, on the morning of the ninth day

bodies rhythmically without moving from their position, began slowly to move in a counter-clockwise direction.

While this performance was going on, practically the entire population of the village formed an attentive audience, some individuals being seated on a stone bench that extended along one side of the plaza, others with loosened hair standing up, while the residue enjoyed the spectacle from the box seats supplied by the terraces of their dwellings.

of facing the center of the ring with the other dancers, this dignitary was inclined toward them at an angle of about ninety degrees and danced backward as they moved counter-clockwise. She wore moccasins and low leggings, a large part of her legs below as well as above the knee remaining exposed, as were her forearms and part of her upper arms. Her shirt was a woven single-piece garment. A veil of horsehair hung down over her forehead, shielding



In the center of the plaza the dancers form a ring and intone a song, at the same time rhythmically moving their wooden slabs up and down



A pair of women, selected earlier in the day, make their appearance dressed as warriors



A woman archer discharging an arrow into space



Women warriors carrying food to be tossed among the spectators

her eyes and most of her nose. During the dance she held a foxskin in her hands.

Suddenly a pair of women, selected earlier in the day, made their appearance. They, too, were clad in male apparel. They were carrying bunches of *qohpi* grass, which they threw on the ground and shot at with bow and arrows. Their archery precipitated loud laughter on the part of the male spectators, for the women were not expert marksmen. Breaking through the circle of dancers, the archers, after depositing their weapons, disappeared from the square but soon returned with two big pottery bowls containing sweet-corn meal, with which they sat down within the circle. These officers wore strange feathered headdresses towering high into the air. At Oraibi Mr. Voth saw another pair of functionaries, namely, two lancers, whose duty it was to throw wheels before them and in turn to hurl long sticks at the wheels; but no such performers appeared at Mishongnovi.

A short time before the conclusion of the ceremony the archers approached, bearing basketry trays filled with peaches. The fruit they threw into the air, and as it descended, the bystanders scrambled to seize it. Then the archers walked away, while the

dance continued for several minutes after their departure. Finally all the dancers passed out of the plaza in single file, led by the shield bearer, and the ceremony was at an end.

Although even the ample accounts of Mr. Voth and of Doctor Fewkes and Mr. Stephen leave the *Majau* performance unexplained in many respects, this much is clear, that it represents, like so many other Hopi ceremonies, a rain ritual connected with the horticultural life of the natives. Thus, one of the deities invoked during the subterranean rites is *Mü-yiñg-wuh*, the germ god; and the shooting performance witnessed by myself symbolizes the lightning striking the corn-field, "an event which is regarded as the acme of fertilization" according to Fewkes and Stephen. The ornamentation of the painted slabs held by the dancers points to the same conclusion. But though the rain ritual undoubtedly constitutes the essence of the ceremony from the priesthood's point of view, we must not forget that the spectacular public rites serve the very genuine need for excitement and theatrical entertainment felt by the populace at large, that, in other words, such solemnities gratify the æsthetic as well as the religious cravings of the Hopi.





A two-headed copperhead (*Agkistrodon mokasen*) obtained by Eagle Scout Irvine H. Marshall in the woods near Coraopolis, Pennsylvania. Enlarged nearly three times



Courtesy of Dr. H. G. Williams

An X-ray of the copperhead, showing the structure of the dual head form

Two-headed Snakes

A NOT UNCOMMON PHENOMENON OF THE REPTILE WORLD

By B. T. B. HYDE

Educational Director, Kanohwahke Scout Camps, Palisades Interstate Park

ACCOUNTS of the occurrence of an extra or abnormal double part in various animals have appeared from time to time, but X-rays of that curious but not altogether rare anomaly, a two-headed snake, have seldom been published. The X-ray on the opposing page, made under the direction of Dr. H. G. Williams, of the College of Physicians and Surgeons, for the purpose of studying the skeletal structure, clearly reveals the dual head form, in which the basal plates are joined. The subject was one of twenty-eight unborn copperheads (*Agkistrodon mokasen*) removed from the dead mother by Eagle Scout Irvine H. Marshall, of Coraopolis, Pennsylvania, who had come upon her in the course of a hike through the woods.

Commenting upon the phenomenon, Prof. J. E. Guthrie, of Iowa State College, in a recent letter to the writer, states:

"It is interesting to know that the copperhead seems to contribute more than its share of double-headed specimens, if one may judge from records made."

Professor Guthrie goes on to say that there are only two instances of double-headedness in snakes that have come under his personal observation: the one a bull-snake embryo, the other a plains garter embryo (*Thamnophis radix*). Of the latter he says:

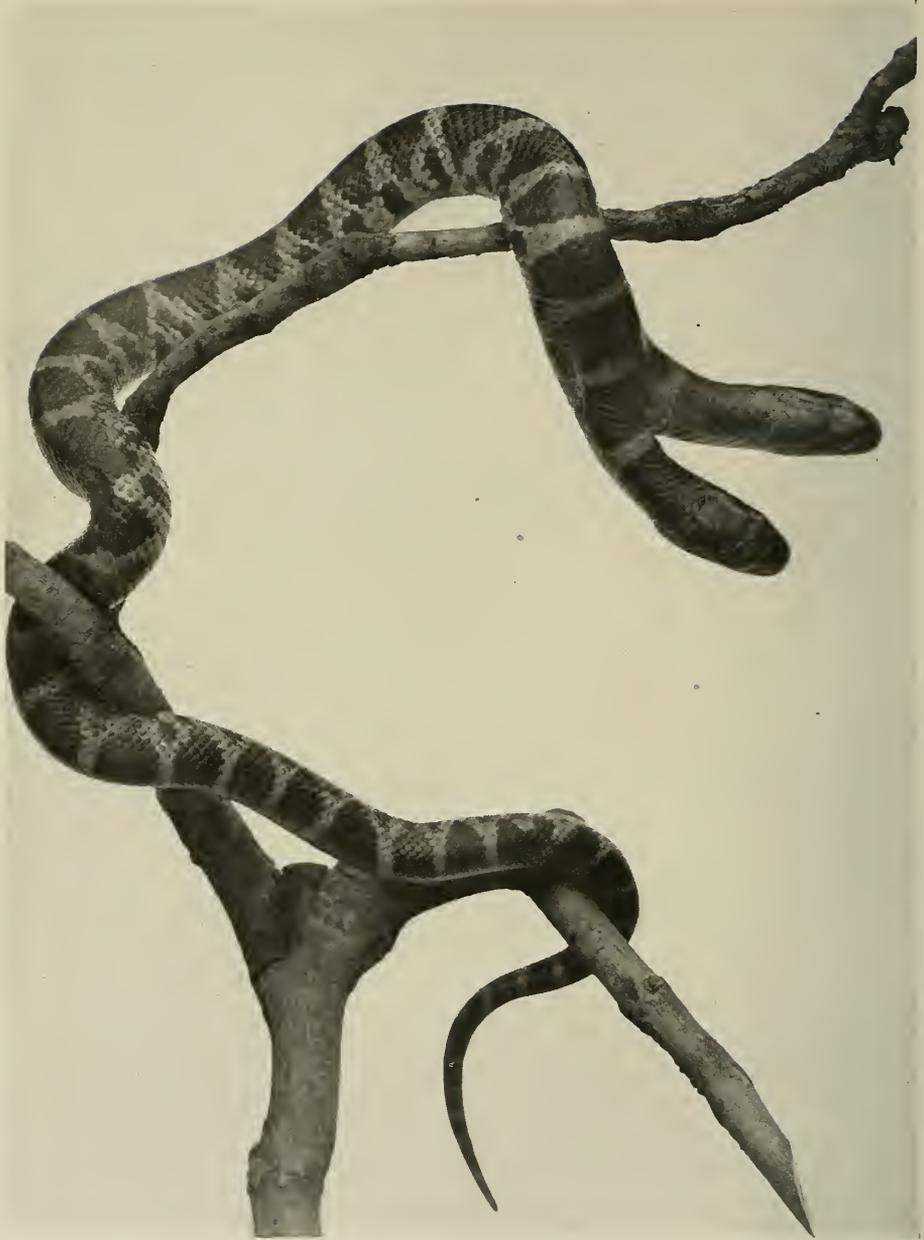
"Evidently the specimen of *Thamnophis radix* is much like the two-headed copperhead of which you speak, in the amount of doubleness, for the head

plates seem to be joined. Some twenty or thirty years ago I remember to have seen an early book of travels in America, but I do not recall the author's name. This man was a geographer and student of natural history, and he wrote about all he saw as did most of those early travelers. He mentions the finding of a double-headed snake of which evidently he did not know the species, and he raises question whether it represents merely an abnormality or whether possibly it is a new species, characterized by two heads. The volume in which the account appears is one of the old-fashioned leather-covered type and must have been issued well over one hundred years ago. I wish I could give you the specific reference but I have no way of knowing now who the writer was."

The instance in question could unfortunately not be traced but other clues contained in an unquoted portion of Professor Guthrie's letter enabled the writer to come upon additional references.

In an article entitled "Notes on the Reproduction of Certain Reptiles" contributed to the *American Naturalist* for April, 1903, Mr. C. S. Brimley tells of eggs of the black snake (*Coluber constrictor*) which came under his observation. One lot "contained among others, one egg which, though entirely normal in external appearance, was very abnormal internally, inasmuch as it contained two embryos, and one of these was a two-headed monster."

A recent letter received by the



Photograph by Elwin R. Sanborn, New York Zoological Society

A TWO-HEADED MILK SNAKE FROM THE BRONX

Unusual interest attaches to this abnormal specimen of *Lampropeltis triangulum* in that it was kept alive for several months in the reptile house of the New York Zoological Park. To feed it, a card had to be placed between the two heads, so that one of them might be restrained from seizing a morsel intended for the other

writer from Mr. Kenneth Lawrence, of Cranberry Lake, New York, may be quoted in this connection:

"On June 8, 1918, Mr. C. H. Eells and I were in the hay field raking up hay, when we discovered a very large female garter snake. We both started after her, and as soon as we caught up with her, the battle was on. When we had killed her, we threw her over a stump. A short distance away we discovered several little ones; there were thirteen, and the thirteenth was a two-headed snake."

An interesting instance is that reported by Mr. Ditmars, curator of reptiles in the New York Zoological Park. This was a two-headed milk snake (*Lampropeltis triangulum*), kept alive for several months in the reptile house in the Park, and photographed by Mr. Elwin R. Sanborn, the staff photographer. As the photograph indicates, the heads were in this case quite separate, each having about two inches of neck. To quote Mr. Ditmars:

"This abnormal creature was picked up as it was about to cross Jerome Avenue in the Bronx. It must have lived on the slope which led to the heights above. This same district also produced a half-grown albino milk snake. Most extraordinary indeed was it to find such a creature in the heart of a great city and unmolested for so long a time; earth worms and larvæ of beetles were probably its food. In captivity, however, its principal food consisted of recently-born mice; and undoubtedly the creature would have lived to a normal age if it had not become infested with mites.

At times the heads would intertwine and wrestle with each other, and again the snake would move forward with the usual gliding motion, the tongues in action. This specimen was apparently about a year and a half old, probably born in August of one year, living through that year, and captured the following June. The snake grew more rapidly than usual, apparently due to the fact that each head seemed always hungry. In order that there might not be a congestion where the esophagi joined, one head was fed at a time, a card being placed between the heads so that one would not know the other was having a satisfying meal; otherwise each brain decided it wanted the morsel and the food was rent asunder."

Mr. Ditmars has had in captivity several young snakes with a dual head structure,—two of them rattlesnakes. In one of these instances the basal plates were joined, one head functioning with eyes and tongue, the other head having the mouth sealed and no tongue visible; in the other instance the two tongues were active and there were well-formed eyes in each head. Mr. Ditmars obtained two-headed creatures also from hatching hog-nosed snakes (*Heterodon contortrix*) and king snakes (*Lampropeltis getulus*).

Many other instances of two-headed snakes might be cited from the published literature regarding this phenomenon, but in this brief article it may suffice to say in conclusion that the recorded instances range from the barest indication of double-headedness to almost complete separation of the two constituent parts.

The Training of a Hawk

INCIDENTS OF A PERSONAL EXPERIENCE

By FRANK B. LEVY

A FEW years ago, while engaged in the pleasant pastime of watching a pair of breeding duck hawks, I became imbued with the idea of training one of the young birds in falconry. One thing led to another and before long I found myself immersed in the literature of the subject, both ancient and modern, with the result that I found the training of hawks was not insurmountably difficult and, at least for a bird lover, one of the most fascinating of diversions. I say fascinating, because it enables us to keep these noble birds in a condition that very closely approaches the wild state, and at the same time absolutely docile and willing to do our bidding. The sheer beauty of the birds, either on the hand or in the air, is in itself an adequate reward for the trouble of training them.

FALCONRY IN OLDEN TIMES

Falconry appears to have originated in the East, and to have been practiced there from time immemorial. At the present day, too, its stronghold is in the East,—China, India, and other parts of Asia.

Although on the Continent and in England falconry was practiced before the time of the crusades, yet it received its main impetus apparently in that era, when returning crusaders brought eastern falconers and their hawks back with them. This, at least, is the generally accepted statement, although the equipment of the western falconers departs from the original eastern pattern, and the methods used by the English trainers seem in some ways quite different from those of the

East. The slow development of centuries probably paved the way for the perfected art that blossomed forth about the thirteenth century. From that time on, falconry was pursued in the British Isles perhaps more keenly than any other sport ever has been. All classes took part in it. Hawks were allotted by rank: while prince and duke admired their falcon for her noble pitch and lordly stoop, the burgher and yeoman made good use of their goshawks, highborn ladies used the merlin, and even the serf and villein were not forgotten, being graciously allotted the useless kestrel. Only members of the royal family could legally use gyrfalcons, which were at that time the most highly prized of birds, enormous sums being spent for the best of them. Stringent laws were passed to protect the sport, and death was the penalty for molesting the falcon of a lord, or even the nest or young of wild hawks.

Of course we cannot help smiling at all this mediæval class regulation, but beneath it there must have been a very real appreciation of nature. Recently I have heard of an oölogist in Massachusetts who has collected in the last few years about 180 clutches of duck hawk eggs. I only wish that in this age there were some way to stop him; at least, if by chance any collector of such eggs reads this article, it is to be hoped that he may come to realize that the living bird is a thing more worthy of preservation than the eggshell emptied of its contents.

But to return to the olden days in England! The variety of quarry flown was remarkable: bustards, herons,

cranes, kites, geese, ducks, grouse, and partridges, all were taken with the peregrine and gyr, besides a host of lesser things. Many of the flights were very elaborate and covered great distances, notably that at the heron and the kite. Game hawking always was a favorite sport; it usually consisted of letting the falcon soar high in the air—"six steeples high" as they very prettily called it—and then putting the quarry up with beaters and dogs. "Hawking at the brook," or the taking of wild ducks in this manner, was probably the most common form of falconry; the jumping duck was usually cut down dead by the terrific stoop of the waiting falcon.

This sort of sport kept up even after the introduction of firearms; in Shakespeare's day, for instance, both hawk and gun were used. However, people gradually discovered that the new weapons could kill a great many more birds than hawks ever had destroyed, and the Civil War in the seventeenth century brought about such an upheaval that falconry in England died almost at one blow, and the Revolution in France had the same effect there. That is not to say that hawking actually became extinct; even subsequent to the Civil War it was practiced in England and Scotland although with none of its former pomp and splendor. It has retired into comparative quiet in clubs and private establishments, but even today peregrines are flown on Salisbury Plain, merlins on the Downs, and grouse and partridges still fall before the blow of the stooping game hawk.

HAWKS SUITABLE FOR FALCONRY

The hawks that lend themselves to falconry are divided structurally into two large groups: first, the falcons,

or long-winged, dark-eyed hawks, and secondly, the short-winged hawks, including the sparrow hawks and the goshawks. The falcons always have been regarded as the nobler group, and they certainly are much easier to handle and work with than their more lowly-bred, short-winged cousins.

In this country we have many falcons, the most noteworthy being the duck hawk (*Falco peregrinus anatum*), which was, and still is, perhaps the best bird that has ever been trained, being thought of by some even more highly than the gyrfalcon. We also have the pigeon hawk, the counterpart of the highly reputed European merlin, a bird that has tremendous dash and speed and that, like the merlin, should be trained in eight days.

Our short-winged hawks excel those of the Old World. We have the sharp-shinned and the goshawk, which are very similar to the Old World sparrow hawk and goshawk, but in addition there is our Cooper's hawk, a bird that possesses all the physical attributes of the sparrow hawk, and is besides large enough for almost any reasonable quarry.

PSYCHOLOGY OF HAWKS

In order to train a hawk you must know just what he will do under any given conditions and, therefore, to some extent, what he is thinking about. The difficulty is that no two hawks are at all alike; they vary individually in character even more than they do in plumage. I have had two birds from the same nest that were as different as could be: one was the best- and the other the worst-natured bird that I have ever seen. The birds will vary in every respect,—strength, size, feeding characteristics, courage, and amiability; and for that reason no man can specify



Photograph by Frank B. Levy

A trained tiercel weathering on the block

the correct treatment for any hawk without first becoming familiar with his pupil.

There are, however, certain characteristics common to all good hawks, and these I will dwell on briefly. In the first place, they are intelligent creatures; they can be fooled easily, of course, but that is rather a help than a drawback to the trainer. Once

convinced of your good intentions, they learn with astonishing rapidity any lesson that is diligently and skillfully taught them. I have trained a tiercel¹ to come to the lure in six lessons. And when they have learned a lesson, they are not apt to forget it; it seems to become a part of their nature.

¹The male is called a tiercel, usually applied to the peregrine.

It is well to remember, too, that they think of only one thing at a time,—when hungry, of food, and, when alarmed, only of that which has frightened them. Thus, to make them do your bidding, it is necessary only to have them think of the right thing at the proper time. The sight of the lure or a remembered sound will suggest food and, if hungry at that time, they will forget everything else, even the fact that they are flying free in the wind. A hawk newly trained may have been trying to get free all day but, if flown at the proper time in the proper way, he will forget that he is unrestrained, and will come to the lure from far across the countryside.

That gentleness is an attribute of the falcon may seem an astounding statement, but I can vouch for its truth. Duck hawks have been described as "the most bloody of our Raptores," but I beg to differ with this statement. Of course it must be remembered that individuals vary enormously, but I have seen wild duck hawks fly through flocks of pigeons without touching one: they certainly are not bloodthirsty creatures. I can state positively that trained hawks show only gentleness toward human beings, and the tiercel that I trained last summer did not once try to harm me after the second day; I used to carry him on my bare hand with complete confidence. Relentless and ruthless as he may be in his aerial pursuits, the duck hawk, when properly handled, makes the most gentle of pets, showing marked affection toward those he knows, and never missing an opportunity to take the coveted perch on the master's glove.

TRAINING

The reader will be wondering by this time just how the birds are trained.

Let us suppose that we have a captive duck hawk,—a rare phenomenon, to be sure, in this country where they are



Courtesy of Mr. MacNeil

Our noble bird in the position in which sportsmen try to put her,—a haggard, or adult peregrine falcon, shot somewhere on our coast

generally shot on sight. If this bird were put in a cage, he¹ would dash against the wires with the strength that only a hawk displays, and speedily kill himself or, at any rate, break most of his feathers. Instead, he is provided with a ruffer hood, consisting of a cap of leather tied on by thongs in back, and having an opening in front so that the bill and nares are outside. All hoods must fit properly, not too snugly or too loosely and must be of the proper shape to give a good fit at the bill opening. Jesses are put on the bird's legs. They consist of two light straps of leather, one of which is fastened around each tarsus. Both are joined to a com-

¹In this account of the training of a hawk the term *he* has been used, because the bird described in this article is a male. The female is, however, usually preferred by the falconer because of the larger size and greater power of hawks of this sex.



Photograph by Frank B. Levy

THE FALCON'S EYRIE

Female incubating on the face of a four-hundred-foot cliff

mon swivel through which the leash is passed. The tiercel is tied to a perch or block by the leash, but special precautions must be taken to prevent tangles that would cause injury. Thus equipped, the bird will probably sit quietly after a while, due to the hood, and may then be placed gently on the glove and carried around steadily, so that he may become accustomed to that position as soon as possible. A great falconer once said that a hawk should know no other perch than the master's glove, and that applies especially to the early part of the training.

It is difficult to understand why the mere act of carrying the bird has so great an effect, and I remember well how puzzled I was when in the early stage of my experience I took a falcon on a long railroad trip and noted how tame she became as a result of my carrying her on my fist all the way. The fact is, this persistent carrying is the great secret of discipline, and cannot be disregarded. Of course, if you can get somebody else to do this part of the work for you, all the better.

It is to be assumed that the hawk was hungry when caught and he should therefore be fed as soon as possible, and through the hood at first. To accomplish this, take a slice of lean steak and, still holding the bird on the left fist, touch him on the shoulder with the right hand and, when he strikes out defiantly at the air, endeavor to have the steak in the way. Sooner or later he will know what to expect and even reach out for more after swallowing a few pieces accidentally, provided of course that everything is done very quietly and gently. Now, when he has learned to eat well through the hood, either chirp or whistle when he is in the act of swallowing, and you will find that in a

remarkably short time he will stretch forward for food whenever he hears that particular sound. This means that he has become convinced to some degree of your good intentions, and it is time to go a step further. The ruffer must be changed for a common hood, one that has a plume on top to enable one to handle it and draw-strings in back so that it can be opened and closed easily. This hood should fit just right, a matter that usually requires some luck and a number of hoods from which to make a selection. The change must be made in absolute or approximately absolute darkness.

A time should now be selected when the pupil is quite hungry, having been deprived of an appreciable meal for twenty-four hours; then, some appetizing but rather durable food under his feet, he should be unhooded in a room with a candle at the far end. Walk toward the light, keeping an eye on the hawk; if all goes well, the bird may be taken into practically full daylight at the first attempt. Either hood the bird or get back into darkness before the meal is finished; and be careful not to let the hawk feel he is being held a captive until much later.

It is a good plan at about this stage to break the bird to the hood, and the only way to do this is to take him into a dimly lighted room and hood and unhood him for hours at a time. He must become accustomed to being handled, especially about the head; his displeasure may be somewhat offset at first by occasionally giving him a morsel of food while continually stroking and hooding him. This part of the training is probably the most tedious of all, but it must be persevered with until the pupil will allow himself to be handled and hooded without alarm.

Meal times are the proper occasions for making progress. At first my tiercel was unhooded by artificial light, then outdoors in the twilight, and so, progressively, until he would feed on the fist quietly in broad daylight. It is well to prolong these meals, and to do so "tirings" are used, morsels that require hard work on the part of the



Photograph by Frank B. Levy

Female peregrine falcon, or duck hawk, a day or two after being taken from the nest, showing how tame these birds become even without training if properly handled. Attention is directed to the short wings and tail at this age

bird before they can be eaten. I found unplucked chicken wings the most useful for my tiercel; it would take him a good half hour completely to pluck and eat one. While the pupil is feeding absorbedly, he may be brought close to strangers and other new things with which he is to be made-familiar. If his interest wanders too much from the meal and he shows uneasiness, his attention may be brought back by the familiar chirp or a tug at the food held in his feet. In this way he should be introduced to society as rapidly as he will allow; great care must be

taken never seriously to alarm him, but gradually to make him feel at home among human surroundings. He should always be hooded before the meal is finished, even at the cost of some minutes of training, for bating, that is flying off, on a full stomach is very bad. One should avoid giving the bird as much as he will eat, for it is all-important that he should have a good appetite each day even at the expense of some loss of weight, but anything even approaching actual starving is to be carefully avoided.

If all this is persevered in, it will be found that the hawk can be carried among people without causing him much alarm, that he will sit pretty quietly without the hood, and in fact gives every indication of having been manned. You must not expect too much, however, at this stage. He may be admirably behaved while occupied with something, but go into fits of bating as soon as his mind is free. For this reason it is a good plan to weather the bird at about this stage by placing him out on a block on the lawn and letting him bate off on to soft grass. Afterwards he probably will sit quite still on the fist.

The next step is to teach him to come to the fist for food. It is not absolutely necessary, but it certainly is a great convenience, to have the bird come willingly, and such willingness also serves as final proof that it is safe to put the hawk on the wing. Begin by allowing him to walk along a perch on to the glove for some tempting morsel. Next, place him on a polished rail, one of those that bend down at the ends. Hold the food a little away from the curved end; when he walks toward it, he is pretty sure to slip and flap to the glove. If the rail is not used, it is generally difficult to make him take

the first leap, but once that is accomplished, he will soon fly considerable distances to the glove. These lessons should be prolonged until he will come from a post outdoors, being still held by the leash of course.

It is now time to use the lure.¹ This should be conspicuously covered with food the first few times, and the pupil allowed to fly to it from a point each time increasingly distant, a string being attached to the swivel of the jesses for this purpose. The lure may be swung once or twice before being thrown down. After a few lessons the falcon will start for it as soon as it is brought out. Soon the string may be discarded, the swivel detached from the jesses, and the hawk flown free. Thus ends the work of training the wild caught falcon, the process of taking one of the wildest creatures in the world and making it gentle and amiable enough to do our bidding.

FLYING THE FALCON

I brought my bird to this point without much difficulty, the entire training taking about two weeks of constant work. It was a proud moment when I first saw him flying free overhead and, queerly enough, rather an anxious one, for the latter part of his training had progressed so rapidly that I had not been able to keep up with him myself. Consequently, I could not quite realize that it was perfectly safe to have him circling around overhead. I usually had an assistant hold him a few hundred yards away, then I would call him by swinging the lure, hiding it as he approached so that he would mount up and wing around.

It soon was evident that the falcon

¹The lure consists of a weight covered with leather, to which some pigeon wings are securely tied. It should be heavy enough so that the bird cannot move it. Thus he learns not to fly away with the quarry.



Photograph by George G. Goodwin

The hooded hawk on the block.—To the right of the block, in the foreground, is the lure

did not know how to pursue hard enough, in spite of being thoroughly proficient in flying,² and the lure was brought into play to remedy this fault. I would call him as usual, but as he came up to the lure, expecting to land upon it, I would jerk it quickly away so that he missed it. He would then swing around, looking for it, and come down again, keeping a little better watch on it than before. Soon he began to chase it, and in a few days it was almost impossible to keep it away from him for any length of time.

The hawk was then ready for serious flights at quarry, he was well trained and naturally pretty fast. Unfortunately, the surrounding country was very unfavorable for long flights, and there was no suitable game to fly. However, the bird had to be "made," so we obtained a common pigeon for the purpose.

The stoop of a game hawk is something that has to be seen to be believed. It has been known to cut the head clean off a grouse, and its speed carries the

²He was a young bird, hatched two weeks.

falcon past the fastest game bird as though it were standing still.

The main objective while training a bird for this sport is to get it to wait on at as high a pitch as possible. Peregrines generally will wait on readily enough. Hiding the lure for longer intervals each day teaches them that, but the attainment of altitude is often more troublesome. It depends a great deal on the individual bird, but there are many tricks used to obtain the desired end, such as rewarding the bird only when he comes from a height, or of having two people call him off, one standing on a hill while the other is on the level below. The bird is allowed to catch only the lower lure, and thus associates success with toiling up and coming swiftly down.

Eyesses, that is young birds, are employed more often in game hawking because of the greater safety attending their use when sent aloft to wait on. They must be properly handled, however, or they will be spoiled before they fly. They must not be taken from the nest until fully feathered and practically ready to leave. Installed in an empty room, or other warm dry place, they must be fed promptly. They generally will take food offered on the end of a pencil, provided it is handed them very quietly and every precaution has been taken from the first against frightening them. Soon they will crowd forward and feed from the hand freely; and they must be fed three times a day punctually.

They have to be liberated for a few



Photograph by Frank B. Levy

The bird has just caught the lure in the air and is prepared to eat the food tied to it. Note the firm grasp of the feet on the supposed quarry and the bell on the leg



Photograph by Frank B. Levy

Trained hawks are offered a bath every day. They bathe while being weathered on the lawn and afterwards fly up on the block to preen and dry. Note the padded top of the block and the leash, jesses, and swivel

weeks in order that they may become strong on the wing. This is called hacking, and the way it is done is as follows: The birds, let us assume, have become accustomed to eat at certain hours; they should now be fed on lures at these times until they come to know the lures. Then they should be freed early some morning with the lures in sight and a very light feed on them. After eating, the hawks will fly up on a neighboring tree or roof,

probably not going far at first. At the accustomed hour the lures should be brought out again and the hawks will find them. Once the birds have come back to feed, they will always return on time if they are able to, but it is very important to be punctual with the food. It must be tied on so that it will not come off. If it becomes detached, the hawk will fly away with it, and thus learn the dangerous habit of carrying. If a trained hawk flies

away with her kill, there is no way of getting her back, so one of the most useful lessons that the birds learn at hack is that food must be eaten on the ground.

They are very pretty to watch at this stage. They daily take long flights about the country, sometimes circling way up almost out of sight and again chasing each other playfully, making seemingly vicious stoops at one another from tall tree tops.

They do not know at first that birds are good to eat and thus rely on the lures, but some day they will discover this fact, and when they do, they must be taken in promptly. You can generally tell if this has happened by a missed meal, the safe period for leaving a peregrine at hack being about a month. A trap or snare must be used to recapture the bird. I found a No. 0 steel trap very heavily padded to be

excellent, but the conventional thing is the bow net. The training from this point on is the same as for a wild bird, although somewhat easier.

The great danger of hacking, is of course, that the birds may be shot; in fact, it is almost a certainty in most parts of the country, in spite of everything you can do to protect them.

To sum up, I can say that falconry is feasible, although difficult for the beginner, and that it offers a rare opportunity to make the acquaintance of a noble bird. I do not wish to persuade anybody to attempt it unless he happens to be exceptionally located, but I might say for the benefit of any such person, that the best book on the subject is *The Art and Practice of Hawking* by E. B. Mitchell, and that all equipment may be obtained from Mr. K. Möllen in Valkenswaard, Holland.



Photograph by Frank B. Levy

A hawk photographed in flight

With Murphy to Peru¹

By R. E. COKER

Professor of Zoölogy, University of North Carolina

THREE thousand years have passed since an elderly "preacher" of unusual wisdom complained that there was no end to the making of books; yet, of all the books that could have been in Solomon's library, those that survive today, if suitably translated, could doubtless be read by one of us in the course of a year. It piques our curiosity to know what may have been in the others, what even were their titles and subject matter. Our curiosity might be excited as well by the vast majority of the books now made each year, concerning which we must remain as ignorant as we are of the mass of the literature of King Solomon's time. We can scarcely read even the greater number of the current books that relate to subjects in which we have some real interest. Consequently, with reference to any new volume from the press, it is a question of the first importance: Is it worth while to spend time upon this particular book? Will it instruct us, or amuse us, or, by taking us easily away into infrequently trodden fields, refresh and invigorate our drooping minds? Tastes differ in reading as in friends but, for a wide class of readers, Murphy's *Bird Islands of Peru* will undoubtedly meet at least two of the criteria just mentioned.

Doctor Murphy is fortunate in his command of the English language. With no labored attempts at a particular manifestation of style and no rigid order of procedure, he speaks naturally and of the things that he saw and knew something about. He seems to be guided not so much by good judgment as by a happy instinct

in the selection of subjects and in the choice of words to make us see things very nearly as he saw them.

He takes us almost immediately to "The City of Kings," but we get no hackneyed description of streets and churches and plazas. If we depended upon Murphy alone, we might never know that there were such things in Lima as a Plaza del Armas or a Palacio del Gobierno. Murphy does not plagiarize the guidebooks. He does take us up on the hills of San Bartolomeo and Morro Solar, whence through his eyes we view the fine panorama of Lima on its sloping coastal terrace, beneath the high-banking Andes. We trace the strange "fog line" by the green or dusty aspects of the nearer slopes, or we turn to observe the sweeping Humboldt Current beyond the heights of San Lorenzo and cathedraled Pachacamac. The crimson sun sinks beneath the Pacific, the tropical sky darkens quickly, and we stand shivering in the cool sea breeze. Incidentally we learn quite a bit about the peculiar climatic conditions that make Lima, and all western Peru in fact, a region unlike any other.

Soon we are in voyage for the guano islands, and first, of course, the historic Chinchas. Thereafter we follow our guide and interpreter to the islands of chief interest—San Gallan, Isla Vieja, Asia, Pescadores, Guañape, Lobos—all alike in being generally dry, inhospitable to plant life, and the homeland of innumerable birds, but notably diverse in size, in height, and in general aspect, as well as in the character of the bird life. Penguins, pelicans, petrels, gannets,

¹A review of *Bird Islands of Peru* by Robert Cushman Murphy; published by G. P. Putnam's Sons, 1925.

gulls, and guanayas—these and many others come in review in their home life or in their wanderings over the sea for food. Through pictures, verbal or photographic, we see them, singly or by “acres,” resting on the islands, soaring in the air, or floating on the water, plunging, diving, or, as it seems, dancing on the waves. Occasionally, we leave the birds and boats and ramble on the mainland shore.

Interspersed with the chapters of narrative are an approximately equal number relating to special topics. In the chapter entitled “Ancient People of the Coast,” the author does not depart materially from his plan of restricting the story to matter that fell within the scope of his own personal attention. We find, therefore, not an historical or archæological study, but a brief account of the author’s observations in burial grounds near Pisco and in the notable museum of Doctor Prado y Ugarteche in Lima. The topic, though lightly touched, serves a useful purpose as a suggestive background for the picture that is being developed in our imagination—a picture of a region and an industry, unique in many respects, a picture that will be complete only when we view the present in the perspective of the past.

The Humboldt Current in its special chapter receives a different form of treatment; for the author presents an account of this phenomenon based upon all that has been discovered and reported, including observations of his own. Here we have the best general readable account of a great ocean stream, less in breadth and in volume than others of the major currents of the seas, but more majestic than any other, because more directly observable and more completely dominating coastal conditions. Practically

nothing about Peru, its appearance, its climate, its industries, or its society, can be comprehended without reference to the Humboldt Current and the oceanographic conditions associated with it.

A somewhat cynical American whose personal geographic experiences were very limited, once said that association with the Andes seemed to affect all travelers alike with a tendency to “tall” statements. It might better be said that familiarity with the Andes and with the adjacent Humboldt Current makes one aware of realities that can be reported only in language that may seem “tall.” If this is not the case, then the camera is as readily corrupted by the evil influences of natural phenomena as is the human eye or tongue. Actually, as the reviewer from his own knowledge can testify, Murphy does not incline to exercise the fullest privileges derived from his associations, but is conservative and desirous to substantiate rather than to startle.

The book is abundantly illustrated with photographs, chiefly, but not exclusively, of birds and colonies of birds, and these reveal the author not only as successful in handling the camera under a variety of conditions, but also as having an instinct for the point of view. Incidentally, some of his photographs give eloquent testimony as to the wisdom and the effectiveness of the Peruvian government in conserving and fostering the great national resource represented by the birds of the guano islands. To one who visited the same places about two decades before, many of the author’s pictures have an entirely familiar aspect, but the broad sea of snowy piqueros shown on the south island of the Guañapes could not have been found there or

elsewhere in 1907. The most abundant, and potentially the most valuable bird of the coast, seems to have changed its nesting habit in a desirable way under the benign influence of a modern regime; or, more likely, it has resumed an original habit which it had long abandoned under force of unfavorable circumstances.

From what has been said of the general tone of the book, it may be inferred that Murphy gives us no general description of the Peruvian people, thus avoiding that fearful vice of so many temporary sojourners in strange lands. Through Murphy we are introduced to a number of Peruvians of both indigenous and acclimated stocks, and we meet them as we might if we were there, merely as the good friends who aid us in our travels in every practicable way, for such they are to those who approach them as good friends.

We meet among others "an ancient Indian" whose dignity and courtesy make him "a man to remember." "During subsequent association with the fishermen of Northern Peru—particularly with Indians from settlements between San José and Sechura Bay," says the author, somewhat incidentally, "I found every man kindly, hospitable and trustworthy." Such people should be reformed. The 1926 models of automobiles and fashion plates and novels might well work wonders with them. But how shall we get such things to them? These people seem to have been more or less exposed for several centuries to the ideas of European origin, without the infection taking so strongly as to alter essentially the character, the habits, and the point of view that were native to them. We refer to the indigenous coastal Peruvian fisher-

men, who have probably been changed little by either Europeans or Incas, not to the "higher powers" who have pioneered in aviation and who have recently given us an example of judicious conservation that would be noteworthy anywhere in the world and that, it may be hoped, will be as effective as the system of conservation that, it is said, prevailed on the same islands five centuries ago.

There remains to fulfill the manifest destiny of all reviews, namely, to point out the glaring defects of the book in hand. Unfortunately for our salvation as a reviewer, the defects did not glare as we read. No doubt they are there and we missed them only because we were too soon deluded into thinking of the author as our host. We ought to go back and search them out, but we hesitate to abandon our delusion. So we lay aside the book for a time, feeling that Murphy has really taken us with him to the islands, waters, and coastal regions of Peru. We have not read a textbook, nor a tale of adventures, nor a catalogue of curiosities and natural history; but we have had a fascinating voyage, and we have become pleasantly acquainted with a region that is notably different from all others that we may have known before. We find it a real place, nevertheless. Whatever may be the seeming anomalies of climate, of natural phenomena, of human history, Peru fits into our world better than before. Unconsciously we may have enlarged somewhat the sphere of our imagination to take in comfortably the shores of the Humboldt, but, at any rate, we did not have to conceive a new world with unique laws to provide place for a region that blends so much of incongruity with a genuine charm.

Ernest Harold Baynes

BORN MAY 1, 1868; PASSED INTO THE GREAT BEYOND
JANUARY 21, 1925

BY FREDERIC A. LUCAS

Honorary Director, American Museum

IT is a simple matter to write a eulogistic notice of some prominent man one has never met, but to write of a friend is different, and anyone who knew Mr. Baynes would feel that whatever might be written would seem cold and perfunctory.

Born in Calcutta in 1868 and passing his boyhood in England, he came with his family to the United States and was graduated from the College of the City of New York, where he acquitted himself well both in scholarship and athletics.

For a short time he tried reportorial work on the *New York Times*, and for some years he assisted his father in his work on the application of photography to modeling, and then, in 1900, took up what was to be his life work: writing and lecturing on natural history and especially on the animals found about our homes.

He was one of those who have the rare gift of making friends with wild animals and some of his experiences may be found in his last book—*The Sprite, the Story of a Red Fox*—though his most popular work is probably the history of Jimmie, the mischievous but most amusing and lovable black bear.

Living as he did near the great Corbin game preserve in New Hampshire at the foot of Croydon Mountain, he had an opportunity to make the acquaintance of some unusual animals. Among other things he broke to harness a pair of bison, though few of his friends really enjoyed a drive behind them as they were given to indulging in little wayside excursions on their own initiative which, though quite good-natured, were sometimes rather startling. Probably this acquaintance with the bison caused him to take a keen interest in their preservation and ac-

counted for the prominent part he took in founding the American Bison Society.

He was naturally fond of dogs but these, as well as his wilder friends, did not always show the same consideration for others that they did for Mr. Baynes. Some of his "pets" indeed could hardly have been beloved by his neighbors whose hens and sheep fell victims to them and, in view of the damages he was now and then called upon to pay, his friends were wont to chaff him with the remark that his pets were certainly *dear* to him if not to his neighbors. It speaks volumes for Mr. Baynes that in spite of these depredations he continued to hold the esteem of the villagers.

His keen sense of justice led him to devote much time during the last years of his life to protests against the misstatements of the so-called antivivisectionists, protests that were financially costly to him, for thereby he lost many thousands of dollars in the way of lectures. But it won him the support of medical men throughout the country and led to the founding of the association of the Friends of Medical Progress (now the American Association for Medical Progress). We all have an admiration for martyrs, however little we may wish to play the rôle ourselves.

When Mr. Baynes was stricken down, he was about to begin the book he had planned on *Animal Heroes of the World War*, and to this he devoted literally his last energies, completing the final chapter on the very afternoon he died. He might well have concluded with the words of Paul "The time of my departure is come. I have fought the good fight, I have finished the course, I have kept the faith."

NOTES

ASIA

THE THIRD ASIATIC EXPEDITION OF THE AMERICAN MUSEUM AND ASIA MAGAZINE.—The largest expedition in which the Museum has ever participated will start from Kalgan, the gateway of Mongolia, shortly after the middle of April, headed for Tsagan Nor, the westernmost point previously reached by Mr. Roy Chapman Andrews and his co-workers. Proceeding thence northwestward into new territory the expedition, will apply all the expert knowledge of the members of its personnel to the scientific conquest of this area. Included in the party besides Mr. Andrews, who for many months has been in the East carrying out with consummate care the bewildering number of details essential to success, are: Mr. Walter Granger, palæontologist and second in command; Dr. Charles P. Berkey, professor of geology at Columbia University, who serves as geologist; Mr. Frederick K. Morris, previously of Columbia University and Peyang University, assistant geologist; Major L. B. Roberts, topographer, who during the War was a member of the U. S. Aërial Mapping Force in France; Lieutenant Butler, assistant topographer; Lieutenant Robinson, assistant topographer; Dr. Ralph W. Chaney, botanist and palæobotanist of the Carnegie Institution of Washington; Mr. N. C. Nelson, associate curator or archæology in the American Museum; Mr. Clifford Pope, assistant in zoölogy; Mr. George Olsen, discoverer of the first dinosaur nest; Doctor Skinner, surgeon; Mr. J. B. Shackelford, cinematographer; Mr. J. McKenzie Young, in charge of motor transportation; Norman Lovell, assistant in motor transportation.

Messrs. Young and Lovell have charge of a fleet of five Dodge cars and two Fulton trucks, and, as in other years, the maintenance of this equipment at the maximum of efficiency may safely be entrusted to Mr. Young and those working with him. At Kalgan one hundred fifty camels have been assembled for the transport to Tsagan Nor of the supplies, which in addition to flour and rice and similar food-stuffs, include all the other necessities for a sojourn of five months in the desert.

Besides the scientific and administrative personnel just listed, the party will include ten Mongols under the veteran camel driver Merin and about an equal number of Chinese, con-

sisting of a No. 1 boy, three cooks, taxidermists, fossil collectors, and chauffeurs.

THE PINK-HEADED DUCK.—When the Faunthorpe-Vernay Expedition set forth in 1922 to collect for the American Museum specimens of the rapidly disappearing fauna of India, one of the most desired objects of the quest was the nearly extinct pink-headed duck. This bird secretes itself in the dense swamps and both because of its rarity and the obstacles presented by its habitat is very seldom seen. Some years ago a specimen was shot on the Nepal border north of Oudh, and two specimens were taken respectively in the Shahjahanpur District and in the Kheri District, but in spite of the most painstaking search the expedition of 1922-23 failed to see a single bird, and persistent inquiry among local *shikari* brought only the disappointing reply "The bird has not been seen."

Ever solicitous of the Museum's needs, Mr. Vernay took the precaution, however, before leaving the Nepal region to commission a local hunter to keep on the watch. That was two years ago; now news comes from Mr. Vernay that the prize has been bagged,—two specimens secured in north Kheri.

NEW YORK ZOOLOGICAL SOCIETY

THE EXPEDITION ON THE STEAMER "ARCTURUS" for the investigation of the Sargasso Sea and other tropical oceanic areas under the leadership of Mr. William Beebe of the New York Zoological Society, sailed from New York on February 10 and after stopping at Norfolk, Virginia, to coal, proceeded to Bermuda, its final stop on the way to the first scene of its operations. The expedition has been made possible through the generosity of a number of contributors, the principal ones including Messrs. Harrison Williams, Henry D. Whiton, Vincent Astor, Marshall Field, Clarence Dillon, George F. Baker, Jr., and the American Museum of Natural History.

President Henry Fairfield Osborn of the Museum accompanied the "Arcturus" as far as Norfolk, and reports from Bermuda and by wireless from the Sargasso Sea itself indicate that interesting finds are being made.

Few scientific expeditions have been more carefully prepared in respect to material equipment or a scientific and technical staff



Photograph by G. Clyde Fisher

SOLAR ECLIPSE OF JANUARY 24, 1925

The picture was taken during totality from the Jumel Mansion at 160th Street, New York City. The following equipment was used: a Graflex camera with a Cooke lens, f.4.5, focal length 7 inches, stop f.16, Kodak Cut Film. The time of exposure was two seconds

better qualified by previous experience, training, and proved accomplishment to take advantage of the opportunities that the voyage will afford for oceanographic and biological studies of all kinds. It is equipped, not only for obtaining data as to the ocean itself and the collection of specimens of animal and plant life, but for studying this marine life under natural conditions, and for recording by photographs, moving pictures, and colored drawings and paintings made by scientifically trained artists, the true colors and appearance of these creatures in life and in motion.

The director of the expedition, Mr. William Beebe, as ornithologist, author, explorer, and director of the New York Zoological Society's Tropical Research Station in British Guiana, needs no introduction to the readers of NATURAL HISTORY. The American Museum has furnished a member of its scientific staff, Dr. William K. Gregory, curator of the department of comparative anatomy and professor at Columbia University. Other members of the expedition are Miss Lillian Kopeloff-Segal, biological chemist, late of the Health Department of New York City; Dwight Franklin, assistant in fish preparation; Charles J. Fish, of the United States Bureau of Fisheries, specialist on diatoms and crustaceans, and his wife, Dr. M. D. Fish, assistant in larval fish distribution; Miss Isabel Cooper, artist; John TeeVan, scientific photographer; Ernest Shoedsack, moving picture expert; Miss Ruth Rose, historian and technician; William H. Merriam, in charge of the mechanical equipment; Dr. D. W. Cady, surgeon; Jay F. W. Pearson, assistant in macroplankton; Hugh Raup, assistant in microplankton, and Serge Chetyrkin, Russian zoölogist and botanist, as taxidermist of the expedition.

The plans of the voyage provide for a trip of about six months. After a study of the Sargasso Sea the "Arcturus" will pass through the Panama Canal and continue its work in the region of the Humboldt Current in the Pacific.

RECENT CONTRIBUTIONS FROM THE NEW YORK ZOOLOGICAL SOCIETY.—Under the splendid sanitary conditions obtaining at the New York Zoological Park the animals, protected from predacious enemies, enjoy a longevity probably rarely attained under natural conditions; but, in so large a population, deaths are inevitable in the normal

course of things, and, when they occur, the animals are sent to the American Museum as anatomical specimens.

Among the great variety of animals thus received during the past few months are several of exceptional interest.

The most noteworthy specimens donated to the department of herpetology include an African smooth-clawed frog (*Xenopus laevis*), a dwarf monitor (*Varanus caudolineatus*) from Australia, an iguana (*Conolophus subcristatus*) captured by Mr. William Beebe in the Galápagos Islands, a Cuban boa (*Epicrates angulifer*), and two red rattlesnakes (*Crotalus exsul*) from California.

Several very desirable birds have been received, among which may be mentioned the six-plumed bird of paradise (*Parotia sefilata*), an adult bald eagle, captured at Peekskill, New York, several interesting pigeons from the Notogean, or Australian, region, a maguari stork (*Euxenura maguari*) from South America, and a particularly fine specimen of Burmeister's seriema (*Chunga burmeisteri*) from the Argentine, where it is locally known as "chunnia." This is one of the most peculiar and interesting of living birds and has long been a puzzle to naturalists. Sharp classified it with the birds of prey, but more recent investigators believe that it is more closely related to the Gruiformes, or the crane-like birds, including the bustards. It has been mounted and will be the first of its kind to be exhibited in the American Museum.

The mammals presented to the Museum by the New York Zoological Society are no less varied than the reptiles and birds. They are represented by specimens from all the continents and include members of very divergent groups. Among them are the following: a red-faced saki monkey, or red ouakari (*Cacajao rubicundus*) from the Amazonian forests of South America, a mandrill (*Mandrillus*) from West Africa, a prehensile-tailed porcupine (*Candou prehensilis*) from South America, a rare species of armadillo (*Cabassous unicinctus*) captured by Mr. William Beebe in British Guiana, a hyrax (*Procapra capensis*) from South Africa, and an aard-vark (*Orycteropus aethiopicus*) from Abyssinia. This queer animal was the first of its kind ever received at the Museum in the flesh. Casts were made of the external features of the animal before its skin and skeleton and some of the soft parts were preserved. The aard-vark is not closely related to any other living

animal. It was consequently removed from the Edentata and at the present time constitutes a separate mammalian order, the Tubulidentata.

Some of the material from the Zoological Park has been preserved entire for anatomical purposes, and forms a very valuable part of the collection of the department of comparative anatomy.

The various departments of the Museum are very fortunate in being favored with such a wealth of material by the New York Zoological Society.

The responsibility for selecting and preserving the anatomical specimens donated has devolved largely upon Mr. H. C. Raven, assistant curator of comparative and human anatomy, and his proficiency and technical knowledge in this field has recently received recognition through his appointment as associate prosector of the New York Zoological Society. He will henceforth share responsibilities heretofore carried solely by the prosector, Doctor Huntington, of the College of Physicians and Surgeons.

THE VERNAY ANGOLA EXPEDITION

To obtain a fine selection of big game for the American Museum's new Asiatic hall has long been one of President Henry Fairfield Osborn's ambitious projects. His high expectations were suddenly realized by the many priceless gifts from Mr. Arthur S. Vernay. As a result of Mr. Vernay's special expeditions into tropical Asia, partly with Col. J. C. Faunthorpe, a series of the most representative groups of wild life is now being prepared for exhibition in the Museum studios under the direction of Mr. James L. Clark.

Mr. Vernay's loyalty to the American Museum and his generosity in undertaking extensive and hazardous field work on its behalf is being strikingly demonstrated in the organization of a new expedition, of which this institution is to be the beneficiary. Mr. Vernay has selected, as a new sphere for his exploits, Portuguese West Africa. This time the habitat of the Angola sable antelope (*Hippotragus varians*) will become his hunting ground. Among the larger antelopes there are hardly any of prouder carriage or more spectacular appearance. The large, scimitar-shaped, rough horns reach a length of sixty-four inches. The glossy dark brown, nearly black, upper side and white under parts of the bull, as well as the presence of nuchal and throat

manes, render it a most conspicuous animal.

The Vernay Angola Expedition will endeavor to make its stay as useful to science as possible through general collecting, for among African regions there could be found few of greater interest. In Angola representatives of the West African, East African, and South African faunas meet. There is a fair variety of game but it is rather scarce. Success in this field will be assured chiefly by Mr. Vernay's fine marksmanship. In addition to mammals and birds, reptiles, fish, and invertebrates will also furnish many interesting data. In view of the fact that there are practically no natural history collections from this region represented in any of the American institutions, Mr. Vernay has decided to have a biological survey made across the country. Several of the Museum departments have taken an active interest in rounding out the scope of this undertaking.

Messrs. Herbert Lang and Rudyerd Boulton, both of the Museum staff, the latter an ornithologist who accompanied Mr. Ludlow Griscom on his recent expedition to Panama, will leave New York on March 14 and a month later will start active field work in Angola near the coast and along the railroad. Toward the middle of June Mr. Vernay will join them and the party will then proceed into the interior. The entire results of the Angola Expedition will be donated by Mr. Vernay to the Museum. Messrs. Vernay and Boulton will return to New York in October. Mr. Lang expects to continue his field studies two months longer by traversing South Africa.—H. L.

IN MEMORIAM

THOMAS LINCOLN CASEY, an authority in the taxonomy of the Coleoptera, died on February 3 in his sixty-eighth year. Born in 1857, he was graduated from the U. S. Military Academy in 1879, and was an officer in the U. S. Army, retiring from active service in 1912. His voluminous contributions to our knowledge of the Coleoptera began in 1884 and continued for forty years. They appeared at first in various scientific journals and, since 1910, in memoirs privately printed. They consist of descriptions of new species or forms, usually coupled with systematic treatment of the group involved, and aggregate 8621 closely printed pages. Opinions as to the permanent value of Casey's work differ. To many coleopterists the forms which he sometimes described as "taxonomic units" appear to be

undeserving of names; and reviews of his work in certain groups have relegated some of the names he proposed to synonymy. On the other hand, a great part of his work was done on families of minute beetles, which had been in part neglected by previous authors, and where his power of systematic analysis is displayed to advantage. The large number of new names he proposed resulted from his untiring perseverance in studying the great collection he had accumulated, and which, with his valuable and extensive library, he bequeathed to the U. S. National Museum. While many of such names may ultimately be considered unnecessary, enough will remain in our catalogues to make their author one of the greatest coleopterological taxonomists.—CHARLES W. LENG.

BIRDS

DR. ROBERT CUSHMAN MURPHY, associate curator of marine birds, who represented the American Museum at the Third Pan-American Scientific Congress in Peru, was one of eleven delegates upon whom the University of San Marcos at Lima conferred an honorary degree. In a graceful address of thanks Doctor Murphy expressed his gratification at being included as Doctor Honoris Causa among the distinguished sons of the South American institution, the founding of which dates from a time long before the birth of learning in the territory now occupied by the United States.

CONSERVATION

THE SAVE THE REDWOODS LEAGUE.—About two hundred fifty miles north of San Francisco on the Redwood Highway are Dyerville and Bull Creek Flats,—groves which have been pronounced by competent judges the finest examples of coast redwood to be found. Many of the trees in these groves are two thousand or more years old, giants of the plant world that tower to a height of as much as 375 feet and have a girth of from 30 to 45 feet. The Save the Redwoods League feels that these superb trees must be preserved, to the lasting benefit of Humboldt County and of the thousands of visitors who in the course of the years will find inspiration in their stately beauty. The two tracts in question are essential to the rounding out of the present fourteen-mile strip along the highway known as the Humboldt State Redwood Park. Fortunately funds are available for their acquisition, and the hearty concurrence of the Board of Super-

visors of Humboldt County in the purposes of the League should be helpful in consummating the negotiations for their purchase now believed to be impending.

SCIENCE OF MAN

THE MRS. WILLIAM BOYCE THOMPSON ARCHEOLOGICAL EXPLORATION OF THE LOWER GILA RIVER, ARIZONA.—The beginning has been made of what promises to be a thorough examination of ancient remains in the region drained by the lower Salt and Gila rivers. Nowhere else in the United States are there indications of irrigation systems so extensive or of such a dense population. An intricate series of ditches furnished water for large tracts of land in the vicinity of Phoenix and Florence, Arizona. The modern ditches in the vicinity of these cities are in many cases the ancient ones cleaned out. In prehistoric times there were considerable cities in this region, the walls of some of which are still standing. Both the irrigation canals and the buildings were examined in 1887-88 by the Hemmingway Expedition of Harvard University led by Frank H. Cushing. Unfortunately but meager reports of this work were published. One well-preserved ruin, Casa Grande, is now under the protection of the National Park Service of the United States Government.

Scattered about in this general region are many ruins small and large and of varying ages. Several of these are situated near mountain valleys where irrigation was not necessary for the raising of maize. One of these, near the state highway between Globe and Superior, Arizona, was recently visited by Dr. P. E. Goddard, curator of ethnology, American Museum, and has been chosen for complete excavation. There are in this ruin about a hundred rooms as indicated by remains of walls of stone. Already a skeleton in fair preservation has been recovered, besides pottery and ornaments of shell and turquoise.

In the neighborhood are well preserved cliff ruins, which have not suffered from vandalism. These will no doubt supply specimens of great scientific value. In one large cave there is a room that has its roof intact and well preserved. The very arid condition of these caves has assured the survival of textiles and other objects which have disappeared in the unprotected ruins.

It is through the interest of Mrs. Thompson, wife of the well-known philanthropist and

mining man, Col. Wm. Boyce Thompson, that the American Museum is able to undertake this important work. Mrs. Thompson some years ago provided for archæological research in Cyprus; and during her travels in Egypt, Peru, and elsewhere has become interested in early civilizations.

A thorough study of the region should throw light on the connection between the prehistoric people of the Valley of Mexico and those who lived and developed a civilization in pre-Spanish times in the region of the Upper Colorado and Rio Grande rivers.

THE INSTITUT DE PALÉONTOLOGIE HUMAINE, which, generously endowed by the Prince of Monaco, has become one of the principal agencies for contributing to the knowledge of early man, announces a spring course of lectures of unusual interest: "L'Aurore de la Pierre taillée" by M. H. Breuil, "Origine et Formation des Grottes utilisées par l'Homme paléolithique" by M. A. Viré, "L'Art quaternaire dans le Pays basque" by M. Passemard, "Découverte du Paléolithique en Chine" by M. P. Teilhard de Chardin, "Une Population primitive actuelle: le Pygmées" by M. R. Verneau, "Les Origines de l'Homme américain" by Doctor Rivet.

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Since the last issue of Natural History the following persons have been elected members of the American Museum, making the total membership 8179.

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Every year brings evidence—in the growth of the Museum membership, in the ever-larger number of individuals visiting its exhibits for study and recreation, in the rapidly expanding activities of its school service, in the wealth of scientific information gathered by its world-wide expeditions and disseminated through its publications—of the increasing influence exercised by the institution. In 1924 no fewer than 1,633,843 individuals visited the Museum as against 1,440,726 in 1923 and 1,309,856 in 1922. All of these people had access to the exhibition halls without the payment of any admission fee whatsoever.

The **EXPEDITIONS** of the Museum have yielded during the past year results of distinct value. The collections made by Mr. Arthur S. Vernay in new areas of Burma, Assam, and Siam, and by Mr. Barnum Brown in southern Asia and the Mediterranean region of Europe; the studies of Andean avifauna pursued by Dr. Frank M. Chapman in Chile; the excavation of fossil sites in Florida and Texas by Dr. William D. Matthew; the extensive survey of Polynesian bird life conducted by the Whitney South Sea Expedition; the work pursued in selected faunal areas of Ecuador by Mr. G. H. H. Tate; the field observations and collections made in Panama by Dr. Frank E. Lutz and Mr. Ludlow Griscom; the underwater studies of reef life at Andros Island carried out by Dr. Roy W. Miner; the notable journey of Dr. G. Clyde Fisher and Mr. Carveth Wells to Sweden and Lapland; and the preparations made for the continuation of the brilliant work of the Third Asiatic Expedition during the coming five years—these (and the list might be extended) are among the notable achievements of the past twelve months.

The **SCHOOL SERVICE** of the Museum reaches annually about 7,000,000 boys and girls, through the opportunities it affords classes of students to visit the Museum; through lectures on natural history especially designed for pupils and delivered both in the Museum and in many school centers; through its loan collections, or "traveling museums," which during the past year circulated among 433 schools, with a total attendance of 1,247,914 pupils. During the same period 598,132 lantern slides were loaned by the Museum for use in the schools as against 440,315 in 1923, the total number of children reached being 5,407,525.

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The **LIBRARY**, comprising 100,000 volumes, is at the service of scientific workers and others interested in natural history, and an attractive reading room is provided for their accommodation.

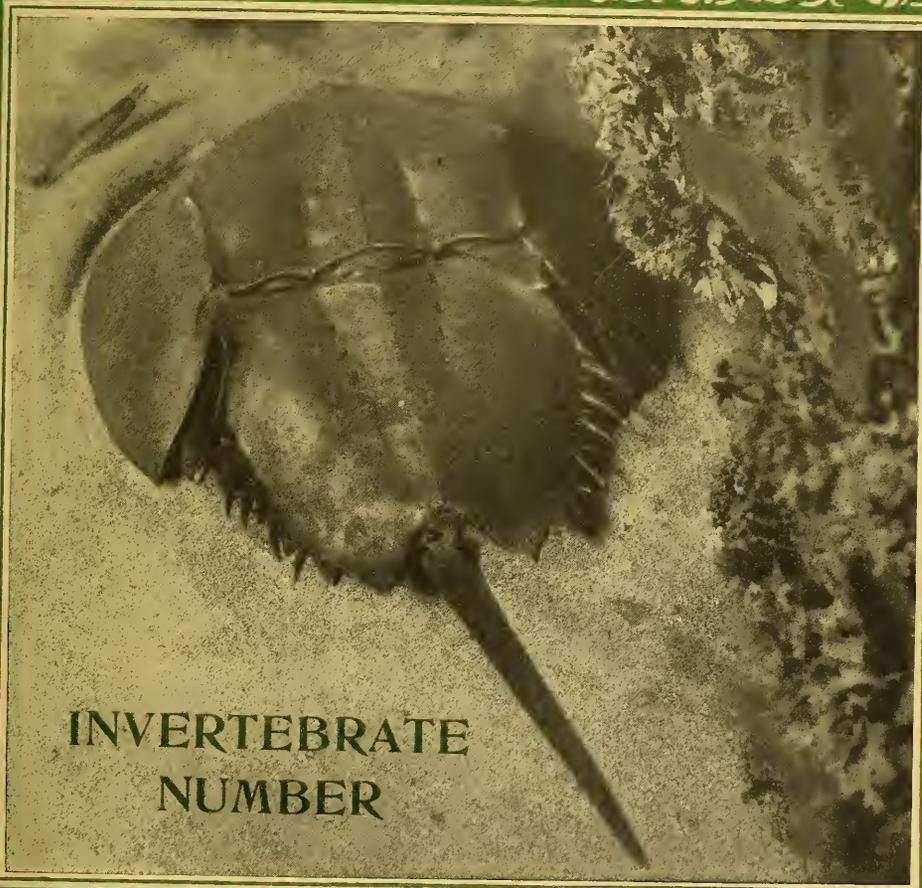
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MAY-JUNE, 1925

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NATURAL HISTORY

VOLUME XXV

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A STUDY IN LOCOMOTION AMONG MARINE ANIMALS

Detail of Wharf-Pile Group in the Darwin Hall of the American Museum

The stationary animals of the wharf piles are contrasted, on the one hand, with the jellyfish (*Dactylometra quinquecirra*), which swims aimlessly without power of direction, and on the other, with the squid (*Lobiogalaxias*) and cummer (*Tautoglabrus adpersus*), both of which possess highly coordinated and efficiently controlled swimming organs

NATURAL HISTORY

VOLUME XXV

MAY-JUNE

NUMBER 3

What Is a Rotifer?

By FRANK J. MYERS

Research Associate in Rotifera, American Museum

INTRODUCTORY NOTE BY THE EDITOR.—A drop of water from the border of a lily pond placed beneath the eye of the microscope, reveals to the uninitiated observer a new world of unbelievable creatures darting and spinning hither and thither amid an environment of strange vegetation. Among the most conspicuous beings in this miniature aquatic world are the toplike rotifers or "wheel bearers," tiny animals whose heads are wreathed with rows of rapidly vibrating hairlike "cilia," which move in rhythmic succession, so that an illusion of rotation is presented. These rotifers are of many diversified species. Mr. Myers, one of the best informed authorities on rotifers, has had the enviable privilege of making a life study of these beautiful organisms, and describes them intimately in this article.

ROTIFERS have engaged the attention of investigators ever since the microscope was evolved, on account of their interesting habits and diversity of form, their complex organization for such small creatures, and the ease with which they may be obtained and studied. They derive their name, meaning "wheel bearers," from several common species of the class which were probably the first ones observed in abundance. These bear two circlets of hairlike cilia on the front of the head, the rhythmic motion of which gives them the appearance of rapidly rotating wheels, for which in fact they were at first mistaken.

There are not many places where one need search in vain for rotifers, provided there is sufficient moisture to sustain life. They abound in lakes and ponds, pools and bogs, among the leaves of aquatic and terrestrial mosses. Even the briny waters of the ocean, including the tide pools along the shore, have their quota. It is, therefore, convenient to divide these animals into ecological groups according to their habitat, which obviously determines both their food and mode of reproduction, and affects profoundly their structure and life history.

The first group includes the limnetic rotifers which are those found in the open waters of lakes and ponds. Their life is a restless one, for necessity compels them to be in constant motion. Their physiological processes are so delicately adjusted that a trip to the bottom would mean instant death. Their food consists of minute lowly plants and animals floating and drifting about in the water.

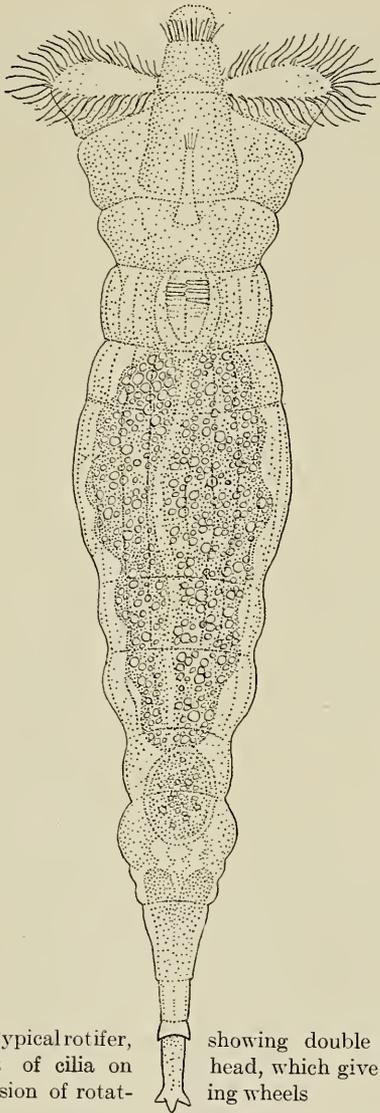
The second group comprises the littoral rotifers, to which probably more than three fourths of all the known species belong. They are those found swarming on plant stems, leaves, mosses, and algæ, close to the shore where the shallow water permits an abundant growth of aquatic plants. Certain species in the adult stage are permanently attached to water plants. They usually surround themselves with a protective case, either secreted by the animal itself or built up of foreign material.

As a rule the same species of rotifers will be found year after year in the same pond, but occasionally a species will disappear completely for several years and then return to its old haunts, as though nothing had happened.

Very few rotifers are parasitic. One

species makes its home in the alga, *Vaucheria*, and seems to be unable to complete its life cycle elsewhere. Others

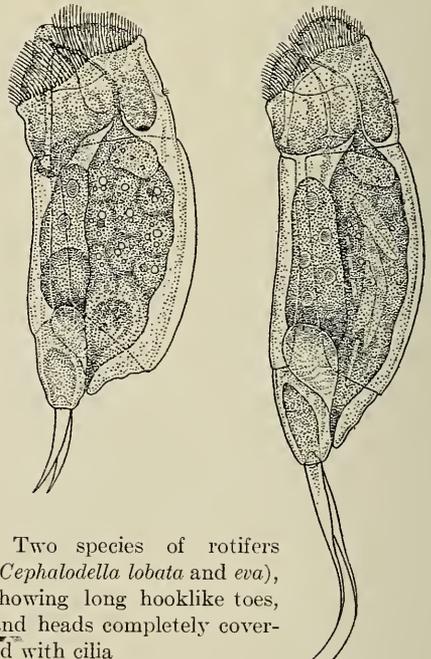
habit, the details of which are known only in this group. When the little tufts of moss in which the rotifers make their homes, begin to show unmistakable signs of drying up, the animals start making their preparations. In every cell of their tiny bodies the chromatin of the nucleus begins to break up and gradually to move toward the cell wall. In the completely dried rotifer it can be found as a very thin inner coating in each cell. This rearrangement of the cell contents allows the oxidation processes to continue during the period of desiccation but at a greatly retarded rate; so much so, that these rotifers may be kept in a dried condition for years, to revive upon the addition of a little water. This adaptation also carries them through the winter, and even permits their being imbedded in ice. James Murray, the naturalist of the Shackleton Antarctic Expedition, tells of sinking an eighteen-foot shaft to the



Typical rotifer, showing double circlet of cilia on head, which give the illusion of rotating wheels

are parasitic on various worms. But as a rule, the rotifers are well behaved.

A large group is found among the leaves of all kinds of mosses, where a little moisture is nearly always present. In order to protect themselves during unavoidable desiccation, these animals have evolved a remarkable

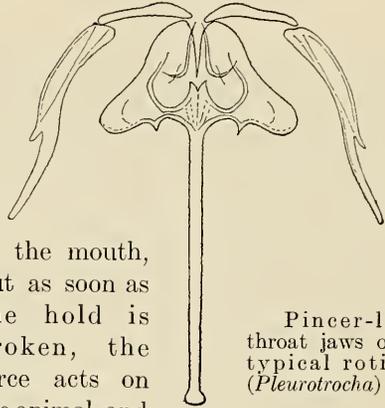


Two species of rotifers (*Cephalodella lobata* and *eva*), showing long hooklike toes, and heads completely covered with cilia

bottom of a completely frozen lake, bringing up some lumps of the frozen bottom ooze which were then thawed out. He found the melted ooze swarming with living rotifers. It is impossible even to guess at the length of time which had elapsed since this lake froze solid, or when, in the natural course of events, such a body of ice would be likely to melt sufficiently to allow the rotifers to take up their interrupted life once more.

On account of the extreme diversity of form and the infinite variety of detail displayed among these creatures, it is quite impossible to give a general definition which will include all the species of rotifers without exception. However, they agree in their minute size, bilateral symmetry, the possession of a crown of hairlike cilia called the corona, and in being absolutely dependent upon moisture for the maintenance of life. The body is protected by a firm cuticle, the lorica, often hardened to form a shell. The posterior portion of the body is usually somewhat elongate and is misnamed the "foot," although "tail" would be more appropriate. It contains two or more "cement glands" discharging a viscous fluid through ducts opening at the posterior end of the body or at the tips of the so-called toes, thus enabling the animals to attach themselves to other objects, either permanently or temporarily. To illustrate the manner in which rotifers feed and swim, let us imagine a man attempting to row a boat which is fastened to a post on the bank by means of a rope. The effort produces currents on each side, flowing opposite to the direction in which the boat is pointed. If the rope is suddenly cut while the man is rowing, the boat glides ahead and continues to do so as long as the man continues to row. The

rotifer is the boat, its cilia the oars, and its foot, with its adhesive toes, the rope. As long as the toes maintain their hold, the force of the moving cilia is spent in the water, producing currents which bring particles of food



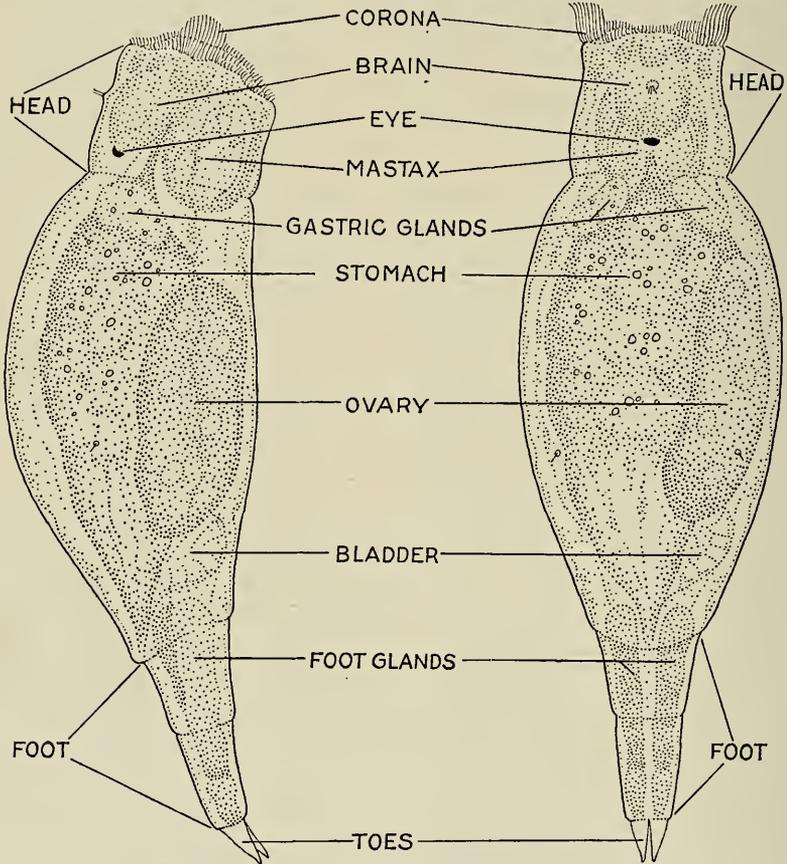
Pincer-like
throat jaws of a
typical rotifer
(*Pleurotrocha*)

to the mouth, but as soon as the hold is broken, the force acts on the animal, and away it glides to seek pastures new.

The rotifer digestive system is very simple. The mouth is at the lower edge of the ciliated corona, and a short cesophagus contains a peculiar apparatus (the mastax) for the crushing and grinding of food. While these internal "jaws" are found in all rotifers, there is nevertheless a bewildering array of variation in the details of their structure. They consist fundamentally of three pieces, one median and ventral, forked at the anterior end, and two lateral pieces somewhat nearer the dorsal side, usually divided at the tips into toothlike processes. The three pieces form a sort of tripod, with the apex toward the front. In one large group of rotifers these three pieces are short and broad and adapted to crushing and grinding the food, which consists of small unicellular algae and similar objects. There is a modification of this type, in which the median element is very much reduced. The function and the diet of the animal is, however, much the same as in the principal type.

The slow-moving herbivorous rotifers that crawl about on the leaves and plant stems searching for food, have jaws of a somewhat different form. The rods of the tripod are more elongate and strengthen the walls of the

or ice tongs, the inner edges often furnished with many needle-like teeth. This whole apparatus can be thrown out through the mouth opening, and forms a formidable offensive weapon. As all the jaws are formed of com-



Anatomy of a typical rotifer (*Pleurotrocha petromyzon*)

mastax. The cavity between is filled with a powerful muscle, which, by its alternate contraction and expansion, acts like a piston, so that the whole apparatus functions as a pump. By means of its pumping action, a rotifer is able to empty a plant cell of its contents, after having pierced the wall with the pointed tips of the jaws. The predatory rotifers, on the other hand, are equipped with highly specialized and efficient jaws resembling pincers

paratively resistant material, it is possible to isolate them by dissolving away the tissues of the body with a caustic alkali. They can then be mounted on slides for detailed study under the microscope, and afford a convenient means of determining many species.

The œsophagus opens into the stomach, the posterior half of which functions as an intestine. A pair of gastric glands is usually present. The

waste products of digestion are discharged through the cloaca, which opens just above the foot.

The muscular system is very simple, but performs admirably the few functions required of it. Longitudinal muscles withdraw the head and delicate corona in case of the slightest disturbance (which means danger to rotifers), and circular muscles drive them forward again by their action on the body wall.

The nervous system is almost as simple. Nerves radiate from a large central ganglion in the head to the different organs of the body. This ganglion is usually called the brain, no doubt on account of its position. It is obvious that this name is far too pretentious for such a simple organ. A rotifer is capable of making so few responses to external stimuli that any complex apparatus for controlling them would be quite useless.

The mode of reproduction is very unusual and interesting. The sexes are distinct, but the females are far more numerous than the males. The males of many species have never been seen, and so far as the moss-dwelling group is concerned, all the evidence indicates that males do not exist. The females are normally developed, but the males are degenerate, possessing neither mouth nor digestive organs of any kind, except in rare cases, and their life span is consequently very short, usually counted in hours rather than days. The following anatomical description therefore applies only to the females.

Nearly all female rotifers lay eggs. In some cases development is completed within the body of the mother, from which the young may not emerge into the outside world until after a second generation has started to mature in the ovary. The normal reproduction

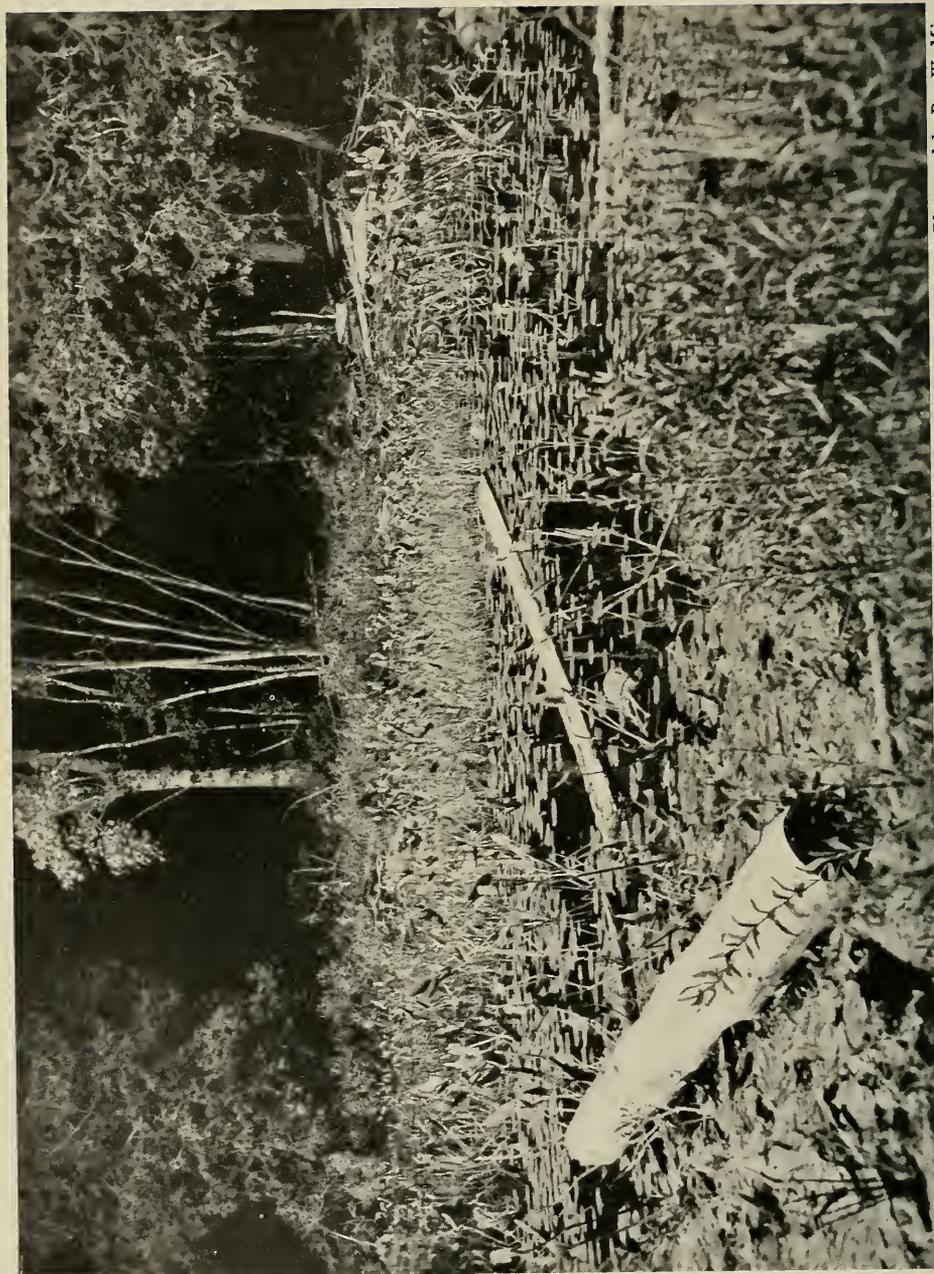
is asexual. The female lays unfertilized eggs which, in a few days, develop into another generation of females. In warm-weather species, this continues throughout the summer. In the fall some of the females will lay larger quantities of smaller eggs, from which



Rotifer (*Trichocerca longiseta*) feeding on chlorophyll of "pond scum" *Spirogyra*. It bores a small hole in each plant cell and pumps out the spiral chlorophyll for food

males develop. These, in turn, pair with the females. The fertilized eggs resulting from this mating have a very tough shell, which enables them to withstand the rigors of winter, and postpone their development until the following spring. This is one of nature's provisions for perpetuating the species by bridging the cold months.

Rotifer eggs are so minute and so readily carried about that there are practically no barriers to their distribution. The most important agent is the wind. When bodies of water dry up,



Photograph by Roy W. Miner

A COLLECTING PLACE RICH IN LITTORAL ROTIFERS

The submerged water plants of such a location swarm with many species of microscopic pond life including rotifers, minute crustaceans, and protozoans. One-celled algae are also found in great abundance



ROTIFER HUNTERS AT WORK

At the left Mr. Myers and an assistant are fishing for rotifers with a fine-meshed silk net, by means of which limnetic (free-swimming) rotifers are captured and concentrated in the tapering end of the net. At the right Mr. Myers is examining samples of his catch, using a small jar of the pond water and a hand glass



Photograph by Roy W. Miner

A beautiful pond such as this is an ideal location for limnetic rotifers, i. e. those of open waters



Even the roadside ditches are replete with rotifer inhabitants

or the level lowered, the wind catches the resting eggs and blows them away. Since they are so small and light, they may be carried long distances, to fall and hatch in places where conditions are favorable, such as other bodies of water or moist places. Water fowl of various kinds distribute the eggs from pond to pond. Not only do the resting eggs become imbedded in the mud that adheres to the legs and feathers, but they also pass through the alimentary tract of the birds without injury.

The best places to hunt for rotifers are in soft-water lakes and ponds, provided one wishes to find many different species, but the individuals will not be so numerous as in similar locations in hard water. As the result of three months' collecting in neutral and alkaline waters in southern California, during the winter of 1915, 106 different species were found, while in one afternoon the following summer, 84 species were collected from near the shore of Lenape Lake, Atlantic County, New Jersey. There are probably more species of rotifers in this small, soft-water lake, than in all southern California. Exactly 100 species were collected during one week's work among the hard-water lakes in the vicinity of Madison, Wisconsin, during the summer of 1916, while a like number, including a few new to science, were collected in one hour in a small soft-water lake near Eagle River in the northern part of the same state. The general statement may be made, therefore, that ponds and lakes in good farming country may contain many rotifers but relatively few species, while in poor farming country, or where there is no farming at all, such bodies of water will contain many species but relatively few individuals. In order to be suitable for farming, the

soil must contain plenty of lime. We have not yet learned how to farm acid soil with any great success.

While rotifers always can be found plentifully in permanent bodies of water containing an abundance of aquatic plants or submerged moss, they are not so easily found in a pond or lake surrounded by rocky shores and containing very little submerged vegetation. In the latter case, however, look for a small cove or protected spot along the shore line. It need be only a square yard or two in area, provided it is protected in some way, perhaps by a fallen log, large stones, or a break in the shore line. The important point is that it must be sheltered from direct wave action and yet have free circulation with the main body of water. In such quiet coves, patches of aquatic moss or algæ are nearly always present and, no matter how small the quantity may be, it is sure to harbor rotifers. The plants should be carefully floated into a wide-mouthed bottle without crowding, and then carried home and allowed to stand quiet for a while. At the moment the bottle is filled, a change in temperature and environment begins. Many of the more delicate organisms soon die and start to decompose, while all the others are using up the life-giving oxygen, which is almost a fixed quantity in the narrow container. As the supply of oxygen decreases, the heavier vitiated water sinks to the bottom of the bottle, while the fresher water rises toward the surface. The rotifers soon forsake the aquatics and ascend with the fresh water, just as we would go to the window of a stuffy room for more air. Finally, they reach the surface where a certain amount of oxygen is present. Being phototactic animals, they assemble at the point nearest to the light



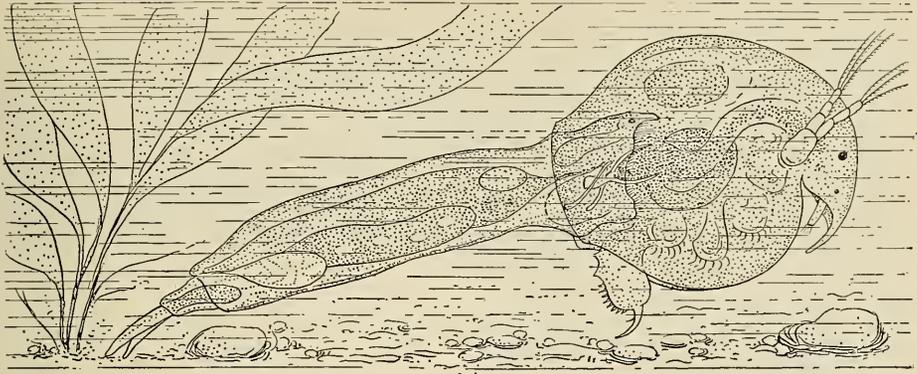
A beautiful stationary rotifer (*Stephanoceros eichornii*) from a model in the American Museum

and crowd into the meniscus, or the angle formed by the water drawn up and around the side of the glass by capillary attraction. They may now be removed in quantity with a pipette. Purely limnetic species are captured by dragging a net of very fine mesh through the water and transferring the contents to stock bottles.

The beautiful stationary rotifers must be looked for in pure water which is comparatively undisturbed, as they

are very sensitive to wave action. The tubes in which these fixed forms live are found attached to the leaves and stems of submerged aquatics and can be recognized readily with a hand magnifier.

Some specific cases of the habits of a few rotifers will possibly help more than anything else to point out why this branch of natural history is so interesting. In the soft acid waters of the New Jersey Coastal Plain there is an animal which goes by the formidable name of *Dicranophorus isotheres*. It tires out small bivalve crustaceans until they open wide their shells, after which the rotifer makes a meal from the organs of its victims. Some time ago, during the study of a pond collection, an apparent tragedy was enacted. A *Dicranophorus isotheres* was caught by the neck between the shells of one of these crustaceans which then promptly contracted, squeezing the neck of the rotifer almost flat and seemingly slowly strangling it to death. In a similar collection a day or so later, the same thing was observed, but this time in five or six instances. This could hardly be accident, and on more prolonged investigation it was found that when a hungry *Dicranophorus* came in contact with these animals it worked its way rapidly toward the posterior end of its victim and deliberately inserted its head between the shells. Of course, the little entomostracan instantly closed, tightly squeezing the rotifer by the neck. Nothing daunted, our rotifer remained perfectly quiet until its victim grew weary and relaxed its shells a little. Then in went the rotifer's head farther and farther until a vital spot came within reach of the formidable pinching jaws. This was the beginning of the end of the microscopical tragedy. The rotifer made a meal on the vitals



A *Dicranophorus* eating its way into a living cladoceran by means of its powerful pincer-like jaws

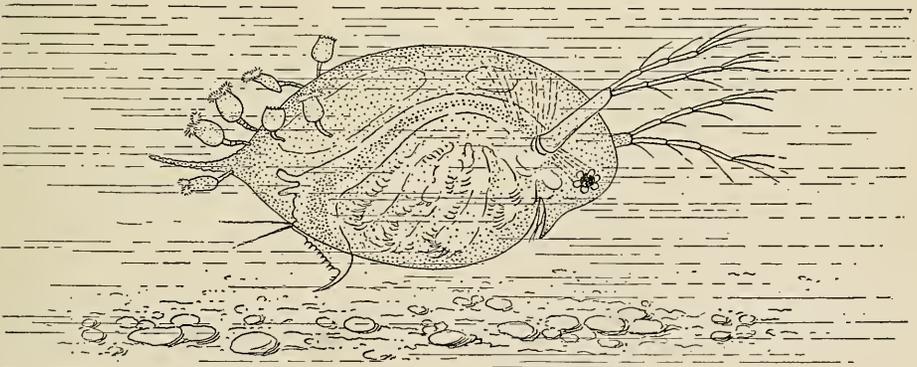
of its victim, leaving only the empty shell, as it slowly swam away in search of more. Rotifers are always hungry. They pass their lives eating, reproducing their kind, and trying to avoid their enemies. In no other group of animals is the struggle for existence more intense. The law of the pond is to swallow everybody smaller than yourself if you can, and keep from being swallowed as long as you can.

The spindle-shaped rotifer with a long tail and longer name, *Trichocerca longiseta*, obtains a living by slowly working its way along a filament of the beautiful alga, *Spirogyra*, our common "pond scum." By means of its jaws, which are adapted for nibbling and

pumping, it bores a round hole near the end of each cell, and then pumps out the green contents.

The glassy-shelled rotifers *Brachionus rubens* and *Brachionus variabilis* ride about, as a means of easy locomotion, by holding on with their toes to the back of the entomostracan *Daphnia*. If *Daphnia* be killed, all the *Brachioni* speedily abandon the dead host. One can imagine a *Daphnia's* delight when, in molting, which may occur once in three or four days, it can slip out of its old clothes and suddenly escape from its unbidden guests.

Ascomorpha volvocicola, a soft-bodied rotifer, makes her home inside the beautiful spheres of the colonial proto-



Small rotifers (*Brachionus*) enjoying a ride on a *Daphnia*, to which they hold on with their toes



A free-swimming rotifer (*Furcularia longiseta*) with enormously long toes

zoan, *Volvox*, feeding on the green monads that stud its gelatinous expanse, or swimming to and fro "like a goldfish in an animated globe." The eggs are laid and hatched within the *Volvox* colony. After hatching, the young eat their way out of their globular prison or are expelled with embryo *Volvox* clusters when Mother *Volvox* dies and decays.

What microscopist, interested in pond life, has not seen the beautiful *Floscularia ringens* carefully making round bricks with her specialized brick-making apparatus, then cementing each one exactly in its place, thus building up her tubular home?

Macrochætus subquadratus and *colinsi* swim through the water with their numerous long dorsal spines appressed to their backs. When danger threatens, the head and foot are drawn within the shell. This action throws outward the dorsal spines, making the little animals about as easy for an enemy to swallow as chestnut burrs.

There are two rotifers with names also far out of proportion to the animals themselves (*Scaridium longicaudum* and *Scaridium eudactylatum*), that use another method to avoid being swallowed. They suddenly spread out their long, stout toes, and then snap them together, actually leaping through the water with such tremendous bounds as to take them out of the field of the microscope so suddenly that they

appear to have vanished completely. Little *Polyarthra trigla* makes a quick succession of leaps and bounds by means of six lateral winglike appendages fastened to its neck and worked by a powerful striate muscular band. The beautiful, flower-like members of the family Collothicea seem to be the original inventors of the modern rat trap. Numerous long hairlike setæ are spread out in the water by the unfolding of the lobes of the coronal cup, from which these setæ arise. Small aquatic organisms come in contact with them and follow them down into a spacious chamber, the coronal cup itself, near the base of which is an arc of cilia that produces currents impelling the prey farther downward. Here there is an opening leading into a long, flexible tube that hangs down into the middle of a second chamber. Woe betide the little animal that touches the entrance of this tube! It is carried through instantaneously by the action of invisible cilia, and dropped into the chamber below, from which there is no retreat. Here it is slowly stupefied and finally ground up by the pincer-like jaws lying near the bottom of the chamber where the entrance to the stomach opens.

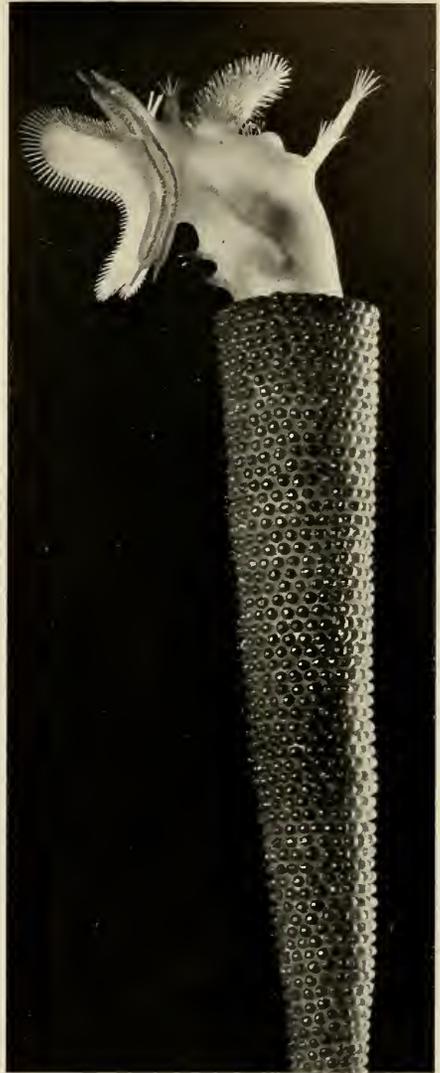
And then there is the voracious *Acyclus inquietus* living only in and among the fixed colonies of another rotifer, *Sinantherina socialis*. As the young of *Sinantherina* are free-swim-

ming and as the adult *Sinantherina* is too large to be swallowed, *Acyclus* devotes its entire attention to the small, free-swimming offspring, snapping them up as they glide past.

Rotifers play an important part in the direct food supply of fishes. To illustrate this very roughly, let us liken the more important classes of small organisms, in a lake or pond, to the rungs of a ladder. The lowest rung would be the bacteria; the next rung above, would be the protozoans, many of which feed on bacteria; the third would be the rotifers, many of which feed on the protozoans; the fourth would be the aquatic worms and entomostracans, many of which feed on the rotifers. The highest rung would be the young and small fishes, all of which feed on entomostracans and aquatic worms. If we remove a single rung of our ladder, we weaken all the rungs above, and by taking out the rotifer rung we reduce the fish supply in a given body of water proportionally.

Rotifers play an important part as scavengers. Their importance depends on their minute size and unparalleled numbers. Many are so constituted that their diet is practically confined to such floating and adhering particles as are present in the water in a state of fine comminution. By disposing of such material, which otherwise would foul the water, they become one of the factors that help to keep the water of our ponds and lakes pure and clean.

We have seen that rotifers have such a wide range of habitats, that it would be hard for anyone taking the trouble, not to find some near home. As Doctor Hudson has so aptly said: "It is so natural to recommend one's favorite pursuit that the recommendation often carries little weight; and yet, there is much to be said for the study of rotifers



Tube-building rotifer (*Floscularia ringens*) making spherical bricks, one of which may be seen just beneath the hair-covered, finger-shaped projection at the top. Model in the American Museum

that cannot be gainsaid. They are to be found almost everywhere; they cost nothing; they require neither expensive lenses nor apparatus; they are beautiful in themselves; they tempt us to take pleasant walks and explore the country; and they suggest all kinds of difficult questions on life and being."



GLASS MODELS OF MINUTE WATER PLANTS MAGNIFIED

Three vesicles of the bladderwort (*Utricularia*). These are traps for capturing the microscopic pond life. A detail of the Rotifer Group, now being prepared in the Museum laboratories, which represents one-half inch of pond bottom with its associated animal and plant life magnified to a diameter of more than four feet. It is blown entirely of glass

The Rotifer Group

By HERMAN O. MUELLER

Glass Modeler, American Museum

THE department of lower invertebrates of the American Museum has in preparation a group illustrating pond life magnified 100 diameters. This group will be a companion piece to the Bryozoa Group which shows two inches of sea bottom magnified 25 diameters, now on exhibition in the Darwin Hall of the Museum. The new group will depict an association of minute animals and plants common in our pond water, but for the most part visible only under the microscope.

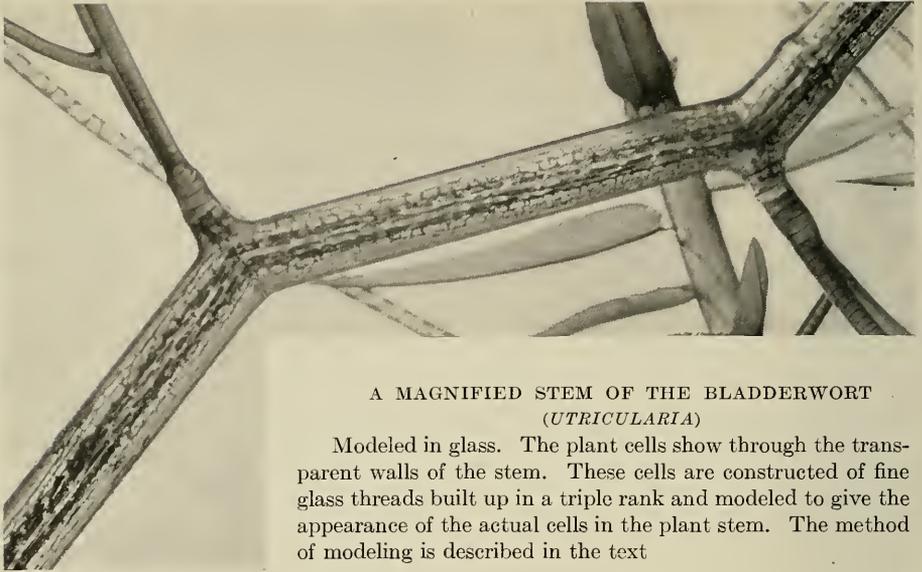
Most of the organisms possess a texture and coloring so translucent and delicate that glass is the only medium capable of reproducing them faithfully and naturally. It may interest the reader to learn something about the technique of constructing a few of the glass models for this group. Although many of the manipulations in glass blowing are very simple, it is quite difficult to describe them, and it is only by actually watching the *modus operandi* that a clear idea of the process may be gained. However, I shall attempt to describe some of the important steps in the process.

A rough drawing embodying the main elements of the group is first outlined. With this as a guide, a sketch model of the group as a whole is constructed. This is usually one quarter or one third the size of the proposed magnification, and includes the most conspicuous objects, made to scale, and grouped roughly together. The value of this scale model is apparent when one realizes that because of its smaller size the different parts can

be altered or moved to more suitable positions, while experimental transparencies for the background may be tried out with less difficulty than in the full-sized group, or additions planned where necessary. It is, so to speak, an experiment station, which, when completed, is a miniature of the final group, but without detail.

All the technical difficulties, however, are by no means solved. On the contrary, when the work on the real group is begun, other problems arise, as for instance, the welding of the single parts, and the handling of the finished pieces, a more complicated undertaking on account of their greater size. Also, the higher the magnification represented, the more complicated is the structure which becomes visible and which must be shown in the model. To accomplish this, careful drawings of the exact magnifications of the plants and animals are made with the aid of the microscope. From these drawings, the various models are constructed in glass, wax, celluloid, or other suitable material.

The *Utricularia*, an aquatic species of the bladderworts, when viewed under the microscope, reveals a form of great beauty and transparency. Naturally, the only medium to be used in its reproduction is glass. For the main stem a glass tube of the proper dimensions was cut in sections of from five to eight inches in length, to be welded together to form the stem of the water plant. Throughout the main stem there runs a network of green-colored cells concentrically arranged in three layers. In making this network a



A MAGNIFIED STEM OF THE BLADDERWORT
(*UTRICULARIA*)

Modeled in glass. The plant cells show through the transparent walls of the stem. These cells are constructed of fine glass threads built up in a triple rank and modeled to give the appearance of the actual cells in the plant stem. The method of modeling is described in the text

smaller tube, about one quarter the diameter of the outer stem, was cut in sections corresponding to the zigzag portions of the outer tube. Around this smaller tube the three layers were built up to form a triple network. First, a mosaic of cells was laid on this tube horizontally, by applying threads of dark green glass and slightly fusing them in the blast lamp so that they stand out in relief on the surface of the transparent inner tube. The green threads or strips, one-half inch long and one-sixteenth inch wide, were placed a short distance apart to form an alternating pattern running lengthwise and covering the whole tube. From the ends of each horizontal thread finer threads about a thirty-second of an inch in diameter were fused to rise vertically about an eighth of an inch. These were connected by cross threads and thus gave the second layer of cells. Above these cells another layer was constructed in the same fashion, forming the third concentric set. As the meshes of all this complicated network must be of just the right size to fit into

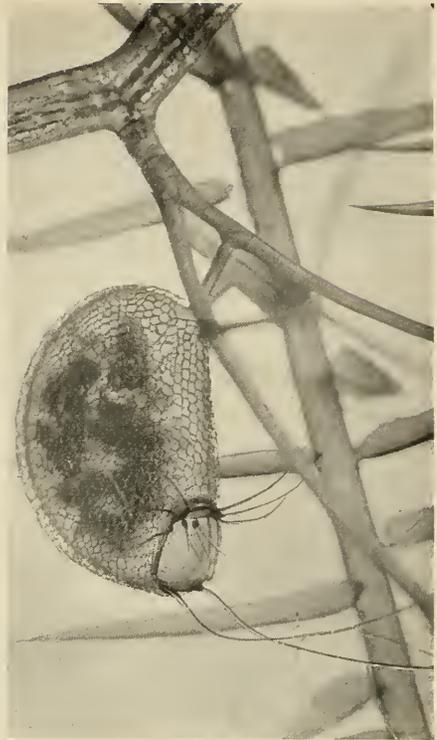
the larger tube or main stem, it was necessary to use the finest needle flame of the blast lamp to make the minute weldings involved.

When one of these cell sections was finished, it was inserted into the corresponding section of the outer stem. Then a new empty section was added to the latter and fused to it at an angle of forty degrees, because of the zigzag shape of the stem. This was repeated until the whole main stem, consisting of ten sections, was completed. At the angles of the stem are situated finely dissected leaves resembling branched spines, to which vesicles or bladder-like sacs are attached, one or more on each leaf. These branched leaves were modeled from small, thin, glass tubes, the terminal ends tapering to a point. To these, shorter tubes were fused at irregular distances and then bent and curved like staghorn prongs. A vesicle was then attached to the basal stem of each leaf close to the main zigzag stalk. These vesicles, which vary in size, were made from a glass tube first blown to form a globe, then flattened

on two opposite sides and shaped to the proper size. In nature the vesicles are traps which capture microscopical creatures, or rather, these tiny swimming animals enter through a trapdoor at the apex of the vesicle. At this juncture a layer of cells was painted on the vesicle, which was then sprayed, by means of an air brush, with tints varying from light rose to deep purple, as in nature. When the color was suffi-



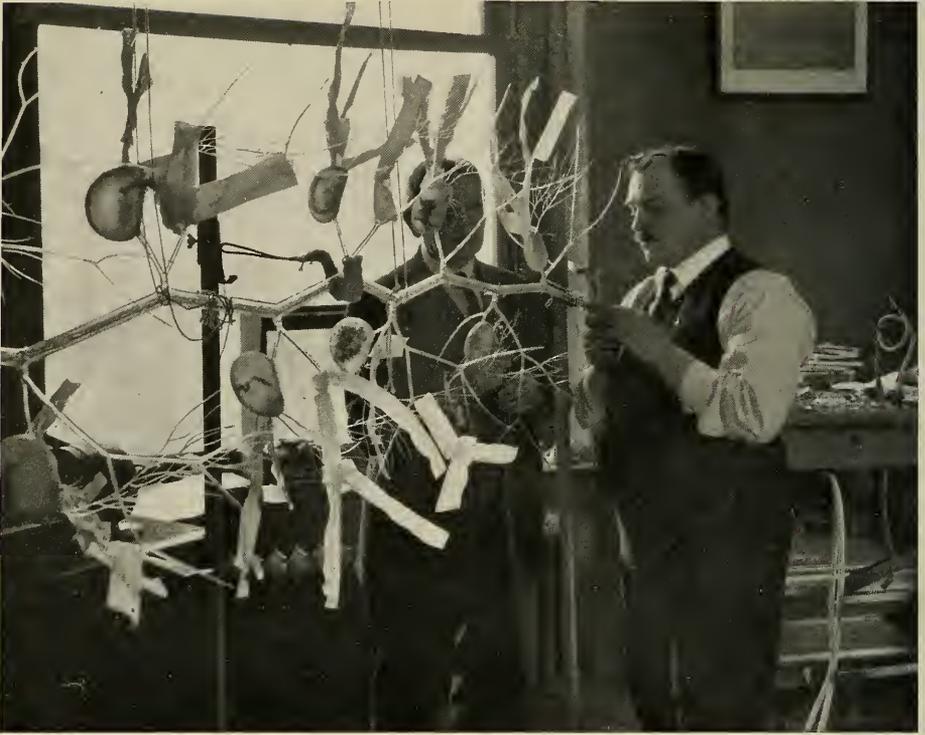
Larva of a harlequin fly (*Chironomus*) just captured by the plant. This larva was feeding upon food particles adhering to the branched spines projecting from the vesicle, and gradually worked its way down the stem until it touched the slippery trapdoor which straightway opened and caught it by the head. Because of the downward-pointing hairs lining the vesicles, the struggles of the larva merely draw it farther into the trap. The frontispiece (Page 224) shows a larva entirely enclosed within the vesicle. The modeling of the hexagonal vesicle cells is described in the text



A vesicle of the bladderwort (*Utricularia*) modeled in glass. The natural size of this remarkable structure is about that of a pin's head. It is shaped like a flattened pitcher and has an ingenious trapdoor equipped with slippery hairs pointing toward a slot which is usually closed. If a rotifer or other tiny pond animal chances to rest upon this door, it immediately slips through the slot which quickly closes upon the prisoner. The animal swims about inside the utricle and finally dies. The fluid product of its decaying body is absorbed by the plant cells for food

ciently dry to permit handling, another layer of green cells was put on the vesicle. But this outer layer was constructed of fine, green glass threads so fused as to form a network of hexagonal meshes. This network layer, shaped exactly to the vesicle, was so flexible that it could be snapped over the vesicle, blending with it so as apparently to form an integral part with the whole structure.

When all the leaves with their vesicles were ready for fusion to the



Two generations of glass modelers.—Herman Mueller and his father welding together the complex parts of the *Utricularia* model. This is probably the most difficult piece of glass modeling ever attempted. Two jets of flame are played around the plant stem to soften it while the delicate branches and vesicles are being attached. The magnification of the *Utricularia* model is graphically shown in this picture. The water plant from which it was modeled measured about one-half inch

main stem, the work had reached a critical stage, for every part was in a delicately and completely finished state, even to the fine coloring. If anything had broken during this fusing operation, it would have been necessary to make over the entire branch. When colored parts are to be fused together, the color must be cleaned off for a distance of about two inches from the junction, otherwise the color burns and creates dark areas in the glass. The clear spaces are refinished afterward. When all the pieces of the *Utricularia* were ready to be assembled, the main branch was mounted on three supports so as to eliminate any tension. As a precaution the tube was covered with

asbestos so that the flame could not strike it while the leaves were being fused into place, and only the spot where the joint was to be made was left bare. The openings at the base of the leaf-branch and of the main stem at the point of junction, were of the same diameter, and two jets of flame played continually around the glass to soften it before the joining was made. After a leaf-branch was fused on, the area around the place of attachment was annealed for some time to prevent future cracking. To perform this delicate operation, it was necessary for two glass blowers to work together from opposite sides of the branch.

Among other water plants to be in-

cluded in the group are three large branches of *Anacharis*, and many filaments of *Spirogyra* spreading throughout the group and clustered in a dense mass at one side. The main stem of the *Anacharis* was made of a glass tube about four feet long and three fourths of an inch in diameter. One end of the tube was closed in the blowpipe and tapered to a conical shape so as to permit the leaves of the branch tip to come close together as if just opening. Numerous holes, corresponding to the number of leaves, were pierced in the tube by means of the blowpipe. The leaves were fashioned from thin, blown-glass tubes of cylinder-like shape. Two glass threads, representing the midrib of the leaf, were fused on this cylinder, one opposite the other, and the cylinder split lengthwise in the fine needle flame. In this manner two leaves were obtained from one cylinder. The irregular edges of these canoe-like shells were finished off and one end drawn out to a point, giving it a leaf-like appearance, while the other end was shaped to fit the main stem. The end which joins the stem was provided with a short peg to hold the leaf in position when it was inserted in the hole provided for it in the stem.

The *Spirogyra* filaments were comparatively simple and were made of glass tubes one quarter of an inch in diameter, varying in length from three feet to seven and one half feet. After they had been bent in the blowpipe flame to the right shape and proper curves, they were ready for coloring. The spiral green chlorophyll bands were painted on the tube, and at intervals a ring was painted to indicate the division walls between the successive cells.

Besides the water plants, the rotifers or wheel-animalculæ are conspicuous



A picturesque corner of the Rotifer Group, showing the bladderwort (*Utricularia*), *Anacharis*, and the fine filaments of pond scum (*Spirogyra*). These plants are the stage setting for the multitudinous animal life which, though now completed in glass, has not yet been inserted in the group. The skeleton of a dead leaf is shown at the bottom of the picture.



A ROTIFER INHABITANT OF THE HALF-INCH OF POND BOTTOM
Modeled in glass. This animal (*Notommata copeus*) is shown crawling along a filament of *Spirogyra*, boring a neat hole in each plant cell through which it pumps out the spiral chlorophyll upon which it feeds

in the group. In fact, the whole group centers around the rotifers, and for this reason it will be known as the Rotifer Group. Many species will be represented, some of them free-swimming, some creeping and sessile, others feeding on plants, with shapes of endless variety and beauty.

In describing the technique of constructing a rotifer model, *Notommata copeus* (page 230) is a good example. The pear-shaped body is blown and modeled from a glass tube to the required magnification, all appendages such as auricles, proboscis, foot, and antennæ, are welded on, and the outer contour of the animal completely finished. At the constriction of the neck, it is cut into two parts to permit the insertion of the internal organs. This cut has to be very clean and sharp, so that there will be no unsightly marks when the parts are cemented together again. Great care must be exercised when the cutting operation is performed, for a failure at this stage of the work will necessitate a reconstruction of one or more parts. The internal organs, consisting of the brain and its appendages, internal jaws, stomach, gastric glands, and ovaries, are shaped separately and then welded together in one piece, each in its proper position, so that there will be no danger of a part becoming displaced when the finished model is handled. After the internal organs are painted with permanent transparent oil colors, they are inserted in the body and cemented fast with Canada balsam. When the cement has set, the model is ready for adding the hairlike cilia.

The most tedious operation in the entire process is making and cementing these cilia on the rotifer models. In some species, the cilia are so numerous and closely set that it is impossible to

fuse them to the corona in even the finest flame of the blast lamp. In such cases, the cilia are formed from fine glass threads drawn out to almost hairlike thinness, curved in the flame, cut to the proper length, and cemented one by one to the model. The lengths of the cilia vary from one thirty-second to one quarter of an inch in the magnified models of the group.

Several species of the desmids, or microscopic algæ, will be represented in the group. They also show great diversity of ornamental form, cylindrical, denticulate, crenulate, and lobed.

To illustrate the process of making a model of this kind, let us take *Closterium* (page 232). This model, magnified 100 diameters, is two and one quarter inches long and three eighths of an inch wide and has the shape of a crescent moon. It was blown from a glass tube to a spindle-shaped form and the two tapering ends bent in the flame to give it the crescent shape. On one side, near the widest diameter, an opening was made for the insertion of the chlorophyll. This granular chlorophyll was imitated by making little beads from fine, green glass threads and fusing them together, so as to form large masses resembling shad roe. These masses were separated into smaller parts which were filled into the shell of the *Closterium*. The temporary opening of the latter was then closed and the model completed for outside coloring. For the larger specimen of *Closterium*, a core of clear glass was first inserted in the shell and a coating of beads cemented around it. The thin layer of green beads over the core gives the desired density and the effect of translucency.

The lower part of the group was modeled in plaster and wax, to imitate a muddy section of a pond bottom. A

partly decomposed leaf, a fragment of twig, and masses of pond sediment are all shown magnified till they give a strange, unfamiliar appearance. The leaf is made entirely of wax. After the microscopic drawing was made and enlarged to the right dimensions, sections of the leaf were modeled in plastilene and plaster molds made from these models. When the molds were hard, liquid wax was poured into them. This was removed from the molds when cool and the wax sections fused to form the complete leaf.

For the background of the group,

three plate-glass transparencies will be used. On the first glass nearly all the objects in the group, plants and animals, will be painted in detail to blend with the foreground. On the second glass fewer objects will be painted, somewhat fainter in color and less clearly defined, while the third will simply be sprayed a light green to give apparent density to the water.

With the exception of the transparencies on which the colorist is now working, the group is practically completed and will soon be ready for installation.



A single-celled microscopic plant (*Closterium*).—modeled in glass. This is one of the minute plants known as desmids, which are very abundant in pond water. The dark granular material is the green chlorophyll. At each tip of the crescent is a cluster of "dancing cells"

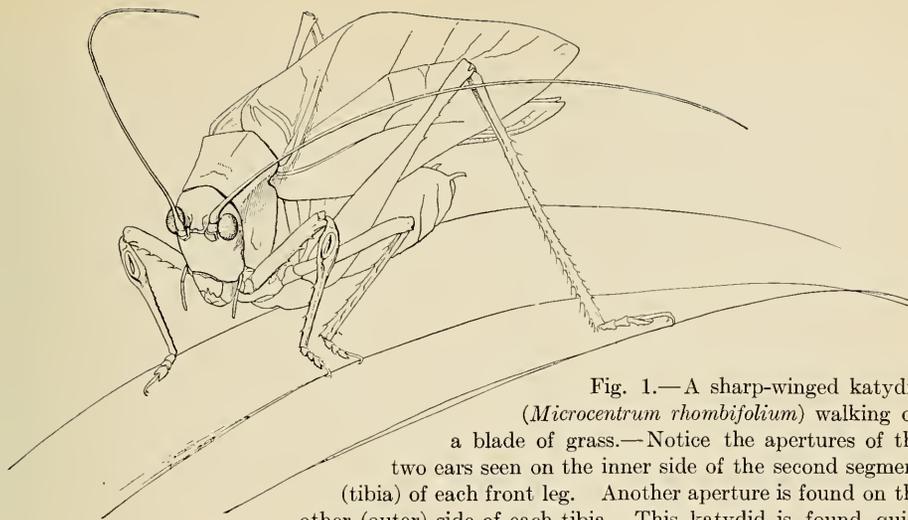


Fig. 1.—A sharp-winged katydid (*Microcentrum rhombifolium*) walking on a blade of grass.—Notice the apertures of the two ears seen on the inner side of the second segment (tibia) of each front leg. Another aperture is found on the other (outer) side of each tibia. This katydid is found quite commonly in August and September on shrubbery, vines, and hedges about suburban homes. In the evening it sounds its note, a sharp *tiic-tiic-tic-tic-tic-tic* at intervals and can be readily traced and captured by this sound. From a sketch by Bruce Horsfall

The Sense of Hearing in Invertebrate Animals

By ULRIC DAHLGREN

Professor of Biology, Princeton University; Director of the Mount Desert Island Biological Laboratory

WE humans are so accustomed to take our sense of hearing for granted, and this confidence is so supported by our knowledge that other highly organized vertebrate animals as the cat, horse, rat, etc., can also hear, that we seldom pause to consider the rest of the world of animal life in its relation to the atmospheric waves that are responsible for what we call sound.

Our sense of hearing, any sense of hearing, is a highly specialized modification of the sense of touch or perception of mechanical stimulation. In the higher vertebrates the sound waves are first collected and concentrated by a loud speaker or megaphone called the outer ear or pinna. These concentrated waves beat against a delicate stretched membrane called the eardrum or tympanum. This vibrates and its whole surface again concentrates

the motion against a chain of three tiny bones, the earbones, named incus, malleus, and stapes. These bones transmit the motion to part of a sac (the ventriculus) filled with fluid. The terminal end of this is elongated into a hollow projection known as the l agena. In the fishes, amphibians, reptiles, and birds, this l agena is straight or slightly curved, but in man and other mammals it has become elongated and compacted into a spiral form called the cochlea. On the inside of the cochlea, and running its entire length, is a strip of epithelium, modified into very sensitive nerve cells. These nerve cells are so delicate that they report to the brain even the slightest mechanical stimulus, so that we interpret it as sound. But even the sound waves in the fluid do not affect these nerve cells directly. First they must strike the wide surface of a delicate membrane

which, secreted by a neighboring row of cells, overlies the fine processes that arise from the nerve cells. The vibrations created in this tectorial membrane, are then transmitted to an organ which mechanically stimulates the ends of the nerve-cell processes and produces, probably through chemico-physiological means, a nerve impulse that travels to the brain and comes to our consciousness as sound or "hearing," a form of "touch."

A most interesting fact about the vertebrate organ of hearing, is that it seems modified through evolution from part of an organ found in lower invertebrates, which originally recorded the sense of balance. This simple sense organ contained one or more stony particles of lime, the otoliths, so adjusted that, through their movements, the animal apparently sensed the pull of gravity and reacted accordingly by modifying its position with reference to the earth's surface. This is called the "static" function and is still the most important function of the inner ear in the lowest vertebrates, the fishes. In higher vertebrates, another portion of the inner ear records, by means of the inertia of certain fluids, the relative positions of the body in successive periods of time. The first function is stasis by gravity, the second, stasis by inertia. Thus our hearing power is due to a modification of part of an organ which was first devoted solely to two other forms of "touch."

But the vertebrate animals, important as they seem to the average man because he himself is a vertebrate, are, from the standpoint of a broadly trained zoölogist, but a small part of the animal kingdom.

Dozens of other groups of animals are found in the seas and on the land, constructed on totally different plans,

as the mollusks, echinoderms, insects, crustaceans, worms, etc. In spite of the differences of structure, however, most of them, like the vertebrates, must eat, move, and fight, and for these activities they must possess senses that will serve to guide them in their life work. Among these senses, we think of them as possessing the power to hear. Do they? To most of them hearing would be of great value, for instance in enabling them to find their way, detect their enemies, seek their mates, and accomplish many other necessary operations.

A large number of them can see. Also many can smell or taste. Practically all possess the perception of mechanical stimuli which we call "touch." Is this sense of touch so equipped that it can register vibrations of the tiny air (and water) waves that produce what we call hearing?

As we experiment with them by carefully observing their reactions to various sounds, we are forced to conclude that most of them cannot hear a sound, or at least cannot distinguish between different tones (wave lengths) of sound. We vertebrates live in an otherwise deaf world! All the usefulness, all the beauty and importance of sound, are unavailable to more than nine tenths of the creatures about us. Many are blind. Many taste poorly. We wonder how they can live as a race under such handicaps. And yet it is under such conditions that life began, and under these same conditions most life still exists.

Naturalists have recognized these conditions and have eagerly sought to discover in the lower animals some structures connected with the nervous system that fulfill the requirements by which sight, taste (and smell), touch, equilibrium, and hearing may operate.

Eyes, olfactory organs, touch organs, and organs of equilibration are well known, but, only in a few cases, do sensory organs appear that can be distinguished as ears or sound-perceiving structures.

One index of the power, in any particular species of animal, to perceive sound, is the ability to make some kind of a noise. This does not always follow, but in many cases it does, and it is this clue that has pointed the way to the discovery in a few cases, of sound-perceiving organs in invertebrates.¹ Clicking, rasping, and other sounds have been noted in many animals.

If one goes out into the country on a still, warm August night, one becomes aware of a great volume of sound. There is no doubt that thousands of individuals of many kinds are engaged in making characteristic noises, and one wonders, "What is the purpose of all these sounds if not to be heard?" And they must fulfill their greatest purpose when heard by other individuals belonging to the same forms as do those that produce each characteristic sound. Observation and experiment show that the sounds are heard, and further study shows that, except for a few vertebrates, most of the sounds come from insects of one kind or another. Also the sounds are confined mainly to one group of insects, the Orthoptera, which includes the crickets, katydids, and grasshoppers among other insects.

Sound-making and hearing are thus localized, in the main, to two general groups of animals, the higher vertebrates and certain insects, to parts of only two phyla out of the twelve or more principal phyla of the animal kingdom. A few examples of sound

production are found among Crustacea (*Palinurus*) and some other forms, but no hearing has been noted. Further, hearing and sound-making are practically confined to air-living and air-breathing forms, although water makes an excellent medium for the trans-

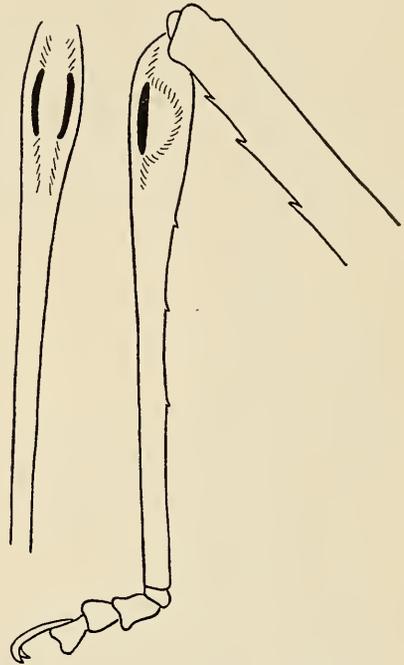


Fig. 2.—Front and side view of the tibia of another species of *Microcentrum*, showing the external appearance of the ear. The openings into the outer tympanal chambers are marked in solid black

mission of the sound waves, and the final fundamental act of sound perception takes place in fluid, a body fluid.

Let us examine a few insects and see what we can find. In certain tabanid fly larvæ, stringlike bands have been observed attached to nerve cells. A hearing function has been attributed to these bands. It has also been noted that the antenna of the male mosquito vibrates to certain tones of a tuning fork, and it is thought that this

¹See however Dr. F. E. Lutz's article entitled "Insect Sounds" Bull. Amer. Mus. Nat. Hist. Vol. L (1924), pp. 333-372.

appendage functions as a hearing organ. In the katydids, crickets, and grasshoppers, however, a very beautiful organ of hearing has been discovered, and since there is proof that it is capable of audition, we shall describe this structure in a katydid and explain how it operates.

There are many kinds of katydids besides our friend that sings on August evenings in the back-yard apple tree or the street elm. Some kinds sing only at night, while others sit singing out in the hottest sun, ceasing their song as night comes on. One of the commonest

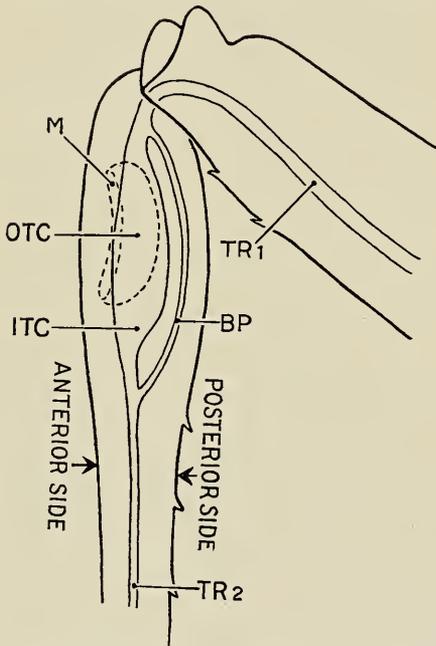


Fig. 3.—Outline drawing of the upper part of the tibia of the katydid, with a diagram of the course and form of the tracheal air passage passing through the ear. M indicates the mouth of the outer tympanal chamber, the extent of which is shown by a dotted line. TR₁ is the trachea above the ear and TR₂ the trachea below the ear. ITC is the expanded part of the trachea that forms the inner or true tympanal chamber, while BP indicates the by-pass or branch of the trachea that begins above the ear and joins the trachea again below the ear

of the day singers is a large green insect that lives in the vines, shrubs, and hedges of suburban homesteads in nearly all localities in our middle eastern states. His name is *Microcentrum rhombifolium* (Figure 1), and he is about an inch and a half long, not including the slender antennæ more than twice the length of his body, which mark him as a katydid as compared with the "short-horned" grasshoppers often seen in association with him. His voice is quite different from that of the evening singer of the trees, which asserts *katy-did* or *katy-didn't* so vehemently. It is a long *tiic-tiic-tic-tic-tic* sounded at intervals during the afternoon or evening, and he often may be traced and captured by this sound.

If we examine this creature under a magnifying glass as he walks about on the hand or clings to the finger, we will see that the upper end of that segment of his front leg called the tibia is enlarged, and that on each anterior edge of this swelling is a narrow crescentic slit, usually marked in brown (Figure 2). The swelling is the ears or organ of hearing. It is not located where we naturally would look for it, because we vertebrates have our ears in the head, and we egotistically decide that the ears of other creatures should be similarly situated. But here it is, in this insect's front leg, and it is not a makeshift ear evolved from a static organ, as is ours. It is a new structure developed directly to fill a need, by what evolutionary processes we can only guess.

If we raise the edge of either one of these slits, we can look into a cavity on the side of the enlarged portion of the tibia. We then see that this cavity is superficial and is covered by an anteriorly directed fold of the integument of the animal.

In order to understand the working of this ear, it is necessary for us to know something about how insects breathe. Insects breathe air through tubes called tracheæ that open inward from a number of holes (stigmata) in the side of the body. These tubes, by a process of branching, reach every part of the body. One main branch passes down inside of each leg to furnish air for the tissues. At the upper part of the swelling, this trachea branches into a large and a small division (Figure 3). Just below the swelling these two branches again unite to form a single trunk of the usual size. We must make some careful preparations before we can see, under the microscope, how the katydid's ear is constructed. The German scientist, Graber, only after developing great skill by long training of the hands, succeeded in dissecting out the organ with needles and tiny sharp-pointed knives and scissors. Our modern method, however, is to cut a series of fine sections, fix each on a glass slide, then stain and mount them serially. We can then study them at leisure and, if necessary, reconstruct the entire mechanism in three planes in wax. This latter is not required for our purposes, however, as we can understand the structure by examining one transverse section and one longitudinal section taken through the "ear."

In the plane of the transverse section

(Figure 4), we see that the larger division of the trachea (ITC) fills the entire middle portion of the leg. The side walls of the leg, excluding the two reflected flaps, are *extremely* thin,

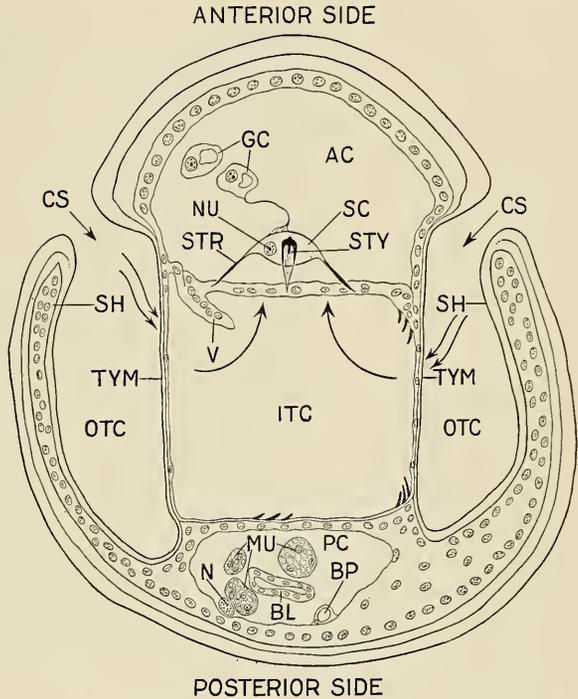


Fig. 4.—A transverse section of the ear. OTC indicates the outer tympanal chambers, ITC the inner tympanal chamber. TYM shows the location of the tympanum or drum, and SH the two shields used to protect the tympana. SC the sensory cell with its nucleus (NU), style (STY) and struts for supporting the cell (STR). GC are the secondary ganglion cells that relay the message to the brain. All these are in the anterior chamber. Below is seen the posterior chamber containing cross sections of muscle (MU), nerve (N), blood vessel (BL), and the tracheal by-pass (BP). The outer chitinous layer is composed of a harder outer part and a softer inner part. The ragged ends projecting from the walls into the inner tympanal chamber represent the displaced ends of the rings of chitin or tænidia that are used to support the walls just as wire is used to strengthen the walls of a length of rubber garden hose

although they retain the usual elements of insect integument, a single layer of cells with an outer chitinous cuticle. Pressed closely against these side walls of the leg are the side walls of the trachea (TYM). Since this trachea was formed by a "pushing in" or

invagination of the outer integument of the animal, its side walls are constructed in the same manner as the side walls of the leg,—an inner layer of cells with an outer cuticle, but these lie in an inverse position on account of the invagination, so that the layer of cells (hypodermis) of the side of the trachea now lies against the layer of cells (hypodermis) of the leg; both layers are so attenuated and so closely pressed together that they really form one layer of remarkable thinness and strength. This structure is called the tympanum or “drum” (TYM) and corresponds functionally with our own eardrum. But the ear in each leg of the katydid has two ear-drums while our ears each have only one.

Because its two side walls are attached so closely to the side walls of the leg, the large trachea or tympanic chamber (ITC) conforms to the more or less square shape of the leg. The other necessary contents of the leg lie either anterior or posterior to it. In the posterior area (PC) we find large muscle cells (MU), two or more nerves

(N), and some connective tissue and blood vessels (BL). All these lie in a body fluid which fills this channel-like division. The tissues (muscle, nerve, blood vessel, etc.), must be able to

pass the ear, because the operation of the whole lower leg depends on their presence and continuity. Also we find in this same posterior chamber a cross section of the smaller branch of the trachea (B P), the function of which is to carry air down into the leg, for two valves, an upper and a lower, cut off the passage of air through the swollen tympanic chamber when the ear is in operation.

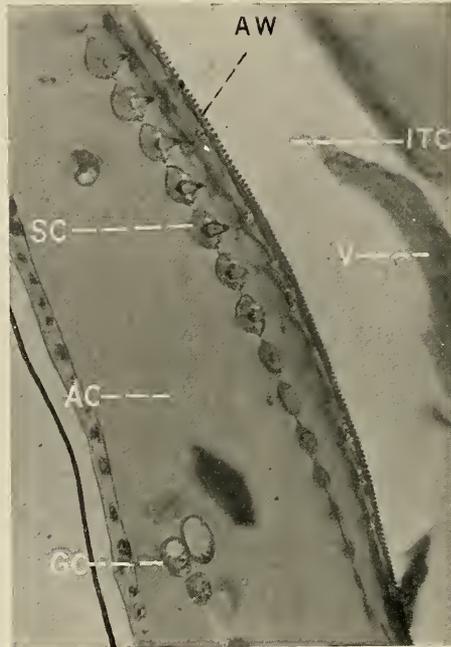


Fig. 5.—Photograph of a stained and mounted longitudinal (antero-posterior) section of the ear of a katydid (*Microcentrum*). Only a part of the anterior chamber (AC) and inner tympanic chamber (ITC) are shown. In the anterior chamber, laying in the animal's lymph fluid (stained dark gray) is seen the row of sensory cells (SC), largest at the top and growing smaller below, and a few of the secondary ganglion cells (GC) each of which contains a large vacuole. The outer chitin is missing from its epithelium but is indicated by an ink line. The anterior wall (AW) of the tympanic chamber shows fine serrations due to cross sections of the tænidia or supporting ridges which line it. A bit of one of the valves (V) is also shown in the tympanic chamber

Interesting as is the posterior chamber or passageway of the leg, the anterior chamber (AC) is more so, for here we find the nervous and principal mechanical apparatus of the ear.

In the cross section, at a favorable level, we find that this space like that in the posterior chamber, is filled with body fluid. Lying in this fluid at a fairly short distance from the anterior wall of the tympanic chamber, is a very large somewhat flattened nerve

cell (SC). Like all nerve cells, it has a nucleus (NU) which lies far to one side. Unlike nearly all other nerve cells, however, it possesses a remarkable structure of dark-staining nature and apparently chitinous substance called the style (STY). This style is very large, and its blunt end is embedded in the cell body, while its long tapering end reaches out of the cell and rests its tip upon the posterior wall of the tympanic chamber, where it is fastened among the hypodermal cells of that wall. The remarkable structure of this style is indicated in Figure 4.

Now we begin to have some inkling of the operation of this ear. The waves of sound in the air enter the two crescentic slits (CS) and beat upon the big wide thin tympana on each side from without. This motion is, of course, communicated to the air in the tympanic chamber (ITC), which is made to vibrate in turn and to beat upon the anterior and posterior walls of this same chamber from within. When it beats on the posterior surface, nothing happens, for on the other side there is nothing but blood, muscle, and nerve, and these cannot feel. But where it beats on the anterior wall, it strikes on the tip of the style (STY) which is imbedded in the nerve cell. This action starts up processes in the nerve cell, which send a message to the brain. This we call "hearing," just as when our tectorial membrane rattles against the little "bristles" projecting from the nerve cells in our inner ear.

And we find a further refinement of the process. When the surface of the tympanic chamber beats on the end of the style, its tendency is to move the whole nerve cell. This of course would tend to lessen the effect of the mechanical reaction between the nerve cell and the end of the style which is imbedded

in it. Hence a mechanism is required by means of which the nerve cell may be held firmly, independently of the style, and thus bring about an improved mechanical reaction between style and nerve cell, and, in consequence, a better stimulation of the processes (probably chemical) that result in hearing impulses.

Such a condition actually is found in our specimen. A straight, firm, thin brace (STR) of some hard material, probably chitin, extends at an angle from each of the lateral ends of the flattened nerve cell. Its other end is



Fig. 6. Leg of cricket showing ear. From model in Insect Hall of the Museum

fastened in the tissues where the anterior wall of the tympanic chamber joins the outer wall of the leg. A glance at the diagram will show the mechanical relationship of the braces to the cell, style, and anterior wall of the tympanic chamber. It undoubtedly holds the cell quite firmly, so that the vibrations of the anterior wall of the tympanic chamber and the consequent mechanical movements of the style give the greatest possible reaction between style and nerve cell.

If now we cut another section of the ear in a plane that passes longitudinally through it in an antero-posterior direction, through the middle of the style in the nerve cell, we find the interesting fact that there is actually a whole row of these cells extending lengthwise on the median line of the tympanic cavity. Figure 5 is a photograph of an actual section of this kind, showing the line of cells (SC). Since the section discloses but a single plane, we can see in some instances only the nucleus in a nerve cell, and in other instances only the style, or sometimes both if the section is thick enough. There is another interesting fact shown by this view. The nerve cells and their styles are much larger at one end of the row (upper) than at the lower. It has been suggested that the larger cells "hear" only lower sounds or longer wave lengths, and vice versa, the shorter ones the higher sounds.

Let us attempt to trace this sound path from the nerve cells toward the brain. The nerve fibers that come off, one from each auditory nerve cell, do not run directly to the brain. In no ear do they do this, not even in the vertebrates. It seems necessary, for some reason we have not fathomed, for the message to be relayed through another nerve cell that lies fairly close

to the auditory cell. Such secondary nerve cells are called "auditory ganglion cells," and, while in man they lie in the core of the cochlea, in the katydid they form a loosely arranged row in the extreme anterior corner of the anterior space of the leg, as shown in the cross-section (Figure 4, GC). Their arrangement is still better shown in the longitudinal section (Figure 5). They are large, and the efferent fiber from each auditory sensory cell joins the afferent fiber of one of these auditory ganglion cells. The nerve pathway is completed by the efferent fiber of each of the ganglion cells forming a member of the small nerve which conveys the sound impulse to the brain. These fibers do not show completely in the sections, as they pass out of the planes in which they are cut. The ears of all katydids and crickets are built on this plan, with interesting but minor variations. For example, in the crickets (Figure 6) there are no overhanging folds to protect the delicate tympana. These are silvery-gray in color and stand out boldly against the black integument.

The grasshoppers have ears built somewhat on the same plan. But instead of being carried on the leg, they are on the side of the body, where the large unprotected tympanum is plainly visible.

An excellent study in connection with these insects, is to follow them up in the evening (or daytime, in some cases), and learn to recognize the characteristic and widely different notes or sounds made by the different species, from the song of the katydid of well-known fame to the singing, whirring, clicking, whistling sounds made by the various grass-katydids, tree-crickets, and true crickets. In this way we learn to regard them as interesting friends instead of merely stupid "bugs."

Animals of the Seashore

AS ILLUSTRATED BY INVERTEBRATE GROUPS IN THE DARWIN HALL
OF THE AMERICAN MUSEUM

These exhibits, prepared in the Museum laboratories, faithfully depict typical sea-animal and plant communities as they actually exist in the shallow waters of the New England coast

By ROY WALDO MINER



THE HORSESHOE CRAB (*LIMULUS POLYPHEMUS*)

This remarkable crustacean is common on sandy, muddy, and rocky bottoms along our shores. It is practically a "living fossil," for the fossilized remains of its ancestors are found imbedded in rocks, the earliest of which date back to Middle Cambrian times, at least 70,000,000 years ago. In spite of its name, it is not a true crab, but is more nearly related to the stock from which the spiders and scorpions have descended. This photograph is a detail from the Gay Head Sound Bottom Group, shown on the following page



ANIMALS AND PLANTS OF A SOUND BOTTOM

An accurate reproduction of a portion of the sea bottom in Vineyard Sound, off the coast of Marthas Vineyard Island, Massachusetts. Here the sea has undermined the clay cliffs at Gay Head, washing out huge granite boulders, which have rolled into the sea to form a reef known as the Devil's Bridge, the scene of many wrecks. On the sandy sea bottom lobsters lurk in the crevices between the boulders, while crabs, shrimp, and other crustaceans are abundant. The rocks are luxuriantly overgrown with seaweeds, among which the Irish moss (*Chondrus crispus*), is conspicuous, while here and there are visible spreading colonies of the northern star coral (*Astrangia danaë*) and of rose-pink soft coral (*Acyonium digitatum*)



THE SARGASSUM WEED (*SARGASSUM BACCIFERUM*)

This seaweed, famous as forming the bulk of the vegetation of the Sargasso Sea, is also found attached to submerged bowlders as far north as Vineyard Sound. Its narrow, tapering leaflets are buoyed upward toward the sunlight by hundreds of berry-shaped floats about the size of a pea. As shown in the group this weed is delicately modeled in glass



THE STRUGGLE FOR EXISTENCE AT THE SEA BOTTOM

An unwary lady crab (*Ovalipes ocellatus*) has ventured out of the sand, where it usually lies buried up to its projecting eyes and feelers, and is immediately pounced upon by a lurking lobster. The crab frantically endeavors to escape by vigorously paddling its oar-shaped hind limbs.

The above photographs are details from the Gay Head Sound Bottom Group, illustrated on the opposite page



A TYPICAL ROCK TIDE POOL ON THE

An accurate reproduction of the famous Bridge Pool at Nahant, Massachusetts, situated at the base of a sixty-foot cliff bounding the shore of Eastern Point. Here the tide rises and falls a vertical distance of nine feet. At low water a natural bridge is disclosed, spanning a tidal basin twenty feet in length, within the quiet waters of which a wonderful display of marine animals and plants is visible. The arch itself is covered with thousands of barnacles (*Balanus balanoides*) reaching to the high-tide mark



WORTH SHORE OF NEW ENGLAND

Below the barnacle zone the rocks are draped with rockweed, the fronds of which conceal clustering groups of purple snails (*Thais papillus*). The rocks within the pool are gay with varicolored sea anemones (*Metridium marginatum*), sea stars (*Asterias vulgaris*), pink-hearted hydroids, finger sponges, and ascidians, while the velvety brown kelp, green sea lettuce, and red dulse float out over boulders covered with brilliantly iridescent Irish moss, pink coralline, and mottled patches of calcareous algae.



A PUGILISTIC ENCOUNTER BETWEEN CRABS

A detail from the Tide Pool Group.—The green crab (*Carcinides manas*) is one of the most active and pugnacious of the inhabitants of the tide pools. Beneath an overhanging ledge the claws of the more peaceful Jonah crab (*Cancer borealis*) may be dimly seen. In the foreground a blue sea star (*Asterias vulgaris*) clings to the rock surface near a group of green sea urchins (*Strongylocentrotus droehbachiensis*), the latter almost too insignificant to merit their long scientific name



A PICTURESQUE CORNER OF THE TIDE POOL

A colony of sea anemones (*Metridium marginatum*), is clustered together on a rocky shelf. At the right, one or two anemones, sheltered beneath the floating rockweed, have ventured to expand their fluffy circlelets of tentacles. Though of flower-like beauty in color and form, they are nevertheless voracious creatures, armed not only with the tentacles but also with sting cells, with which they slay and capture small creatures and even fishes which form their food. A number of the anemones have contracted, withdrawing mouth and tentacles within their bodies



DETAILS OF THE BRYOZOA GROUP

Here are shown, greatly magnified, the minute animals found growing over seaweeds, dead shell-fragments, and pebbles, in an area of only two inches of sea bottom. To the left are the star-shaped colonies of an ascidian (*Beryllus gracilis*), which forms jelly-like masses in the eelgrass. Newly hatched larvae swim out from the central chamber of the colony. These are tadpole-shaped and of comparatively advanced structure. They are seen settling down in the eelgrass to pass through the globular initial stage of metamorphosis into the more lowly adult condition. Above to the right, is a colony of moss-animals or bryozoa (*Bowerbankia gracilis*), while below them are shown flower-like individuals of another species (*Schizoporella unicornis*). Associated with these latter are club-shaped hydroids (*Corymbis agassizii*), from the sides of which expand balloon-like buds which will later develop into tiny, free-swimming jellyfish.



A TREELIKE COLONY OF BRYOZOA

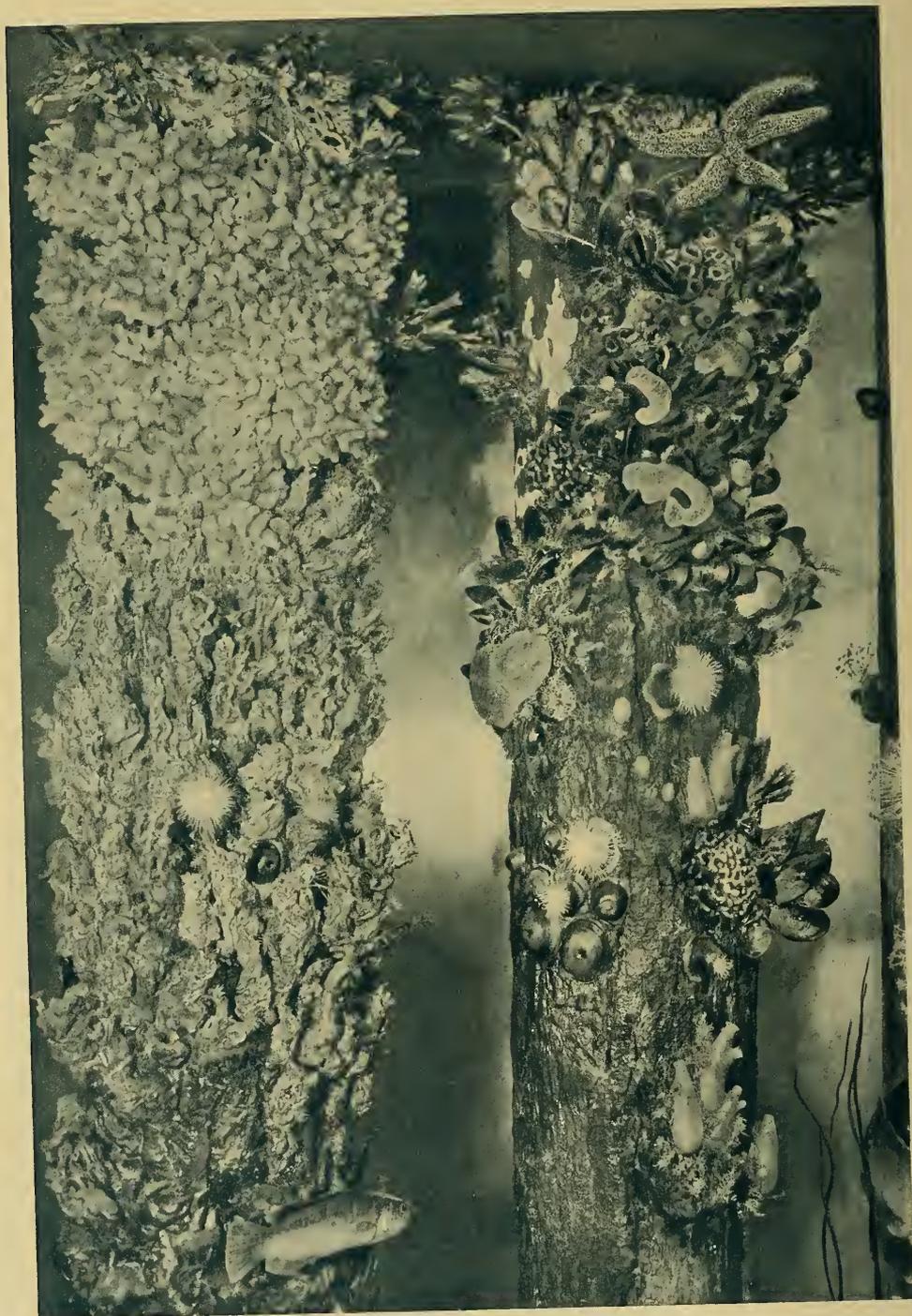
One of the most beautiful species (*Bryozoa bicornis*), the individuals of which construct transparent "houses," attached to one another in a double row to form what appear to be the branches of a spiral tree. The whole colony may be no larger than a ten cent piece. A small portion of the growth is here shown, with the bryozoan animals peeping out of their houses like lilies from miniature glass vases



A TUBE-BUILDING WORM

This beautiful worm (*Hydroides dianthus*), is crowned with a gayly colored circle of breathing-plumes. It builds a coiled calcareous tube on dead shells. This is a detail of the Bryozoa Group, which represents two square inches of sea bottom magnified to cover a space five feet in diameter. The magnifying glass shows the group as a whole





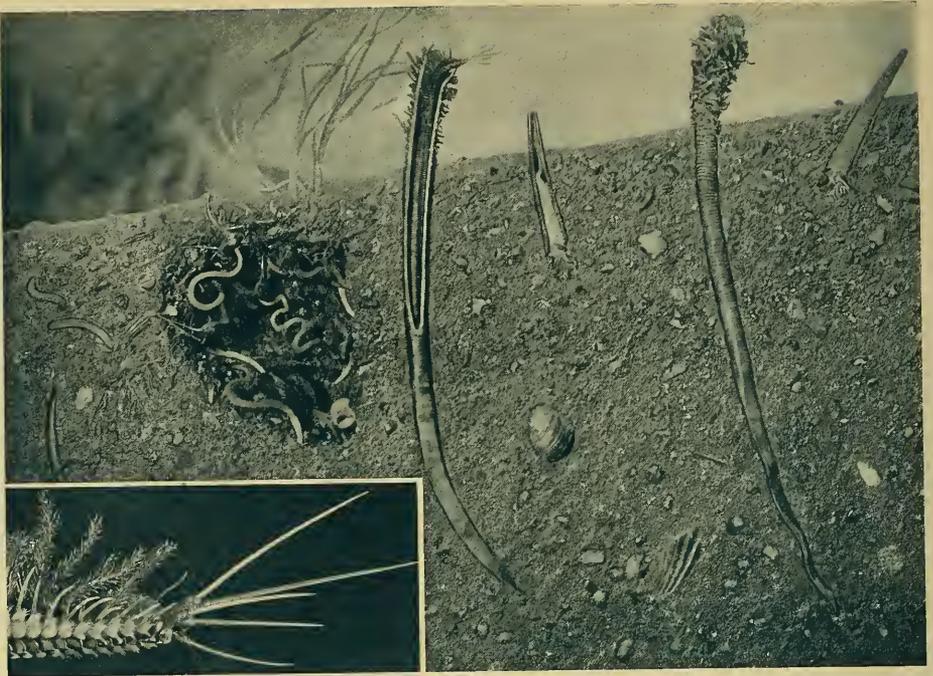
ANIMALS OF THE WHARF PILES

The piles of abandoned wharves are often completely covered with luxuriant growths of sea-animal colonies which here find a convenient vantage ground for securing their food. The sea water abounds in microscopic creatures, which are filtered out of it by the pile-dwellers, as it is pumped through their small bodies



THE BROKEN WHARF PILE

Another detail of the Wharf Pile Group. The broken pile has become completely capped with edible mussels (*Mytilus edulis*), which in turn are overgrown with feathery colonies of pink-hearted hydroids (*Tabularia crocea*). Near by swims a jellyfish (*Dactylometra quinquecirra*)



Burrowing Sea Worms.—A detail from the Sea Worm Group, showing the burrows of the plumed worm (*Diopatra cupræa*), and the trumpet-shaped shells of the trumpet worm (*Pectinaria belgica*). The head and shoulders of the plumed worm are shown in the insert, displaying the plumelike gills which give it its name. The trumpet worm constructs a tube of sand grains. Above to the left is a colony of acorn "worms" (*Balanoglossus kowalewskii*)



Animals of a Sand Spit.—The sand spit at Cold Spring Harbor, Long Island, is completely overgrown with ribbed mussels (*Modiola plicatula*), between which fiddler crabs (*Uca pugilator*) have dug their burrows. The Mollusk Group in the Darwin Hall shows this association, including a bit of the sea bottom at low tide where a starfish is engaged in opening an oyster

An Instance Where Evolution Has Turned Backward

THE ASCIDIANS, DEGENERATE RELATIVES OF THE VERTEBRATES

By WILLARD G. VAN NAME

Assistant Curator, Department of Lower Invertebrates, American Museum

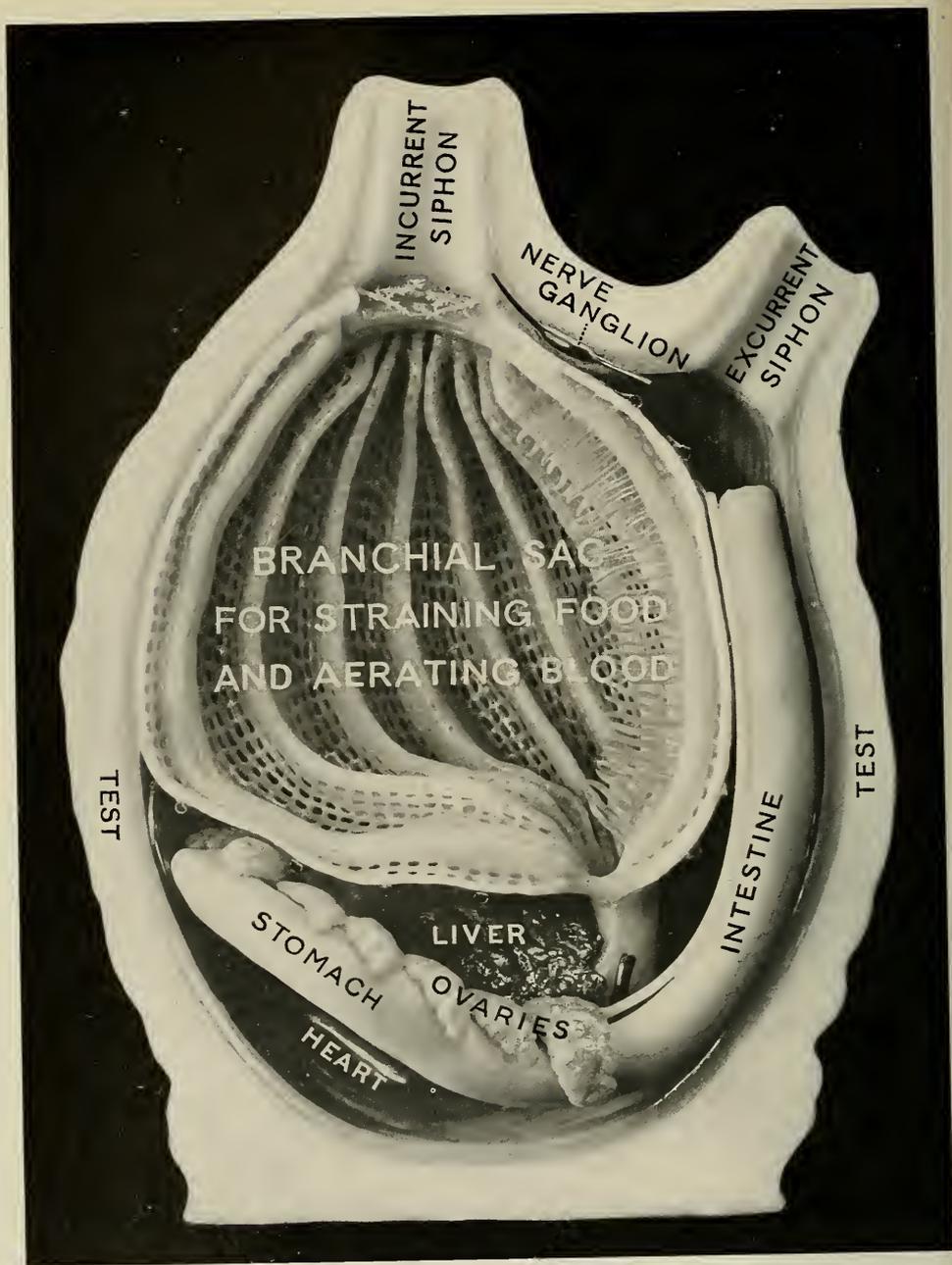
WE generally think of evolution as a process of advancement and of development from simple to complex forms of life,—as the elaboration of creatures of the kind we describe as higher from those we call lower, but there are also cases, though they are much less numerous, where the process has been apparently a backward one, and lower and simpler animals have been derived from higher and more complex ancestors.

In animals leading a parasitic life upon or within the body of some other animal and obtaining their nourishment at the expense of their host, such backward evolution is very common, because the disuse of many of the parts and organs of the body incidental to such an existence is accompanied by their gradual degeneration and loss, until the creature would be unable to exist in any other way than as a parasite.

There are, however, some cases of retrograde evolution in which parasitism is not a factor. Among the common marine animals, for instance, there are two striking examples of this kind, the barnacles, which are descendants of shrimplike crustaceans able to swim about freely, and the ascidians. The ascidians are regarded as having descended from the same ancestors as the vertebrates, but as having gone backward in their evolution instead of having advanced, although, among all the great variety

of forms of animal life that are to be found in favorable situations along the seashore, growing or clinging to the rocks or other objects uncovered at low tide, there are few that at first sight show so little relationship to any of the higher animals.

The ascidians, like the barnacles, permanently attach themselves to rocks, shells, the piles of wharves, and other objects under water, and live upon the minute organisms that the waves and tides carry to them. The typical ascidians are saclike objects of oval or irregular form, usually from half an inch to a couple of inches in diameter, rarely much more, and are covered with a more or less tough though somewhat flexible outer tunic called the test, which protects the delicate internal parts as does the shell of a mollusk. By the older naturalists the ascidians were in fact classed as soft-shelled mollusks. The test not only serves to protect the body from injuries, but also to fix it in place, since it attaches itself firmly to solid objects, or, if the animal lies buried in the sand or mud of the sea bottom, as many species do, it often develops hairlike or rootlike extensions to anchor the body in place. It entirely encloses the body except for two small openings which are commonly situated at the tips of conical protuberances or short projecting tubes. One of these, the mouth or incurrent siphon, is the entrance to the body. Through it



INTERNAL ANATOMY OF THE ADULT ASCIDIAN OR SEA SQUIRT

The upper incurrent siphon brings the stream of sea water into the large pharynx or branchial sac through the meshes of which the water is strained to pass out of the excurrent siphon, leaving behind it the minute organisms which form the ascidians' food. The latter are then passed into the stomach and intestine and digested. Blood vessels in the walls of the branchial sac absorb the oxygen from the water.

It is not in this simple and degenerate adult state but in the early or larval stages of its development that the relationships of the ascidians to the vertebrates are apparent.

passes a continuous current of sea water bearing the minute organisms on which the creature feeds, as well as the oxygen utilized in respiration. The other, called the excurrent siphon, allows this water, as well as the waste products of the body, to pass out, and also serves for the escape of the eggs or young.

The ascidians have very poorly developed organs of sense, but when the animal is touched or otherwise alarmed by any sudden movement of the water, its muscles contract, and the water contained in the body is forced out through these apertures in small jets, hence the name "sea squirts."

If we cut one of these animals open, we find that the tough external test is lined with a layer containing muscles and blood vessels, while the remainder of the body is largely hollow, the internal organs being of small bulk compared to the space in which they lie. An exception to this is a very large, though delicate, membranous sac lying rather loosely in the cavity of the body, but so attached to the inner side of the body wall at its front end that the mouth opens directly into it. Its walls are pierced with such vast numbers of minute clefts that it is in fact a net or sieve. This is known as the gill sac or branchial sac. It serves not only for respiration (its walls being full of blood vessels) but also for straining out the minute organisms which form the food supply of the ascidian. As the water taken in at the mouth passes through the minute clefts, called stigmata, into the outer cavity, and then out through the excurrent siphon, it leaves the food within the gill sac, which opens at its rear end into the stomach and intestine.

Now if the reader will pardon the introduction of these anatomical details

and think for a moment about the significance of them, it will be seen that this is really the way a *fish* breathes.

The fish also takes in the water through its mouth; the water passes into the cavity of the throat, or pharynx (corresponding to the gill sac of the ascidian), and from there it passes through gill clefts in the sides of the pharynx (corresponding to the stigmata in the ascidian). The walls of these clefts bear the true gills or structures containing the blood vessels by which the oxygen in the water is absorbed, just as it is by the blood vessels in the walls of the gill sac of the ascidian. Even in their feeding, many fishes, as the herrings, which live on minute swimming organisms, use a method similar to that of the ascidian, the gill apparatus straining the food from the water as it passes out through the gill clefts.

Here in spite of the low, simple organization of the ascidians, we have a distinct point of resemblance to the fishes, members of the vertebrate group, the highest primary division of the animal kingdom, of which man himself is a member. The possession of these structures by the ascidians might not be significant if we found them in other invertebrates, but when we consider that, in all the vast and infinitely varied assemblage of invertebrate animals of the land and sea, we find the above correspondence to the vertebrate type only in the ascidians and a very few forms evidently closely related to them, its importance becomes obvious.

If we study only the *adult* ascidian we find little else to suggest relationship to the vertebrates, and many things that seem to argue against it. One of these may be mentioned because of its strangeness. This is that the

heart of the ascidians, after beating for a number of seconds in one direction, stops and reverses its action, so that the vessels which at one moment function as veins leading blood to the heart, the next moment function as arteries carrying blood from the heart.



Typical ascidians (*Ciona sociabilis*) attached to a wharf pile. A stream of sea water enters and leaves the creature's saclike body, by means of the apertures on the ends of the siphons. When the young ascidian has once attached itself, it remains permanently fixed, depending for its nourishment on the small organisms and other food carried in the water

This remarkable process, which can be watched easily through the microscope in some small and transparent species of ascidians, certainly does not argue for relationship to the vertebrates, but on the other hand it does not indicate relationship to the other invertebrates either, for it is quite unique.

As soon, however, as we study the life history of the ascidians, we find very strong evidence, first, that the ascidians are degenerate animals which have had ancestors more highly organized than themselves, and second, that

these ancestors had the general type of structure that is possessed by the vertebrates and by the vertebrates only. Each additional point of similarity makes it less probable that we are dealing with mere coincidences and confirms more strongly the conclusion that a real relationship exists, due to descent from common ancestors.

No species of animal or plant can survive the vicissitudes and changes that occur around it if its individuals remain fixed in one place throughout their life span. Sooner or later failure of food supply or other unfavorable changes will destroy it, and if nature fails to provide a means of dispersing its offspring into other localities, where some may survive, the species becomes extinct. Plants, for instance, (even the largest trees) produce small seeds easily blown about by the wind, floated by water, or carried by birds or animals to establish the species in new localities; animals such as the oyster, the barnacle, and the ascidian, that in the adult stage are permanently attached to some object, usually pass through a free-swimming larval stage immediately after hatching. This larval stage is, as a rule, quite different from that of the adult. In the ascidians the larvæ have a form and appearance very similar to the larval stage or tadpole of the frog, though of comparatively minute size, the largest being only a few millimeters long. The larvæ of the ascidians were known to zoölogists in the first half of the last century, but the resemblance to tadpoles was then regarded as only accidental and more or less superficial. At that period, when the theory prevailed that each species of animal and plant was the result of a special act of creation by God, such resemblances did not have the importance that they

acquired when the publication of Darwin's *Origin of Species* in 1859 raised the theory of evolution into prominence, and gave them significance as possible indications of lines of descent.

A very few years after that date (in 1866) the Russian naturalist Kowalevsky created a sensation among zoölogists by publishing an article in which he described in detail the ascidian larva, and demonstrated clearly several remarkable points of resemblance to the vertebrates both in structure and development. He also called attention to the bearing of this on the question of the origin and descent of the vertebrates, which he hinted might be derived from the larval stage of the ascidian, if it were able to reproduce in that stage, as some animals are known to do. Kowalevsky's admirably illustrated article, though of no great length, remains to this day one of the classics of zoölogical literature, and most of his observations and conclusions have stood the test of time and later investigations.

Though there is room for important difference of opinion with regard to certain points, few zoölogists now question the comparatively near relationship of the ascidians and vertebrates. Coming at a time when Darwin's views were still the subject of the keenest debate, and many zoölogists of distinction, particularly some of the older ones, were still opposing the new theory, Kowalevsky's clear and convincing account of his surprising discoveries was an important factor in attaining the remarkably prompt acceptance that the theory of evolution secured among the scientific men of that period.

The main characters of structure and development on which these conclusions were based, needs to be made

clear, even though a few more anatomical details must be given to do this.

The first of these is that the tadpole-like larval ascidian possesses, just as



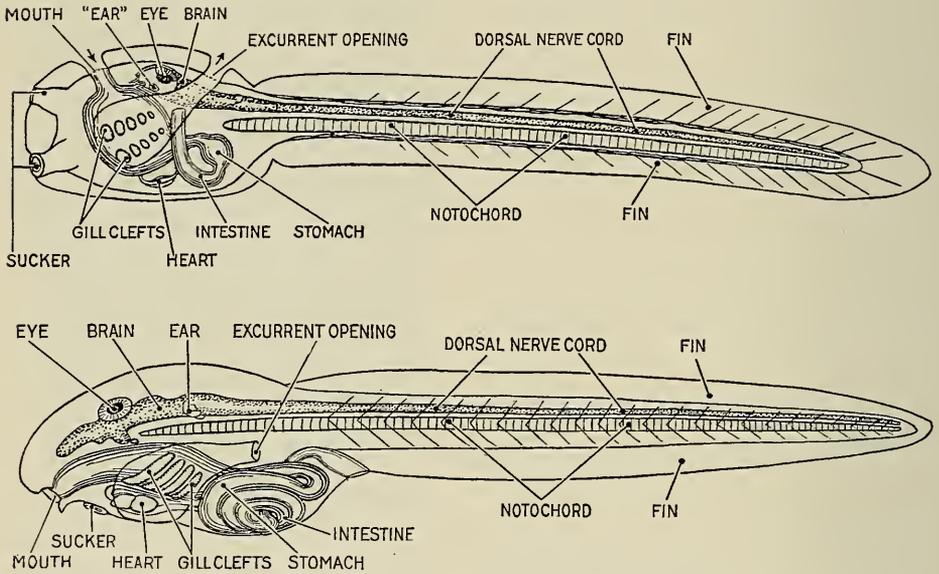
Another species of ascidian (*Molgula manhattensis*) growing in masses on a wharf pile. Many of the individuals have the siphon apertures open. This species is popularly known as the sea grape, a name suggested by the clustered mass of individuals

does the tadpole of the frog, a cylindrical rodlike stiffening or supporting structure extending nearly the length of the body. This structure, called the notochord, represents in position and in function the backbone of the vertebrates. It is found in the early stages of development of all vertebrates, including man, and, in the higher vertebrates, the bony segments or vertebræ forming the backbone or spinal column develop around it. In many of the lower vertebrates it persists throughout life, running through the center of body of each vertebra. Here again we have a character not found among invertebrates, but common to the vertebrates and ascidians. Moreover, if we study the process of its development in the early stages of the embryo, we find it to be the same in these two groups.

Another important character common to the vertebrates and the ascidian larva is the possession of a central nervous system of elongate tubular form lying dorsal to the notochord. In the vertebrates this is called the spinal cord, and both in the ascidians and in the vertebrates it develops in the embryo in the same way, by a pair of

the back or dorsal region as in the vertebrates.

The mode of respiration by means of gill clefts in the wall of the pharynx, the notochord, representing the first step toward the development of a backbone, the dorsally situated and tubular central nervous system or spinal cord, all separate the ascidian larva from in-



Comparative diagrams of the tadpoles or larval stage of an ascidian (upper figure), and of a frog (lower figure), to show their correspondence in many points of structure, especially in having gill clefts in the walls of the pharynx or throat, and a rodlike notochord corresponding to the backbone in the higher animals, above which is the main part of the nervous system, corresponding to the brain and spinal cord

folks growing up on each side of the middle line of the back to form a troughlike area. The edges of this trough soon arch inward and join together, thus forming a tubular passage which becomes the central canal of the spinal cord. Here again we find that this character is not possessed by invertebrates. In them the usual type of central nervous system is a pair of parallel nerve cords which are solid, not tubular, and which usually lie in the ventral part of the body, and not in

vertebrates and ally it to the vertebrates. There are several other structures regarded by many as confirming this relationship, but space will not permit of their discussion here.

All these resemblances are for the most part recognizable only in the larva of the ascidian, being lost or obscured in the adult by degenerative changes that begin to take place after the larva permanently attaches itself. This it does after swimming about for a few hours or at most a day or two. It

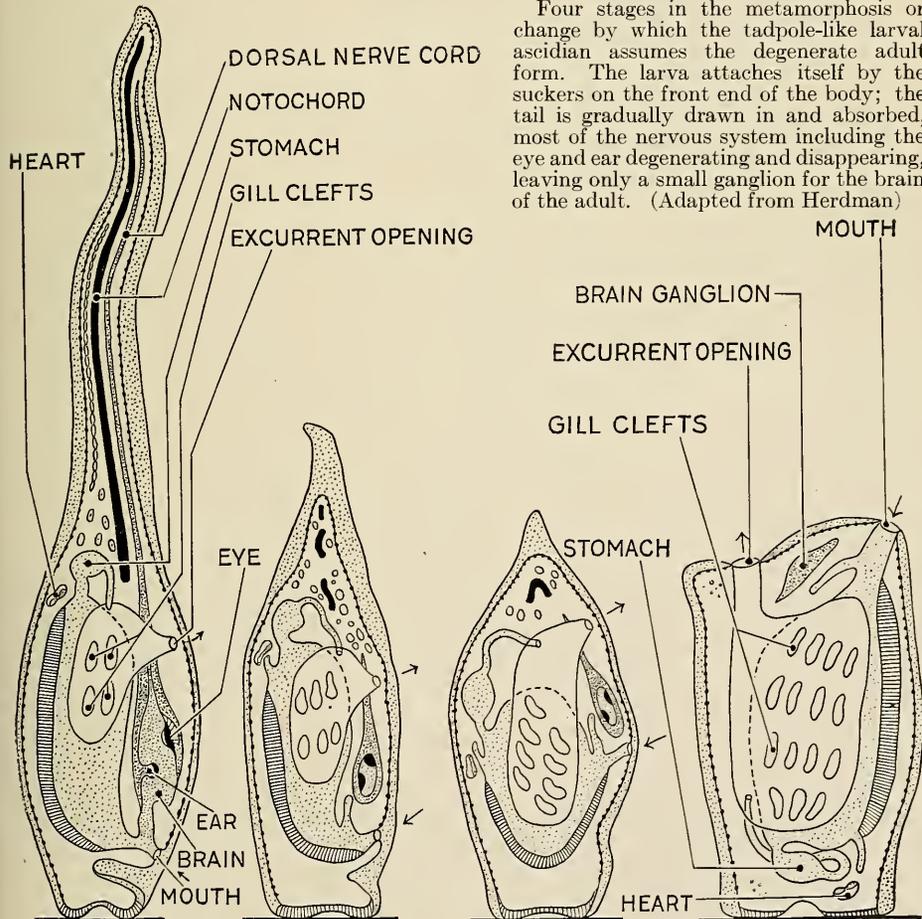
fixes itself to some solid object by means of adhesive organs developed for that purpose on the front end of the body, and the tail is soon drawn in and absorbed. The notochord and most of the nervous system degenerate, as do also the single eye and an organ supposed to serve either for hearing or for balancing the body. The animal grows in size and relapses into the almost mechanical and vegetative existence characteristic of the adult ascidian.

We should not leave the subject of the ascidians without mention of one other important character which seems at first sight to separate them from the

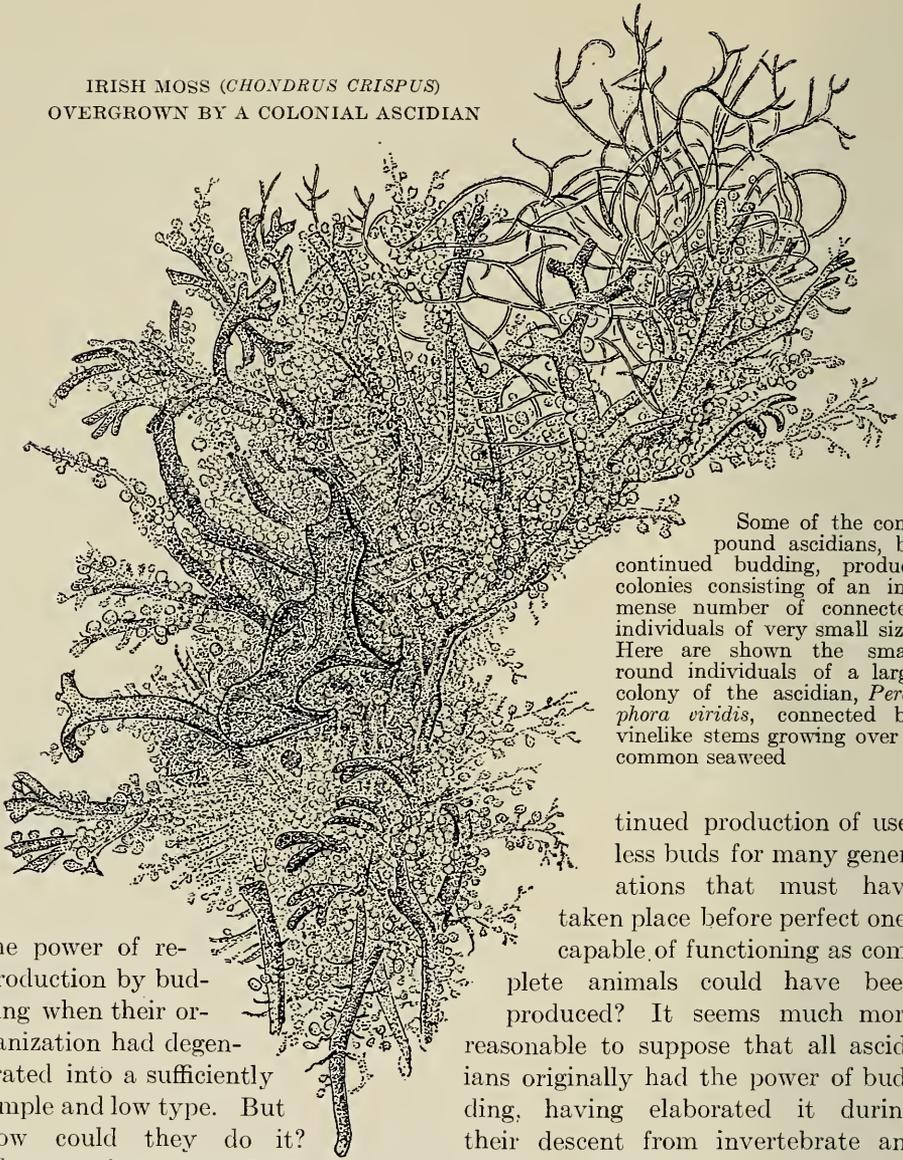
vertebrates and to connect them with the lower forms of animal life. This is that many of them (distinguished as *compound ascidians*), in addition to laying eggs developing into the tadpole-like larvæ, can reproduce their kind by a process of budding, that is by direct outgrowth of a new individual from the body of the parent, just as a plant buds out branches, leaves, or flowers. It is easy to see that very complex vital and mechanical processes are involved in this, and it is not surprising that it is found only in the smaller and more simply organized animals. It is commonly assumed that the compound ascidians "acquired"

METAMORPHOSIS OF AN ASCIDIAN

Four stages in the metamorphosis or change by which the tadpole-like larval ascidian assumes the degenerate adult form. The larva attaches itself by the suckers on the front end of the body; the tail is gradually drawn in and absorbed, most of the nervous system including the eye and ear degenerating and disappearing, leaving only a small ganglion for the brain of the adult. (Adapted from Herdman)



IRISH MOSS (*CHONDRUS CRISPUS*)
OVERGROWN BY A COLONIAL ASCIDIAN



Some of the compound ascidians, by continued budding, produce colonies consisting of an immense number of connected individuals of very small size. Here are shown the small round individuals of a large colony of the ascidian, *Pero-phora viridis*, connected by vinelike stems growing over a common seaweed

the power of reproduction by budding when their organization had degenerated into a sufficiently simple and low type. But how could they do it? There are immense difficulties in the way of explaining how they could acquire such a wonderful power as to bud out a new individual like themselves and capable of the functions of life, especially *while their own race was degenerating*. We cannot assume that the power of producing these buds was acquired otherwise than by a gradual evolutionary process, and if so, what caused the con-

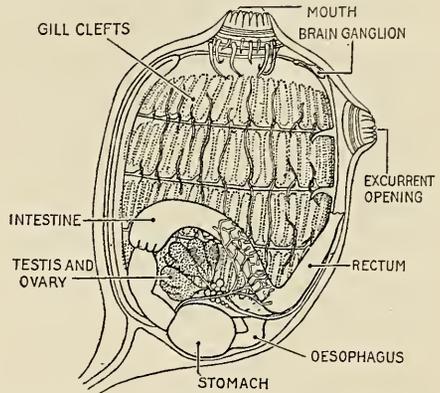
tinued production of useless buds for many generations that must have taken place before perfect ones capable of functioning as complete animals could have been produced? It seems much more reasonable to suppose that all ascidians originally had the power of budding, having elaborated it during their descent from invertebrate ancestors so simple that budding was merely a process of growth, and that some of the ascidians lost that power, did as the vertebrate branch, which has descended from the same ancestry.

If we accept the relationship of the ascidians and vertebrates as an established fact, and it seems we can hardly refuse to do so, the question arises, when did the two branches separate? This cannot be answered definitely.

No fossils have been discovered that can be recognized as ascidians, nor is there much expectation that any will be found, since soft-bodied creatures without bones, teeth, or other hard parts, are preserved as fossils only in exceptional instances. We may feel sure, however, that the separation occurred at a geological period very remote, perhaps even in pre-Cambrian time. Among many indications of the great antiquity of the separation is the fact that the ascidian larva lacks the paired eyes which are a conspicuous and universal character of the vertebrates. It lacks also all trace of the two pairs of limbs, which, whether modified into fins, legs, or wings, are found in nearly all higher types. Such important and fundamental characters as these must have evolved entirely subsequent to the separation of the ascidians and vertebrates. Just what the common ancestors of the two groups were like at that remote time we do not know, but we can safely assert that they had the gill clefts in the wall of the pharynx, the notochord, and the dorsally situated central nervous system of tubular form.

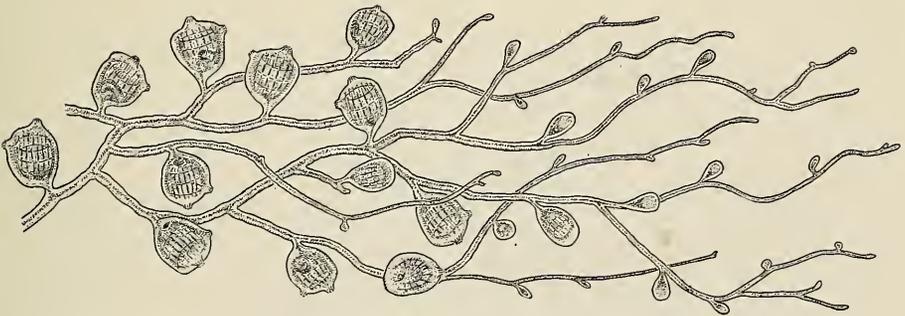
In the whole animal kingdom there

is no stranger contrast than is shown by the subsequent history of these two groups, endowed at the start with the same physical structure. The vertebrates were destined to make con-



An individual, enlarged eighteen times, from the colony of compound ascidians shown on the opposite page. Such individuals develop from buds formed on the branching stems of the colony, as shown below

tinued progress, advancing beyond any other group and culminating in the evolution of man. The ascidians have sunk into insignificance and a state of apparent degeneracy out of which there appears no prospect of their ever rising.



A detail of the compound ascidian colony figured on the opposite page, showing more clearly the branching stems which produce the buds that grow into the individual ascidians. These remain permanently attached to the stems throughout their life



A SUBMARINE CORAL FOREST ON THE ANDROS REEF

Treelike growths (*Acropora palmata*). These massive coral formations are constructed by millions of minute polyps. The under side of the water surface shows at the top of the picture



Typical coral polyps (*Astrangia danaë*). This is the only species found as far north on our coast as Cape Cod, Massachusetts. Through the transparent body, the internal structures are visible

The Reef Builders of the Tropic Seas¹

BY ROY WALDO MINER

Curator of Lower Invertebrates, American Museum

THE Island of Andros in the Bahamas extends for a distance of about 130 miles opposite the coast of Florida. Its eastern shore is bounded by a long line of coral reefs parallel to the coast at a distance of about one to two miles for its entire extent. The lagoon thus enclosed between the reef and the shore is navigable for vessels of moderate draft, while the inner side of the cays or small islets which dot the line of reefs at intervals provides shelter and safe anchorage against most storms not of hurricane velocity.

Outside the reef, the platform on which it is situated shelves rapidly off into deep waters descending precipitously into the profound depths of the Tongue of the Ocean, an abyss measuring a thousand fathoms, which extends as an arm of the sea, curving between the eastern and western banks on

which the Bahama Islands are situated.

The steady trade winds blowing always from the east are favorable to the growth of the coral formations on the edge of the submerged platform. At low tide the tips of their interlacing branches break the surface of the sea.

The dominant character of this reef is that of a forest of branching coral trees (*Acropora palmata*). Their orange-brown fronds are tipped with snowy white. These seem to form the bulk of the reef, with huge trunks and zig-zagging branches towering up to the water surface from a depth of fifteen to twenty feet.

Just in front of this forest the sea floor is covered with bristling staghorn and fan corals (*Acropora cervicornis* and *Acropora prolifera*), while posts capped with orb corals (*Orbicella annularis*), grow like huge mushrooms in a clearing extending between the

¹Submarine photographs in this article were taken by the author and Mr. J. E. Williamson through the Williamson Submarine Tube, by the courtesy of the Submarine Film Corporation.



The reef at Andros, Bahamas, seen at close range from the water surface. The tops of the branching corals extend above the water at low tide



A submarine view through a weird tangle of coral forest, giving the impression of a strange world



Coral posts capped with living *Orbicella*.
down through the over-arching coral trees

Reef fishes play in the sunbeams which filter

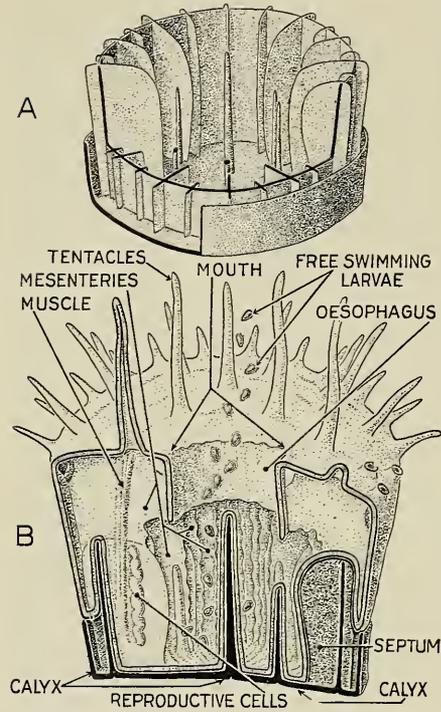
coral groves like a forest aisle. This clearing is floored with nodules of golden yellow *Porites*, with velvety brown foliate masses of stinging coral (*Millepora alcicornis*) rising between them. Magenta sea plumes (*Gorgonia acerosa*) and purple sea whips (*Pterogorgia anceps*) wave back and forth between ranks of vari-colored sea fans (*Gorgonia flabellum*) all bending in unison before the tidal currents.

These living growths rise from a sea floor apparently composed entirely of prostrate trunks, branches, and nodules of dead corals, fragments of a reef life of bygone days. How deep this tangle

of coral limestone may be, it is impossible to say.

The creatures responsible for the immense coral growths on this reef and on countless others in all parts of the tropic seas are the animals known as coral polyps. These are quite lowly in organization and range in size from a pin head to more than a foot in diameter. They are typically cylindrical creatures with a mouth opening at the top, surrounded by a circle of tentacles armed with sting-cells. By means of the latter they sting to death the still tinier microscopic animals which form their chief food, and which

are passed by the tentacles into the mouth. This opens into a short tube or "œsophagus" which hangs down within the cavity of the saclike body, and is anchored in place by a series of delicate fleshy partitions, the mesen-



(A).—Diagram of a typical calyx—the skeleton of a single coral polyp.

(B).—A sectioned polyp, showing its internal structure and its relation to the calyx pictured above. See accompanying text for details. Modified from Delage and Herouard

teries, the inner edges of which are attached to the œsophagus and radiate to the wall of the hollow body where their outer edges are attached. The lower end of the œsophagus opens about halfway down into the cavity of the polyp, but the mesenteries continue below it, their inner edges here becoming free, so that a series of pocket-like alcoves is formed around a central rotunda. The inner edges of the mesenteries secrete the digestive fluid by means of which the food is

prepared for assimilation, while their sides are supplied with contractile muscles and reproductive cells, from which latter the polyp's eggs emerge.

This very simple anatomical arrangement is practically identical with that of the sea anemone of our coasts, and thus the two animals are closely related. The coral polyp has one remarkable peculiarity, however, not possessed by the sea anemone. The base and sides of the cylinder are covered with cells (calicoblasts) which have the power of seizing the carbonate of lime abundantly dissolved in tropical sea water and of depositing it in solid form beneath the base and around the sides of the cylindrical polyp body, thus forming a limestone cup (the calyx) to hold the coral animal.

When the polyp is hatched from the egg, it is a little pear-shaped larva that swims freely about by means of the coating of moving hairs (cilia) covering its body. After a time it settles down on some solid substance, its base becomes flattened, and it assumes a more or less cylindrical form. Six little tentacles now grow out symmetrically around its mouth, and in the spaces between them, another six. A third cycle of tentacles then appears in the interspaces thus formed, and so on until a large series surrounds the mouth. If perfectly developed, it is evident that the total number must be a multiple of six. Hence the coral polyps and sea anemones are sometimes grouped together as the Hexactiniae. Each of the tentacles is hollow and its cavity is a prolongation of one of the above mentioned alcoves. The mesenteries bounding them develop simultaneously with the tentacles and are the same in number as the spaces between them.

In the case of the coral polyp an-

other feature must be noticed. As the polyp lays down its coral cup or calyx to act as a shell or "house" to live in, it elaborates it by making a series of radiating limestone partitions (septa) which, as they grow inward, push in the sides and bottom of the animal's body so as to throw it into pleated folds. These partitions are so located that they alternate with the fleshy mesenteries, and hence they push the folds of the polyp body into the spaces of the alcoves between the mesenteries. Since they are parts of the calyx, they are obviously located outside the polyp body which is thus seated upon them, and folded down between them. When the polyp dies, the calyx with its star-shaped pattern of radiating septa is left behind. In each species of coral there is a characteristic pattern for the calyx. There are several other details of the structure of this coral "skeleton" which need not be mentioned here.

The coral polyp has two ways of reproducing its kind. One of these is sexual and involves the production of eggs which are fertilized and develop into the free-swimming larva already described. The other is asexual, and involves in some cases a process of budding, in others a division of the entire polyp into two equal halves.

As the coral polyp grows, it keeps adding to the top of its calyx, so that the latter elongates and becomes stalk-shaped. The upper part of the polyp body "overflows" the rim of the calyx and forms a fold of living flesh over the outside of the stalk. From this fold a new polyp may bud out, like the parent in every way, and proceed to lay down its own skeletal calyx, diverging from the side of the parent stalk. The repetition of this process produces a branching colony.

Reproduction by the division of an entire polyp begins with a constriction in the middle of the mouth and the production of additional mesenteries within the polyp, according to a certain pattern. Soon the polyp has two mouths and the body becomes oval in ground plan instead of circular. Additions to the top of the skeleton now conform to the oval shape of the

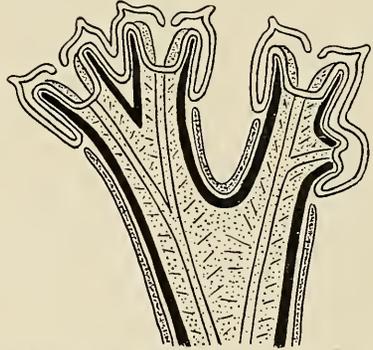
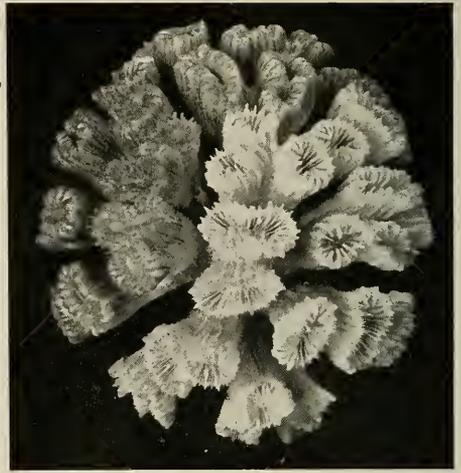


Diagram illustrating the reproduction of coral polyps by division (upper left of figure), and reproduction by budding (right of figure). The skeletal part of the colony is shown by heavy black lines. Modified from Delage and Herouard

extended polyp base. This becomes pinched in as the process of division continues, the crown of the skeleton becoming hourglass-shaped. Soon the top of the animal entirely divides, the separation, gradually proceeding down the cylindrical body, finally results in two polyps, each of which has a separate calyx, so that the skeleton now assumes the form of a Y. In some species, new divisions of the polyps occur before the old divisions are completed, so that the polyps never entirely separate, and form long strips, each with a row of separate mouths but with continuously connecting body cavities. These strips of polyps wind around other strips in the same colony in a sinuous pattern, thus forming the so-called brain corals (*Meandra*).

When forward growth of the skele-



To the left is a typical branching coral skeleton (*Lophohelia prolifera*) showing budding calyces on sides of branches. Above, a coral (*Eusmilia fastigiata*) with polyps in various stages of division. A part of this specimen shows a modeled restoration of the living polyps with their mouths and tentacles

ton becomes more rapid than the budding from the sides, finger-like skeletal stalks are produced with polyps housed in bracket-shaped calyces on the sides. These stalks branch at intervals, as in staghorn and fan corals.

The brain coral is a massive dome-shaped colony, as is also the orb coral (*Orbicella*) and the starry coral (*Siderastræa*). In the two latter the polyps are completely separated and their calyces star-shaped, but crowded close together in a dense compact dome of solid limestone of considerable weight.

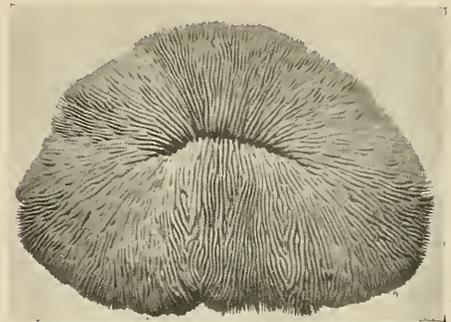
The fungus coral of eastern seas (*Fungia*) is a single polyp sometimes a foot in diameter. This grows on a narrow stalk and expands like the top of a mushroom, becoming flat and disc-shaped or oval. After it reaches a certain size it detaches itself from the top of the stalk and lies loosely on the sea bottom, while a new polyp grows in its place. The flexible gorgonian

corals such as the sea fans, sea plumes, sea bushes and sea whips have skeletons made up of small, limy spicules or needles of irregular shape. These are cemented together by a horny substance which renders the entire colony flexible so that it bends to the ocean currents as already described. Gorgonian polyps always have eight tentacles with toothlike side branches as shown on page 258. The precious coral of the Mediterranean and the Sea of Japan belongs to this group, but is peculiar in having so little of the horny substance that its rosy spicules are welded like a rigid solid mass capable of taking a high polish, and hence it is prized for jewelry.

The coral polyps and their kind, together with certain calcareous algæ known as nullipores, and the calcareous shells of tropical mollusks, are responsible for much of the coral limestone forming the reefs of the world.

Mayor observed the growth rate of various species of corals in Pago-Pago Harbor, American Samoa, occurring in a reef area of about two and a half millions of square feet, and estimated that they added about 800,000 pounds of limestone to the reef each year. Much of this limestone is ground up by wave action to form coral mud. All these substances eventually become compressed and solidified to produce the coral rock and limestones of many oceanic islands like the Bahamas, and even parts of continents, such as the southern part of Florida. Thus the reef builders of tropical waters become world builders as well, within the regions where they flourish.

Their remarkable formations are found extensively developed in the Pacific, Indian, and Atlantic oceans in the zone included between latitudes 30° N. and 30° S., that is to say for about 2000 miles north and south of the equator. In the Atlantic, their northernmost limit is the island of Bermuda, and their southern, the latitude of Rio de Janeiro. In the Pacific, they range from southern Japan to Queensland, Australia. They flourish in shallow seas from low tide to a depth of 120 to 200 feet. They cannot exist

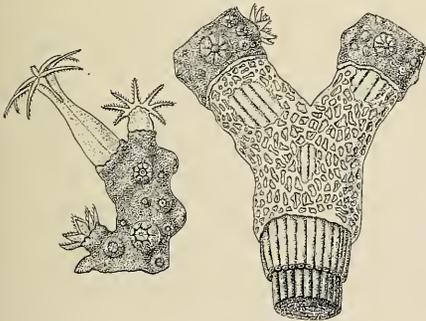


Skeleton of mushroom coral (*Fungia*) of eastern seas. This is a single polyp, often of large size

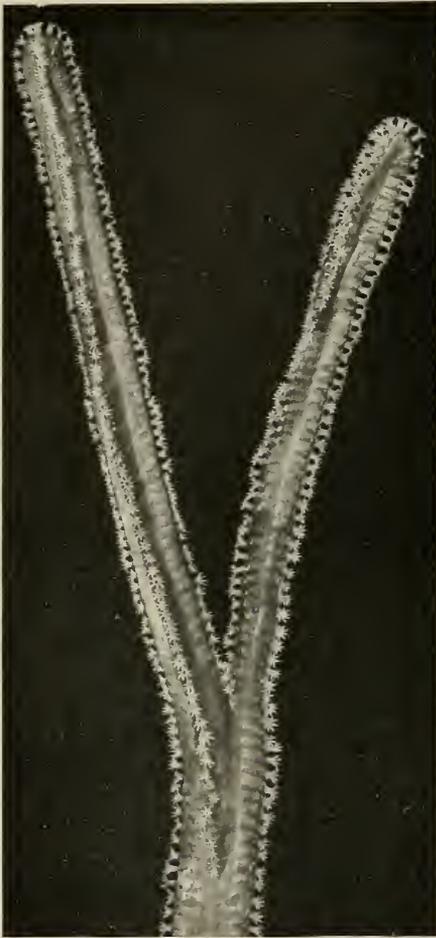


Specimen of brain coral (*Meandra cerebriformis*) showing the coiled strips of incompletely divided polyps resembling the cortical layer of the human brain

in waters having a winter temperature of less than 68° Fahr. A few species grow in isolated patches in colder seas, one even being found so far north as Archangel, while the star coral (*Astrangia danaë*), illustrated on page 251, spreads in small colonies on rocks in New England coastal waters. These, however, are not prolific enough to be reef-forming, nor are the various species of deep-sea corals which have been dredged from all depths down to 1500 fathoms. The true reef-forming corals grow on the borders of continental masses in the tropics, surround oceanic islands, or spread over submerged banks, where the stony skeletons of the living colonies rise in tree-like growths or dome-shaped masses to the water's surface. The tropical Atlantic is comparatively free from



At the left is shown the magnified tip of a branch of precious red coral (*Corallium rubrum*) with polyps expanded. At the right the stalk is dissected to show the hard inner core, polished by jewelers for ornaments. Modified from Delage and Herouard



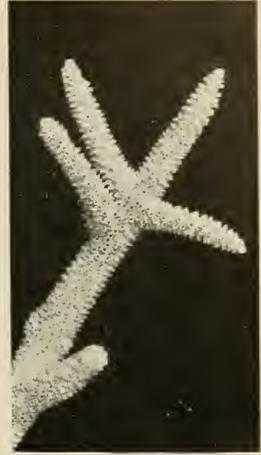
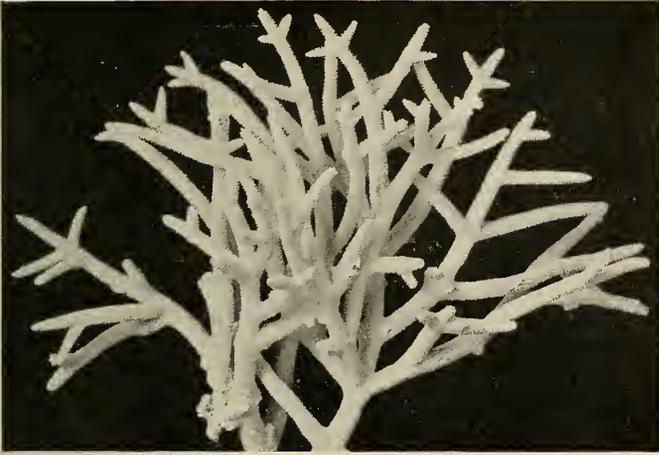
At lower right, the sea whip (*Pterogorgia anceps*) growing in a coral reef. At the left, a magnified branch with rows of polyps. Above at right, enlarged tip of branch showing the individual gorgonian polyps

coral reefs, except in the West Indies and along the coasts of South America and Africa; but the southern Pacific with its hundreds of small, volcanic islands, some rising from extensive submerged banks and others directly from profound depths, is dotted with coral reefs.

Coral reefs are usually classified into three types of growth, fringing reefs, barrier reefs, and atolls.

Fringing reefs are submerged coral flats bordering directly on the shore of an island or continental mass. As

they grow out into the open sea they form a bank of which the outer edge tends to be more elevated than the inner portion. The windward location of this ridge is favorable for the prolific growth of new, living corals, as the incoming waves are loaded with the minute floating creatures that are the food of the polyps. The inner part of the coral platform grows more slowly, and large portions of it become floored with disintegrating fragments of coral and shells brought in by the sea. Coral growth is suffocated by this pulverized



Skeleton of a branching staghorn coral (*Acropora cervicornis*). At the right, the tip of a single branch on a larger scale shows the bracket-like calyces formed by the individual polyps on the side of the central stem

material, while much of the lime passes into solution. This lower part of the platform forms a channel or lagoon between the mainland and the living outer edge of the reef. Parts of the latter grow until they reach the surface when the branching corals are broken up by the waves and even the dome-shaped growths are heaped up by storms. The crevices become filled with small fragments, and the whole mass is gradually compacted into coral rock rising above the waves to form low-lying reefs parallel with the mainland but separated from it by the lagoon, from one to several miles in width. Such a reef is a barrier reef, the second type mentioned above.

The outer face of the barrier reef slopes steeply into deep water and is covered with flourishing living corals. Barrier reefs often entirely surround islands, with here and there a break forming a channel into the lagoon. There is always a channel opposite the mouth of a stream, as the silt eroded by its waters kills the living corals.

Coral atolls are ring-shaped reefs surrounding a central lagoon with no

island enclosed. They are usually oval rather than round, and there are always channel-like openings on the side away from the wind. The lagoon within is floored with dead coral, though living clumps rise here and there. The steadily blowing trade winds cause a more prolific growth of coral on the outer windward side of the atoll, and here the waves, especially during storms, have built up the reef more continuously and, rushing over the top, find an outlet on the leeward side, which is soon deepened into a tidal channel. Many atolls are composed of discontinuous reefs forming a broken ring with several channels.

Darwin believed that atolls were originally barrier reefs surrounding volcanic islands, and that in the course of time, through a general subsidence of the ocean floor, these islands slowly sank beneath the waves, but so gradually that the barrier reefs surrounding them were built up by the coral animals at the same rate, so that their tops always broke the surface of the sea. After a time the enclosed volcanic peak entirely disappeared and continued to



After Saville-Kent

The Great Barrier Reef of Australia, showing prolific coral growths exposed at low tide. In the middle distance may be seen the lagoon separating the Barrier Reef from the distant shore. This great reef extends for more than 1200 miles along the Australian coast

sink until its summit was covered by the corals flooring the lagoon. The barrier thus became transformed into an atoll. Since Darwin's time this view has been disputed by many observers, but there are strong evidences in its favor. Many of the islands in the Pacific are apparently sinking, as shown by the flooded valleys surrounding their central mountain peaks, while the barrier reefs ringed about them remain at the sea level. The logical outcome of this process would produce atolls.

An alternative view is that the sea has risen since the last ice age as the result of the melting of the great polar ice caps of that period. This would produce practically the same result. A recent view embodying both theories is based on geological evidence indicating that the time elapsed since the last ice age is not sufficient to account for all the changes,

and that the character of the submerged valleys shows that subsidence must have occurred in a preglacial period as well. The flooding of the oceanic islands caused by this subsidence would be halted temporarily during the ice age, counteracted by the loss of the water evaporated out of the seas and imprisoned in the immense quantities of ice then capping the continents from the polar regions far into the temperate zones. When this was released after the melting of the ice sheet, the resulting rise of the ocean flooded what is now the submerged continental shelf of the greater land masses, and also the oceanic islands. Wherever subsidence of the sea bottom took place at the same time, their submergence would proceed at an accelerated rate. It is believed by various scientists that both these processes have been important factors in the production of atolls.

Spiders as Fishermen and Hunters

By E. W. GUDGER

Associate in Ichthyology, American Museum

ABOUT three years ago I published in this journal an article entitled "Spiders as Fishermen"¹ in which I brought together what I fondly believed to be all the known data relating to the peculiar habit in spiders, of catching and eating fishes. One case of the trapping and devouring of tadpoles was also included. However, no sooner had that particular number of NATURAL HISTORY appeared, than my attention was called to an overlooked article. In addition, two first-hand accounts came to me by letter, together with a newly published article on spiders as fishermen. All these new data are presented in this article, as well as a number of interesting accounts of spiders as hunters. In all these accounts saye two, the spiders not only catch their prey but eat it.

SPIDERS CATCHING AND EATING FISHES

In no one of the five accounts contained in my earlier article is there a reference to actual observation of spiders devouring the fish, and serious doubts have been expressed on the part of those best acquainted with the habits of arachnids, whether they do so. When all the evidence is in as to spiders catching vertebrates, this subject will be discussed. A presentation of the facts now follows.

The Rev. Nendick Abraham, long known to me as a keen observer and accurate recorder of the habits of fishes, on November 22, 1911, delivered a lecture before the Natal Scientific Society in which he described the

habits of a spider he had observed in the act of catching and devouring fishes. This lecture seems to have been reported in *The Natal Advertiser* and reprinted in *The Agricultural Journal of the Union of South Africa*. Mr. Abraham also published some brief notes from his article in the *Transactions and Proceedings of the Natal Scientific Society*, 1911, Vol. 2, No. 2. I have not been able to lay my hands on any of these journals. Fortunately, however, Mr. E. C. Chubb, of the Durban Museum, Natal, feeling that this interesting phenomenon ought to be more widely known, published in *Nature*² the extracts quoted below, from the newspaper accounts of Mr. Abraham's article.

In the year 1905 I was living in Greytown, Natal. One day I was catching small fish and aquatic insects for an aquarium. I was using a small net in a shallow stream. I happened to see on the edge of the water a fine spider, which I captured. On reaching home I placed my specimen in a large aquarium, where I had a number of small fish. The spider measured about three inches when its legs were extended; the body is small, but the legs are long. After being on the rockwork of the aquarium for some time, it took up a very interesting position. It rested two legs on a stone, the other six rested on the water, well spread out, the ends of the six legs commanding a definite and well-defined area of water.

Being busy, I merely took a note of its attitude, and left it to its devices. After a few minutes my servant boy came into my study to say that the spider I had put into the aquarium was eating one of my pet fish. I at once went to see what had happened, and soon saw the spider on top of the rockwork, holding in its grip a beautiful little fish about four times the weight of its captor. For a moment I was startled into a strange surprise. How could this spider, which has no power to swim, catch a lively, quick-swimming fish? I looked at it in wonder, as it seemed to clutch the fish as a cat clutches a mouse. It soon began to devour its catch, and after some time had

¹Gudger, E. W. "Spiders as Fishermen," *NATURAL HISTORY*, 1922, Vol. 22, pp. 565-68.

²Chubb, E. C. "Fish-eating Habits of a Spider." *Nature*, 1913, Vol. 91, p. 136.



Photograph of a spider (*Thalassius spenceri*) in an aquarium, in the fishing attitude. Its hindmost legs are hooked on to a stone while the others rest on the water. A small fish is seen approaching below. After Abraham

passed nothing was left of the fish but its backbone. The spider had eaten it as surely as an otter eats its trout.

I was now anxious to find out how the spider caught the fish. That night, about 11 o'clock, when I had finished my day's work, I sat down by the aquarium to watch the spider, with the hope that I might see how the fisherman caught his fish. The spider had taken up a position on a piece of stone, where the water was not deep, and had thrown out its long legs over the water, upon which their extremities rested, making little depressions on the surface, but not breaking the "water skin." The tarsi of two posterior legs firmly held on to a piece of rock just above water-level, the whole of the body was well over the water, the head being in about the center of the cordon of legs, and very near to the surface of the water.

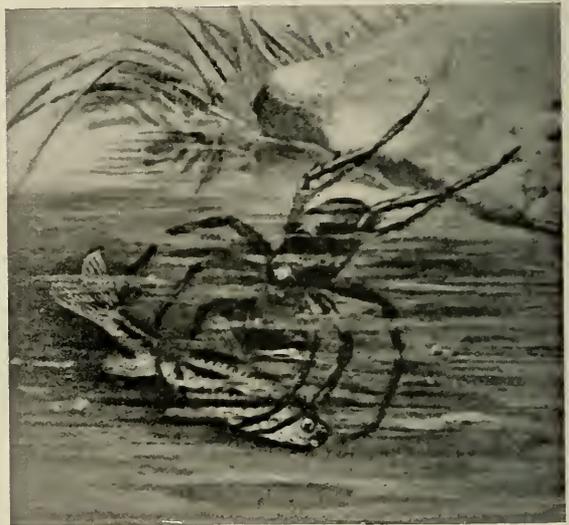
After watching for some little time, I saw a small fish swim towards the stone and pass under the outstretched legs of the spider. The spider made a swift and sudden plunge. Its long legs, head, and body went entirely under the water, the legs were thrown round the fish with wonderful rapidity and in a moment the powerful fangs were piercing the body of the fish. The spider at once brought its catch to the rocks, and began without delay to eat it. Slowly, but surely, the fish began to disappear, and after the lapse of some time the repast was over.

This very definite and clear-cut observation and description was corroborated by evidence which came

later to Mr. Chubb, and which he adduces in the following words:

Recently the Rev. Father Pascalis Boneberg, of the Marianhill Monastery, Natal, has added to Mr. Abraham's observations. Father Boneberg has seen examples of this same spider catching and devouring tadpoles of the toad *Bufo carens*, and adults of the little frog *Rappia marmorata*. It is his intention, I understand, to communicate an account of his observations to a German scientific publication shortly.

This was done, and the account may be found quoted in full in the section of this article



The spider in the act of catching the fish. The fourth pair of legs anchor it to the stone, the remainder of the body, excepting the posterior part of the abdomen, is submerged. From a drawing by the Reverend Smit. After Abraham

dealing with the catching and eating of tadpoles and frogs. The spider in question was *Thalassius spenceri*.

The next account is in the form of a communication from Mr. D. R. Crawford, an instructor in fish culture in the College of Fisheries of the University of Washington. The observations were made and the report written when Mr. Crawford was a scientific assistant in the trout hatchery of the

U. S. Bureau of Fisheries at Erwin, Tenn. Here follows his report to the Bureau, under date of May 6, 1922:

To the long list of fish enemies we can now add spiders. This morning I observed a very large aquatic spider clinging to the side of one of the concrete ponds entirely under water with a trout fingerling held in its mandibles. Spider and fish were removed from the water and placed in formalin. The fish was evidently freshly caught since the delicate coloration of life was still evident and blood was flowing freely from some lacerations. This fact is very interesting because it would have been necessary for the spider to actually swim in the water or for the fish to have been practically exposed above the surface for the capture to take place. In any case, the fish was evidently caught alive and killed subsequently. The victim was about $2\frac{1}{4}$ inches long and judging from its rotundity and coloration it was by no means a weakling, which indicates the activity and power of the spider.

Several days previously this spider or a similar one was observed lurking in a crevice between the outlet screen and the concrete wall above the water.

Mr. Keesecker [superintendent of the station] said that he had observed similar large spiders eating trout fry. He also mentioned the fact that these spiders catch their prey in the water, attacking active fish rather than picking up dead or nearly dead ones.

No doubt such a spider is capable of accounting for a considerable number of trout fry, which fact is of value in the final checking up of results from the experiments now under way in the ponds. Of course, the larger aquatic beetles and bugs (*Dytiscus*, *Hydrophilus*, *Bellostoma*, etc.) prey upon the young fish also.

Mr. Crawford has kindly added the following data in a personal communication to the present writer:

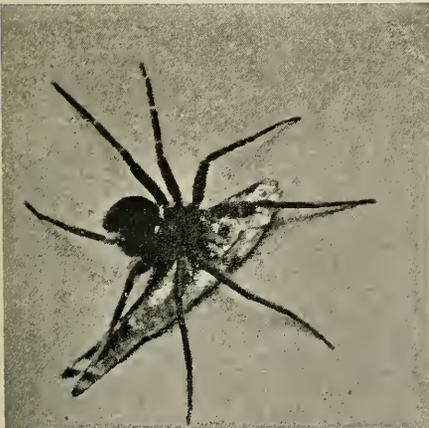
On May 6, 1922, I observed a large aquatic spider below the water clinging to the concrete wall of a small trout pond at Erwin, Tenn., station. This spider was holding a trout fingerling by means of its fore legs. Length of fish $2\frac{1}{4}$ inches or 57.15 mm. Length of body of spider, $\frac{3}{4}$ of an inch or 19.05 mm. Length of legs of spider, $1\frac{3}{2}$ inches or 27.78 mm. Species unknown. Species of trout, *Salmo irideus*, (or *shasta* according to Dr. W. C. Kendall).

There is no doubt that the spider caught the fish, since the victim was bleeding at the wounds caused by the spider's suction, and the colors were still life-like.

Mr. A. G. Keesecker, superintendent at the station, has seen these spiders swim out and capture young fish."

Early in 1924, Mr. C. M. Breder, Jr., went to Panama as a member of the Marsh-Darien Expedition, charged with the task of collecting fishes, amphibians, and reptiles for the American Museum. Early in February I had a letter from him containing the following interesting account:

While collecting frogs along the Rio Tapia on February 1st, I found one of your fishing spiders. I was wading in the stream, turning over brush on its rather steep shores, when my eyes were caught by an unusually large blackish spider with its two forward pairs of legs resting on the water, the other two holding the animal securely on the shore. The fore and aft reach of the spider's outstretched front and hind legs was about $3\frac{1}{2}$ inches and the right and left spread of the third pair of legs (the longest) about 2 inches. Below it (i.e., down stream) in rather swift water a number of small *Characins* were disporting themselves. On perceiving the spider, I stopped dead still only about $1\frac{1}{2}$ feet away from it, while it appeared entirely oblivious of my presence. All of a sudden it lunged slightly forward, too rapidly for the eye to follow readily, and then bobbed back to the same position on the bank, holding in its palps a little fish about an inch long which hardly wriggled at all. It "mouthed" its prey considerably and probably began withdrawing its juices at once. Being in a cramped position, my foot slipped and the slight ripple created thereby caused the spider to relinquish its prey. I attempted to capture the spider but was prevented by the proximity of a deep hole in the stream. In the meantime the little fish turned over on its side, was quickly carried away by the very rapid current and was lost sight of while I was trying to catch the spider, which appeared to be one of the so-called "wolf" spiders.



Photograph from life, of spider eating the fish which it has dragged out on land. After Abraham

When a copy of NATURAL HISTORY containing my article on "Spiders as Fishermen" reached the Natal Museum, Mr. Abraham's attention was called to it by Dr. Ernest Warren, the director. Mr. Abraham, desirous of making his observations more widely known, rewrote them and added further details, illustrating his paper with three figures which are reproduced on pp. 262 and 263 through his kind permission and that of Doctor Warren.¹

The first figure is a photograph of a living spider (*Thalassius spenceri*) and a small live fish in an aquarium. The spider is shown in its characteristic fishing attitude, its body supported on the surface of the water on three pairs of legs but anchored to a projecting stone by the hindmost pair. Just here it should be recalled that the spider observed by Mr. Breder also anchored itself to the bank by its two hinder pairs of legs. In the figure one sees the little fish approaching the spider only an inch or two below the surface.

The next figure is a photograph of a colored sketch of Mr. Abraham's observations. The hind legs still hold fast to the stone but all the body except the extreme hinder part of the abdomen is submerged. The first three pairs of legs hold the fish firmly. The next figure is a photograph of the spider in the act of devouring the little fish, which it has dragged out on the land. These photographs—two of which are of the spider and its living prey—are invaluable in making clear this most interesting and unusual phenomenon.

SPIDERS CATCHING TADPOLES AND FROGS

In my previous paper I quoted a statement by Berg that in Argentina a spider of the genus *Diapontia* was

observed to catch tadpoles, which presumably it devoured. This spider constructed a funnel-shaped net just at the surface of the water and into this literally drove the tadpoles. The conjecture that she ate them is based on Berg's statement that "The shrivelled-up tadpole-skins surrounding the net convinced me of the skillfulness of the spider as a fisherman."

Let us here recall Chubb's account previously referred to of observations by Father Boneberg. These were published in 1914 and refer to the activities of two predacious spiders, *Thalassius fimbriatus* and *Thalassius* sp. His account is too long to be quoted here but will be put in epitomized form. His observations in full may be found in the reference cited below.²

In January, 1913, Boneberg collected a large water spider in a little pond near Marianhill. Having no other place to keep it, he put it temporarily in a glass dish 15 cm. wide, in which were twenty full-grown tadpoles of *Bufo carens*, and three full-grown tree frogs (*Rappia marmorata*). Some days later, on examining this improvised aquarium, Boneberg was surprised to find that apparently the number of tadpoles had been considerably diminished. Recalling his friend Abraham's experience with fish-catching spiders, Boneberg at once suspected the spider as the culprit. To make sure, he put twelve tadpoles in the jar with the spider and the frogs. Three days later inspection showed only three tadpoles left, and as the jar had been kept covered all the time, he was now assured that the missing tadpoles had been eaten by the spider. This spider later killed and ate one of the frogs, as

¹Abraham, Nendick. "Observations on Fish and Frog-eating Spiders of Natal" *Annals Natal. Museum*, 1923, Vol. 5, pp. 89-94, pl. with 9 figs.

²Boneberg, Father Pascalis. "Notizen über die Lebensweise einiger südafrikanischer Wolfspinnen (*Thalassius fimbriatus* Walck. und *Thalassius* sp.)" *Societas Entomologica*, Stuttgart, 1914. Jahrg. 29. pp. 45-46; 49-51; 53-54.

will be described presently, and was itself then killed and preserved.

Later Boneberg brought in from the same pond a *Thalassius* of an undetermined species, and put it in an aquarium with six tadpoles of *Xenopus laevis*. He described what happened in the following words: "The above mentioned specimen was only 10 minutes in the small aquarium when it leaped from the stone projecting from the water on which it had established itself, seized a *Xenopus* larva swimming about in the water, dragged it out of the water, and in the course of half an hour ate it all up beginning at the tail." Twice during the afternoon he saw this repeated. Next morning only two of the tadpoles were left, while the spider had greatly increased in girth. The size of these tadpoles is not given, but it is evident that they were small.

Another experiment was then tried. Three specimens of *Thalassius* (one a female caring for a brood) were placed each in a jar containing twelve *Bufo carens* tadpoles. The next morning there were but two tadpoles in one of the jars, and three in the second, while the spider with the cocoon had touched none of those in her jar. These were left with her for a week but were untouched. This was also found true of another female with a cocoon, but shortly after her young were hatched, she devoured in one night five full-grown tadpoles of *Bufo carens*.

It will be recalled that during Boneberg's first experiment he placed a spider in a jar containing both tadpoles and tree frogs (*Rappia marmorata*). The spider first ate nine of the twelve tadpoles, and then caught and ate one of the frogs. Boneberg's own words are: "When on the following morning . . . I again looked for the spider, I found it sitting among the twigs of

the branch in the jar holding in its palps not a larva of *Bufo carens* but a full-grown tree frog, *Rappia marmorata*, which still convulsively twitched its hind legs and now and then made a feeble effort to escape." The branch



Photograph from life by P. Boneberg of a spider which has caught and is eating a small tree frog, *Rappia marmorata*. After Abraham

with the spider and its prey was then taken out of the aquarium and photographed, the spider remaining undisturbed all the while. The spider was then killed and it and the frog preserved. The body length of the spider was 18 mm., that of the frog 30 mm. This photograph was reproduced in Abraham's paper (1923) and is refigured herewith.

Two weeks later Boneberg put into

a jar a *Thalassius fimbriatus* and a 30 mm. long *Phrynobatrachus natalensis*. The frog weighed 2 g. 390 mg., the spider 435 mg. Some days earlier, this spider had eaten a *Bufo regularis* 22 mm. long and 820 mg. in weight. It now proceeded, however, to kill and partly eat the *Phrynobatrachus*. Later Boneberg put into the jar with one of the spiders a 30 mm. *Bufo regularis*, and on the following morning all that could be found of it were the bones and some pieces of skin. This spider caught another toad of the same species but, while under observation, the toad got away. Several days later it was found dead. Still later this same spider caught and carried up into the network of twigs at the top of the jar a *Rana fasciata* measuring (body only) 30 mm., with legs extended 120 mm. This was taken from the spider and preserved, but that night she killed and ate a 30 mm. specimen of *Phrynobatrachus natalensis*.

Boneberg collected thirty specimens of *Thalassius* at the small pools wherein he found in great numbers the tadpoles of the various frogs and toads named above. These spiders were found there only at the beginning of and during the spring rains, when the frogs were spawning and the eggs hatching. During the dry season, when the ponds had dried up and the tadpoles and fishes were absent, no spiders were seen, although diligent and repeated search was made. From these facts Boneberg believes that they collect at the pools at those times when tadpoles abound, to find in these an abundant food; that the spiders disperse after the frog larvæ metamorphose, and scatter widely as the ponds dry up; and finally, that full-grown frogs of these small species not infrequently fall a prey to the "bandit arachnids."

In this connection attention is called to a recent article, (see footnote p. 271). in which I quoted a letter from Mr. Charles H. Baker, of Zellwood, Florida, concerning the very strong webs made by *Nephila plumipes*. After speaking of the large insects caught in so strong a web, he says, "I have also found it holding one of our small green tree-frogs, on which the female was feeding." Here, then, is evidence from a place thousands of miles distant, corroborative of the same peculiar habit of spiders observed in South Africa.

SPIDERS CATCHING AND EATING SNAKES AND LIZARDS

In addition to fishes, tadpoles, and frogs, animals as strong and active as lizards and snakes have been caught by spiders. McCook, in his delightful book on spiders¹, says that he has made strenuous efforts to run down all accounts of spiders catching small vertebrates, and then to separate the wheat from the chaff. The first of these incidents which McCook gives is from the pen of S. Cummings,² whose account is reproduced herewith:

On the evening of the 13th inst. a gentleman in this village, [Batavia, N. Y.] found in his wine cellar, a *live striped snake*, nine inches long, suspended between two shelves, by the tail, by spiders' web. The snake hung so that his head could not reach the shelf below him by about an inch; and several large spiders were then upon him, sucking his juices. The shelves were about two feet apart; and the lower one was just below the bottom of a cellar window, through which the snake probably passed into it. From the shelf above it, there was a web in the shape of an inverted cone, eight or ten inches in diameter at the top, and concentrated to a focus, about six or eight inches from the under side of this shelf. From this focus, there was a strong cord made of the multiplied threads of the spiders' web, apparently as large as common sewing silk; and by this cord, the snake was suspended.

Upon a critical examination through a

¹McCook, Henry. *American Spiders and their Spinning-work*, Philadelphia, 1889, Vol. 1, pp. 233-46. 3 figs.

²Cummings, S. "A Live Snake Suspended by Spiders." *American Journal of Arts & Sciences*, 1835, Vol. 27, pp. 307-08.

magnifying glass, the following curious facts appeared. The mouth of the snake was fast tied up, by a great number of threads, wound around it, so tight that he could not run out his tongue. His tail was tied in a knot, so as to leave a small loop, or ring, through which the cord was fastened; and the end of the tail, above the loop, to the length of something over half an inch, was lashed fast to the cord, to keep it from slipping. As the snake hung, the length of the cord, from his tail, to the focus to which it was fastened, was about six inches; and a little above the tail, there was observed a round ball, about the size of a pea. Upon inspection, this appeared to be a green fly, around which the cord had been wound as the windlass, with which the snake had been hauled up; and a great number of threads were fastened to the cord above, and to the rolling side of this ball to keep it from unwinding, and letting the snake down. The cord, therefore must have been extended from the focus of the web, to the shelf below, where the snake was lying when first captured; and, being made fast to the loop in his tail, the fly was carried and fastened about midway, to the side of the cord. And then, by rolling this fly over and over, it wound the cord around it, both from above and below, until the snake was raised to the proper height, and then was fastened, as before mentioned.

In this situation the suffering snake hung, alive, and furnished a continued feast for several large spiders, until Saturday forenoon, the 16th, when some persons, by playing with him broke the web above the focus, so as to let part of his body rest upon the shelf below. In this situation he lingered; the spiders taking no notice of him, until Thursday last, eight days after he was discovered; when some large ants were found devouring his dead body.

In the same issue of this journal is included another account of this phenomenon by D. Lyman Beecher.¹ This differs in some details but in all essential points corroborates Mr. Cummings' account. Beecher says that three spiders were concerned, that when first seen the snake was entangled, that the spiders then came down the web and fastened threads to the body and braced these in every direction.

¹Beecher, D. Lyman. "A Live Snake Suspended by Spiders." *American Journal of Arts and Sciences*, 1835, Vol. 27, pp. 309-10.

Next they proceeded to wind a web around his head and mouth, very effectually muzzling him. And finally they proceeded to suspend him by the tail as described by Cummings. Cummings gives the names of various reputable citizens of Batavia who attest the accuracy of his account. Beecher in

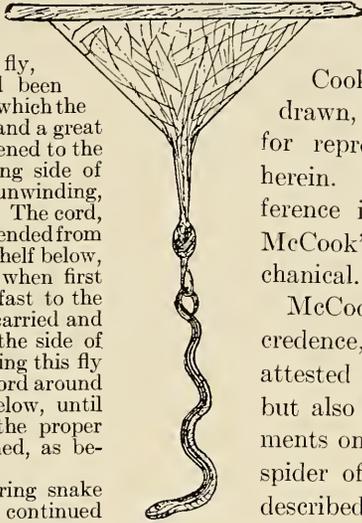
his turn gives a figure showing how the snake was suspended. Mc-

Cook has had this figure redrawn, and as his figure is better for reproduction, it is copied herein. Absolutely the only difference in the figures is that McCook's drawing is less mechanical.

McCook gave this account full credence, not only because it was attested by credible witnesses, but also because he made experiments on webs of the medicinal spider of a size similar to that described. He placed on the webs alcoholic specimens of snakes of the exact size of that in the original observations, from

the collections of the Academy of Natural Sciences of Philadelphia. He found that one of these webs could support six or seven of the snakes without tearing. This seemed so satisfactory a demonstration, that he included the full account in his book, as quite dependable. He thought that the spider concerned was the medicinal spider, *Tegenaria medicinalis*.

There is, however, another similar account extant, one from the pen of Dr. Asa Fitch, a well-known American entomologist. The article has been republished, without any indication of the source of its original publication, in the *Annual of Scientific Discovery*,



A snake snared in a spider's web. The spider has made a loop around the snake's tail by which it has raised it off the floor. After McCook, from Beecher

1862, pp. 334-35. It may be remarked here, in passing, that McCook seems to have been perfectly satisfied of the authenticity of this phenomenon also, which occurred at Havana, Chemung County, New York.

This account of Dr. Fitch's, which is written in very flowery fashion, may be "boiled down" to something like the following: An ordinary spider had built her web on the under side of a shelf beneath a counter in a store at Havana. A "common silk snake" (whatever that may be) about a foot long had taken up its residence on the floor underneath the shelf. The spider eventually captured the snake in her web, just how is not known, for when first discovered it was found that the spider had managed to get a loop of her silk around the snake's neck, and from this loop had carried up and attached to the under side of the shelf a single strand which just lifted the head of the little snake about two inches off the floor. This was done in spite of the frantic efforts of the snake, which was moving around in a circle as large as its tether would allow, and seeking to get its head down to the floor and out of the noose.

In the meantime the spider, avoiding the lunges of the snake, was passing up and down between the shelf and loop, and at every trip she was adding another line to that holding her prey. Each line, as it was drawn tight, lifted the head of the snake a little higher. Doctor Fitch's informant told him that at first only the neck of the serpent was surrounded with the loop but that later the head became covered with a network of threads, some placed vertically (these first probably) and others horizontally, until the head of the snake was enveloped in a veritable muzzle. "No muzzle or wickerwork for the

mouth of an animal could be woven with more artistic regularity and perfection. And the snake occasionally making a desperate effort to open its mouth would merely put these threads upon a stretch."

The snake continued its efforts to break away, but the spider went on adding threads and shortening them until at length only two or three inches of the snake's tail remained on the floor. The snake finally died about six days after the situation had been discovered. There is nothing in the statement to indicate whether the spider feasted on the snake.

McCook, who probably knew Fitch personally, gives full credence to this account. He thinks that, from all the data at hand, the spider was probably *Theridium tepidariorum*. He found that this spider weaves a large web and one strong enough to catch and support a small snake of the size mentioned. Furthermore, *Theridium* is a very bold spider, courageously catching and killing large beetles and raising them relatively long distances to the center of her snare.

The similarity of action pursued by the two spiders in catching the snakes is marked. In both instances the snake is muzzled, a loop is formed and strengthened by the formation of other threads, and the victim is finally raised from the floor, in one case by the tail, in the other by the head. How the snakes became entangled at the beginning is not clear, but it seems reasonable to suppose that they glided into the web, or more probably fell into it, and became entangled. The spider then secured the intruder beyond hope of escape as described in the various accounts. There is no reason to believe that the second account is a plagiarism of the first.

Fitch's standing as attested by McCook forbids such a belief.

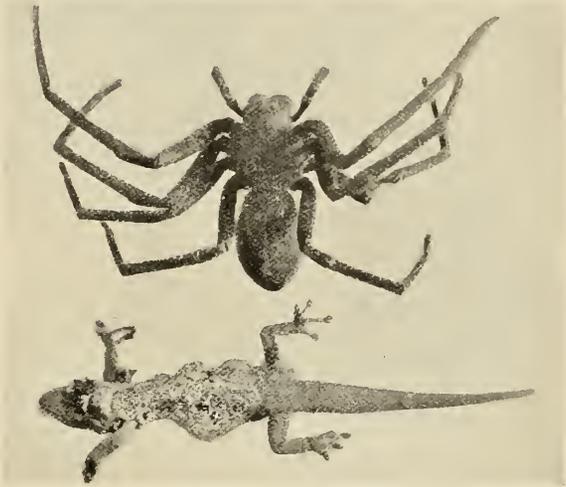
In the same journal which contained Abraham's article previously quoted, there is an interesting account by the director, Dr. Ernest Warren, of a South African spider which catches and eats lizards. Here is Warren's account in his own words.¹

At the beginning of July, 1923, Mr. W. G. Rump, caretaker of the Natal Museum, noticed on a sunny morning at about 10 A.M. in a garden in Pietermaritzburg two large spiders on the wood-work of a fence, at a height of about 4 ft. above the ground. The two spiders, with a leg span when walking of about 3 in., were seen close together clinging to some large, dark object. One spider was killed, while the other escaped, and the object to which both spiders had been attached proved to be the body of a recently killed lizard, *Lygodactylus capensis* (A. Smith), which, when straightened out, was about 2½ inches in length. The spider which had been secured was a female, and probably the one that had escaped was of the same sex.

The lizard was dead. One side of the neck had been considerably chewed, and the surrounding muscles and tissues were in an excessively soft condition. Also, all the muscles and tendons of the front portion of the body had been rendered so flaccid that the head and both fore-limbs had been doubled up and forced into the semi-fluid region at the side of the neck. The remainder of the body of the lizard was in normal condition and the tissues were perfectly fresh. Subsequent experiences render it probable that the lizard had been killed by the spider, or spiders, less than an hour previously. The tail was entire, and it may be concluded that death had been extremely rapid, with no appreciable struggle.

In order that this phenomenon might be observed more carefully, two living specimens (female and male) of this spider were obtained and placed in separate glass receptacles, with several small lizards about one and three quarter inches long. At the end of two and one half hours it was found

that the female spider had captured one of the lizards and had eaten practically all of it. There remained only "the terminal portion of the tail adhering to the glass side of the receptacle and a somewhat large, globular, pulpy, semi-

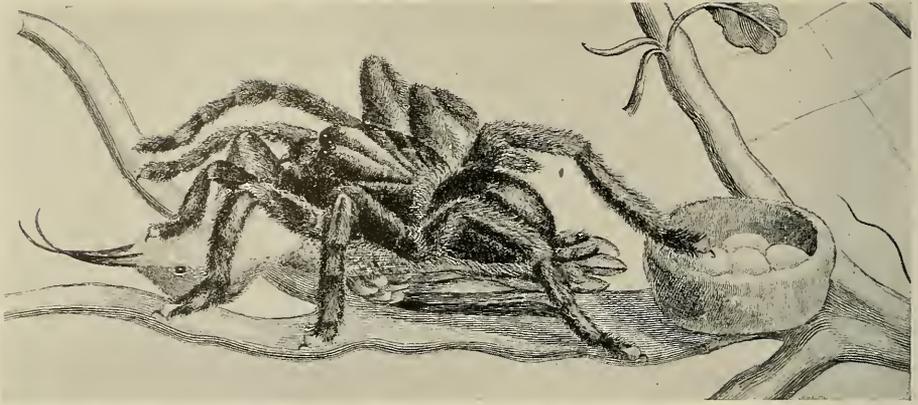


A South African spider (*Palystes natalius*) and its prey, the lizard (*Lygodactylus capensis*). Photograph (natural size) by Dr. C. Akerman. After Warren

fluid mass held by the pedipalps against the chelicerae while these powerful toothed appendages were continuously chewing it." How the feeding is done is more explicitly described as follows:

A lizard of about one and three quarter inches in length had been caught by the spider a few minutes previously on the floor of the cage and had been carried by it on to the vertical glass side. The lizard had been seized on one side of the neck close to the shoulder and was hanging down limp and dead, with the claws of the chelicerae of the spider implanted in the flesh. The tail had not been snapped. The pedipalps now came into play, and with their finger-like, flexible tarsi the body of the lizard was pressed against the chelicerae. The chelicerae maintained a very constant chewing movement, and each time they were divaricated the terminal claws were raised, and on the chelicerae beginning to close together again these raised claws were thrust into the flesh of the prey. The inner sharp edge of the claw lacerated the tissues very effectively, owing to the fact that the hinged claw closed down on the inner toothed edge of the chelicera while the two appendages were approaching each

¹Warren, Ernest. "Note on a Lizard-eating S. African Spider." *Annals Natal Museum*, 1923, Vol. 5, pp. 95-100.



A giant spider (*Mygale*) feeding on a humming bird which it has just dragged from her nest. After Merian

other to meet in the middle line. The breaking up of the tissues of the prey seemed to be assisted to some extent by the wounded surface of the lizard being pressed against the scopulæ of the endites of the pedipalps.

The only other scientist, so far as I know, to assert that spiders catch and feed on reptiles is Perty.¹ In describing the articulated animals collected in Brazil by Spix and Martius, he says definitely that *Mygale blondii* of South America feeds on small reptiles, especially lizards of the genus *Anolis*.

SPIDERS WHICH HUNT BIRDS

It is a well known fact that *Mygale* (*Avicularia*), the bird spider of South America; catches and eats small birds, but it was a great surprise to find that scientific accounts of this phenomenon go back to 1705. In this year appeared at Amsterdam a large folio in Latin by Madame Merian on the insects of Surinam.² On page 18 of this work she says that certain great spiders will take little birds (called *Colobritigens* [*Colibris*, humming birds] by the Belgians) from their nests and suck their blood. On her plate 18 this phenomenon (among

others) is shown, and that part of her plate is reproduced herein. So far as I know this is the earliest known account of this habit of *Mygale*.

Madame Merian's observations were discounted by MacLeay,³ who declared that the food of *Mygale* consists solely of invertebrates, largely insects. *Mygale*, he asserted, was a ground-dweller, and the humming bird arboreal. Further, he tried the experiment of placing a living humming bird and an *Anolis* lizard in the burrow opening of one of these spiders. These "were not only not eaten by the spider, but the latter actually quitted its hole, which it left in possession of the intruders." One cannot doubt MacLeay's statement of the results of his experiment, but, that the alleged phenomenon is an actual fact seems to be proved by the weight of evidence now to be presented, and further by an eyewitness, H. W. Bates.

This same phenomenon is attested by other writers. A. M. F. J. Palisot de Beauvois, in his *Insectes Recueilles en Afrique et in Amerique*, etc., Paris, 1805, (p. 135), says that

¹Perty, Maximilianus. *Delectus Animalium Articulatorum que in Itinere per Brasiliam . . . Collegerunt Dr. J. B. de Spix et Dr. C. F. Ph. de Martius*. Monachii, 1830, p. 37.

²Merian, Sybilla Maria. *Metamorphosis Insectorum Surinamensium, etc.* Amstelodami, 1705, p. 18, pl. 18. There is a Dutch edition of the same date, and others appeared in 1719 and 1730. Another Latin edition appeared in 1726.

³MacLeay, W. S. "A Few Remarks Tending to Illustrate the Natural History of . . . *Mygale* of Walkenaer." *Proceedings Zoological Society of London*, 1834, (Pt. 2), pp. 11-12.

Mygale blondii of Santo Domingo climbs trees, takes the newly hatched birds out of the nest, and feeds on them; that it even breaks the eggs to get at those still unhatched. The same fact is alleged by Perty, to whose work previous reference has been made.

Nearly all modern travelers in Brazil and the adjoining countries repeat the story, probably at second hand. Not so, however, H. W. Bates in his classic book *The Naturalist on the River Amazons*, London, 1863. He describes and figures (p. 161) two birds caught and killed by one of these great spiders. One of the birds was dead, but the other, which lay under the body of the spider, was not quite dead, though it was smeared "with the filthy liquor or saliva exuded by the spider." Bates expressly says that he saw this capture taking place, and that he drove the spider off and secured both birds (the second of which soon died). He adds that this thing was "quite a novelty to the residents hereabouts" [Comitá on the Tocantins]. Bates's figure is herewith reproduced. Presumably it was drawn under his direction.

In a series of papers published elsewhere,¹ I have brought together a number of accounts of spiders' webs so large and strong that birds were caught in them. In none of these accounts was any direct reference made to the eating of the bird by the spider. Indeed, there is reason to believe that the orb-weaving spiders in all likelihood cut the net and let the bulky and feather-protected bird fall to the ground. This actually took place in an experiment conducted by MacLeay (previously referred to) when he in-

serted a bird in such a web. None of these articles was illustrated. However, a popular book by C. A. Ealand (*Animal Ingenuity of To-day*) contains a picture of a bird caught in the web of a huge Madagascar spider. The original reference to this I have been unable to run down. The figure (entirely the concept of the artist) is very defective. The web is too weak to prove a snare for a



This huge South American spider has just caught a bird and is now covering it with saliva. After Bates

bird of the size shown, and the spider is larger and heavier than the bird. It does not seem necessary to reproduce this inadequate figure.

There is, however, one authentic account of a bird caught in a spider's web and devoured. In 1850, Capt. W. S. Sherwill,² when traveling in the Karrakpur hills near Monghyr on the Ganges, chanced upon a number of gigantic webs made by a large red and black spider. A captured spider, when set up, measured six inches across the legs, while the nets measured about

¹Gudger, E. W. "The Most Remarkable Fishing-Net Known—the Spiders' Web Net." *Bull. N. Y. Zoological Society*, 1918, Vol. 21, 1588-90, 2 figs.—"On Spider Webs and Spider Web Fish Nets." *Ibid*, 1918, Vol. 21, 1687-89.—"More About Spider Webs and Spider Web Fish Nets." *Ibid*, 1924, Vol. 27, pp. 94-97. 2 figs.

²Sherwill, W. S. "Note on the Bird-devouring Habit of a Spider." *Journal Asiatic Society of Bengal*, 1850, Vol. 19, 474-75.—*Annals and Magazine of Natural History*, 1851, 2. ser. Vol. 7, pp. 427-28.

five feet across the orb proper, though the guys had a spread of from 10 to 20 feet. Captain Sherwill says:

It was in the web of this very spider that I found the bird entangled, and the young spiders (about eight in number . . .) feeding upon the carcass. The bird was much decomposed and enveloped in the web. . . The bird hung with its head downwards, its wings were closely pinioned to its sides by the entwined web, and it was nearly in the center of the web. The old spider which I secured was above the bird about a foot removed.

SPIDERS THAT CATCH SMALL MAMMALS

Mammals, even small ones, are such strong and active animals, that accounts of their capture are few and far between. The best and most definite data that we have comes from McCook, who investigated the matter at considerable expenditure of time and effort, and absolutely satisfied himself of its authenticity. The phenomenon happened at Lebanon, Kentucky, in 1881, and was written up by Mr. J. W. Hopper, editor of the *Standard and Times*. His account follows:

A very curious and interesting spectacle was to be seen Monday afternoon in the office of Mr. P. C. Cleaver's livery stable in this city. Against the wall of the room stands a tolerably tall desk, and under this a small spider, not larger than a common pea, had constructed an extensive web reaching to the floor. About half past eleven o'clock, Monday forenoon, it was observed that the spider had ensnared a young mouse by passing filaments of her web around its tail. When first seen the mouse had its fore feet on the floor and could barely touch the floor with its hind feet. The spider was full of business, running up and down the line and occasionally biting the mouse's tail, making it struggle desperately.

Its efforts to escape were all unavailing, as the slender filaments about its tail were too strong for it to break. In a short time it was seen that the spider was slowly hoisting its victim into the air. By two o'clock in the afternoon the mouse could barely touch the floor with its fore feet; by dark the point of its nose was an inch above the floor. At nine o'clock at night the mouse was still alive, but made no sign except when the spider descended and bit its tail. At this time it was an inch and a half from the floor.

Yesterday morning the mouse was dead, and hung three inches from the floor. The

news of the novel sight soon became circulated and hundreds of people visited the stable to witness it. The mouse was a small one measuring about one and a half inches from the point of its nose to the root of the tail.

Mr. Hopper not only sent Doctor McCook his printed account as noted above, but in answer to a letter added the following additional note:

As you will see from this account, no one observed the actual entanglement of the mouse. In a very short time after it was first observed, I myself was informed of it, and went to the stable to examine it. This was Monday, August 22d, 1881. The office of the stable is a small room. The desk referred to is something over three feet high, four feet four inches long, and something over two feet wide. From the bottom of the desk to the floor the distance is two feet ten inches. The spider's web extended perhaps three-fourths the length of the desk next to the wall, and covered the bottom of the desk to the width of about fifteen or sixteen inches. It was about three feet long by sixteen inches wide.

You will observe that the narrative in the news slip ends with Tuesday morning, August 23d. My paper, which is a weekly, went to press late Tuesday afternoon. The hoisting process continued all day Tuesday, and employes about the stable say that by dark Tuesday night the mouse was four or four and a half inches from the floor. Tuesday night a meddlesome boy entered the room in the dark and accidentally broke the web, and the mouse fell. Next morning, according to my recollection, the web was brushed away. I greatly regret that the spider was not allowed to complete his work, and that he was not captured and preserved. I was greatly mortified when I found how the affair had terminated.

The sketch here introduced was made to illustrate Mr. Hopper's second definite account. Both these accounts are in turn corroborated by a letter to Doctor McCook from Mr. P. C. Cleaver, in whose office the incident in question occurred. He writes that when he first saw the mouse it was suspended by the tail from the spider's web under the desk, with its toes barely touching the floor, while the spider was in the web about eighteen inches above it. The spider kept working at the mouse until it was raised three or four inches from the floor and it was still alive when Mr. Cleaver went home

at night. He concludes his account as follows:

I left the spider at work that evening at sunset, with orders that it should not be touched. But the web was knocked down that night—by some boys, I think, as a great many were there to see the sight, and my clerk thinks it was lost in that way. The spider, mouse, and web were all gone when I returned to the stable the following morning. . . . I am as sure that the spider caught and raised the mouse three or four inches from the floor by himself without the aid of man, as though I had been present from first to last.

forenoon—the spider having made its thread fast to the end of the tail of the mouse, of perhaps fifty times its own weight, gradually hoisted its prey so that it could barely touch the floor with its front paws, and was still busily “hoisting away” while the mouse was no less vigorously endeavoring to break loose. That afternoon, perhaps near five o'clock, in company with Mr. Hopper, the editor of the *Standard*, I again visited the scene of the singular capture, and found that the mouse had been raised so that the top of its nose was precisely four inches from the floor, as I ascertained by actual measurement with a pocket rule. The spider was still actively at work and the mouse still struggling. The next morning I found the mouse dead, its nose about six inches from the floor, and the spider still at work. The thread was attached to the end of the tail.

McCook was satisfied as to the facts set forth, but sought to obtain specimens of spiders supposed to be identical with the one whose exploits were chronicled above. Some spiders were sent to him from Lebanon. These proved to be *Theridium tepidariorum* and he believed that the spider which caught the mouse was of the same species. Furthermore, McCook experimented with spider webs similar to the above and with mice of various weights and found that the webs would support mice of weights even greater than that cited above. Whether the spider would have eaten the mouse is a matter of conjecture, since the phenomenon unfortunately did not go forward to that point. It is recorded, however, that the spider repeatedly bit the mouse on the tail.

But one other account of the catching of a mammal by a spider has come to light. This is in an interesting book by the Australian writer, E. J. Banfield (*Tropic Days*, London, 1918, p. 36). He found a bat that, having flown into a spider's web during the night, had become so entangled that escape was out of the question. As he came on the scene, the spider (a large one) pounced upon and sunk its fangs in its feebly struggling victim. Not a



Sketch of a mouse caught in a spider's snare and lifted above the floor by threads attached to its tail. After McCook

The Hon. J. Proctor Knott, a representative in Congress from Kentucky at that time, also saw this phenomenon, and confirmed the preceding accounts in a letter to McCook accompanied by the “memory” sketch shown on p. 274. He writes:

When my attention was first called to the matter—about ten or eleven o'clock in the

minute elapsed before the bat was released but it was too late, for it expired immediately. From this account it may be inferred that, if given time, the spider would probably have eaten its victim.

HOW SPIDERS CONSUME THE
FLESH OF THEIR VERTEBRATE PREY

Seeking information on this subject at the time I published my first article, I wrote to Dr Alexander Petrunkevitch, the most eminent student of the Arachnida in America. He did not doubt that spiders caught fish, but hesitated to believe that so small an insectivorous animal could eat a fish. As I stated earlier in this article, none of the accounts in my first paper described the eating of the fish by the spiders, though in the statement about spiders catching tadpoles this was inferred. Doctor Petrunkevitch's reply was published in my first article, but I think it will bear repeating here:

May I add that I am a little in doubt of the possibility of spiders using fish as food for the reason that spiders pre-digest their food by injecting the secretion of the maxillary glands into the wound inflicted by the fangs. This fact has been demonstrated by various observers and is beyond any doubt, at least in the case of spiders feeding on insects. It has been suggested that *Tarantulae* may at times feed on small birds but even that is considered to be doubtful. This does not mean that a spider cannot kill a bird or a mouse or a fish, as it has been observed on various occasions, but it is not likely that any vertebrate is ever used by spiders as food.

Now, however, we have definite data to prove that spiders do feed on vertebrates—on fishes, tadpoles, frogs, snakes, lizards, and birds; and inferentially on mammals. But how do they do

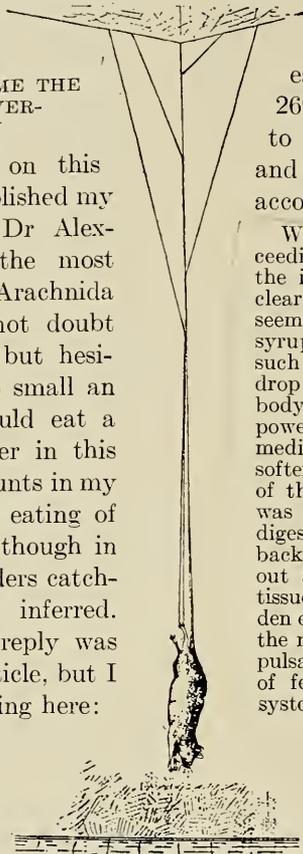
it? Few men have had the opportunity to witness this phenomenon, and of the few, but one had the requisite training to enable him to work out the answer.

This fortunate scientist was Dr. Ernest Warren, whose note on a lizard-eating spider is quoted on page 269. Attention is again called to his photograph of the spider and the lizard. Here is Warren's account of the feeding process:

While the chewing action was proceeding a copious fluid was spread over the tissues of the prey. The fluid was clear and slightly yellowish in color, and seemed to have the consistency of thin syrup. It gushed out of the mouth in such volume that I noticed a good-sized drop run down over the surface of the body of the lizard. This fluid had a powerful digestive effect; it acted immediately on the tissues and rapidly softened them, and the chewing action of the chelicerae and pedipalp-endites was greatly assisted thereby. The digestive fluid was gradually sucked back into the mouth and then gushed out again suddenly over the chewed tissues. This slow in-sucking and sudden expulsion of the digestive fluid from the mouth was maintained as a regular pulsating action during the whole time of feeding. There were about two systoles per minute. The divarication and closing together of the chelicerae were much more frequent, but it was noticed that the out-gushing of the digestive fluid seemed to occur just as a divarication was on the point of commencing. The continuous flow of digestive fluid over and through the tissues of the prey must accelerate very greatly the processes of digestion. The fluid in the course of time

seemed to become heavier and thicker through the solution of the food. In the course of an hour the whole body of the lizard, with head, limbs and tail, had been kneaded into a round, wet mass permeated with the digestive fluid and continuously being chewed by the chelicerae. The singularly flexible and sensitive tarsi of the pedipalps served admirably as hands for pressing the softened body of the prey against the chelicerae.

Spiders have poison glands and silk glands, and it is said there is a small gland in the region of the rostrum. This, even if present, Warren thinks



A "memory" sketch (by Proctor Knott) of the ensnared mouse depicted on p. 273. After McCook

would be too small to produce the large amount of fluid vomited forth; he believes that this comes from the intestinal tract, and that its quantity is fairly constant because of the rhythmical sucking-in and vomiting-forth action of the sucking-stomach. The biting and chewing action of the chelicerae he thinks is merely for the purpose of breaking up the flesh into fragments small enough for the digestive juice to have thorough access. No small pieces are swallowed. As to the action of this digestive fluid on solid flesh, let us hear Doctor Warren.

All the ordinary tissues, including tendons and cartilages, were rapidly softened, and the body became plastic, while the bones were completely disarticulated. The voluntary muscle and all the softer tissues dissolved with great rapidity when the out-flowing and in-flowing currents of digestive fluid gained access to them. After a period of about two and a half hours the body (about $1\frac{3}{4}$ in. long) of the lizard had been reduced to a small, blackish, rounded and somewhat dry mass about $\frac{1}{4}$ in. in diameter. This mass the spider allowed to drop to the ground. On examination some naked limb-bones could be seen projecting from the mass. The mass was steeped in about $1\frac{1}{2}$ c.c. of tepid, distilled water for a couple of hours and was then carefully pulled apart in order to ascertain what tissues had remained undissolved by the digestive fluid. I could detect no trace of voluntary muscle and no epithelial elements whatever, with the exception of remnants of scales. The residue of the body-tissues consisted of shreds of fibrous connective-tissue and of soft sheets of homogeneous substance, which were doubtless the remains of perichondrium and other connective-tissue membranes. There were traces of separate vertebral centra, some isolated long-bones of the limbs, isolated maxillae with teeth, and possibly, angular bones from the lower jaw. The rest of the skeleton was apparently broken up and disintegrated. The bones that were left were entirely clean, and not a vestige of the abundant marrow remained, and the same was the case with the pulp of the teeth.

Warren took some of the flesh covered with the fluid and steeped it in distilled water. He then tested with litmus but found no acid present. It

seemed to be neutral or very slightly alkaline. At any rate, the bones showed no chemical reaction, as they were still firm and entire—undecalcified. As he suggests, the matter is one worthy of further investigation.

On the basis of the data set forth herein, there is ample justification for the following quotation from a letter from Mr. Abraham: "It may interest you to know that some years ago I sent my observations on the fish-eating spider to a spider specialist in the U. S. A. and he declined to publish them until my observations had been confirmed." Surely that confirmation has come in ample measure.

FAMILIES OF VERTEBRATE-EATING SPIDERS

Looking at the matter from the standpoint of the *systematique*, we have evidence that four families of spiders eat vertebrate food. Longest known is this habit in the bird-eating spider, *Mygale* or *Avicularia* of South America, belonging to the family Aviculariidae. Next come *Dolomedes* (possibly several species) in North America and *Thalassius* (at least two species) in South Africa, both belonging to the Pisauridae. Then there is a *Diapontia* of the family Lycosidae in South America, which practices the same habit. And latest of all we have the South African *Palystes* belonging to the Heteropidae. In time and space these families genera, and species of vertebrate-feeding spiders are widely separated, and this habit is evidently one acquired independently in the different families, in the different species, and possibly in the various individuals.



The *Pronuba* moth is white above and dark underneath. The female may be seen grasping a stamen in a somewhat similar position to the one she assumes when gathering pollen from the anthers. The other moth, slightly smaller, is the male

A Remarkable Partnership

BETWEEN THE SPANISH BAYONET AND THE YUCCA MOTH AS SHOWN
IN ORIGINAL PHOTOGRAPHS

BY WILLIAM M. SAVIN

THE striking interrelationship between the moth *Pronuba yuccasella* and the lily known as the Spanish bayonet, (*Yucca filamentosa*), was discovered more than fifty years ago by Professor C. V. Riley, and studied by him for twenty years. It is one of the most interesting illustrations in nature

of that absolute mutual dependence of a plant and an animal organism, which occasionally comes to the notice of naturalists. The moth owes the perpetuation of its species to the lily, and the *Yucca* looks to the moth for its continued existence. Unless *Yucca* is pollinated by *Pronuba* it produces no



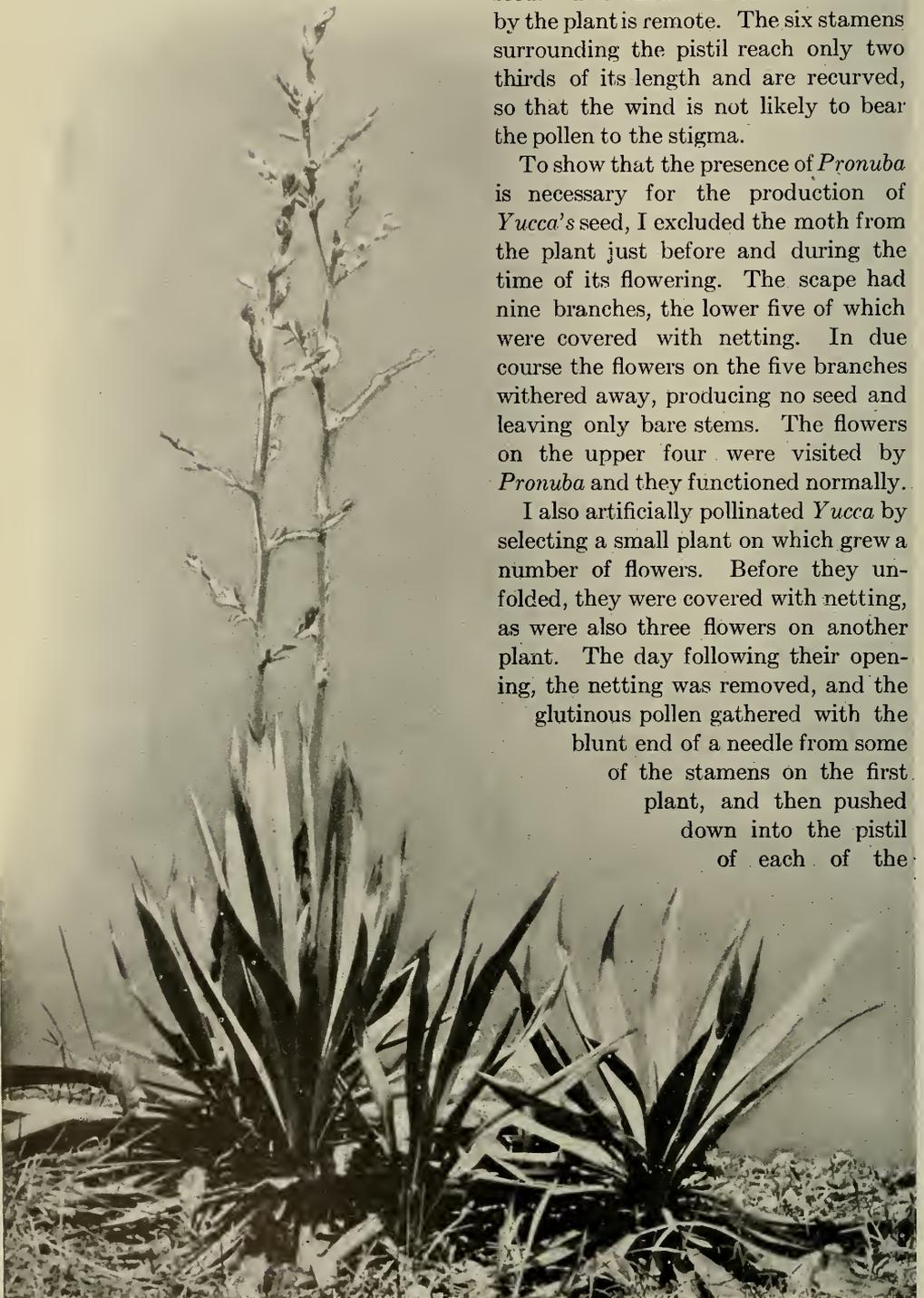
YUCCA LILY IN FULL BLOOM

Though *Yucca filamentosa* is a favorite garden plant because of its beauty, to naturalists its chief interest lies in the interrelation existing between the plant and the *Pronuba yuccasella* moth. These are reciprocally dependent. *Pronuba* is the only insect that visits *Yucca*, and it visits no other plant

seed. The chance of self-fertilization by the plant is remote. The six stamens surrounding the pistil reach only two thirds of its length and are recurved, so that the wind is not likely to bear the pollen to the stigma.

To show that the presence of *Pronuba* is necessary for the production of *Yucca's* seed, I excluded the moth from the plant just before and during the time of its flowering. The scape had nine branches, the lower five of which were covered with netting. In due course the flowers on the five branches withered away, producing no seed and leaving only bare stems. The flowers on the upper four were visited by *Pronuba* and they functioned normally.

I also artificially pollinated *Yucca* by selecting a small plant on which grew a number of flowers. Before they unfolded, they were covered with netting, as were also three flowers on another plant. The day following their opening, the netting was removed, and the glutinous pollen gathered with the blunt end of a needle from some of the stamens on the first plant, and then pushed down into the pistil of each of the



YUCCA PLANT BEFORE THE EXPERIMENT. NOT YET IN BLOOM

three flowers on the second plant. These three flowers were again covered with netting. This pollination was not so skillful as that of the moth's, for only one of the three produced seed. The pod also differed somewhat in shape from those produced by normal pollination, for there was missing the constriction at the middle which is always present when the moth has oviposited in the flower. The female visits the flower simply to perform her mission of ovipositing. She can partake of no nourishment, for her alimentary canal is aborted. She aims solely to perpetuate her species.

Most moths lay their eggs externally on the food plant. *Pronuba*, however, inserts them into the tissue somewhat as the ichneumon fly does. Shortly after oviposition the pistil turns to a darker greenish hue and soon the pod is formed. This is three-lobed and each lobe is divided into two compartments filled with a row of disc-shaped seeds usually numbering between forty-five and sixty. These ripen as the larva develops. Thus the larvæ that hatch from the eggs are found in these compartments with



DURING THE EXPERIMENT. FIVE BRANCHES PROTECTED BY NETTING



YUCCA PLANT AFTER THE EXPERIMENT

The flowers on the five lower branches of the scape, which were covered with netting and not pollinized by *Pronuba*, withered away and produced no seed. Those on the upper part of the plant were visited by *Pronuba* and functioned normally



Three *Yucca* seed pods are shown above, of which the first developed from an artificially pollinated flower, and differs in shape from the other two, which are pollinated by *Pronuba*. The pod to the right is cut to show a row of seeds. Below, to the left, is a pod with openings made by escaping larvæ. Many of the seeds shown have been eaten through the center. At the right is a full-grown larva and below it a larva still partly within its tunnel of seeds

a supply of seed food at hand. As they eat only the tender center of the seed, leaving a periphery, they soon form a tunnel continuing from seed to seed throughout the entire line. They then work their way out of the pod and drop to the ground. Somewhat more than half the seeds in a compartment are disposed of by a single larva. On the seed pods there are numerous holes through which the larvæ have emerged. As there are many pods on the plant, and as the

Yuccas are likely to grow in groups, it is easy to see that many hundreds of larvæ may emerge to appear in that location as moths the following year. For various reasons they, however, do not appear in such numbers.

After dropping to the ground, the rose-colored or greenish larva spins a cocoon in which it passes the winter, becoming a chrysalis about a week before the flowering season of the *Yucca*. It then issues as a moth to continue the work of its ancestors:



A CAÑON IN THE DESERT MOUNTAINS OF ARIZONA. A TYPICAL SPECIMEN OF SUJUARO CACTUS IS SHOWN IN THE FOREGROUND

A Sujuaro Desert in Arizona

BY DELANCEY VERPLANCK

DOTTED with bushes, burrowed by rodents, afutter with birds, this wide expanse of yellowish-gray ground is no mere waste of sand. The ants that make it their home gather seeds in season, but men call it a desert because far too little rain falls there to support any crops of theirs. Its plants challenge the curiosity of a traveler from the rainy parts of the world, for few of them seem even third cousins of the plants he has left behind him. The dark, evergreen, glossy little leaves of the creosote bush, and in a few places the pale leaves of small sage, are the only foliage visible except after rains, and at no season does nature attempt broad thin leaves of any sort in this land of thirst. Apart from the creosote, the general color of the desert growth is dull and grayish; the ocotillo stretches up long gaunt arms, gray and bare, covered with strong thorns; and the many kinds of cactus at their brightest are merely greenish. Thorns so abound that the creosote and the sage are again exceptional in bearing none.

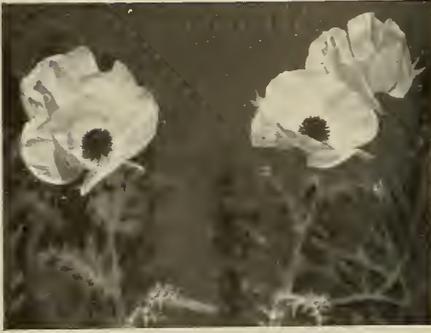
The buckhorn cactus is everywhere. Here and there is the cholla cactus, ready to detach whole sections of its furry-looking, close-thorned stem, which follow its victim—man or beast—and plant new chollas at a distance. More widely separated are large barrel cactus plants, rightly named from their form, bristling with fierce-looking hooks, but too conspicuous to be a real enemy. The slender spider cactus, lurking beside a bush, escapes notice until its long thin thorns are felt. The small paraboloid thumb cactus and the still smaller fishhook cactus, low to the

ground, demand wary steps. The prickly pear, here growing erect, is sometimes, though rarely, as tall as a man, its flat upright segments meeting the light at varied angles with a pretty mottled effect.

Each has its own beauty. King of them all is the sujuaro cactus, a tall fleshy trunk, the few branches, if any, of nearly equal bulk with the main trunk, the whole very heavy with stored water. Though this cactus has the stature of a tree, it is woody only with respect to the slender reënforcing rods within.

To one bringing with him the memory of the graceful elm of wide-spreading shade, the sujuaro seems grotesque at first, but let him live near it for a time and its charm as a tree will penetrate the mind, the sujuaro deserts will seem finished and beautiful, other bushy deserts unmeaning,—as would the dreary flats of France without the cathedral spires. The simple, striking, unforgettable forms it takes might be letters of some quaint alphabet. Within its trunk woodpeckers nest, on its top the mocking bird perches for his morning song, and in its narrow but solid shadow a man is glad to rest in the scorching heat of summer, though he must follow the shadow on its dial of sand as if he were seeking shelter from a telegraph pole.

Bushes are wide apart, the sujuaro at wider intervals, for here a permanent plant of any kind requires much soil from which to draw a little precious moisture. The paloverde is a tree on a small scale, and western people, who have forgotten what a tree is, call groups of paloverde or of the scrubby



White prickly poppy



A branch of the creosote bush

mesquite "the woods." Between the bushes stretch barren earth, sand, or pebbles. A rising ground swept by winds is often covered with the pebbles in many colors fitted together like a tessellated pavement.

Now watch the magic of the spring rains, if any fall. These may be only light showers, but they "make the desert to blossom as the rose." Suddenly little green herbs spring up, and soon the ground is starry with flowers—*Terrestria sidera flores*. The ocotillo is clothed for a brief time with small green leaves, and the ends of its branches put out tassels of red blossoms. A little later poppies appear, making great patches of flame; the

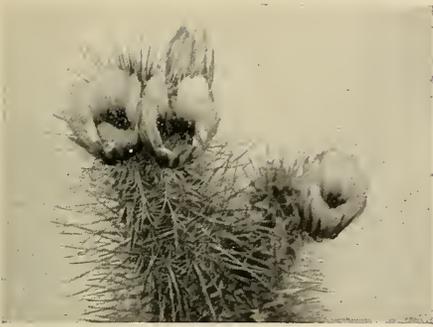
new thorns of the cholla frost it over with white; and every cactus after its kind begins to display its own blossoms, transmitting the sunlight in stained-glass effects. The flowers of the prickly pear are yellow, those of the thumb cactus almost purple, those of the buckhorn vary from yellow to red and from red to brown, according to the individual plant. If the traveler wishes to see this new glory of the desert, he must endure the blazing heat of spring until the paloverde is a mass of yellow bloom humming with pretty brown bumblebees, and the sujuaro bears, on its tiptop, creamy white flowers as big as saucers.

Soon the small annuals will be dry

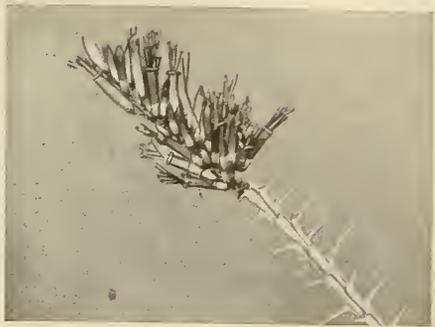


Small desert poppy, "cream cup"

Blue flowers of the desert (*Gilia*)



Ocotillo flower



Flowers of the ultra thorny cactus

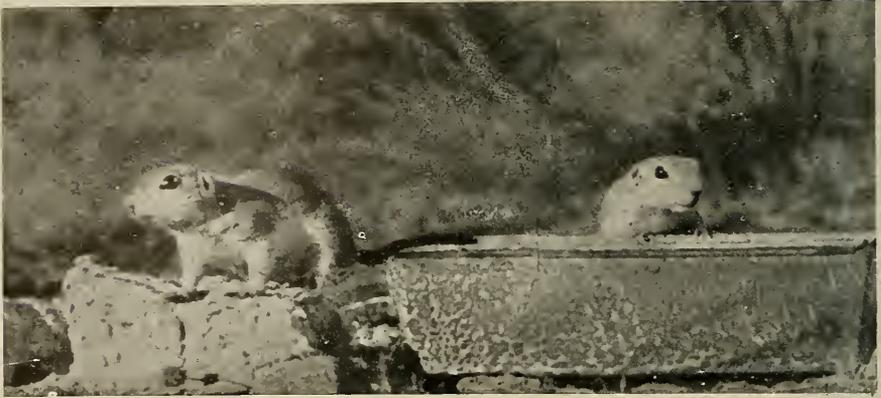
and prickly to walk through, because of sharp hairs, sharp angles, and chaffy projections on the seed vessels. They will shed their seeds and be ready to crumble under the feet, and in course of time the wind will sweep away their brittle stalks.

No one of our party of travelers can now remember where he first heard the barking and howling of the prairie wolves or coyotes at night. It is everywhere in the untamed West, in mountain, in forest, and in desert, one of the soothing sounds of the night, rising and falling, coming near and dying away. Then, out of the deep silence, comes the soft patter of the little feet of the small furtive desert creatures.

It is a wonder how so many animals can exist in this dry land. Birds, it is said, fly to water, reptiles wait for rain, and the small rodents chew the flesh of the cactus,—but we never saw them do any of these things. A very small river crossed this desert only a few miles from our post of observation. All the creatures were thirsty enough. Even the cottontail rabbit, popularly supposed to be indifferent to water, came to partake of that element placed in a pan within its reach, and of course the spermatophiles found it. Every evening at the same hour the Palmer thrasher would say slowly and softly in a fluty voice, reminding one of the preliminary notes of the thrushes—

Yellow flower of the desert (*Gilia*)

Rocky hills in bloom after rain



Unstriped, smooth-tailed spermophiles coming at early evening to get a drink from a pan under the creosote bushes

Pretty. Pretty. Pretty quick. Pretty quick—and then timidly fly down to the pan. A large tortoise that we had picked up in a dry hollow, stretched its neck gratefully to feel the water we poured over it, then drank copiously. Our own water cask was well known to some brown lizards, rather slow, with very long tails trailing behind them, that came out from under our tent-house to drink the spilled drops when they heard us dipping; and one of them even learned to drink from a cup held in the human hand, prettily flashing its vermilion tongue over the white china. Another species of lizard, smaller and more sun-loving, well deserving its name of "swift," or "silver swift," emitted in the heat of the day a faint, birdlike chirp that was very hard to locate. A third member



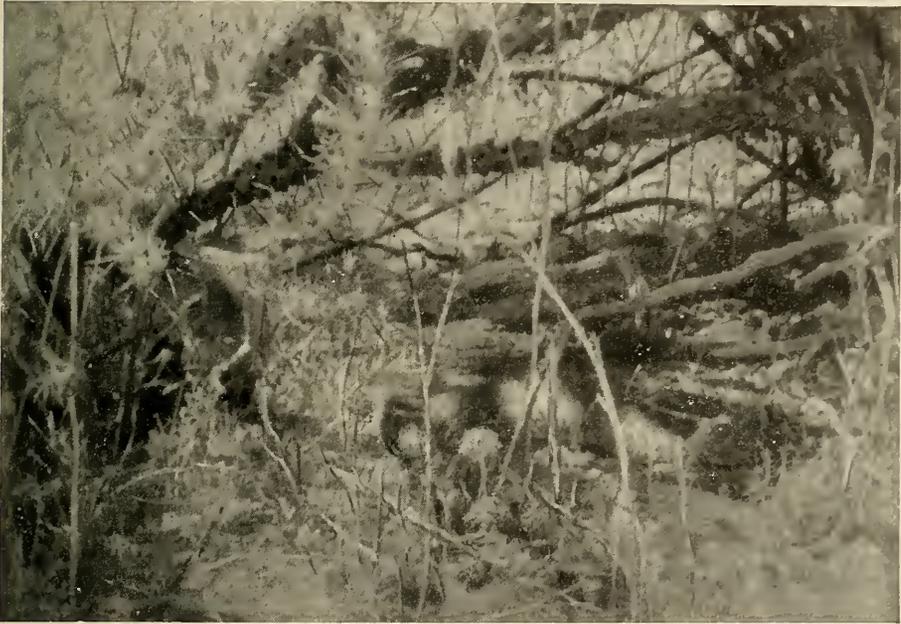
Horned lizard photographed in a tin basin

of the lizard family was the so-called "horned toad." We were amused to see a little girl bestow unwelcome kisses upon one she kept as a pet, turning it over to kiss the throat, the only soft place. A fourth lizard called the "Gila monster," much larger than the others, thick in figure and yellow and black in color, is the only poisonous lizard known. We met no one who had known the bite to cause death but we were told by an eye witness how on one occasion the monster's jaws held his victim with such a bull-dog grip that they had to be pried away with irons. Extreme illness resulted from the bite. We ourselves never saw the creature alive, but we were shown by a man and his wife wintering in the neighboring hills the fourth Gila monster they had shot that season.

People from the eastern United States naturally think of the rattlesnake as living in mountainous places where there are piles of broken rock, but the Arizona desert species is found also in level deserts. Here it makes its home in the holes of rabbits, spermophiles, etc., having, perhaps, first eaten the architect. Miners and others who live in the habitat of the

rattlesnake, speak of it with a fine air of careless contempt. "Oh, rattlers!—they always give warning before they strike. You better not step on one; and sometimes, in digging out rabbits, you're liable to get bitten, but rattlers don't go hunting trouble." On one occasion we found one of the large southwestern rattlesnakes sleeping its heavy postprandial sleep, inconspicu-

lantern appeared desert rats and mice—pretty yellow things with remarkably large eyes. The "trade rat" is an interesting animal. It builds over its burrow a superstructure sometimes several stories high, apparently not used, of sticks, old horns, segments of cactus, including the fearful cholla, also bits of bright tin, and what not. A striking feature of the landscape



Rattlesnake in a cactus desert.—Puzzle picture: find the snake. It lies slightly behind the slender upright growth and has put its head into a hole

ous in the mottled shadow of a bush. When pelted with pebbles it at length awoke just enough to creep to a hole and put its head in, but refused to coil for the benefit of the camera. It was finally shot. Within the snake were two quadrupeds without their skins, probably "gophers."

The spermophile shares the popular name of gopher with other burrowing animals in various parts of the continent, including another rodent in Arizona. At night in the light of our

is the large western jack rabbit—more properly a hare—sitting up to reconnoiter, with long dark ears erect, then bounding with its long legs over the bushes and far away. The wild-cat so closely matches the ground in color as to escape notice so long as it remains quiet. However, from some elevation, as a wagon or the back of a horse, the traveler may chance to obtain a glimpse of the cat as it flees across the open, his attention being first directed to it by the sight of cottontails scat-



Our camp in the cactus desert.—Numerous awnings failed to subdue the glare of the sunlight. In the foreground stands a creosote bush dotted with seed pods. Close beside it is a barrel cactus. The tallest bush or small tree is a paloverde, while scattered between are the plants of the buckhorn cactus

tering in all directions before their enemy.

Close to our camp a tarantula had its den in a hole in the ground. We could peer down and see the creature's eyes flaming out of the darkness like jewels, as it awaited its prey at the bottom. Around the top of the hole it had made a neat fence of fine stalks, into which it wove a bit of thread that we presented. It did not concern itself with us nor did we meet disagreeable insects of any kind.

A desert is a very convenient place in which to study birds, because it affords them little concealment as they hunt about for the manifold species of insects abounding in this region. The flicker and other woodpeckers are conspicuous as they go in and out of their holes high in the *sujuaro*. Other birds build or perch, perforce, in isolated bushes. The black-throated sparrow's

nest is but slightly concealed by the light foliage of the creosote. The wren, the thrasher, and the dove, build in cactus bushes in plain sight, their feet surprisingly indifferent to the thorns, which are doubtless useful in protecting the eggs and young from snakes. The poorwill is scarcely hidden as it sits on the ground in the daytime on the steep side of a stony gully. Flocks of valley quail walk about in the open, conversing at ease in their peculiar way, the narrow loose plume on the top of the head nodding to their brisk steps. Thanks to the sparseness of vegetation, one may reasonably hope to see a hen of this species leading her brood of dainty chicks.

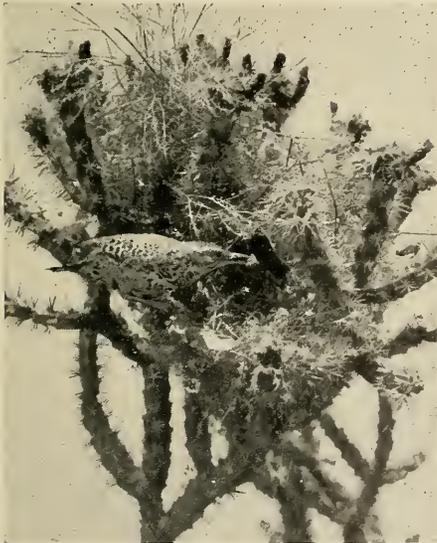
In the spring the nest of the cactus wren, a bird larger than most wrens, is to be seen every few rods in a buckhorn or prickly pear,—a covered nest entered by means of a long horizontal passage.

The photographer placed a camera before one of these nests, and then retired to a discreet distance at the end of the long tube. The parent birds flew about in wild anxiety, scolding in vain at the strange black object and afraid to pass it even to carry food to the crying young within. At length a stuffed bird of their species was placed on their own bush, angering them so much that they forgot the camera, defied the invader from all sides, flew underneath and pecked its feet, poked it warily with their bills, and at last, finding it a humbug, passed boldly in and out of the nest while both camera and man were beside it.

In a thick bunch of mistletoe vine on a paloverde tree nested a pair of plumbeous gnat catchers—prosaic name for a charming bird, songless though it is, a tiny sprite of a creature. The male of this species is clearly distinguished by his black cap. The pair take turns in the weary work of sitting upon the eggs.



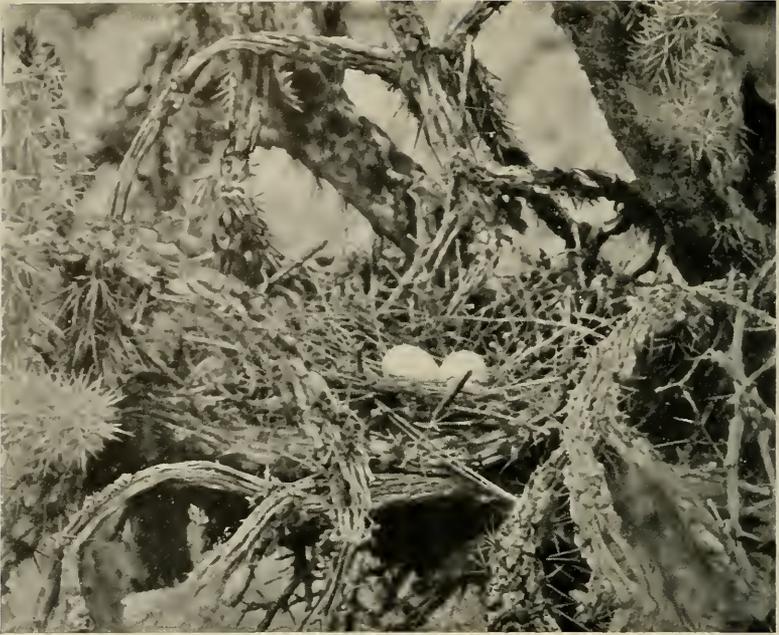
Nest of the plumbeous gnatcatcher in a paloverde tree. The bird's black cap shows it to be a male; that it is a "plumbeous" gnat catcher is shown by the form of the white tip on one of the tail feathers



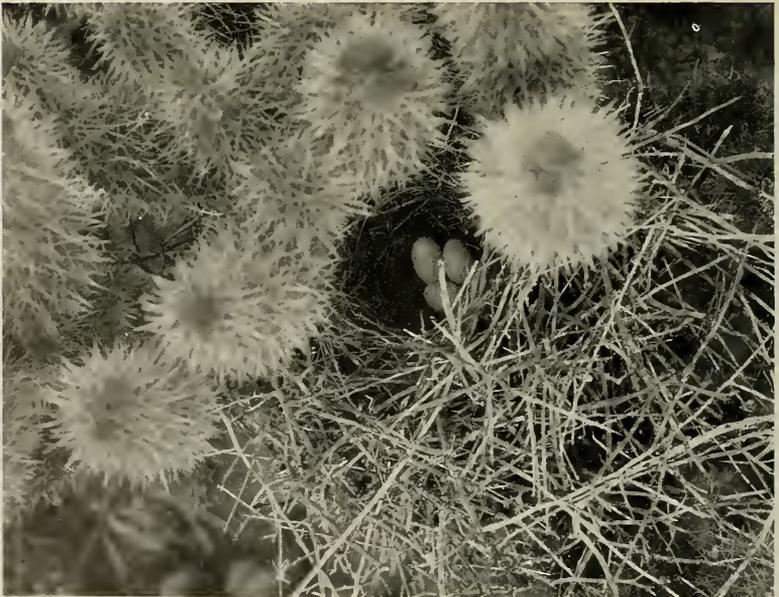
The nest of the cactus wren is a long bag-like structure of slender weed stems that spray out beyond the bag. The young birds are far within. The old bird holds a bee in its bill

The female of this pair would retreat from the nest at our close approach, but the male would hold his ground if we moved softly. He would even accept a fly offered by human fingers or drink a few drops of water from a lady's thimble. Several times we found Mrs. Gnat Catcher in the nest, and halted a few yards away. On these occasions Mr. Gnat Catcher soon returned, perched on a certain twig, softly called his timid spouse from the nest, and took her place to face the danger as a true knight should.

If part of the natural screen of twigs, which ordinarily protects the nest from marauders and desert heat, is removed for the purpose of photography, it is needful to restore both shade and concealment afterward. In this case



Nest of a dove in an old buckhorn cactus.—Observe how the dove has taken advantage of the curves of the cactus branches to support the nest



Nest of a Palmer thrasher in cholla cactus

we were careful to restore the shade but neglected to provide sufficient concealment, and the nest was soon rifled by the bird's foes. To requite the bird's confidence by revealing his citadel to some enemy is rather too bad.

The desert variety of our song sparrow, as well as the chipping sparrow, black-throated sparrow, white-crowned sparrow, and Gambel sparrow, was the most evident of that sweet-voiced company, the American sparrows. The white-crowned sparrow only visits the desert on its way to the uplands. Hawks, shrikes, Say's phœbes, black phœbes, roadrunners, and ash-throated fly catchers were to be seen. Flocks of lark bunting made a brief stay, their black and white plumage very showy against the dun tints of the desert. At twilight the poorwill flew so low over our heads as to seem to threaten us, or it perched close at hand, repeating the cry *poorwill! poorwill! poorwill!* much as if a whippoorwill had omitted the *whip*. At dawn the Gila woodpeckers began to shout from the sujuaro directly over our camp.

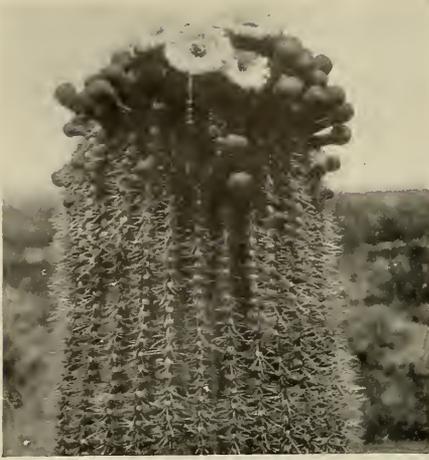
Leaving the level, the traveler may drive across a sea of desert hills, then down the bed of a stream into a narrow defile between crags, and suddenly out into a small triangular oasis, containing cottonwood trees, a garden, and a lawn of green grass, the verdure contrasting sharply with the barren hills that hem it in, and made possible by an unfailling stream of warm water that flows from a rock—Castle Hot Springs.

In parched and glaring Arizona, this little piece of shaded ground, with its rills of pleasant water, is a paradise for birds. In spring the trees are brimful of wings and song. Birds are not much disturbed by a luxurious hotel amid the palms planted by the hand of man, or people bathing out of doors in a pool



Gila woodpecker at its nest hole in the trunk of a sujuaro cactus. It is bringing a moth to feed its young

of very hot water to cure their rheumatism, if predatory man can be convinced that "Citizen Bird" is not to be shot. Associated here, side by side, are the brown birds of the desert and the brilliant species belonging to leafy regions.



Flowers of the tall cactus—sajuaro. They are often as big as saucers

Now some bright warbler is seen, now one of the several western goldfinches, now that quintessence of fire, the scarlet flycatcher. The hooded oriole will "pour a note rich as the orange of his throat"; then we hear "a voice from out that green retreat, at once so loud, so wild, so sweet" that there is no mistaking an old friend, and we are back in a moment across these broad United States to a swampy place in Virginia, where something deep red moves about in a tree near a tangle of cat brier. As we see him here in the field, he might well be that same cardinal. Even when he whistles afterward, outside the oasis, he looks strangely out of place on top of a sajuaro, Arizona cardinal though he is. The differences are slight.

The oriole, at home in the palms, pulls the long fibers fraying from the leaves and sews them through small holes that he makes in the leaves, so that they dangle in a sort of curtain. Then he loops this up, and by further weaving produces a nest, sheltered from sun and rain by the broad roof of the palm leaf. A pair watched by

the camera man nearly all day for several days, seemed never to appear, yet somehow the interior of their nest was finished for use, though on the outside, through lack of time, many threads were left dangling.

Before the arrival of the migratory oriole, its last year's nest was regularly appropriated by the house finch, a familiar neighbor of man, common in the streets of Arizona towns. The wide miles of desert have thus far protected Arizona from the English sparrow. Alas, that some day those vulgar, harsh-spoken fellows, accidentally shut in a freight car, will successfully cross the desert and, multiplying, will drive the finches with their pleasant song from the neighborhood of men.

A cañon wren—a small perky bird, as a wren should be—very different from the cactus wren, would sit on an electric light wire directly over a balcony of the hotel, and sing his clear, sweet song that "trips down the scale," then go to his nest built in the hole where the wire entered the house. The song was more effective over in a neighboring



The wild spineless cactus, the original of Burbank's spineless variety



Nest of Arizona hooded oriole under a palm leaf. The bird weaves its nest with long fibers frayed from the leaves. A detail of the stitches is shown in the insert

high-walled cañon when, perched high overhead, the tiny musician filled with his piping the great cathedral of rocks.

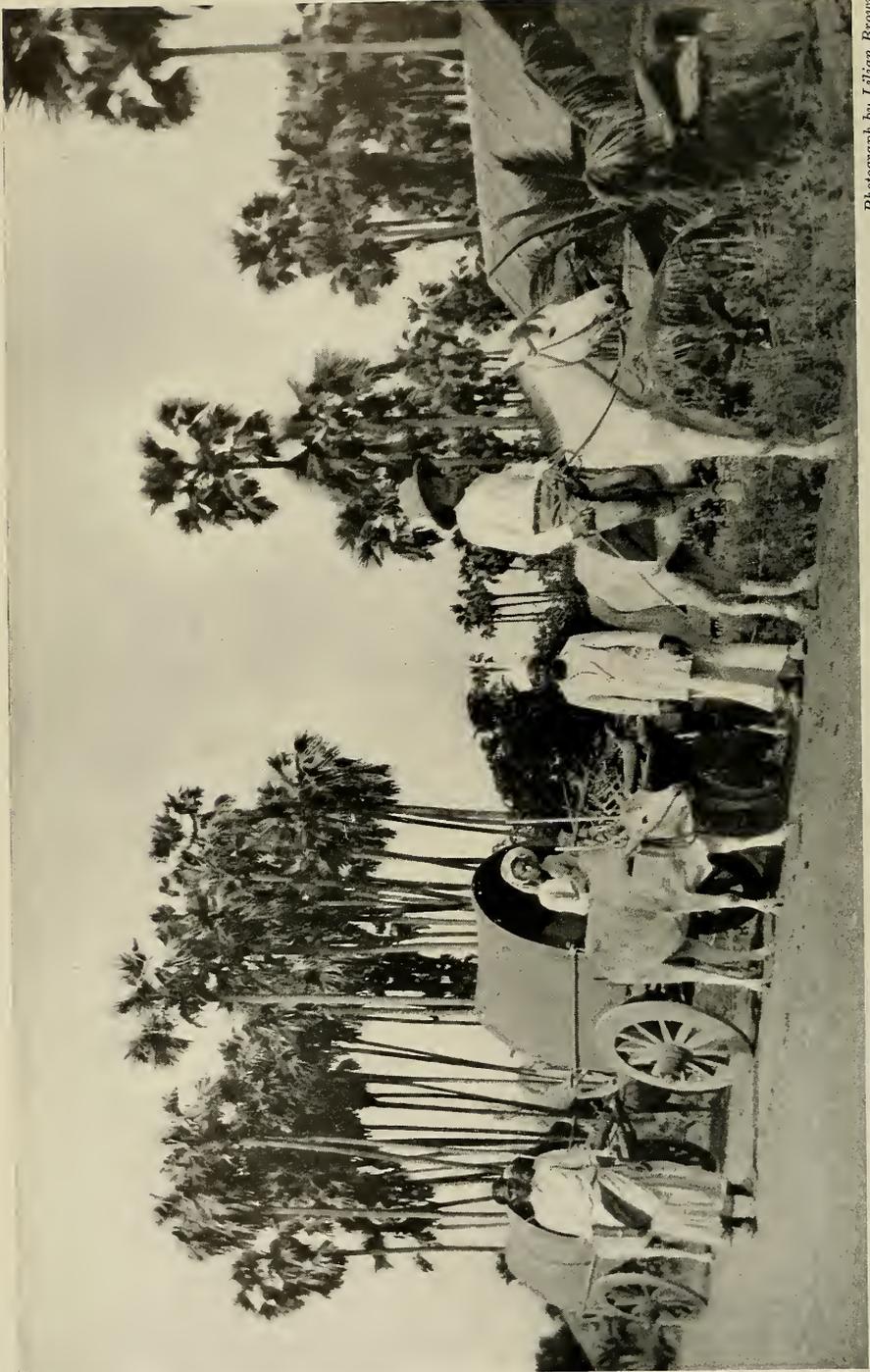
In this cañon grew the wild spineless cactus,—the species that was the original of Burbank's spineless variety.

In the same cañon a humming bird had built her nest, secure from snake and quadruped, in a vinelike bush that dangled from an overhanging portion of the cañon wall and swayed with the breeze produced by a slender waterfall below. Now and then she would leave the nest for a moment, and it was pretty to see her, suspended motionless on her wings, drinking the thin water that crept down the overhanging rock. The male humming bird is a deserter.

This desert is not after all a lonely

place, not uninhabited. Some one has said that the animal world is the true world and man an interloper.

Usually in the sunsets over the desert, the clouds are very few, very small, and very bright, floating in a wide, clear glow. Sunset is followed by a beautiful upright streak of white in the west, the zodiacal light. Night brings stars multitudinous and splendid, as dwellers in moist lands never see them. Except after a rain, there is no dew, no need of waterproof covering when one sleeps outdoors. It is a joy anywhere to sleep in the open, but especially here,—to lie gazing at those undimmed stars, and then to be wafted into the Land of Nod on a gentle current of air blowing over endless miles of dry, clean desert.



Photograph by Lilian Brown

OUR CARAVAN IN A SHAN VILLAGE NEAR MONTYWA

Our Madras servants, Mary and her husband Doss, in the foreground. Mary died of malaria contracted on this journey. The carts were in size equal to a large packing-case, uncomfortable to ride in, but large enough to carry 600 pounds, which was a heavy load for the little bullocks. The toddy palms, *Caryota urens*, in this section produce most of the sugar used by the inhabitants

Byways and Highways in Burma

By BARNUM BROWN

Associate Curator of Fossil Reptiles, American Museum

BURMA was completely annexed to the British Empire at a comparatively recent date (1886). In size it equals the state of Texas, an area of 262,000 square miles with a population of 12,000,000 people in 1911. The native inhabitants represent four distinct cultural stocks, Shans, Kachins, Karens, Talaings, and several linguistic divisions, the Shans being dominant and most numerous.

There are still extensive areas unadministered, and entire regions are thickly overgrown with jungle, where, off the traveled thoroughfares, transport of impedimenta must be accomplished by bullock carts, coolies, or elephants, for horses are a luxury rarely seen.

The country does not offer the attraction of such rich deposits of vertebrate fossils as are found in India, but those of Eocene age and Pleistocene age already known are of unusual interest, alluring to the explorer who may be fortunate in making new discoveries in unmapped, little-traveled sections. Fossil invertebrates, on the other hand, are abundant in parts, and of inestimable importance as determinant factors in the search for oil.

The economic importance of locating petroleum, minerals, and gems, has been the main incentive for the major portion of the geological work so far accomplished but much of the data secured is of a private nature and unpublished.

The country is rich in minerals. Probably the richest silver-lead-zinc ore bodies in the world are those of the Bawdwin mines in the Northern Shan states. Tin and wolfram deposits are

widespread. Mogok supplies the world with rubies and many fine sapphires, while much of the amber and jade that is manufactured in China comes from Burma.

The physiography is controlled largely by its geology, the great featural units of which may be described as follows:

(1) The Shan plateau, which occupies all of the eastern part of the country and is a continuation of the Yunnan plateau of China, is composed chiefly of Paleozoic rocks and some early Mesozoic strata, with local Tertiary and Pleistocene basins. Folding is complicated but not so pronounced as in the Himalayan region, and in its stable nature the plateau is comparable with the *peninsula* of India. This plateau averages from 3000 to 4000 feet above sea level and terminates abruptly on the west in a well-defined fault that has been traced several hundred miles in a generally north-south direction.

(2) A Central Tertiary series of rocks, bounded by the Shan plateau on the east and the Arakan Yoma on the west. This area, now marked by the course of the Irrawaddy River and its tributaries, is 130 miles wide and 600 miles in length. Invertebrate fossils and the strata containing them show conclusively that it was formerly a great narrow gulf or embayment filled in since the Eocene period by alternating marine and fresh-water sediments in which there is little folding, and that of minor character.

(3) The Arakan-Yoma range and subsidiary folds, of which the geology is little known. Trias-Cretaceous rocks

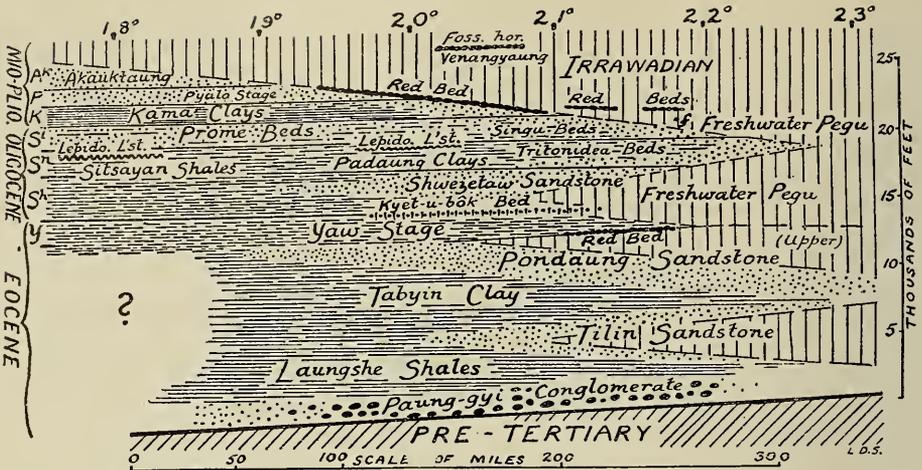
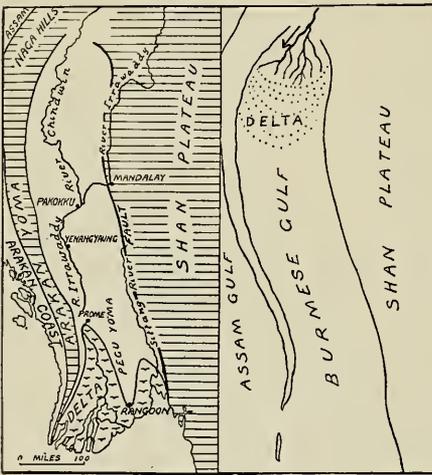


Diagram of the Tertiary strata deposited in the ancient Burmese Gulf, showing the interfingering of marine, brackish, and fresh-water beds in a north-south section. After L. D. Stamp



Left.—The present natural regions of Burma with clearly defined border of ancient gulf. Right.—The same area in early Tertiary times. After L. D. Stamp

form their base and they are flanked by Tertiary strata.

The history of the Tertiary period in Burma is largely that of the infilling of the Burmese gulf by sediments of continental and marine origin,—a gradual filling in by river deposits, with retreat of the sea southward. Recurrent invasions of the sea northward took place

when folding occurred in the Arakan-Yoma mountains on the west.

Many subdivisions or stages have been determined by the invertebrate faunas, but beds that are distinctly marine in the south become brackish farther north, and finally are of purely fresh-water origin in the north.

A north-south cross section of the entire series of beds would show an interfingering of marine, brackish, and fresh-water beds. (See above figure.)

Rangoon, two days' journey by steamer from Calcutta, is the chief port and the commercial heart of Burma. It is essentially a shipping port and administrative city, connected with the interior by a single railway and a line of steamers. Its chief exports are rice and teakwood, the latter worked at the mills by elephants and water buffaloes.

The government is classed under the Indian Bureau, but the officials are semi-independent and happy in their administration, for the wave of popular unrest that broods over India has not to any extent permeated this country.



Photograph by Lilian Brown

The great Shwe Dagon pagoda, at Rangoon, most sacred Buddhist edifice, seen through a latticed arch. It is 370 feet in height and covered with gold leaf, and resembles a huge gold bell

Crowning a suburban hill, the great Shwe Dagon pagoda dominates the landscape, its base surrounded by myriads of minor pagodas. Enshrining, as it does, relics of all the Buddhas, it is the most sacred edifice of the Buddhists, and attracts pil-

grims from all countries of the faith.

Survey officials were very helpful to me, and provided all data and credentials necessary for a trip to the interior where vertebrate fossils are found, but they were doubtful of the success of my expedition.



Photograph by Barnum Brown

Some of the myriad individual pagodas that surround the base of the Shwe Dagon, each containing a statue of Buddha



Photograph by Barnum Brown

Miniature gongs suspended from the umbrella-like crown of the temples tinkle in each zephyr breeze, and the spirits that ride the winds rest on the ornate "Nat" poles placed for them near the temples



Photograph by Lilian Brown

An ornate pagoda with a part of Shwe Dagon seen on the right. The bamboo frame at the left surrounds a pagoda under construction

Leaving Rangoon by rail one night, we arrived in Prome the next morning in time for the daily steamer up the Irrawaddy. In the early days the Irrawaddy Flotilla Company had a monopoly of transportation, and its comfortable steamers still ply all the waterways offering the only connection between many parts. In aggregate tonnage it equals many of the Atlantic lines. Its steamers were transferred to the Persian Gulf during the late war, and did great service in the Mesopotamian campaign.

Scenically the river journey offers but little of interest,—low-lying banks on either side, occasional villages, jungle, and Buddhist temples crowning the few visible hills.

Stops are made at the chief villages, where the Burmese deck passengers—laughing, chattering crowds in brilliant, vari-colored two-piece garments—are loaded and unloaded. Coming directly

from India to Burma, one is impressed with the contrast between the people of the two countries. In India general somberness in dress and soberness of manner and character prevail. Life in all its aspects is serious. In Burma one is immediately struck by the general air of happiness and indolence reflected in the disposition of the people and in their bright-colored garments. Even the monks and nuns in their yellow robes look like canaries. Truly the Burmese are called the happiest people in the world.

As we proceed up the Irrawaddy, rice fields decrease, but an occasional oil derrick is seen on the higher ground at Thayet Myo, at Magwe, at Minbu, and at Yenangyaung a whole forest of them comes into view, for this is the great center of Burma's oil production. A considerable colony of Americans operate the oil fields, which, though



Photograph by Lilian Brown

An unusual grotto pagoda, probably a family shrine, at the base of Shwe Dagon. Each niche, large and small, contains a sitting Buddha



Photograph by Barnum Brown

A CROWD OF BURMESE PASSENGERS WAITING TO GO ABOARD THE STEAMER AT A LANDING PLACE ON THE IRRAWADDY
Men and women are dressed alike in brilliant vari-colored silk skirts and white jackets, a vivid picture against the tropical green foliage



Photograph by Lillian Brown

"GIVE US THIS DAY OUR DAILY BREAD,"—IN THIS CASE, RICE

Every housewife prepares a certain amount of food for the monks or nuns, who eat but once a day and come early for their dole. As the line passes by, the woman of the house gives a spoonful of rice to each monk



Photograph by Lilian Brown

A Twinza, or Burman hand-dug oil well at Yenangyaung. The Burman, protected from gases by a kerosene-can helmet with air tube attached, goes down 300 feet to dip up oil in buckets

they have passed the zenith of their production, still supply the largest quantity of oil in the Far East.

This is the most arid section of Burma, with an annual rainfall of less than twenty inches, and scanty desert vegetation; a marked contrast to the luxuriant jungles that border the upper and lower reaches of the river.

A few hours' journey above Yenangyaung one comes to Pagan, an ancient city with thousands of ruins extending for twenty miles along the river. It is said that in the day of Pagan's glory 3000 pagodas and monasteries could be counted. Some of the ancient pagodas were enormous structures built in various styles of architecture. Traces of Hindu influence were apparent in

some of the pictorial decorations. The most notable examples are kept in repair by the government.

Decay in a Buddhist structure does not necessarily imply great age, for, according to Buddhistic belief, everything is transient, and no individual may obtain merit by repairing a temple built by someone else; hence the most elaborate building soon goes to pieces. The modern city of Pagan is celebrated for its lacquer industry.

A short distance up the river lies Pakokku, headquarters of the district of that name. From this point we started into the jungle. The Commissioner gave me a unique document calling upon all headmen to supply carts, coolies, eggs, chickens, etc., at

fixed rates, an *open sesame* that was of great assistance, extending to the remotest part of his district. Equipment and supplies were rigidly reduced to minimum necessities, for this was to be an arduous journey through jungle and over mountains with and without trails.

Plump little bullocks pulled the tiny carts with a maximum load of from four to six hundred pounds, while a day's journey was eight or ten miles, usually to the next village, where other carts were secured, nor could the jungle people be induced to go beyond a short fixed distance. To them money is no inducement, a contrast to my experience in India. They require little from the outside world. Bamboo furnishes material for their houses and enters into a variety of uses; the soil produces



Photograph by Barnum Brown

A "Nat" house in the jungle. The Burmans are Buddhists but most of them revere "Nats," good or bad spirits of the trees, mountains, homes, etc. The spirits are propitiated by food offerings placed in these miniature houses each morning

peanuts and rice in favorable places, and the toddy palm yields sugar. In almost every village there is a Pungyi



Photograph by Lilian Brown

A traveling store in the jungle. The merchant walks from village to village, followed by coolies carrying his wares. Near the zhat building on the left is a tall "Nat" pole surmounted by the Brahmany goose, sacred bird of the Burmese

Kyaung (monastery) with a zihat (shelter) alongside for travelers.

For several miles beyond Pakokku the strata are of the Irrawaddy and fresh-water series, lacking vertebrates and with but few invertebrate remains. Near Myaing, however, a new system of rocks appears, the Pondaung Eocene beds. They are sandstones and aggregate several hundred feet in thickness, with intercalated clays near the top. Conformably overlying them is a bed of clays fifty feet thick, brilliantly colored red, blue, and yellowish-white. Where continuous and on edge, the color blends into a purplish "rainbow" streak, but to the westward it is soon lost to view in the jungle. Vertebrate fossils were found exclusively in this layer.

Near Bahin a complete skull and jaws of a rare little anthracothere were found, sufficient incentive to follow this elusive "rainbow" through seventy-five miles of increasingly thick teak-bamboo jungle, where the beds would appear here and there, but rarely continuous for a hundred yards. Due to erosion and earth movement, the layer would appear sometimes on the right, sometimes on the left of where it was expected, my only guide a faithful continuation of characters in the underlying sandstones.

This horizon corresponds in age to the Uinta beds of the western United States and to the Irдин Manha of Mongolia, but its fauna, so far as known, is much more limited than either. Anthracotheres (piglike animals), titanotheres (aberrant rhinoceros-like animals) and rhinoceroses comprise the mammals. Alligator vertebræ were most numerous, but often many days' search went unrewarded by even fragments of bone.

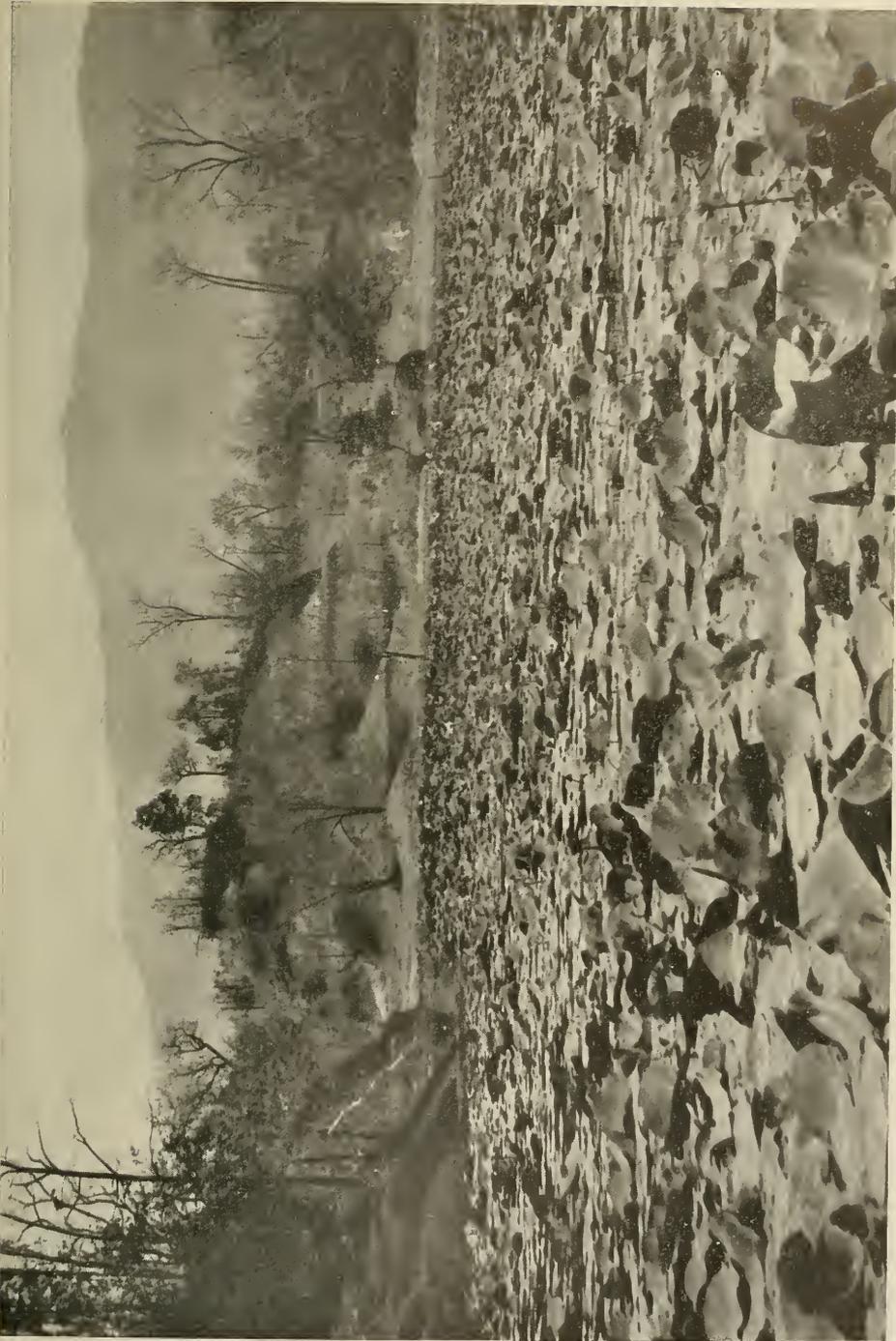
As we approached the higher Pondaung hills, spring was advancing with

riotous colors. The bamboo was not yet in leaf; but many trees were covered with sweet-scented blossoms, while others were festooned with varieties of brilliant orchids. More shades of green, brown, and red may be seen in these woods than have ever been produced by the art of man. In north temperate zones foliage is most brilliant at the end of the season, but in Burma the leaves pass through all gradating colors in the spring. The enormous teak leaves, two feet in length when fully open, first appear on the young trees as waxy, brilliant red spikes, changing in color to bright green as they open to full size.

Often at first in the dense bamboo I searched for human habitations, led on by the crowing of a rooster, but, when I drew nearer to the sound, a bright-colored cock would scuttle into the underbrush, while the drab-colored hens flew away—wild jungle fowl, some species of which it is believed were ancestral to our domestic fowl. Few other birds, rarely a rabbit, and occasionally a barking deer, were seen. North of Myin the rare tsine are fairly numerous. Night is heralded by *Tuc, tuc, tuc, tuc; Tuc'-tu, Tuc'-tu, Tuc'-tu*, the call of a large tree gecko, easily heard a quarter of a mile away.

Few villages are seen in the hill districts, but in the lowlands the population increases, although never so numerous as on an equal area in any part of India. The village life, customs and costumes of the different races are quite distinct, but everywhere one remarks the fat, healthy babies, and the fact that women are dominant in all phases of society. They are the merchants as well as the managers of the household.

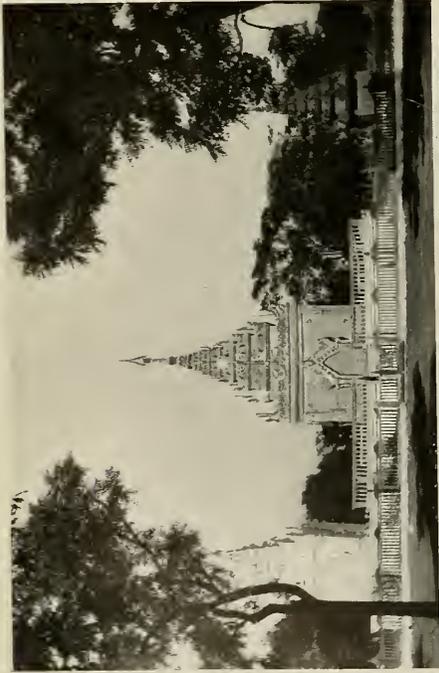
Monywa, on the railway, was the end of our 150-mile bullock-cart jour-



Photograph by Barnum Brown

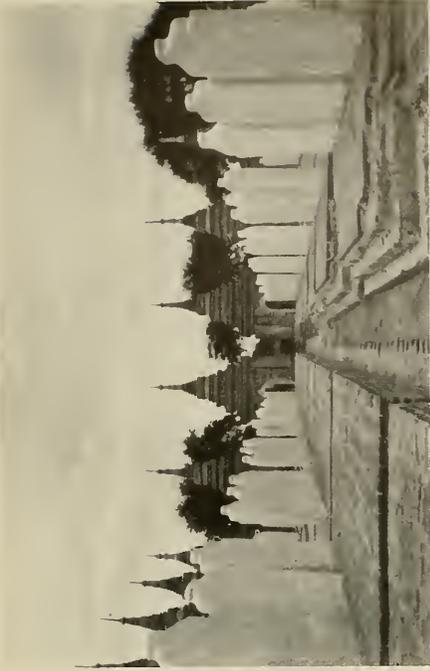
A LOTUS POND NEAR WETCHA

A patch of Pondaung Eocene fossil-bearing clays beyond, with the Pondaung Hills in the distance. These thin clay beds, fifty feet thick, were brilliantly colored but rarely exposed in areas of this size. Like a rainbow streak the beds curve through the cloud of bamboo-teak jungle, appearing at infrequent intervals



Photograph by Lillian Brown

Mosaic glass tomb of King Mindon Min, in the fort at Mandalay. This fort and the king's palace are preserved by the British Government



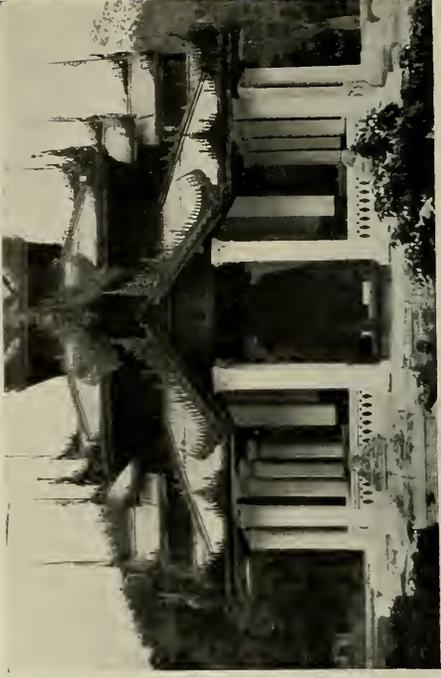
Photograph by Lillian Brown

Buddhist scriptures engraved on 729 stone tablets near Mandalay Hill. Over each group a pagoda is built



Photograph by Barnum Brown

The great pagoda at Mingun, discontinued at a height of 250 feet



Photograph by Barnum Brown

The great bell at Mingun, the largest in the world that rings, is sixteen feet across the mouth, and thirty feet in height



Photographs by Lillian Brown

BURMESE TYPES IN CHARACTERISTIC COSTUME

Left.—A Shan jungle maiden, short and erect with broad shoulders and slender hips, extremely graceful of carriage. The features are decidedly Mongolian. Center, Karen girls, Mongoloid in features, but lacking the freedom and grace of the Shans. Their necks are elongated by the masses of metal rings decreed by custom. Wrists, ankles, and knees are similarly adorned. Right.—Kachin girls in native costume. In stature they are much shorter than the Shans, finer-featured, and a timid people. The short heavy skirt is woven by each woman. Around the waist there are dozens of loose thin bamboo hoops. The jacket may be purchased cloth, usually adorned with immense silver buttons. Large silver neck rings complete the toilet

ney, where I received news of vertebrate finds near Mandalay. For several miles above and below Mingun, opposite Mandalay, are seen the most typical exposures of the Irrawaddy beds in Burma, and here I found rare elephant jaws and palates.

In this vicinity all the prominent mountain peaks are crowned with pagodas, while nestled among the hills are innumerable ornately carved Pungyi Kyaungs (pronounced Poongi Chaungs), the homes of monks and nuns, fittingly secluded for meditation. Bamboo and teak-log rafts float past on the way to the mills; occasionally one goes by loaded with rice, while countless native boats with elaborately carved sterns sail up and down. On the banks are enormous mango trees, and at Mingun one sees the ruins of a mammoth pagoda, planned to be the largest in the world, but discontinued at a height of 250 feet because of faulty construction.

The sites of several ancient capitals border the river in this vicinity. Mandalay, the last, was surrendered by King Thibaw to the British in 1885 without firing a gun. The fort and the

quaint wood palace of the former king, with its seven-storied entrance denoting royalty, are preserved by the government. The huge market and many silk bazaars are places of attraction in the city. On Mandalay Hill there are celebrated pagodas, and near by is an interesting enclosure containing several hundred stone tablets resembling gravestones, on each of which is carved one of the precepts of Gautama Buddha.

A few miles above Mingun the sandstones of the Irrawaddy beds are eroded away and are again seen in only a few limited patches below the second defile, from which point northward the river trenches the harder ancient limestones. The scenery becomes more rugged and, at the first defile, quite picturesque.

From Bhamo several trails lead up to the Yunnan plateau of China. It was my purpose to search there for a possible continuation of the Eocene beds to the north, but the second day out, malarial fever compelled me to return to a hospital in Mandalay, thus terminating further work for the season in Burma.



Photograph by Lilian Brown

East meets West on the Shan border. Barnum Brown at the hot spring, Momauk

The Born Naturalist

By HENRY FAIRFIELD OSBORN

President of The American Museum of Natural History

THE Naturalist, like the Poet, is born, not made. One of the first of the many lines of inquiry before the aspirant to a scientific career is the self-examination: "Am I really a born naturalist? Am I so endowed by nature that I can follow in the footsteps of the men, great and small, who have made Science what it is?" At best the path is long and very arduous. If we read the biographies of Faraday, of Maxwell, of Agassiz, of Huxley, of Pasteur—in brief, of any of the great physicists, chemists, geologists, or biologists whose names adorn the literature of Science—the early pathway is ever seen to be a hard one; yet, as Huxley observed of his voyage on the "Rattlesnake," it is a good thing to be on the bare bones of existence.

There must be within the aspirant, therefore, not only the will to conquer, but also a belief, through a kind of spiritual and intellectual impulse, as well as of self-confidence, that he can conquer in the end. Even with this will-power and self-confidence a long period of apprenticeship and self-experiment is necessary before the novice can positively ascertain whether he has the natural gifts that will enable him to achieve even a reasonably successful career in Science. As a teacher of forty years' experience, I have watched some of my students for many months, and in some cases for two or three years, before I could satisfy myself that they possessed the rare combination of powers which makes a man of Science.

First of these essential qualifications is a keen sense of truth; the second is a

keen power of observation; the third is the rare power of creative imagination; the fourth is indomitable will, energy, and determination—the spirit that delights in difficulties, that loves obstacles, that is not dismayed by any scientific ascent, however lofty, or by any scientific descent, however deep.

Once satisfied that he has his fair share of these four absolutely necessary endowments, the student may enter his career with real confidence, and if he maintains his health and keeps alert his moral and his spiritual senses, his chances of ultimate success are more than reasonable—they are bright. There is very little room at the bottom of a scientific career, because every profession is crowded with men and women who have made a wrong choice, who should have been content with some other walk in life. Halfway up, however, there is plenty of room in every scientific profession, room for extremely useful lives as teachers, if not as investigators. As one approaches the top he becomes more and more isolated and may finally stand alone, like the great Spanish neurologist, Ramon Y. Cajal, who has lately retired loaded with honors. The career of Cajal is typical. As a student he did not discover in all medical literature one Spanish name of note, and he made a vow to place his own there, if possible. Entering a most difficult field of research, he pursued it with ardent determination, his imagination suggesting hundreds of new applications of the scientific method discovered but only partially employed by the Italian, Golgi. Now every medical work in every language

in the world gives page after page to the work of Cajal.

To attain this end the student, if he is destined for research, must be born with an intense interest in one certain aspect of science; his tastes must not be too diffuse; he must especially love either the rocks, the fossils, the plants, the insects, mathematical problems, psychology, chemistry, astronomy—the one special form of scientific inquiry that attracts him most is that in which he will best succeed. This discrimination may not come at first; it may come after many trials, as in the case of Pasteur, who started as a crystallographer, continued as the discoverer of a new universe of ultra-microscopic life, and ended his life as founder

of the great science of Bacteriology.

Finally, the student must be endowed with the stimulus of ambition. Many young men are gifted in all the other essential qualities but are totally devoid of ambition. In many cases the professor in charge of their work has to supply the ambition, to spur, to stimulate, even to threaten the student in order to compel him to continue a certain piece of research and push it through to the point of publication.

May I therefore close this informal disquisition on "The Born Naturalist" with the lines from Milton's *Lycidas*:

Ambition is the spur
That doth the clear spirit raise
To shun delights
And live laborious days.



Courtesy of Charles Scribner's Sons

Louis Pasteur in his laboratory

“Impressions of Great Naturalists”: A Review¹

BY WILLIAM K. GREGORY

Curator, Comparative and Human Anatomy, American Museum

THE great naturalists of the Victorian age, Lyell, Darwin, and the astronomers, revealed to mankind a new earth and a more spacious universe, and freed the human spirit from the shackles of the old Semitic cosmology. Then Pasteur and his successors opened the way of salvation for the human body and mind through the discovery of nature's laws and the mastery of her forces. These and other great leaders still speak to us through their imperishable writings, but inexorable Time has removed them from the stage, and the great inspiration that came from personal contact with them is no longer possible. Fortunately for us, the author of *Impressions of Great Naturalists* is not too young to have sat at the feet of Huxley, or to have lived in the stirring times when Darwin's works were winning recognition and acceptance; nor is he too old to infuse the learning of the fathers with the ever new spirit of a growing science. Fortunately, too, he has had the most intimate acquaintance with leading representatives of all the special fields of Natural History in its broadest sense, and in this book he makes them live again before us, letting us behold the men themselves, the forces and circumstances that determined their careers, and the broad results of their life work.

In the essay on Alfred Russell Wallace the author shows how nature and nurture conspire to make a naturalist, and what a fortunate combination of heredity and environment produced the co-discoverer of the principle of Natural Selection. We follow Wallace on his wanderings in the tropical

forests, and observe him absorbing vast accumulations of facts, which were afterward discharged in the form of great generalizations: on the significance of colors in nature, on the origin of adaptations through natural selection, and the like. The excellent personal relations of Darwin and Wallace, each recognizing the other's independent discovery of the principle of natural selection, make pleasant reading.

The essay on Darwin traces the formative influences at Cambridge and on the voyage of the *Beagle* around the world, which prepared Darwin for his truly sublime discoveries. A quotation is necessary to do justice to the subject: “Where his great predecessors Buffon and Lamarck had failed, Darwin won through his unparalleled genius as an observer and reasoner, through the absolutely irresistible force of the facts he had assembled, and through the simplicity of his presentation. Lacking the literary graces of his grandfather, Erasmus Darwin, and the obscurity of Spencer, Darwin was understood by every one as every one could understand Lincoln. It is true the cause was immediately championed by able men, but victory was gained, not by the vehement and radical Hæckel nor yet by the masterly fighter Huxley, but through the resistless power of the truth as Darwin saw it and presented it. It was not a denial, as had been the great skeptical movement of the end of the eighteenth century, but an affirmation. Darwin was not destroying, but building; yet at the time good and honest men trembled as if passing through an earthquake, for in the whole

¹Osborn, Henry Fairfield. *Impressions of Great Naturalists*. Published October, 1924, by Charles Scribner's Sons.

history of human thought there had been no such cataclysm." The author shows that Darwin's achievements are so unique that his place in the history of ideas is next to Aristotle, who preceded him by more than two thousand years.

In the addresses on Joseph Leidy and Edward Drinker Cope the author presents a vivid contrast between these two American naturalists of the highest rank, whose very names are unknown to the great majority of Americans today, notwithstanding their far-reaching discoveries in the vertebrate fossils and vertebrate evolution. Leidy, who patiently described and accurately figured many of the first fragmentary mammalian fossils from the ancient deposits of the West, is described as a master of details, of accurate description, of finished workmanship, cautious and sure, rarely venturing generalizations, but leaving a treasure house of splendidly collected evidence for evolution. Cope, on the other hand, was brilliant, daring, combative, highly original, wandering at will over the vast fields of vertebrate zoölogy and vertebrate palæontology, incautious, often hasty and inaccurate, but a great organizer and innovator in classification.

In his accounts of John Burroughs and John Muir the author attempts to harmonize with his favorite doctrine of the "racial soul" the striking differences between these two distinguished nature lovers. This doctrine is in brief that the human soul is full of reminiscences, responding to past conditions and experiences, and especially that it differs widely in different strains and races. Though the tribes of psychologists and anthropologists may sneer, the author thinks it well supported by direct evidence, and an inevitable inference from what is known of the hereditary and physiological bases of behavior in different races of animals.

In "The New Order of Sainthood" the author, almost unintentionally, answers those who preach that modern biology is hostile to the religious spirit. He traces the rise of two great lines of thought: the Oriental movement, concerned only with man's relation to God and lacking curiosity about natural law, and the Western movement of the search for natural law. The latter movement after deploying widely among the Greeks, subsided for a long period; then, regaining power in Copernicus and Galileo, it culminated in Darwin. Here man is again perceived as a part of nature; in the study of nature man finds his physical well-being; man through nature becomes the redeemer of physical man. The author argues that, if the laws of nature are manifestations of the divine power and wisdom, the attitude of the Church toward these laws should not be hesitant, defensive or apologetic, but active, receptive and aggressive. Considered in this way, the great scientific inquiry of the latter half of the nineteenth century is not destructive, but constructive, purifying, and regenerating; it takes us back to the lost faith of Saint Augustine, which found in nature a manifestation of the divine order of things. The author consequently regards Pasteur, the devout and humble investigator, as the greatest benefactor of mankind since the time of Jesus Christ, and, showing how Pasteur was inspired by religious sentiment, pleads that he be enrolled among the saints and enshrined in our cathedrals.

At this time, when many deny the very fact of evolution and would gladly erase the names of Darwin and his successors from the memory of mankind, Professor Osborn's book comes as a fresh revelation of their sublime version of man and of nature.

NOTES

IN MEMORIAM

The American Museum of Natural History has recently suffered a severe loss in the death of Dr. Louis Robert Sullivan, associate curator of physical anthropology, who passed away April 23, 1925, in Tucson, Arizona, where he had taken up temporary residence in the hope that his health might be restored.

At a joint meeting of the Scientific and Administrative Staffs of the Museum held April 27, 1925, minutes and resolutions were adopted from which the following is quoted:

"During the early years of Dr. Sullivan's service he laid the foundations for a career in human biology, seeking training in general anatomy with Doctor Gregory at the Museum, with Professor Huntington in the College of Physicians and Surgeons, and in general anthropology with Professor Boas at Columbia University, receiving the degree of Doctor of Philosophy in 1922. But from the first, his genius for research was evident, there appearing at short intervals seven important studies in racial anatomy, each of which made a worthy contribution. The war interrupted these investigations, Doctor Sullivan entering the army in 1918 and serving until general demobilization.

"His first important field undertaking was a study of races in the Hawaiian Islands, an investigation in which the Bishop Museum of Honolulu coöperated with the American Museum. In all, eighteen months were spent in the Islands, during which time a careful study of the native Hawaiian type was made and practically all the children in the public schools of Honolulu examined. For the most part these data remain unpublished, yet two memoirs, dealing with the anthropology of the Polynesians, have been completed.

"Soon after Doctor Sullivan returned from Hawaii, a severe illness confined him to his home for many months. The nature of this illness called for a change of climate, so as soon as he was able to travel he set out for the Southwest, taking up temporary residence in Tucson, Arizona. There his health improved so markedly, that within a few months he took up active field-work, making studies of Mexicans and Indians in the vicinity. Later he carried on archæological explorations in New Mexico and finally set out on an exhaustive racial survey of the western Indian tribes, following up new character determinations of his own devising. With a wealth of new data he returned to the Museum, May, 1924.

"Unfortunately, shortly after his arrival in New York, his health took a more serious turn, necessitating his return to Tucson, where after a lingering illness he passed away.

"BE it therefore resolved, that

"WE, the Scientific and Administrative Staffs of the Museum, record with sorrow the death of our colleague, Doctor Louis Robert Sullivan, a man of sterling character, of fine personal qualities, and a scientist of unusual promise. His field technique was admirable; no one was ever more successful with native peoples than he. In the exhibition work of the Museum he showed not merely skill and originality, but positive genius. Thus, it is, that though still young in years, he leaves with us in passing, the impress of a great life.

(Signed)

ROY WALDO MINER,
Secretary, Scientific Staff.

(Signed)

HENRY J. LANGHAM,
Secretary, Administrative Staff."

THE GRATACAP MEMORIAL TABLET.—A marble tablet, a memorial to Louis Pope Gratacap, the first curator of mineralogy in this Museum has been placed upon the north wall of the Morgan Memorial Hall by the New York Mineralogical Club. The tablet which measures 24x18 inches, carries a bas-relief portrait of Doctor Gratacap, and is inscribed with the following words:—

In memory of Louis Pope Gratacap, Scientist, Author, Educator, for forty-one years in charge of the Minerals of this Museum, and for sixteen years Curator. Erected by the New York Mineralogical Club.

The tablet was dedicated on the evening of May 13, Dr. George F. Kunz, president of the Mineralogical Club making the presentation address. President Henry Fairfield Osborn accepted the tablet on behalf of the Trustees of the Museum.

The Rev. Henry Mottet, a classmate of Doctor Gratacap, spoke eloquently of his personality and magnetism.

Mr. Lewis Sayre Burehard, praised his gifts as a writer and a public speaker.

Mr. Herbert P. Whitlock paid a tribute to his scientific and curatorial work.

Other speakers were Mr. Julius Hyman, Mr. Joseph L. Bittenweiser, Mr. George C. Lay, and Mr. Gilman S. Stanton, treasurer of the New York Mineralogical Club.

ASIA

ARCHÆOLOGICAL RESEARCH IN ASIA.—The archæological reconnaissance work contemplated by the American Museum this season in connection with the Third Asiatic Expedition under the leadership of Roy Chapman Andrews, promises sure rewards. The region to be investigated is the Gobi Desert and the adjacent foothill country bordering the southeastern base of the Altai Mountains, fully 1000 miles inland from the nearest Pacific shore. It is true no actual proofs are available that either our human precursors or even any very early man ever roamed these now partially desiccated regions; nevertheless, a number of circumstances contribute to the fair prospects.

The first occasion for faith in this new venture is that Walter Granger and other members of the previous expedition into the Gobi in 1922-23 have already found in two or three places traces of a Neolithic culture.

A second and very weighty circumstance is that considerable collections of both Paleolithic and Neolithic data have been excavated in recent years by a number of investigators, Russian, Swedish, French, and American, in several of the regions bordering on Mongolia. Thus the American Museum possesses a good Neolithic series from the headwater district of the Obi River, across the Altai Mountains to the northwest. Professor Petrie of Vladivostock University is reported to have found, in the Lake Baikal district to the north, a culture deposit containing no less than nine different levels. Dr. S. M. Shirokogoroff, whom I had the pleasure to meet in Shanghai, tells me of having found several Neolithic deposits along the banks of the Amur River to the north and northeast. In Manchuria, to the east, it is well known that Dr. Torii of Japan for a number of years has made extensive Neolithic discoveries. To the southeast, south, and southwest, in China proper, Dr. J. G. Andersson, mining adviser to the Chinese Government and a most enthusiastic archæologist now for all of seven years, has made numerous exceedingly important discoveries, in both caves and open sites, of what he considers a late Neolithic industry called by him the Yang-Shao culture after his first type station in Honan. In passing, it may be remarked that the ceramics of this culture, which is proto-Chinese in general character, shows definite connections with Mesopotamia and southeastern Europe and

puts an end to the supposed complete independence and isolation of Chinese civilization. M. C. W. Bishop, of the Freer Gallery of Art in Washington, D. C., together with his American and Chinese associates, has likewise made discoveries bordering on the prehistoric in both northeastern and north central China. Finally, last year Teilhard de Chardin, of the Natural History Museum in Paris, together with F. Licent of the Hoang Ho-Pai Ho Museum of Tientsin, made the first positive and very remarkable discovery of a Mousterian industry beneath the loess of the Ordos region, i. e., the country of the great bend of the Yellow River. Paleolithic implements associated with extinct animal remains were found here, not in one but in several different localities in the Kansu and Shensi provinces of China proper, as well as in the adjacent parts of Inner Mongolia. With prehistoric finds so numerous in all directions around the territory we expect to explore, it seems certain that similar discoveries await us. Whether or not we shall find evidences of Quaternary man depends, of course, on the presence or absence in the region of actual Pleistocene deposits; but of post-Quaternary or Neolithic man we can be fairly certain.

In view of the above considerations two things stand out prominently. One is that the old traditional idea of Asia as the mother or inspirer of human culture, if not the actual cradle of the human race, seems in a fair way to be realized. The other is that scientific investigation is not dead in Asia—no, nor even asleep. We may perhaps flatter ourselves with the thought that the Third Asiatic Expedition has spurred on both local and foreign interest, for example, in archæology. It is to be hoped, therefore, that the Expedition itself may contribute something to the elucidation of human prehistory in northeastern Asia and thereby indirectly to the better understanding of the anthropological problem presented by pre-Columbian America
—N. C. NELSON.

THE JAMES SIMPSON-ROOSEVELT EXPEDITION of the Field Museum of Natural History sailed from New York May 11 for a destination in southern and central Asia. Colonel Theodore Roosevelt, Jr., and his brother Kermit are in charge of this expedition, which has for its purpose the collecting of mammals and other forms of animal life in a region which hitherto has been worked very little. These two sons of a father well known as a

gifted naturalist and a keen observer have inherited no little of his love of exploration. Kermit Roosevelt especially has hunted large game in many continents and has had in mind for a long time the possibility of this expedition now under way.

Mr. James Simpson, a trustee of the Field Museum, has made it possible for the Roosevelts to undertake this expedition by providing the necessary support, and the party goes well equipped for general zoological collecting. Mr. George K. Cherrie is a member of the party and his experience over so many years of museum collecting is a guarantee of the important results certain to be obtained by this undertaking. Additional collectors will doubtless be engaged in India or possibly in England, and no efforts will be spared to make the collections as thorough as possible.

The ultimate destination of this important expedition of the Field Museum is the Pamir region and the Thian Shan Mountains. In order to arrive at this inaccessible section of Asia the expedition must cross the Himalayas by way of Leh and the Karakoram Pass. The party will land in India at Bombay. Details of the movements of the expedition cannot be given in advance since they will be governed by local circumstances, but it is expected that work can be done in other parts of Turkestan and adjoining regions. Because of the uncertainty of local transportation and other matters which may not be foretold in advance, the duration of the trip may be prolonged beyond the present year.

The region to be worked is best known to the general public because it is the home of Marco Polo's sheep, one of the very finest of the wild sheep with splendid curling horns. Other large game only slightly less spectacular includes the Thian Shan ibex (*Capra sibirica*), the horns of which are much larger than those of the European ibex; the Markhor (*Capra falconeri*), most prized by sportsmen of all the wild goats; and the long-haired tiger.

Although some collections have been made in this region and papers have been published based on these results, the area under question is for American museums practically *terra incognita* and there remains considerable to be done there for the modern zoological collector. The results should be especially interesting when compared with collections made on the north by Roy Chapman Andrews and the Third Asiatic Expedition and those

made on the south by the Faunthorpe-Vernay Expeditions.

The Roosevelts take with them the best wishes of all for a successful expedition, and natural science in this country is most fortunate in having for patrons such men as Mr. James Simpson who are so generous in the matter of financial support.

"ARCTURUS" EXPEDITION

Recent letters and radio messages received from the Arcturus Expedition of the New York Zoological Society, under the leadership of Mr. William Beebe relate many interesting experiences and give a vivid idea of the remarkable progress made by this expedition.

After a fruitful voyage to the Sargasso Sea the expedition proceeded to the Galapagos Islands where, through a combination of in-shore and deep-sea collecting, as well as diving in shallow water with the aid of the submarine hood, they were fortunate in securing unique observations and unrivalled material for museum exhibition. The expedition returned to Balboa in the Canal Zone early in May and is now taking on supplies for a second six weeks' trip to Galapagos to complete their oceanographic work in the Pacific, after which they intend to make a final visit to the Sargasso Sea on the way home.

The readers of *NATURAL HISTORY* will be interested in the following extract from a letter received from Professor W. K. Gregory of the Museum staff who accompanied the Expedition, dated S. Y. "Arcturus," Balboa, Canal Zone, May 7, 1925:

"As to life on the 'Arcturus,' we have enjoyed more sights and wonders per diem than I can digest and assimilate. The volcanic eruption was most satisfying and sky-filling as we watched it toward nightfall. Yet it was much less exciting than the Tide Rip and the swarming fishes of the shallow bays as seen from under water. The Tide Rip was a great strip of troubled waters, due to the dislocation of normal currents, which met and clashed before us. Myriads of small invertebrates were swept together in this way, and sea birds fluttered after the fish, but the most imposing item was an enormous troop of dolphins that came charging down towards us in crescent formation.

"The fishes of a volcanic island as seen under water from our diver's helmet would make a wonderful museum group. Background of

great volcanic blocks seen through the misty distance, float of irregular blocks carpeted with soft-hued sessile invertebrates. Center of interest, an immense flock of hundreds of 'cowfishes' (really surgeon fishes), mostly streaming leisurely past, but many of them browsing on the rocks. Yellow tails waving languidly—perhaps as a warning 'keep off my spikes.' Tiny nibbling mouths with close-set horselike teeth and extremely long horselike snout surmounted by bulging cowlike eyes. On one side the observer trying to see through a cloud of small silvery fish, **swarming** like gnats about his helmet—a friendly young sea lion peering curiously at him,—dozens of impudent fat-bodied pomacentrids with protruding lips and pickaninny eyes almost nibbling his legs. In the rocks a few cautious blennies (about ten inches long) slithering along the surface and diving instantly into the crevices when the observer shoots his spear at them.

"Thanks to Beebe's many-sided and at the same time intensive interests and methods we are getting many slants on the vast, interconnecting complexes of inshore, pelagic and deep-sea faunas. Direct observation of the fishes living in their own medium, study of fishes in aquaria, examination of stomach contents, dissection of muscles, etc. of fresh material, identification of fish, recording of many measurements and constant study of ecologic interrelationships, evolution, development, correlation of larval and post-larval stages with adult forms, keeps us all busy and leaves no time for *ennui*; to say nothing of exploring parties when on shore and the whole business of collecting. Oceanographic work includes sounding, taking temperatures at different levels, dredging, trawling and surface hauls, all going on almost every day when at sea. On the side of herpetology it was a great day when I first saw and photographed *Conolophus* and *Amblyrhynchus*, picking them up, watching them run or swim. *Ambly*. undulates in the water like a mosasaur. I grieve to admit that I caught a lovely garter snake and then let him escape while I was trying to put an *Ambly*. into the bag! I hardly dare begin to talk about the deep-sea fishes—but Isabel Cooper's and Dwight Franklin's excellent color drawings will give you a vivid idea of them.

"We are now refitting for our next trip southward, returning here about June 20. I hope we will take in the western end of the Sargasso Sea on the way home."

EXTINCT ANIMALS

A MAMMAL FROM THE DINOSAUR BEDS OF MONGOLIA.—The red sandstone formation in Mongolia where the Third Asiatic Expedition found the famous dinosaur eggs has yielded another treasure. The expedition obtained besides the eggs a great series of skulls and skeletons of dinosaurs, mostly of the *Protoceratops* which laid them. Also they found a number of predacious dinosaurs and a few skulls of primitive lizards and other smaller creatures. One of these supposed small reptile skulls, when cleared from the rock, has turned out to be a mammal, belonging to one of the rare and little-known kinds that lived in the Age of Reptiles.

These Mesozoic mammals are exceedingly scarce, mostly known only from a few jaws and scattered teeth, and with one exception this is the oldest mammal skull ever found. It belongs evidently to the order Multituberculata, a group of very primitive mammals which lived through the Age of Reptiles and became extinct at the beginning of the Age of Mammals. Their true relationships are in dispute, whether to the marsupials or to the monotremes, or neither, and it is hoped that this specimen may help to settle the problem.

It is a point of interest that Professor Cope many years ago suggested as a possible reason for the extinction of the dinosaurs that these multituberculates developed the habit of sucking their eggs, for which purpose their teeth and jaws seemed to be very well adapted. Professor Osborn has already described a peculiar kind of dinosaur found near the eggs and strongly suspected of egg-stealing habits. Now we find that this ancient dinosaur nursery was infested by another marauder which, although diminutive in size, has long been under a similar suspicion.—W. D. MATTHEW.

INVERTEBRATES

A LUMINOUS SPIDER.—One day in Central Burma the trail in the jungle was exceptionally difficult. It was long past noon when I realized that the return journey would be equally long and tiring.

Camp lay on the other side of a high range of hills, and there was a short cut from the main trail that would save several miles, but this trail was faint. I reached the supposed cut-off about dusk and followed it upward. Darkness came on swiftly and my pony began to stumble. Somewhere we had missed the trail. I dismounted, confident of reaching camp without a trail, for at intervals I could

still glimpse the crest of the hills and I knew my general direction.

Fireflies sparkled here and there. Presently, a few feet away, I saw a ball of light as large as a man's thumb. This ball was stationary. Tying the horse, I advanced as carefully as possible toward the object, which was surrounded by thorny bushes. It did not move and I pressed the brush aside until I

Burmese never leave their houses after dark on account of their fear of spirits, so it is not surprising that the natives had never seen one, but some other traveler may be so fortunate as to capture one of these spiders.

The place where I saw the specimen was between the villages of Kyawdaw and Thikyaing, Pakkoku District, about 120 miles



Photograph by W. Hickle

Typical Burmese jungle like that in which the luminous spider was found. Shan beaters for a hunting trip in the foreground

was directly over it; then I struck a match. There in full view was a spider, his large oval abdomen grayish with darker markings. Still he did not move, and as the match flame died out, his abdomen again glowed to full power, a completely oval light, similar in quality to that of the fireflies. Remembering native tales of poisonous insects and spiders, I wrapped a handkerchief around one hand, parted the brush with the other, and when close enough, made a quick grab. Alas! The handkerchief caught on a stick before I could encircle him and my treasure scurried away. I followed as quickly as possible, but the light soon disappeared under stones, brush, or in some burrow, for I never saw it again.

Many nights I searched in the jungle and questioned natives and white officers who had passed through that district, but apparently no one else had reported a luminous spider, nor can I find record of any known elsewhere.

west of Mandalay, Burma, in April, 1923.

Three possible explanations have been advanced: (1) That the spider had been eating fireflies. Dr. E. Newton Harvey on one occasion believed he had discovered a frog that was luminous, but on dissecting the frog, he found that it had eaten fireflies, which glowed through the belly with considerable intensity. This explanation I think could hardly apply to the case of the spider, which would not have eaten the fireflies whole, but would have sucked only the juices of the body. Moreover, my examination was deliberate and the light was a perfect oval, conforming to the outline of the abdomen. Had the luminous material been eaten, the light would have been diffused through the entire body. (2) An infection by luminous bacteria or fungi. Considering the habits and food of spiders, this explanation likewise seems improbable. (3) A true luminous organ.—BARNUM BROWN.

DR. HORACE W. STUNKARD, research associate in parasitology, American Museum, and this year on leave of absence from New York University, has returned from Europe, where he has been working on the parasitic worms collected by the American Museum's Congo Expedition. From the first of September until the first of January he was at the Molteno Institute for Research in Parasitology, Cambridge University, Cambridge, England, and during the months of January and February at the Laboratoire de Parasitologie, Université de Paris. These laboratories were selected as the most suitable places in which to pursue the investigation since their large collections of African forms would aid greatly in determining the classification of doubtful or poorly preserved specimens. The facilities of these two research laboratories, probably the best of their kind in the world, were freely placed at the disposal of Doctor Stunkard, and the American Museum wishes gratefully to acknowledge the kindness and courtesy of the directors, Professor Nuttall of Cambridge University and Professor Brumpt of the Faculté de Médecine, Université de Paris.

The collection was shipped to Cambridge and Paris and returned to the Museum without breakage or loss.

The study of these worms has progressed favorably; all the trematodes have been identified and a good start has been made on the cestode material. A number of forms new to science have been carefully described, and certain difficult helminthological questions, notably that concerning the tape worms of the rhinoceroses, have been elucidated. The study is being continued at the Museum, and we are looking forward to the time when this large and valuable collection will be available for exhibition and use.

While in England, Doctor Stunkard published a short paper describing *Oculotrema hippopotomi* n.g., n.sp., from the eye of a hippopotamus. This is the only polystome known to infest either birds or mammals. One of the five specimens of this new form is deposited in the parasitic collection of the department.

Another paper, "The Present Status of the Amphistome Problem," an outgrowth of the Congo trematodes, is soon to appear in *Parasitology*.

REPTILES AND AMPHIBIANS

DR. G. KINGSLEY NOBLE, curator of herpetology in this Museum, has recently been

elected a Fellow of the American Association for the Advancement of Science.

THE AMERICAN SOCIETY OF ZOOLOGISTS has appointed Dr. G. Kingsley Noble as one of its representatives on the Advisory Board of *Biological Abstracts*. Doctor Noble was recently invited to the Wistar Institute for their Twentieth Anniversary of the Organization of the Advisory Board. At this meeting "Changes in Methods of Biological Research as Pursued by Museums and the Possibilities of the Future" was discussed by Doctor C. E. McClung. This address was a plea for further coöperation between museums and the biological research workers of America.

MAMMALS

At the Seventh Annual Stated Meeting of the American Society of Mammalogists held April 7-11 in the United States National Museum, Washington, D. C., Mr. H. E. Anthony, associate curator of mammals of the Western Hemisphere, American Museum, presented the following addresses: "The Pleistocene Mammalia preserved in the ashbeds of Punin, Ecuador; "A Statistical Summary of the Mammalia of the Antilles."

SCIENCE OF MAN

UNDER THE TITLE "THE PUNIN CALVARIUM: CRANIOLOGY" by Louis R. Sullivan and Milo Hellman, there has been issued by the department of anthropology, American Museum, a report on a human skull discovered in Quebrada Chalan, Punin, near Riobamba, Ecuador, in the course of a zoölogical expedition under the leadership of Associate Curator Anthony. The point of greatest interest in connection with this find is its position in the midst of Pleistocene fauna. Messrs. Sullivan and Hellman examined the skull in great detail and find that it is basically related to the Australian and Melanesian type and fundamentally different from the prevailing Mongoloid American Indian types.

THE VON LUSCHAN ANATOMICAL COLLECTION.—In 1924 the American Museum purchased the important osteological collection gathered together in the course of many years by the late Professor Felix von Luschan of Berlin. The collection consists of more than 5000 human crania, some eighty complete human skeletons, a good teaching collection of anthropoid skeletons and skulls, and a comprehensive anthropological library. The human crania and skeletons have been checked

with Professor von Lusehan's original catalogue, which has been translated and reorganized, the crania placed in individual boxes, and the entire collection classified geographically, by continents, countries, provinces, etc., and placed in storage cabinets so that it is readily accessible to students.

THE DANIEL GIRAUD ELLIOT MEDAL

THE COMMITTEE ON AWARD has recommended to the National Academy of Sciences that the Daniel Giraud Elliot Medal and honorarium be presented to Abbé Henri Breuil for his work in collaboration with MM. Capitan and Peyrony on the volume *Les Combarelles des Eyzies*, as the most outstanding contribution of 1924 in this field.

Henry Breuil is the foremost living authority on the archæology of the Old Stone Age. His chief contributions are the recognition of the great Aurignacian upper palæolithic stage and the monographing of the entire Stone Age art of France and Spain. *Les Combarelles des Eyzies* is the last and most comprehensive of a series of epoch-making monographs. It describes and interprets every one of the 291 figures discovered in the Grotto of Combarelles. Abbé Breuil is a man of untiring endeavor, great personal courage, and deliberate and philosophic interpretative powers. He is the head officer of the Institut de Paléontologie Humaine, which was founded by the late Prince of Monaco.

This is the eighth award of the distinguished Daniel Giraud Elliot Medal, previous presentations having been made as follows:

- 1917: Frank M. Chapman—Distribution of Bird Life in Colombia.
 1918: William Beebe—A Monograph of the Pheasants.
 1919: Robert Ridgway—Birds of North and Middle America (Part VIII).
 1920: Othenio Abel—Methoden der Paläobiologischen Forschung.
 1921: Bashford Dean—A Bibliography of Fishes (Volume I).
 1922: William Morton Wheeler—Ants of the American Museum Congo Expedition.
 1923: Ferdinand Canu—North American Later Tertiary and Quaternary Bryozoa.

HENRY FAIRFIELD OSBORN, Chairman,
 American Museum of Natural History
 CHARLES D. WALCOTT,
 Smithsonian Institution.
 FREDERIC A. LUCAS
 American Museum of Natural History.

NEW MEMBERS

SINCE the last issue of NATURAL HISTORY the following persons have been elected members of the American Museum, making the total membership 8234.

Patrons: MR. LOUIS J. HOROWITZ AND MRS. LOUIS J. HOROWITZ.

Fellow: MR. HARRY F. KNIGHT.

Life Members: MESDAMES HENRY J. FISHER, MONROE D. ROBINSON, HENRY ALVAH STRONG; MISS CLAUDIA LEA PHELPS 2D; PROF. H. VON W. SCHULTE, DR. ISAIAH BOWMAN; MESSRS. WILLIAM C. ATWATER, MAX FARRAND, ALBERT R. FISH, CHARLES LEYLAND HOLMES, FREDERICK HUSSEY, E. PENNINGTON PEARSON, KERMIT ROOSEVELT, JULIUS ROSENWALD, GEORGE B. ST. GEORGE, D. B. WENTZ, HAROLD C. WHITMAN, J. MACY WILLETS, AND HENRY WITTMER.

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FISH—REPTILE NUMBER

JULY-AUGUST

The July-August number of **Natural History** will appear under the joint editorship of Dr. E. W. Gudger, associate in ichthyology, and Dr. G. Kingsley Noble, curator of herpetology. In this number there will be a finely illustrated article by Dr. David Starr Jordan on the giant game fishes of Santa Catalina. Professor E. Newton Harvey, of Princeton University, will describe the luminous fishes of the Banda Sea and will explain the curious mechanisms by means of which they screen off their lights at will. These remarkable organs are entirely different from those of all other luminous fishes. Mr. J. T. Nichols will figure and describe some interesting Chinese fresh-water fishes from the collections of the Third Asiatic Expedition. Professor E. C. Starks, of Stanford University will recount some personal experiences of a fish collector in Brazil. Dr. E. W. Gudger will contribute another of his series of unique articles. Mr. C. M. Breder, Jr. of the New York Aquarium, will give a vivid description of some of his experiences while studying the reptiles and amphibians of Darien, "The Tale of an Old Gator" will be told by Mr. Percy Viosca, Jr., Dr. C. C. Mook will recount "The Ancestry of the Alligators," and personal experiences of Mr. W. Henry Sheak, "With Big Snakes in Captivity" will take the reader behind the scenes of the traveling menagerie. For the first time the life story of the red salamander will be made known as the result of the observations of Mr. S. C. Bishop. An interesting account of "The Iguanas of Bitter Guana Cay" by Mr. A. M. Bailey will be illustrated by unique photographs, and with the aid of a fine series of duotones Dr. G. Kingsley Noble will give NATURAL HISTORY readers "Glimpses of the New Hall of Reptile and Amphibian Life" in the American Museum.

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For the enrichment of its collections, for the support of its explorations and scientific research, and for the maintenance of its publications, the American Museum of Natural History is dependent wholly upon membership fees and the generosity of friends. More than 8000 members are now enrolled who are thus supporting the work of the Museum. The various classes of membership are:

Associate Member (nonresident)*	annually	\$3
Annual Member	annually	\$10
Sustaining Member	annually	\$25
Life Member		\$100
Fellow		\$500
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NATURAL HISTORY: JOURNAL OF THE AMERICAN MUSEUM

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NATURAL HISTORY



THE
FISH - REPTILE
NUMBER

JOURNAL OF THE AMERICAN
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THE AMERICAN MUSEUM OF NATURAL HISTORY

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THE JOURNAL OF THE AMERICAN MUSEUM

DEVOTED TO NATURAL HISTORY,
EXPLORATION, AND THE DEVELOP-
MENT OF PUBLIC EDUCATION
THROUGH THE MUSEUM



FISH—REPTILE NUMBER

EDITORS

EUGENE WILLIS GUDGER, Ph.D., Fishes

G. KINGSLEY NOBLE, Ph.D., Amphibians and Reptiles

JULY—AUGUST, 1925

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NATURAL HISTORY

VOLUME XXV

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The Bird Number

The September-October issue of NATURAL HISTORY will be a "Bird Number" under the editorship of Dr. Frank M. Chapman, curator of the department of birds. This issue has been planned to show what the members of the department have done lately or are doing, both in the field and in the Museum; to report on our expeditions; to present information in regard to the bird life of the New York City region which will be interesting to the general reader and useful to the special student; and to review general activities in the field of ornithology as they are reflected in the work of other museums and in recently published literature.

The leading article will be by Dr. Robert Cushman Murphy, associate curator, who, returning in November, 1924, to the Pacific coast to resume his studies of marine bird life, encountered there climatic phenomena which possessed for him an especial significance. Mr. Waldron DeWitt Miller, associate curator, will write of the birds of a still comparatively wild portion of northwestern New Jersey; while Mr. Ludlow Griscom, assistant curator, will list the surprisingly large numbers of birds which visit Central Park. Dr. James P. Chapin, associate curator, will present some of the results of his studies of birds in the Congo region, and Dr. Frank M. Chapman will take for his subject the European starling, the early history of which in America is intimately associated with the Museum. Illustrating coöperation between Museum departments, as well as the interrelation of their respective fields, Dr. E. W. Gudger of the department of fishes, has contributed an exhaustive article on "Fishing with the Cormorant."

There will be extracts from the letters and reports of Beck in the Fijis, the Olallas in Ecuador, Benson in Panama, Tate in Venezuela, and Boulton in Angola—all tinged with that spirit of adventure which colors the life of the exploring naturalist.

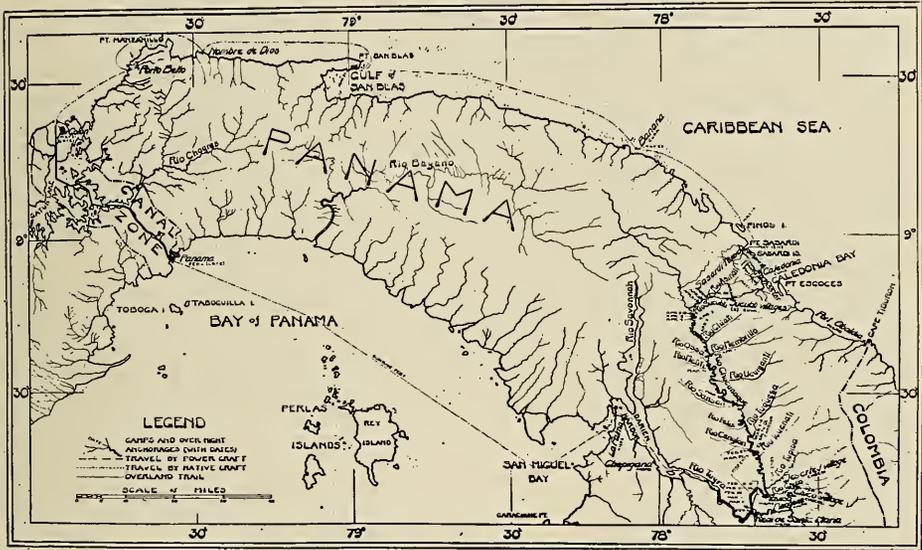
First place under a report on "Additions to Our Collections" will be accorded a pair of the much sought for pink-headed ducks, which we owe to the Vernay-Faunthorpe Expedition. This will be illustrated with a colored plate by Jaques of the Museum staff.

The books reviewed will include Phillips' *Ducks*; Cory and Hellmayr's *Birds of the Americas*, Part III; Mathews' *Birds of Australia*; and Thorburn's *British Birds*. There will also be brief mention of the more important articles in the ornithological magazines.



THE GUARDIAN OF THE TRAIL

The giant toad, *Bufo marinus*, brings us to a halt. In the light of the flash lamps he presents a formidable appearance



The route of the Marsh Darien Expedition of 1924.—The Rio Chucunaque, where most of the following observations were made, is the large river on the right. The map is based upon data compiled by Mr. R. O. Marsh

In Darien Jungles¹

EXPERIENCES OF A STUDENT OF REPTILE AND AMPHIBIAN LIFE IN A LITTLE-KNOWN PART OF PANAMA

By C. M. BREDER, JR.

New York Aquarium

FIELD naturalists are those more or less enviable persons who occasionally have to break away from civilization and plunge into the wilderness, there either to drink their fill of happiness and fresh breezes, or to drain the cup of hardship to the dregs while securing data in regard to some problem of animal or plant life. I was the first in such a rôle ever to have visited that particularly inaccessible part of the Isthmus of Panama drained by the Rio Chucunaque. My problem was to work out the life histories of some of the amphibians and reptiles, to

collect fishes, and to determine as far as possible what cold-blooded vertebrates inhabit this remote section of Panama. As a member of the expedition organized by Mr. R. O. Marsh in 1924, I was generously provided by him with all possible facilities while carrying on this work in the interests of the American Museum.

It is not my intention to report here upon the work of this expedition, nor to enumerate in detail the many pleasant and the few unpleasant events which occupied our time. But looking back upon those six months of travel and

¹Photographs by the author.



Combining new and old methods of transportation.—Outboard motors were attached to native dugouts, making our progress rapid on the lower, open reaches of the Chucunaque. Higher up the river the motors were rendered useless by the low water and river débris

investigation, certain happenings come to mind which may serve as a sample of my own experiences. These events were not always important in themselves, and most took place without the knowledge of my companions. Perhaps some were interesting only because of their setting or associations. My work was carried on largely at night, and the sense of hearing was necessarily relied on more than that of sight. Often I could imagine myself converted into a keen-eared jungle creature slipping quietly through the forests, listening each moment for some new sound to break the stillness.

I remember one particular evening when I settled down just before dusk near the bank of a small stream which flowed into the lower Chucunaque. The short twilight had passed with that abruptness so characteristic of the tropics, and I felt the darkness rushing in upon me from all sides. Harry Johnson, our taxidermist and my companion of the earlier part of the even-

ing, had gone off to run down some unknown howl. While sitting there fascinated by the approaching night, I became aware of a slight rustling in the fallen leaves behind me and thought at first that Johnson was returning. But when the rustling became louder and louder and spread to both the right and left, I realized that there was something unusual about it. There was a peculiar squashy quality in this rustling, quite different from the noises made by the twigs or nuts broken off by monkeys in their arboreal travels. I thought of peccary herds, and knowing that at times they were rather dangerous, I imagined that it might be awkward to be surprised in my exposed position. Seizing my flashlight, I stood up in preparation for what might come. The noise ceased immediately. After some moments of intense silence it began again on all sides of me and this time I did not delay for a moment. The first long flash across the forest floor revealed the sources of these



The field laboratory.—The absence of insect pests and the abundance of amphibian life made camping conditions ideal along the Lower Chucunaque

peculiar sounds. Frogs of all shapes and sizes were beginning to migrate toward the water, literally covering the ground in their jostling haste. There were species of *Rana*, *Bufo*, *Hyla*, *Leptodactylus*, and *Eleutherodactylus* in this hodgepodge of tumbling frogs. Nearer the water I spied the little piping frog, *Phyllobates*, moving in the opposite direction,—away from the streams,—for, as far as my observations go, this species is entirely diurnal. It seemed as though the latter

was moving away to make room for the great hordes of nocturnal anurans which had begun their migrations at the fall of night. As I stood and wondered, some of the larger frogs took up appropriate positions and began to call loudly for mates.

Every night, not far from our camp near Yavisa, one cry arose above all the others. This was a tremendous *Whoop!* which sometimes echoed for more than half a mile through the jungle. Finally the voice was traced

to a large, handsomely marked frog, *Leptodactylus pentadactylus*. The individuals of this species spent their days in solitary burrows which, in some cases at least, they doubtlessly dug for themselves under the great rocks in the



Eyes like brilliant rubies mounted in an emerald frame. The handsomest tree frog of the whole region is *Phyllomedusa callidryas*

forest. At night they emerged from their retreats and whooped loudly to one another, apparently calling for mates. In this they were evidently successful, for many egg masses were found beaten into a froth by the parent frogs and laid in contact with small puddles of water under the heavy growth. Frequently these egg masses covered the water entirely, leading me to believe at first that the eggs had

been merely laid at the bottom of one of the innumerable depressions in the forest floor. These foamlike formations hardened on the outside into a dry crust. Slim-bodied tadpoles hatched from the egg capsules and swam easily about in the liquefying interior of their foamy incubators. The foam method of egg-laying is obviously a successful adaptation to breeding in a region subjected to alternate cloud bursts and droughts. The first falling of the dashing rain of this country shatters the crust on the nest and washes the little tadpoles rapidly into the open streams where they take up a more venturesome existence. On one occasion I watched the entire process of the release of the tadpoles under the whipping of a terrific storm. Although I tried to shelter myself under a clump of palms, I was soon thoroughly drenched. As the rain ended in its customarily abrupt manner, a light breeze sprang up and the sun burst forth from behind the rapidly disappearing clouds. My clothes acted as a kind of evaporation bag, and before I reached camp my teeth were chattering. Although only 8° from the equator, at little over sea level, I suffered more from cold than I ever have in snow-bound New England.

The result of such a rain after the protracted dry season is considerable. The giant forest trees, burdened down by a load of soaking vegetation, frequently crash to the ground. The weight lies not only in their own structure, but in the great masses of vines or "Bahukas" which struggle upward to form the warp and woof of the canopy completely "roofing" the jungle. The same rain which tore open the frog nursery, brought down a giant tree not sixty feet away. The first warning was a gentle creaking and

cracking as the tree listed to one side under the soft caress of the breeze. Then followed a swishing and grinding, as the great Bahukas writhed back and forth like so many serpents in their death agonies. The great tree hung forward supported by its vines, which gave way one after another until the remaining few could hold on no longer. The former dwelling of innumerable tree frogs, jungle fowl, and monkeys, would now soon become the home of countless hordes of wood-boring insects which would gnaw its great bulk into a labyrinth of rotting pulp.

Silence is frequently more awe-inspiring than sound. It is the silence following upon the fall of the forest giant which is clearer in my memory than the vicious swish and slash of the broken branches. Similarly, it was the silence between the cries of the howler monkeys or the calls of the whooping frogs which tingled my nerves more than the sounds themselves. Some of these silent moments of the jungle are difficult to explain. Many a time while I sat quietly beside some stream bed watching the dozens of frogs pursuing their spawning activities, I thought my ears would split from the deafening chorus of the innumerable unmated males. Then suddenly, without warning, this mighty chorus would stop as if given a signal from the leading chorister. The silence — the tremendous silence — which followed always thrilled me by its magnitude. Some minutes later a timorous peep would arise, then on the

other side another frog deigned an answer. Then another and another, until the whole chorus was once more in full voice. Again, without warning, the babel would cease. What caused these silences? Surely, the frogs had not spied me. Could it be something



The great lagoon-building frog, *Hyla rosenbergi*. In this daylight portrait the pupil is contracted to a horizontal slit. Compare with the flash-light portraits which follow

unseen by me that brought their song to such a sudden termination? No such an enemy was ever found, and I must admit that the whole problem is still quite beyond me.

The forest along the Chucunaque proved to be a most untrampled wilderness. As recently as 1916 Meek and Hildebrand,¹ who spent considerable time in Darien collecting fishes,

¹Meek, Seth E., and Hildebrand, Samuel F., "The Fishes of the Fresh Waters of Panama." *Field Mus. Nat. Hist. Pub.* 191, *Zool. Series*, Vol. X, No. 15.



THE FOREST NEAR YAVISA
Many nights of field study were devoted to this jungle



EVERY JUNGLE STREAM INVITED EXPLORATION

Such pools as this seldom failed to yield a rich return of amphibian life



A favorite pool of the cooing frog.—The patches of white at the far side of the pool are the foamy nests of the cooing frog, *Eupemphix pustulosus*



Two frog nurseries.—These basins of mud have been constructed by the large tree frog, *Hyla rosenbergi*

dismissed the thought of field work along the Chucunaque with the following brief but expressive statement: "This stream lies almost wholly within the San Blas region. Its exploration was therefore not undertaken." At night this forest offered innumerable more difficulties than during the day, but it was only at night that many of the interesting forest denizens were available for study. It was, therefore, necessary for me to carry on most of my work after the twilight hours, while my companions were resting from their diurnal labors about a pleasant camp. In the light of my headlamp many of these forest creatures took on strange shapes and colors. Crocodiles which during the day had lain gazing stupidly out of their greenish eyes, now turned two red coals of fire toward my flash light. Lizards which had played all day in the sunlight were now flattened out against the branches in sleep. My nightly prowls were easily the most delightful part of the entire trip. There is something indescribably fascinating about the jungle at night. The general quiet broken only by the calls and howls of the nocturnal prowlers or the swish of a bat wing close to the ear, while empty and stupid when described, was incredibly soothing after chasing lizards all day in the baking sun.

One night sound that held my attention from the beginning was a triple knock like three cabalistic blows on the paneled door of a secret lodge. This sound came from one of the drying stream beds some distance from camp. My light, settling upon the edges of the stream, revealed a series of circular mud nests, each built up as a tiny lagoon above the surface of the water. In each with few exceptions there sat a large tan tree frog with the throat distended for calling. In some cases

the nests were so close together that their walls touched. The few nests that lacked a guardian tree frog were filled either with spawn or wriggling tadpoles. Many a night I came back to these lagoon nests and tried to increase my knowledge of the habits of these creatures. One night, after I had spent a large part of the evening making the usual observations and records of the nests and their contents, I suddenly saw one of the frogs which had been calling in a near-by nest, turn down stream and continue calling with renewed energy. Another frog was hopping toward him up the middle of the stream. She, for it subsequently proved to be a female, kept advancing until almost at my feet. Then they sat and appraised each other while my flashlight outfit illuminated the forest with its sudden glare. Soon the female resumed her flirtatious stroll. I thought this particular affair had terminated, for another male was calling twenty-five feet away, and she was directing her movements toward him. But the first was not to be outdone, and hopping out of his nest, while I continued to photograph the scene, he called loudly for her to stop. Half way between the two she hesitated and while the first suitor moved around toward the far side of his nest and continued his calling, she suddenly seemed to make up her mind, or perhaps better,—the necessary stimulus was received,—for no sooner had he well begun his call than she hopped back straight into his nest, in spite of the continued vocal efforts of the interloper.

The following day there was a large mass of spawn in this nest that I had been watching. The eggs soon hatched into tadpoles as sturdy and active as the thousands of others in neighboring



A male *Hyla rosenbergi* calling from the mud nest he has constructed. (The first of a series of flash-light studies of a single nest)

nests. Anticipated rains did not arrive, and to my dismay the tiny lagoons began to dry up like the many shallow depressions that they were, exposed to the dryness of the tropical air. I imagined that nature would take care of its millions of little polliwogs struggling in these basins, and I assumed that they would wriggle down into the earth until a passing storm would give them the chance to make their way to the adjacent river. But the storm never came, and these innumer-

able tadpoles were doomed to death within the tiny clay walls which their father had so carefully, even though mechanically, erected for their welfare. No doubt similar tragedies were happening every day in different parts of this great jungle, but these tadpoles I had claimed for my own, and I could not easily become reconciled to their inevitable fate.

My interests in Darien were not entirely centered upon the frogs and toads for there was work which took me



A female attracted by his voice approaches the nest; the male turns hopefully in her direction and continues to call. The female is in the lower foreground with her head turned toward the male



But another male is calling from another nest. The female moves on toward him while the first starts after her

far afield during the day as well as during the night. In the hot sun of the morning lizards came from their nocturnal retreats, and it was with a view to learning more of the habits of these creatures that I spent most of my daylight hours in the field. One afternoon I came upon perhaps the most famous lizard of Central America, the basilisk, well known for its habit of running swiftly over the surface of the water. There were several young ones together, scampering about in search of insect

prey. As I halted to light my companionable old pipe, one of these little fellows, instead of fleeing as usual, came running toward me until it was only about five feet away. From this position it regarded me with what appeared to be considerable curiosity, frequently nodding its head in the peculiar manner of its kind. After the "light" had been secured, the match was naturally tossed to one side. This act deflected the lizard's attention and an immediate short



Rejected, the first male returns to the nest and begins calling for another mate. The vacillating female, changing her mind once more, returns to the first suitor, and enters his nest from the rear

run brought it beside the fallen sliver, which it scrutinized with equal eagerness and lack of fear. Nearly half a box of matches were wasted in amusing this infant lacertilian before I could satisfy its "inquisitiveness." While it was being thus entertained, I shifted



A Chocoi Indian meal.—Sawfish and plantain on the bottom of a dugout canoe

first to a sitting position and finally to a reclining one, while two more basilisks of similar size scampered over from the other side of the creek to see what was going on. These, however, failed to show the lack of fear evinced by the first and were in no way so interesting. From my low position I could not refrain from feeling a certain kinship for the little brute that had showed a curiosity not dissimilar to my own. One of its companions leisurely walked into the shallow stream while constantly regarding me from the corner of its eye.

It seems odd that these light animals, so adept at racing over the surface of the water, should sink so readily when their speed is sufficiently reduced.

At other times during these brilliant daylight hours, fishes, too, received their share of attention, and sometimes led me into rather embarrassing situations. One species in particular received the attention of even those of us least interested in the lower vertebrates. This was one of the *Sardinas* (*Astyanax ruberrimus*) of our negroes. How well I remember the day of our first swim, when, with the initial plunge into the muddy lower Chucunaque, innumerable nibbles of small sharp teeth began on our, at this time, rather tender skins. Only by violent thrashing about could we keep them off. Later we learned to scorn all but their most violent onslaughts. On a seining party later I stationed a man at either end of my net and proceeded to "swim-out" the fishes from a rather deep hole, the little sharp-toothed fishes no longer being of sufficient significance to prevent me. In a few minutes I had splashed about sufficiently to have driven whatever fish-life may have been in the hole to the waiting net, and ordered it drawn up. Then came a shock. On gazing into the catch of this twenty-foot seine we found that in addition to numerous small fish, I had driven into the net a three-foot sawfish (*Pristis microdon*) and a four-foot crocodile (*Crocodylus acutus*). Naturally, thereafter, I was a trifle more discreet. Another time, however, while wading in some clear water to study the swimming movements of a sawfish, a great swish about fifteen feet away revealed that an immense crocodile nearly twenty feet long had attacked the fish and only missed it by a matter of inches. I was

not aware of the crocodilian's presence and apparently it was unaware of mine, —or possibly it did not realize how dangerous I could be at times.

Numerous other adventures, some highly exciting, were encountered by all of us on our eventful journey across the divide. Our experiences with Indians of two very different types, a terrible experience in a stupendous flood in which I nearly lost my life, strange sounds in the night that we never satisfactorily traced, and many other happenings, cannot be gone into here. The loss of two of our comrades, although still fresh and painful in my memory, I feel must be mentioned, if only briefly. Mr. Roaul Brin, representative of the Panama Government, and botanist, became stricken in the early part of the trip by malignant malaria which, together with the cumulative effect of previous attacks, proved too much for his otherwise rugged constitution. He was able to return to Panama City, but too late for medical aid to be of any avail. Professor J. L. Baer, anthropologist of the Smithsonian Institution, my tent mate for

most of the time, collapsed under the strain of the trip and repeated insect infections. We were unable to send him back, and hence took him across the divide to the Atlantic coast. He grew steadily weaker. A Navy aeroplane that had been sent for arrived about a half hour too late. He now rests amid a grove of coco palms at Caledonia, a martyr to the cause of science.

Our expedition was one on which we experienced our full share of misfortunes as well as happiness. Although the field into which we penetrated is still scarcely touched, my own work, I am happy to say, has proved a satisfactory beginning. There remains a considerable area covering the low divide between the headwaters of the Chucunaque and the Bayano still unknown, which, with our present knowledge, could be entered with less difficulty than we experienced. It is always with a pang of regret and hope for the future that I scan a chart of these areas we missed by merely a few miles. I hope some day that I may push on from where we left off.



Chocoi Indians spearing fish

Giant Game Fishes

SWORDFISHES, TUNAS, AND OTHERS

By DR. DAVID

Chancellor Emeritus of Leland



XIPHIAS GLADIUS
THE "BROADBILL" SWORDFISH

Photograph by Ernest Windle of the world's record catch with rod and reel—weight 377 lbs. Taken at Avalon, Santa Catalina Island, August 3, 1916, by H. W. Adams, of Vermejo Park, New Mexico. The time required for the capture of this giant mackerel was one hour and fifty minutes

THE little port of Avalon on Santa Catalina Island, off the coast of Southern California, is known to all deep-sea anglers the world over. There in the spring and summer the giants of the mackerel tribe gather for their annual feast of flying fishes and sardines. Swiftest of all fishes, wandering far and wide and hunting in packs, these monsters, or some of them, are found along the edge of the tropics in all warm seas. The headlands and channels of Southern Japan, from Izu to the Ryukyu Islands, are alive with them. They also gather about the Hawaiian Islands. Some of them abound in the West Indies, swinging northward in the Gulf Stream. A small minority breed in the Mediterranean, but a chosen summer resort of most of them is found in the Santa Barbara Islands, and at Avalon the sea anglers of the world meet them halfway.

All these fishes are shaped like a clipper ship, some of them (swordfish and spearfish) with a long bowsprit, the rest with noses unarmed but sharp as if whittled to a point. All of them have small, sleek scales, more or less hidden in the skin, and dorsal fins that slip back into a groove. Each has a slim tail with a strong backbone, moved by powerful red muscles and ending in a

of Santa Catalina

MACKEREL-LIKE SPECIES

STARR JORDAN

Stanford Junior University

broad, forked, fan-shaped caudal fin, their means of propulsion through the water.

The species of true mackerel (*Scomber*) are the smallest of this tribe, existing in countless millions, the common mackerel of the Atlantic from an economic point of view outweighing all the rest. The smaller chub mackerels of several different but scarcely distinguishable species swarm on the coasts of all temperate regions. Another tribe now regarded as a distinct family (*Cybiidæ*) is represented by the Spanish mackerel, so called, perhaps, because it is not found in Spain, a wide-ranging group of many species, all with pale, finely flavored flesh, but none being large enough to come into the range of this paper. It is a singular fact that while but one species allied to the Spanish mackerel occurs in California, and that one most rarely, not less than eight distinct genera (*Thyrsoles*, *Thyrson*, *Zaphleges*, *Ocystias*, *Turio*, *Auxides*, *Xestias* and *Escharion*) are found in the Miocene deposits in the same region.

Passing by the true mackerels with scant recognition of their economic value, we turn at once to the discussion of their huge relatives.

First of these stands the swordfish (*Xiphias gladius*) known to anglers as the "broadbill," a fish



TETRAPTURUS MITSUKURII
THE "MARLIN" SWORDFISH

From a photograph by Ernest Windle of a specimen taken with rod and reel at Avalon, Santa Catalina Island. The "marlin-spike" fish differs from the "broadbill" in that it has a narrow and rounded "sword," is adorned with transverse white stripes, and has its high dorsal fin long-drawn-out posteriorly

that ranges the whole ocean, never overlooking Avalon. In this species the "sword" is longer and stronger than in any other. As the fish grows up, it absorbs all its teeth, and unlike all others of its race, it has no ventral fins.

The swordfish is a creature of tremendous force, the hardest to manage of all that take the angler's hook. The largest taken at Avalon (337 pounds) was the prize of Mr. H. W. Adams of Vermejo Park, New Mexico.

Fishes of this size cannot be very handily examined and compared in museums, and we have to use photographs. But these, whether taken in the Atlantic or Pacific, show no difference, and there is probably but one living species of *Xiphias*.

The swordfish does not seem wantonly fierce, but there are many records of the thrust of its beak through the bottom of a vessel. One New England fishing boat was attacked twenty times in one season. Ordinarily however, the fish uses this savage weapon mainly to stir up schools of sardines, mackerels, and menhaden, which slip through its toothless mouth into an ample gullet. It may be that it spears whales as described in ancient fish stories, but it cannot devour them, and it probably has no mischievous purpose in opening them up with its sword. There is, however, a very old belief that the swordfish and the thresher shark (*Alopias*) combine to destroy the whale. According to this tradition, "the swordfish pricketh from below," while the long, slim, flail-like body of the thresher, pounds the whale as it rises from the water to shake off its enemies.

Personally I have no faith in this tale. The swordfish cannot be convicted of continued malice and the thresher is one of the gentlest of sharks, with small teeth and a mild disposition.

What is mistaken for shark and swordfish is no doubt the great killer, *Orcinus orca*, a giant porpoise, with a high dorsal fin shaped like that of a swordfish. It is of a wolfish disposition and its teeth are long and strong. The killers hunt in packs and are capable of mutilating any whale. They also destroy sea lions and fur seals.

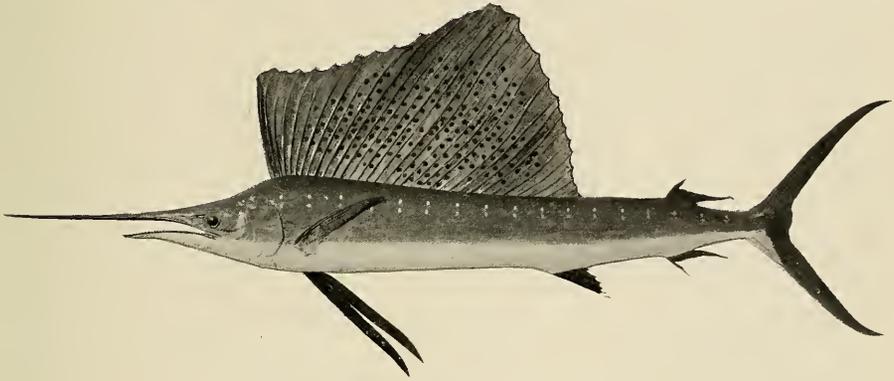
I once saw an attack by killers on a whale off the coast of Lower California. The great animal sprang into the air for almost the length of the body, with one or more killers clinging to its sides, writhing and twisting in its efforts to detach these marine bulldogs. A skilful photographer, Mr. W. W. Richards, had the fortune to see, off Santa Cruz in California, a fracas of the kind. He made of it a picture, probably absolutely unique, which I have reproduced in *Days of a Man*. Around the suffering whale, attracted by the blood, are multitudes of greedy shearwaters (*Puffinus*) known as "whale birds," clamorous for their share of the spoils.

The nearest relative of the swordfish is the smaller spearfish (*Tetrapturus*) known at Santa Catalina as marlinspike-fish, in Hawaii as *a'u*, and in Japan as *kajiki*. It has ventral fins as well as teeth, thus differing from the true swordfish. Its sword is short, narrow, and sharp, and it may be dangerous. Like the swordfish this creature is dark gray in color, but the body is ornamented by cross-streaks of white or silver gray. The species in California and Japan is known as *Tetrapturus mitsukurii*, but as eight or ten other species have been described in various parts of the world, and as no one has got the different forms together, we do not know whether the California spearfish is different from the European *Tetrapturus belone*, or from others named in the West Indies, India, Chile,

and Japan. In any event all warm seas have at least one species of *Tetrapturus*, and that one extremely active and gamy. The largest one recorded from Avalon, taken in 1917, by Mr. C. G. Conn of Elkhart, Indiana, weighed 339 pounds.

Most striking of the sword bearers is the great sailfish, *Istiophorus gladius*. This is like the spearfish in form, but larger, with an immense dorsal fin,

(*Thunnus thynnus*) largest of the family of tunnies or Thunnidæ. These are huge mackerels of the warm seas, capable of swallowing half a dozen of the true mackerels at one gulp. A dog-fish weighing eight pounds has been found in the stomach of a tuna. The tuna is known from all related forms by the short pectoral fin, scarcely more than half as long as the head and not reaching nearly to the front of the soft



Istiophorus gladius, the sailfish. Photograph of a mounted specimen taken on the coast of Florida by Mr. R. T. French of New York City, and presented to the American Museum by Mrs. French

trimmed with sky-blue, which stands up like a huge sail, and, umbrella-like, may be depressed in a deep groove which runs along the back. This sailfish is occasionally taken in the open seas, both Atlantic and Pacific. Anglers get it once in a while off Florida and Cuba, and at times in Hawaii and Japan, but it has never yet appeared in California. As in the other cases, no adequate comparison of specimens has been made, and we do not know whether there is one species of sailfish, or two, or three.

The other giant mackerels of which I shall speak are without swords, but are equally noted for strength and swiftness. The most famous game fish of Santa Catalina is the "leaping tuna"

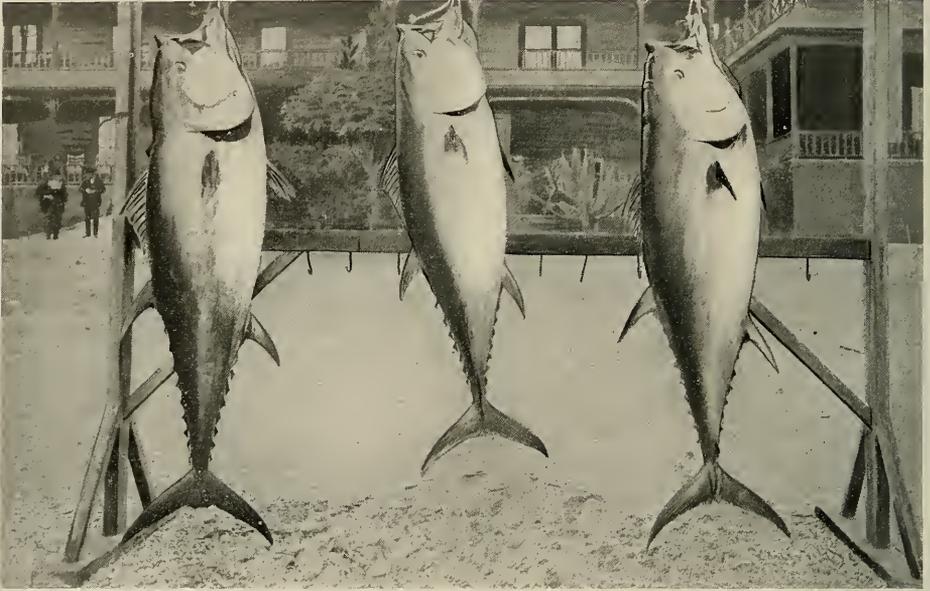
dorsal fin. The color, as in all fishes of this type, is a metallic blue-gray, the young being marked by wavy cross streaks of silver-gray. The fins are colored like the body, hence the great tuna, or tunny, is sometimes called the "blue-fin."

Of all fishes taken on a hook the capture of the tuna requires the greatest skill. At Avalon, this is a form of sport, the acme of angling, but in Japan and in the Mediterranean, where it breeds, tuna fishing has long been a great industry. In Hawaii it is rapidly becoming so, and in Southern California the "tuna canneries" now absorb most of the catch.

I may note here that this particular canning industry began some twenty

years ago with the albacore, the most toothsome of these giant fish. It was put in tins under the name of tuna. The flesh of the albacore is pale, only moderately oily, and of an agreeable taste. That of the tuna is red and coarser and of stronger flavor. But as the canned fish in any case is used mostly as a condiment, for that purpose

ments of their schools are very irregular. They often disappear for years at a time, and then return to their old feeding grounds. I suppose that all of them belong to the same species, *Thunnus thynnus*, although different names have been given to them in different regions and no one yet has made minute comparisons.



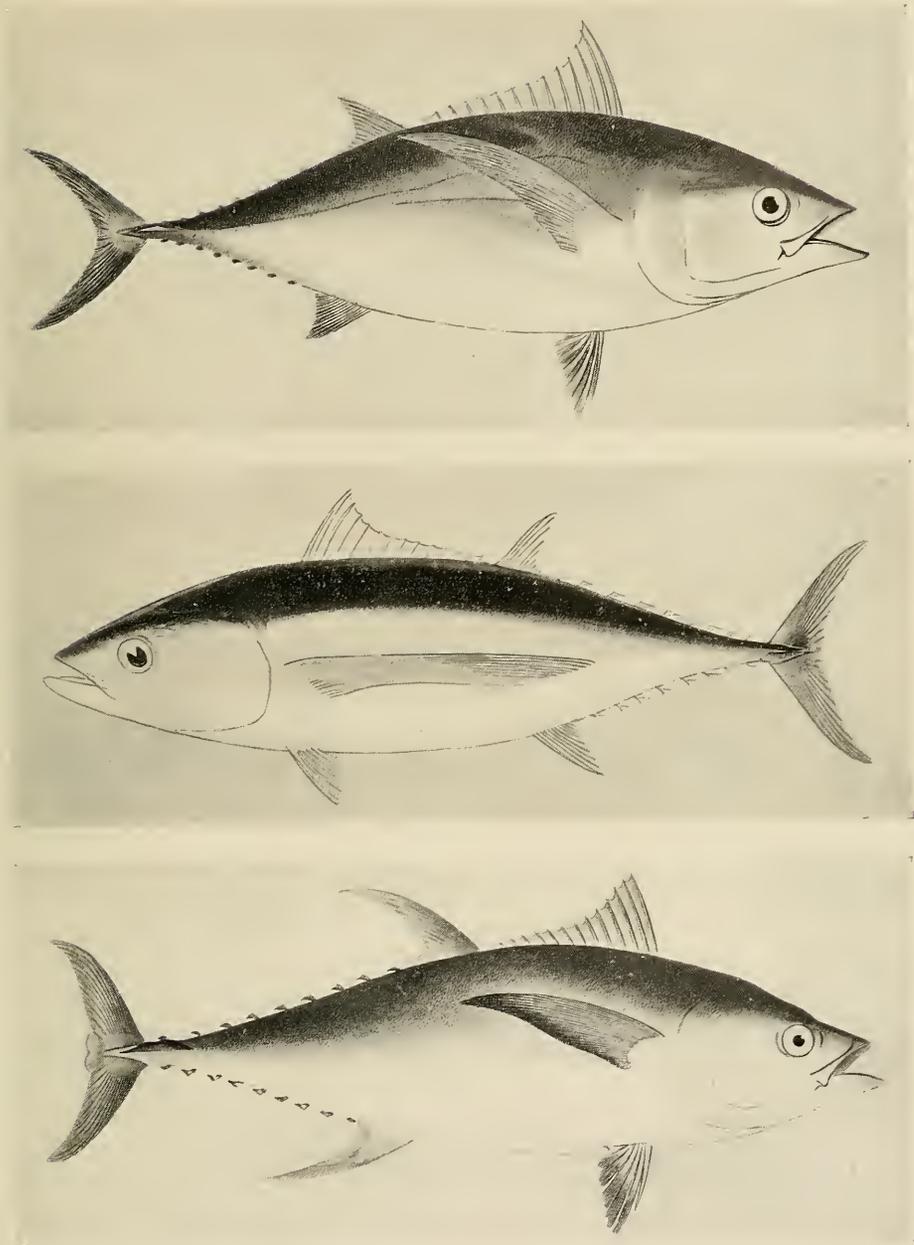
The tuna or tunny, *Thunnus thynnus*. From a photograph of three large specimens taken at Santa Catalina. The pectoral fin of each fish is broken. This fish sometimes attains a weight of 750 lbs

the one is about as good as the other. Later, it has been found that all the tunny family, the tuna, the different albacores and bonitos were alike available for commercial purposes. A large part of the canned tuna of commerce is derived from the oceanic bonito.

The name *tuna* belongs to the south of Europe, but it has been adopted in California. The French name is *thon*, the English, tunny. Great tunnies are found at times in the waters of the Mediterranean, in the Gulf Stream, in Japan, and in Hawaii. The move-

In the Pacific, the largest I have seen weighed about 500 pounds. The maximum record from Japan is 750 pounds. The largest taken by rod and reel at Avalon, according to the careful record kept by Mr. Ernest Windle, weighed 251 pounds, the prize in 1899 of Colonel C. P. Morehouse of Pasadena. When caught, the tuna is said to "leap ten or more feet in the air, presenting a beautiful sight, as the jump is a perfect curve, with no ragged angles."

Smaller than the leaping tuna, but equally interesting, is the albacore,



A group of three giant mackerels. Above, *Neothunnus macropterus*, the yellow-finned albacore. Center, *Germo alalunga*, the long-finned albacore of California, the *tombo-shibi* of Japan. Below, *Parathunnus sibi*, the shibi-albacore common in Japan and Hawaii, but seen only once in California. Upper and lower figures after Temminck and Schlegel, central one after Kishinouye

Germo alalunga, the *tombo-shibi* of Japan. It may be known from other albacores by the absence of yellow on its fins, and from the tuna by its very

long ribbon-like pectoral, which reaches well past the front of the second dorsal. The albacore (not albacore, since its Arabic name *Al Bacoro*, said to mean a pig, has no relation to *albus*, white) is found wherever the great tuna occurs and in still greater abundance. It has received different scientific names in different regions, but whether the Japanese, Hawaiian, Californian, or other forms differ from the "germon" or "alilonghi" of the Mediterranean, we cannot know without adequate comparison of specimens. The largest albacore taken at Avalon was caught by Mr. Frank Kelley of Goshen, Indiana, in 1912. Its weight was 66¼ pounds.

I once secured in the Santa Barbara Channel an albacore which was a veritable prize package. In its stomach was a big hake (*Merluccius*) recently swallowed. In the stomach of the hake was a fresh example of a deep-sea fish, never seen before nor since. This we called *Sudis ringens*.

Another tuna-like fish found in increasing abundance about Avalon is the yellowfin albacore, *Neothunnus macropterus*, common in Japan, where it is called *kiwada*, and in Hawaii where it is known as *ahi*. It has never been found in the Atlantic. It has the long ribbon-like pectoral of the true albacore, but its dorsal fin is twice as high, yellow in color, and the long array of finlets behind the dorsal and anal are bright lemon-yellow. In size, gaminess, and food qualities, this handsome fish is much like the albacore.

Still another fish of this type is the shibi-albacore, *Parathunnus sibi*. In this species, the dorsal fin is not much elevated, and the finlets are dull yellow, edged with black and whitish. While it is common in Hawaii and also in Japan, where it is known as *shibi*, or *mebachi* (wasp-eye), it has been

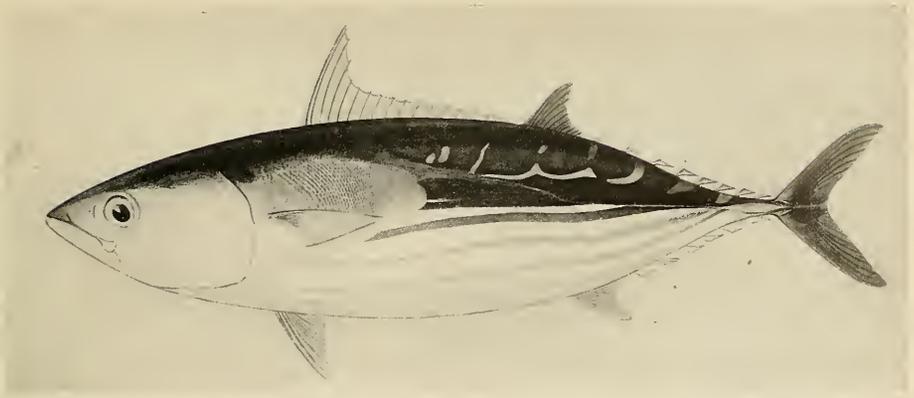
but once noted in California, and never in the Atlantic.

Omitting all notice of the Atlantic bonito, *Sarda sarda*, and of its Pacific twin, *Sarda chilensis*, as well as of several smaller members of this group, I need mention but one more species, the oceanic bonito (*Katsuwonus pelamis*), the *aku* of Hawaii, *atu* of the South Seas, and *katsuwo* or "victor-fish" of Japan. Like the tuna and the albacore, this is found in the open seas of both oceans, and at times in incredible numbers. It rarely weighs more than eight or ten pounds, and its distinguishing mark is the presence of four long, wavy black stripes on each side of the white belly.

The oceanic bonito is coarser in flesh than its larger relatives, and is canned in an increasing amount in California and in Hawaii, where the demand for fresh fish absorbs all the better species, leaving the *aku* to the canneries.

All the fishes I have mentioned in this paper cast their spawn in the open sea, hence we seldom see the young near the shore. They come usually in schools to feed on flying fish, sardines, anchovies, and other helpless forms. In Hawaii great quantities of a small anchovy called *nehu* (*Anchoviella purpurea*) are netted and thrown into the sea to attract the *aku*. The *aku* in turn is cut into pieces as bait for tunnies and albacore. The oceanic bonito or *aku* runs in prodigious schools. I have a record, from a credible source, of a procession ninety-six miles long of these fishes passing the Hawaiian Islands.

The method of reproduction in all of them has a suggestion of the order which pervades all things large and small in the domain of nature. Each of the millions of egg cells cast off by



Katsuwonus pelamis, the oceanic bonito, the "victor-fish" of Japan, the most beautiful of the mackerels considered in this article. After Kishinouye

the female *aku* in their migrations contains the minute hereditary elements or chromosomes within the nucleus, together with a bit of food yolk to nourish the young fish should the egg be hatched. Such also is the essential structure of each of the billions of male or sperm cells. Without yolks, microscopic, moving about for a time in the water by a rudderlike tail, all those which do not enter a female cell die, wasted, like the wind-blown pollen of the pine.

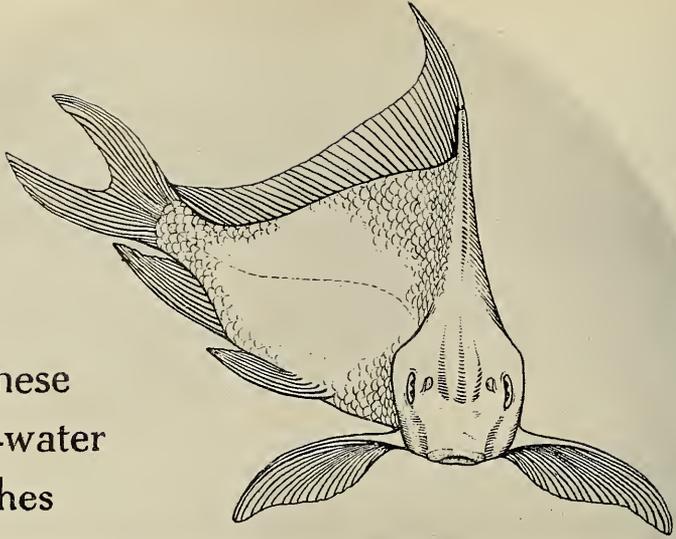
Each one of these cells, male or female, when cast off is a half cell, carrying but half the chromosomes of a completed cell, and forming a living being only when the two halves come together, mingling their chromosomes or heredity-content. Within each cell, the chromosomes bear all the inborn tendencies of the race. As the fertilized cell subdivides, the new cells produced from its division range themselves to provide a body with gills and fins and the various other organs of a fish. As the fishlike form progresses, it acquires the thin scales, the two rows of finlets together with all other mackerel-like details. Later on come the characters of the genus *Katsuwonus*, the most notable being a trellise-like modifica-

tion of the lower side of each vertebra. Then come the surface marks, the four long, curved black stripes of this particular species. These traits the young fish will never fail to secure, for they are carried equally by the chromosomes of egg and sperm, neither of which ever matures unless joined in the sea by a wandering cell of the other sex and of this same species.

Yet no two germ cells, in theory at least, were ever quite alike, and thus as each fish has two parents, again not quite alike, there is endless minor variation in each completed fish. This variation runs in narrow channels in the oceanic bonito for in the sea the range of its schools meets with few obstructions, and the process of natural selection is about the same in one place as another.

Yet with every animal or plant or man the same amazing process in one way or another must take place. No man could have thought out its details in advance, nor yet hopefully guessed at them. Only through instruments of precision could we ever have found them out, and when found out the whole matter of heredity is still enveloped in mysteries more inscrutable and more profound.

Chinese Fresh-water Fishes



SOME INTERESTING FORMS FROM THE COLLECTIONS OF THE THIRD ASIATIC EXPEDITION

BY JOHN TREADWELL NICHOLS

Associate Curator of Recent Fishes, American Museum

THE American Museum's Third Asiatic Expedition has brought together an extensive collection of Chinese fresh-water fishes which are proving of much interest. These were obtained in large part by Mr. Clifford H. Pope at various points. Mr. Harry R. Caldwell, working in the province of Fukien, is also to be credited with a considerable part of the collection, which, taken altogether, is probably the most comprehensive series of Chinese fresh-water fishes an ichthyologist has ever had the good fortune to examine at one time. It comprises upward of 200 species.

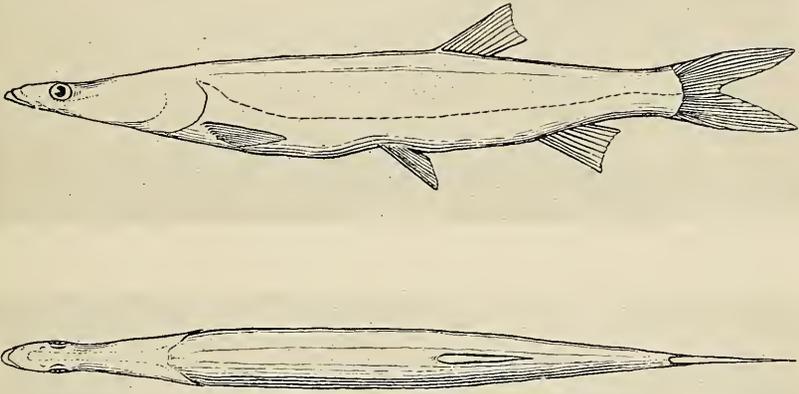
The carp family dominates the fish life of Chinese fresh waters. Nowhere else are there so many peculiar divergent carps. In this connection one with a very broad fat head, which attains a large size and is extensively cultivated in ponds for food, may be mentioned. It is known as *Hypoph-*

thalmichthys, and has the eye placed below the central axis of the head instead of more or less above the same, as in almost all fishes. Another peculiar form, *Luciobrama*, has the forepart of the head long and narrowed, ending in a small oblique mouth. This suggests the condition which is carried to a greater extreme in certain marine forms, notably the pipe and trumpet fishes, but it is none the less surprising to find it in a fresh-water species, particularly one belonging to the familiar conservative carp family. Competition is keener on the seacoast and there is more diversity of fish life to be expected there. In *Luciobrama* the whole front of the head is lengthened, not merely the snout as in these marine forms. Its eye consequently is far forward.

Certain predacious carps are of particular interest because of changes which their mouth parts have undergone to fit them for habits to which the carp

family in general is ill adapted. Carps have no teeth in the jaws and ordinarily do not seize living prey of any considerable size. They have small teeth on the pharyngeal bones of the throat, which teeth may be slender and slightly hooked, or blunt and molar as in the

near Urga, north of the desert, and the two species represented in this lot were both Salmonidæ (trout family). The present barrier area is widened by the nature of the Yellow River, so charged with silt as to be suitable for comparatively few species.



Luciobrama macrocephalus. This peculiar carp was collected by Mr. Clifford H. Pope at Tungting Lake, close to the Yangtze River in central China

carp itself, *Cyprinus*, a gross vegetable feeder. *Opsariichthys*, a very common fish in eastern China, Japan, etc., has a pointed knob on each side of the lower jaw fitting into a reëtrance in the upper jaw, thus simulating a canine tooth. *Scombrocypris* of the Yangtze is a slender predacious species with long, firm, and peculiar jaws, suggesting the mouth of a mackerel.

There can be little doubt that the existence of such peculiar, predacious carps in China is correlated with the isolation of that region, for a long period of time, from northern waters where predacious species of other families, the trout and the pike, are the rule. Probably the barrier has been, as it appears to be today, the Gobi Desert. Members of our Asiatic Expedition sent in a few specimens from a stream

Various types of carps, though not exclusively Chinese or east Asiatic, occur in China in a profusion elsewhere unknown. Such is the subfamily Rhodeinæ, small deep-bodied (flat) fishes with peculiar spawning habits. There is a European species of this subfamily, which lays its eggs in the mantle cavity of the fresh-water mussel, the female fish having a long external ovipositor for that purpose. Another group, the gudgeons, includes a species which is generally common in Europe, a bottom fish with eye placed rather high, and an inferior mouth with a conspicuous single barbel in the corner. In the Yangtze River more or less related forms occur in such numbers and diversity that several well-marked genera are recognized, the commonest of which, when adequately studied, will doubtless

be found to include many species. This subfamily of gudgeons forms an important factor of the fish fauna in the Orient, dwindling to the southward, where it meets an abundance of forms more nearly related to the carps proper and with Indian affinities.

No matter whence it originally came, the carp family has been in central China for so long a time and is there so highly diversified that one is justified in assuming that the Yangtze valley is its center of distribution. A comparatively small number of types of carps occur in Europe, and each type has few representatives.

This condition fits the hypothesis that European forms came from the Orient, bearing in mind the distances and obstacles to be overcome in such a journey. Still fewer types have gotten into America by the Bering Sea route, though North American carps present an abundance of species, which have been separated into closely allied genera. Compared to China, America is peculiarly rich in small minnow-like forms, which provide excellent food for the abundant North American trouts, pikes, and percoids (perchlike fishes). This suggests that in the struggle for survival destruction may sometimes be more easily met than competition. It is also interesting that a minnow-like type particularly abundant and widely distributed north from central China, crossing the muddy Yellow River by frequenting its small clear tributaries, is very close to and has been identified with an American genus, *Phoxinus*. It is not impossible that some fish of this sort may be ancestral to various American minnows.

The fishes of Asiatic Russia and its boundaries have recently been rather thoroughly investigated and many of them figured by Dr. L. V. Berg of

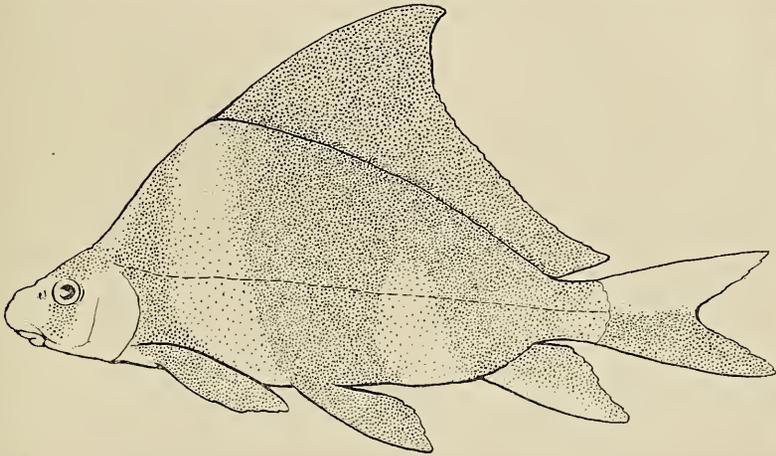
Petrograd. This author recognizes a northern zone of fresh-water fish life equivalent to the *Arctagæa* of Huxley. Its southern boundary in eastern Asia is marked by the Gobi Desert and by the Amur River section of Manchuria. China lies outside this northern region, although Chinese and northern types mingle in the basin of the Amur. According to Berg's faunal divisions, a comparatively homogeneous fresh-water fish life extends from Europe across Asia into northern America past Bering Strait, and south over the United States to the Gulf of Mexico, but the very short distance across the Gobi to China results in the distribution of dissimilar fishes.

The occurrence in Asia of the ganoid fishes *Psephurus* and *Pseudoscaphirhynchus*, representing *Polyodon* and *Scaphirhynchus* of the Mississippi River, may be taken as emphasizing the relationship of Asia to America. A peculiarly interrupted distribution of such ancient types, however, appears to the writer to have very little bearing on the way one delimits present-day faunal areas. They are relics of a bygone order in fish life, when they and their associates must have been uniformly distributed. Whether they have survived today in a single restricted locality or two such localities on opposite sides of the world seems but a matter of chance. Much more modern and, *a priori*, with more present-day significance, should be the distribution of the subfamily of suckers, bottom-feeding carplike fishes wherein the pharyngeal teeth are numerous like those of a comb instead of being in restricted number. The suckers are almost exclusively American. They are certainly an offshoot of the carps proper and, as such, should have originated in Asia in line with our hypoth-

esis of carp distribution. Carps which were able to invade America have been comparatively little differentiated and specialized as a whole since reaching there.

Interestingly enough, the single sucker, *Myxocyprinus*, found outside of America (with the exception of an Arctic species on both sides of Bering Strait) still occurs in central China, the center of the carp family's abun-

abundant and varied in China is the loaches—unquestionably derived from the carps. In fact there still exists in China one very peculiar genus, *Gobio-botia*, sometimes relegated to one, sometimes to the other family. It is loachlike in having its air bladder inclosed in a bony capsule, and in having three pairs of barbels on the lower jaw, as well as one on the upper, whereas in carps two pairs at most are present,



Myxocyprinus asiaticus resembles but probably is not closely related to certain suckers of our Mississippi Valley. It is the only known member of the sucker group occurring in China, where it is widely distributed though nowhere common. See also headpiece.

dance and variety. It was earlier united generically with highly specialized forms of America's secondary carp center, the lower Mississippi, but as the theoretical probability of any such specialized cyprinoid having crossed to America is small, the present-day view that the resemblance here is a parallelism seems most rational. The suckers have run their course in China, have left but this single peculiar representative behind, and have been superseded more or less by the present-day gudgeons. In America the group is still young.

Another family of fishes which is

one at the center and one near the end of the upper jaw. In other respects, it looks like a carp of the gudgeon group. Loaches might be described as degenerate carps. Their scales are small or wanting, and they frequently are eel-like or have a peculiar erectile defensive spine beneath the eye. Evidence points to their being a comparatively recent offshoot of the carps. Otherwise it is reasonable to suppose that they would have reached America, where none are present. Some of the more or less specialized loaches are confined to China. On the other hand, the genus *Barbatula*, of variable and



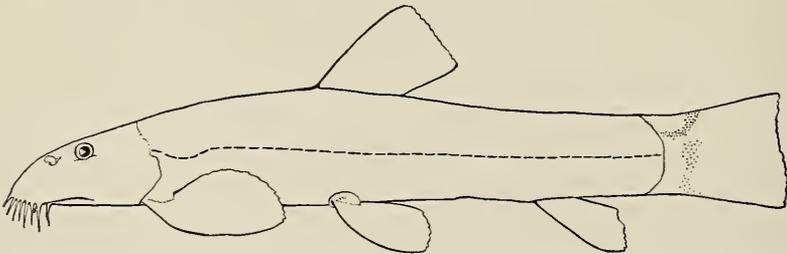
Botia citrauratea, an orange-colored loach. Photograph of a color sketch made in the field from the type of this new species

highly adaptable species, is exceedingly abundant in the highlands of central Asia, and has one species at least which has penetrated to Europe. Given the opportunity, it should have crossed a Bering Strait land-bridge as readily as any carplike fish known to us.

Mr. Pope, while collecting at Tungting Lake, in Hainan, and elsewhere, was accompanied by a Chinese artist (Mr. Wang) who made color sketches from life of various fishes obtained. It is hoped that these will be reproduced at some future date. The life colors of fishes, usually lost at death, are frequently bright and as attractive as those of any other group of animals. Species that swim actively about in the water are more brilliant in coloring. On the other hand most of the loaches, eel-like or bottom forms, have colors of a neutral tone, though often prettily mottled. Specialized loaches of the

genus *Botia* are more actively free-swimming, to judge from their trim forms and forked caudal fins, and therefore tend to be highly colored and boldly patterned, so that coloring here becomes very helpful in differentiating the species. Two previously unknown forms taken at Tungting, have been respectively named *purpurea* (purple) and *citrauratea* (orange). The former has a bold dark cross pattern on a delicately purplish ground; the latter is suffused with a strong rich orange, marked off and intensified in spots along the back by dark shading. As fishes of this genus are armed with a sharp erectile spine on each side of the head below the eye, their colors may also have something of a warning significance.

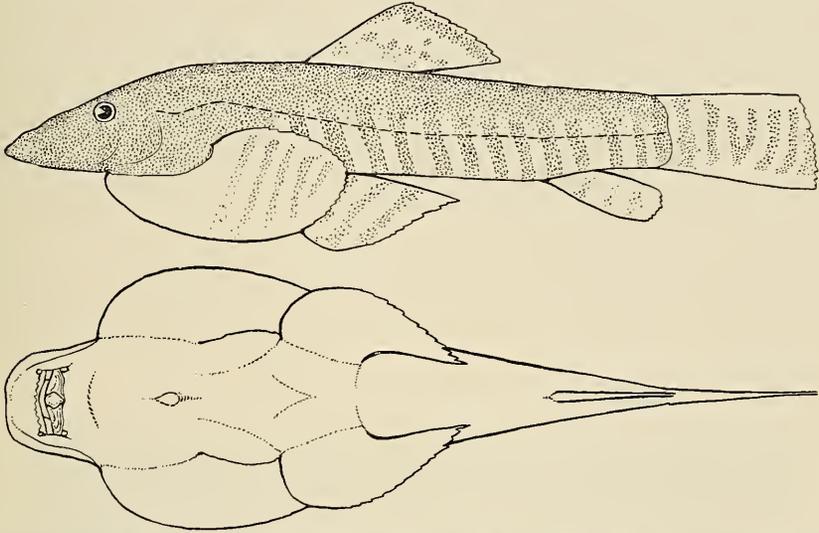
One of the best marked genera of loaches, namely *Crossostoma*, was described almost a half century ago by the French ichthyologist, Sauvage, but



Crossostoma davidi, a loach with a fringe of thirteen barbels hanging from the snout in front of the mouth. Loaches have an indefinite number of barbels, as compared with two pairs at most possessed by members of the carp family, but this little-known species is particularly be-whiskered

has been seldom seen since. It gives us pleasure to figure a specimen obtained in Fukien province by Mr. Caldwell. If the loaches are too recent to have crossed to America, their evolution (or devolution) has been exceedingly rapid, especially

Due beyond question to the Gobi Desert barrier, the important inter-faunal line in eastern Asia for fresh-water fishes occurs well north of the Yangtze, and it is logical and convenient in considering them to limit one's Chinese area to China proper,



Hemimyzon zebroides, a new loach from Fukien, short-bodied and peculiarly flattened. In body form and appearance it resembles the more specialized genus *Gastromyzon*, but in technical characters it is closer to the parent form, *Homaloptera*

southward, giving rise to what is at least a distinct subfamily of peculiar specialized forms with flat breast and rounded pectoral fins extended in a horizontal plane. These, known as the Homalopterinae, are well represented in China but are particularly characteristic of the Indian region and East Indian Islands. One of the most peculiar, specialized genera is the short-bodied *Gastromyzon* flattened for clinging to the rocks. It was previously known from certain of the East Indies, but we have a new species from Hainan Island, and also from the province of Fukien, the second known representative of the genus *Hemimyzon*, which latter forms a transition between *Gastromyzon* and its allies.

excluding Mongolia. To the south, the central Chinese fauna gradually merges with or gives place to the more tropical Indian one, but nowhere does there seem to be an abrupt change. There should be a theoretical line of demarcation, based on climate, in the neighborhood of the Tropic of Cancer, and a secondary division probably can be drawn in that general latitude to advantage. Thus, though there has been much systematic work upon the fishes of central China, and there is a very large scattered literature on the subject, we have felt confident in describing as new species, a large proportion of the collection which Mr. Pope obtained in the Island of Hainan south of the tropic. They were mostly close-

ly related to forms already known from China and, in some cases, to East Indian forms. A few were southern representatives of Chinese fishes, which had already been described from Tonkin; and a better knowledge of the fishes of that area will probably show the fish life of Hainan to be rather closely related to it.

In the light of present knowledge it is convenient to bound our Chinese area on the south as on the north, by the limits of China proper. So also on the west. The fishes of high central Asia are very different from those of China. A few peculiar types are represented by a great variety of species. These types enter the western provinces rather freely, they are also found here and there farther into

China and they are comparatively few in species even in Szechuan, where the fishes of the larger rivers at least are rather typically central Chinese.

From the point of view of the sportsman, the possibilities of Chinese fresh-water fishes are as yet little known. A correspondent, Mr. Robert P. Sanderson of Tien-tsin, writes of a giant carp, *Elopichthys dauricus*, locally called *huang-dzuan* or the "yellow screw," which is taken in north China in winter. He has seen fish of this species from Nanking weighing up to 92 pounds. Mr. Sanderson has also angled for the Japanese bass, *Lateolabrax japonicus*, and to his courtesy we owe photographs of this latter fish, one of which is here reproduced, showing Mr. Sanderson and his catch.



Lateolabrax japonicus, a large Japanese bass taken by Mr. R. P. Sanderson at Pei-Tai-Ho, June 29, 1918. It weighed $16\frac{1}{2}$ pounds, with a length of $39\frac{3}{4}$ inches and a girth of $18\frac{1}{2}$ inches. This species, which is related to our striped sea bass, is found in China and Japan, probably running in both fresh and salt water as our striped sea bass does. It is spotted somewhat like the southern weakfish or sea trout.



Three individuals of the luminous fish, *Photoblepharon*, are here shown with the luminous organ exposed. The light due to luminous bacteria is continuous and not under the control of the fish. There is, however, a curtain of black pigment which it can pull up, thus shutting off the light. This organ, being luminous even when removed from the fish, is used by the Banda Islanders as bait for fishing at night. After Dahlgren.

Luminous Fishes of the Banda Sea

By E. NEWTON HARVEY

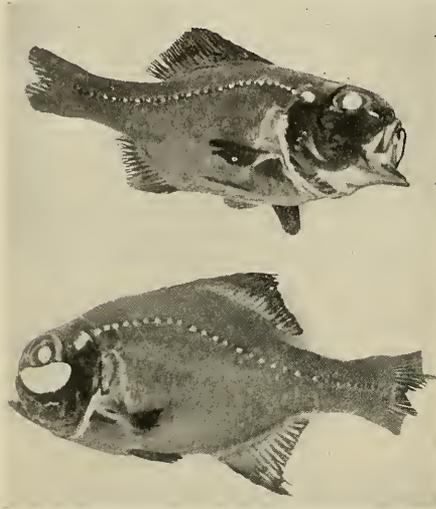
Professor of Physiology, Princeton University

EVERY naturalist is familiar with plants or animals which seem to have become completely isolated from all their relatives, both phylogenetically and geographically. Thus we have the duckbill of Queensland with close relationships to no known creature; or the dodo, now extinct, of Reunion Island; or, in our country, the Venus's-flytrap of the Carolina savannahs. One wonders what the factors can have been to bring about so limited a geographical distribution, for often these forms are endowed with unusual structures that one might conceive would place them in a rather favorable position in the evolutionary struggle.

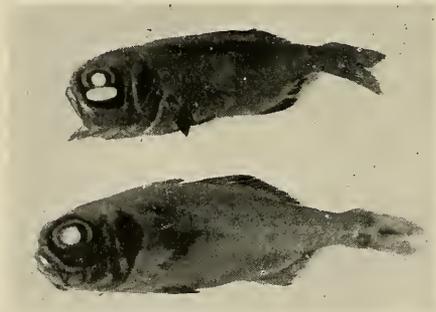
In the East Indies occur two fish, *Photoblepharon* and *Anomalops* which are remarkable in many respects. I had the opportunity of studying them in the fall of 1920 under the auspices of

the Department of Marine Biology, Carnegie Institution of Washington. *Photoblepharon* is found only in the Banda Islands in the very middle of the archipelago. *Anomalops* is abundant at Banda, but has occasionally been taken in Celebes, Fiji, New Hebrides, the Paumotus, and Porto Rico. As the names indicate (*Photoblepharon* = light eyelid, and *Anomalops* = irregular eye), and the figures show, there is a large white organ just under the eye of each fish. It is not always visible, for the fish are able to conceal it at will, and different methods of concealment are used in the two cases. We now know that it is a luminous organ and produces light, but the earlier views of its function, arrived at merely by inspection of preserved material, were indeed fantastic. Some thought that it was to protect the eyes of the fish from injury

by the branches of the coral among which the fish lived, while others thought it a protection of some delicate tissue against the rays of the tropical sun.



Photoblepharon palpebratus with light organ exposed (lower figure), and closed (upper)



Anomalops katoptron with light organ exposed (upper fish), and closed (lower)

Any native could have revealed its function, for the Banda islanders cut out this phosphorescent organ, attach it to a hook, and use it for bait in fishing. The light lasts for seven or eight hours. So useful has this method become that I found it necessary to pay fairly high prices for enough material for my scientific work.

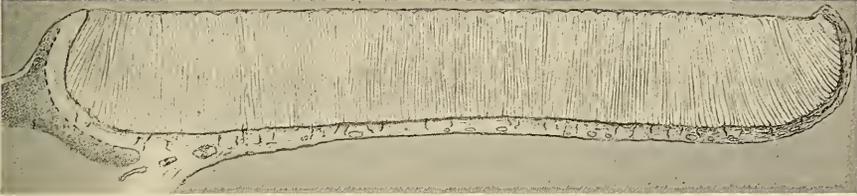
The Banda Islands rise from the Banda Sea, a very small volcanic group, whose peak, Gunong Api, has been active during the past century. The harbor of Banda Neira is almost completely landlocked and formed an excellent anchorage for Dutch vessels in the halcyon days of the spice trade. For Banda was once a prosperous place where wealthy Dutch merchants exported nutmegs to all the world. It still is a nutmeg center and old villas still remain, but they are empty and the air is one of isolation, of peace and quiet and decay. Ganong Api stands, a lonely sentinel, now dead and calm, meditating on the stir and bustle of the past, and even resenting somewhat the bimonthly arrival of the little Dutch mail steamer that connects these parts with the central government in Java. Amid these surroundings the fishermen have been catching *Photoblepharon* for no one knows how long.

The coastal waters are rich with corals but the bottom suddenly drops off to depths of 12,000 feet. However, these fish are not deep-sea forms. *Photoblepharon* swims alone or a few will swim together among the stones and corals. Hence the native name, *ikan (fish) leweri (?) batu* (stone). *Anomalops* swims in schools of a hundred or more at the surface but in somewhat deeper water. Hence the native name, *ikan leweri laut* (sea). Both fish are from 8 to 11 cm. in length, but my friend, Sech Ahmed bin Said Baadilla, who acted as my interpreter, told me of an *Anomalops* 25 cm. long.

It is a most extraordinary sight to watch these fish swimming through the water, turning their lights now on and now off, like great marine fireflies. The actual light production is continuous, and in this respect they differ from most animals, which flash only on stimu-

lation, but the organs can be screened. Two totally different methods of screening are employed in the two genera. *Photoblepharon* has a fold of black tissue on the lower surface, which can be drawn up over the organ like an

fungi alone among luminous organisms emit a steady light independent of and unaffected by stimulation. In chemical behavior and reaction to various substances, the organ emulsion behaves just like an emulsion of luminous



Longitudinal section of the light organ of *Anomalops* showing the parallel tubes in which the symbiotic bacteria grow. After Steche

eyelid, completely obscuring the light. In *Anomalops* the organ is attached at the antero-dorsal corner by a hinge which allows the whole organ to be turned over downward into a groove or pocket that completely obscures the light. Why two such closely allied genera, similar in other respects and almost exactly alike in the general structure of the light organ, should have developed such totally different mechanisms for obscuring the light is a great mystery.

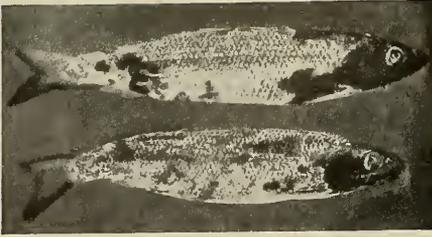
The organ in each fish is made up of rows of tubes containing luminous material with blood capillaries running between them and a very rich blood supply, for the organ is extremely sensitive to lack of oxygen and becomes dark very quickly when the supply of oxygen is discontinued. Imagine my surprise upon examining the contents of the luminous tubes with a microscope, to find a mass of moving bacteria, curved rods in most cases. The organ was evidently a device for the growth of symbiotic luminous bacteria, and this view gives us an explanation of the continual luminescence of the organ. For luminous bacteria and

bacteria, and in my mind there is no doubt that the light of these fishes is due to symbiotic luminescence.

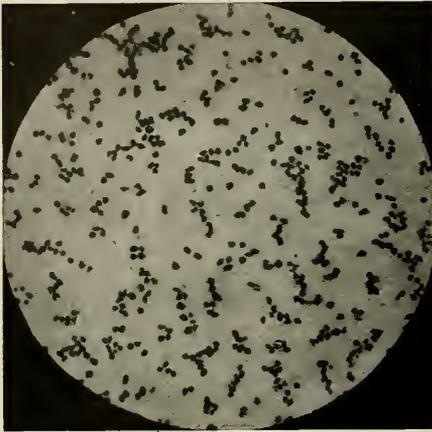
Despite many attempts to grow the bacteria in artificial culture media, no



Ordinary luminous bacteria growing in an artificial culture medium. Only the colonies and not the individual bacteria can be seen. After Molish



Dead fish infected with ordinary luminous bacteria. The bright spots are the colonies of light-producing bacteria. After Rosen



Highly magnified luminous bacteria, *Photobacterium javanense*. After Gerretsen

success was attained, or rather, I should say that bacteria from the organ would grow in artificial media but they never produced any light.

This may be due to the fact that these symbiotic forms require some peculiar nutrient material of the living fish which is absent in the artificial media. Most luminous bacteria of the sea grow with great readiness in any culture medium of the proper alkalinity and salt content. They appear as colonies on dead fish (before putrefaction begins) and have been known to infect living organisms such as sand fleas. The sand fleas become luminous,

and the malady, finally fatal, can be passed by inoculation from one animal to another. There is no reason why symbiotic bacteria, requiring special nutrient materials, should not exist.

We have in these fishes another example of a mutual benefit partnership between two organisms. The bacteria get food from the fish but what the use of the light to the fish may be, I should hesitate to say. The natives say it is a searchlight. Certainly it is advantageously placed for seeing. The immediate field of illumination must be clearly visible to the fish. But I must confess skepticism regarding this as its real value. It seems incredible that the light of these bacteria can have been of such value to *Photoblepharon* that the complicated luminous structure, blood supply, and obscuring mechanism should have been developed. How did the organ ever get its start? Here is a problem for the evolutionary philosopher. Perhaps there will come to light some intermediate steps.

Other fish may harbor symbiotic bacteria. I suspect that *Monocentris* of Japan is one. Its light shines continuously day and night, and I should predict that any fish whose light organ shines continuously, is probably a harbinger of symbiotic luminous bacteria. Let us hope for the discovery of such a form nearer home than the Banda Islands.

Whatever the intermediate steps in the evolution of this light organ, we see in *Photoblepharon* and *Anomalops* the final product in all its perfection; the light itself is steady and self-perpetuating, the supply of air is insured by a rich blood supply, and the screening can be instantaneously controlled.



The mud hut with roof and partitions of palm thatch in the village of Pirangi, in which Doctor Starks and his party lived while collecting in that region

Experiences of a Fish Collector in Brazil¹

By EDWIN C. STARKS

Professor of Zoology, Leland Stanford Junior University

IT is May day and we are steaming into the Amazon. I can scarcely realize that right over there is a land of my boyhood dreams—a long line of low dark islands, or jutting capes of the mainland, closely covered with trees. The river is made up of definite streaks of dark water with darker water between. Strange leaves and seeds float past. Occasionally someone exclaims over the triangular fin of a shark cutting the water. More often the exclamations are called forth by logs and snags, that become all sorts of monsters in the eyes of the passengers. We hope in

vain for a glimpse of the famous freshwater porpoise of the Amazon. Peculiar, long, snaky fishes, are frequently seen scurrying over the surface of the water in zigzag tracks to the right and left of the bow of our ship. Only their tails are submerged, but they make surprising time, sculling themselves like boatmen, and we wonder if they are on the way to become a new group of flying fishes in a few millions of years.

Para, with its big windows and high open doors, its pavements and sidewalks, its little wine shops and its

¹This account of collecting in Brazil relates to a trip made in 1911, and is lifted almost bodily from my journal. The day-by-day sequence, however, is broken, and the parts extracted that relate especially to fish collecting. It is of an expedition to Brazil made by a party of eight zoologists and geologists under the leadership of the late Dr. J. C. Branner, to study especially the region about Cape San Roque and northward. The photographs are by the author.



View of a basin in the harbor of Para next to the market. It is crowded with boats of many kinds laden with produce of many kinds



A nearer view of the basin adjoining the market in Para, showing in more detail the great variety of strange things offered for sale by the owners of the boats

numerous other details, recalls Naples rather than the other Latin-American cities I have seen.

We first visit the market, where one always sees the most life and color, for it is the shopping place for the great mass of people. Here we find strange fishes, reptiles, birds and mammals, likewise fruits and vegetables, many of which we have never even heard of before. Among the mammals are agoutis and armadillos and monkeys of which we may have seen pictures but never before have beheld in the flesh. In front of the great market building is a large basin crowded to overflowing with market boats which are loaded with all sorts of strange things—fish, pottery, vegetables, heavy timbers of various unfamiliar kinds, palm leaves for thatch, leaves, bark and seeds that we can only guess have some medicinal value. The boats are strange in shape and rig, with sails of various shades of brown, or occasionally sky-blue.

We find the zoölogical garden of great interest, for the animals all are living healthy lives in the climate in which they were born. There are tapirs, sloths clinging upside down in the branches, all sorts of strange monkeys that have never been brought alive out of Brazil, ant bears that have an attendant whose sole duty is to find ants for them, big snakes and gorgeous birds—all looking contented and at home.

Never were we so opulent! One of my friends "touched" me for a loan of ten thousand until he could get to the bank. We handle money in sums of which we have only dreamed before. We feel important until we reduce our money to the standard of home and find that each thousand reis represents thirty cents. For five dollars one gets fifteen thousand reis at the money changers. Every old market

woman has a fat roll of bills, not one of which is below three figures.

We see crude rubber everywhere—on the docks, arriving in boats from up the Amazon, piled in the warehouses or being packed for shipment. Nearly every store has a little, for apparently everybody deals in it to some extent. Para is a child of the forest, for all of her wealth comes from out of the woods—rubber first, then timber, Brazil nuts, tonka beans, balsam, Peruvian bark, and many other forest products.

Prices are high. A straw hat costs from 1,000 to 10,000 reis. The boys have to pay ten cents for a coconut and are asked thirty-five cents for a pineapple. Perhaps it was because they (the boys) are green, but one can get them (the pineapples) for less in New York. Even street car fares are high, and it costs us from nine to twelve cents to ride distances much shorter than those for which we pay five cents in any of our own cities. Apparently the conductor collects an additional hundred reis whenever the humor strikes him.

After a couple of days our ship is ready to sail southward, and a voyage of about four days brings us to the town of Fortaleza, more usually called Ceara—the name of the state. Here we stay for about ten days, always hoping for the appearance of the boat that is to carry us to Natal. Ceara is a city of about 40,000 people, but like all Latin-American towns one would not guess nearly that number. The market is indescribable save by the brush of a skilled artist. The pottery vendors spread out their wares under the trees in a large splotch of rich red. With the gaily colored wearing apparel and piles of fruits and vegetables, it is simply color run riot. The town is much scattered; toward the outskirts



A fishing village near Natal, Brazil.—Drawn up on the beach are two *jangadas*, pointed rafts of logs roughly shaped like boats

are picturesque little thatched huts; down on the beach is the climax of picturesqueness in a long row of fishermen's huts with raftlike boats drawn up in front of them.

There is little collecting here. The fishes in the market are the common ones caught with hook and line. Once or twice I follow cast-net men along the beach with little reward. The shore here is a clean-swept sand beach, but there are some rocky tide pools about five miles away. Early one morning several of us set out to walk to them. Our way lies along a hard sand beach. It is delightfully cool. A lighthouse on a distant point looks twice as far in the haze arising from the surf as it actually is. It marks our destination. We pass three different fishing villages among the palm groves. In front of the grass and mud huts are the raftlike boats known as *jangadas*. The *jangada* is simply a pointed raft of logs in the shape of a boat. As the waves wash over it at will it does not answer to the description of a boat in the nonsense verse: "A boat's to keep one's feet from getting wet when one is on the sea." There are various sizes of *jangadas*; little ones for one man to

paddle, and big ones that carry a large stretch of canvas and several men. Considering their construction, they are surprisingly swift and seaworthy. The fishermen go long voyages on them, venturing even out of sight of land.

Natives pass us in a continuous procession, some on donkeys, but most of them making beasts of burden of themselves. They are on the way to market carrying produce of various kinds.

Never in all my fish-collecting experience have I seen more promising pools than those we find at the end of our walk, but they are almost bare of animal life. I find only four kinds of fishes, where I should find a dozen or more kinds to compare with the tide pools I have known elsewhere.

At noon a porter arrives from the hotel with our so-called "breakfast." We fare royally under the palms, for the great box that he has carried all of these miles on his head contains all of the courses and china dishes that we would have had at the hotel. Then for a few pennies we hire some natives to climb the long, slender coconut palms and pitch down the green nuts that seem to be community property of the

villagers. The rich milk, contained in the nuts before the meat has hardened on the shell, makes a very delicious addition to our repast.

Next, a rail journey into the interior takes two days. We travel in our own private train furnished with the com-

rock hills arise straight from the plain like gigantic boulders. After dinner we sit in front of the little hotel in the light of the full moon, and, although we are within a couple of degrees of the equator, it is as cool as a summer evening at home.



The little town of Quixada nestles at the base of a great rock rising out of the plain. In the small lake in the foreground the inhabitants do their washing

pliments of the railway people, some of whom accompany us. Our train consists of two long, plain cars, with loose chairs instead of stationary seats, and with hammock hooks on the walls—these and the hammocks being all that make a sleeping car in Brazil.

We stop sometimes at an outcropping of rock that the geologists wish to see, or sometimes at a likely-looking place where beasts might lurk. The end of our journey is Quixada, where we spend the night. In all directions great

In the morning I obtain a few small fishes from a pond near the village. These, with some lizards, are all the region contributes to our vertebrate collections. In this region the rich fauna of Brazil, of which we have heard so much, is conspicuous by its absence. Even insects are scarce, with the exception of mosquitoes. Of these I speak feelingly, for last night in my hammock I would often awake after a short, fitful sleep, to find myself "tacked down" by mosquito bills from below.



The village of Pirangi, showing the beach and also the palm trees in which the little town is embowered

Our ship comes into the harbor after we have remained at Ceara much longer than we had anticipated. She is a large, dirty boat, commanded by a big American whom we later find upon closer acquaintance to be a rather decent fellow full of troubles of his own. Not being able to get good rooms together, we are scattered over the boat. My roommate is a mahogany-colored gentleman. I retire early, and as I am about to climb into my berth, I note a peculiar handle protruding from under his pillow. Curious, I draw it out, and find it to belong to a slender stiletto with a blade a foot long and a point like a needle. My back twitches in fearful expectation all night. But later we find that everyone wears a stiletto, and that the elaboration of the handle is an index to the prosperity of its owner.

Our old tub of a boat limped into Natal last night with a very bad list and

we anchored outside of the reef until this morning. As we run into the quiet waters of the harbor, a steamer flying the government colors puts off from shore and we find to our surprise that we are the reason, for our chief, the late Dr. J. C. Branner, is a great man in Brazil. We are at once carried on shore, where we find a sumptuous breakfast awaiting us. Then we are taken to a new house, next to the governor's residence. The owner has donated it and our new friends completely furnish it for us from their own homes, so that we are very comfortable. After this we are officially received by the governor with gold lace and champagne, and then we are left to ourselves.

Our boxes of freight are placed in a large government storehouse opening on the water front and here we expect to do our laboratory work. The harbor extends for some miles inland as a mangrove-lined estuary. Across the

mouth of it is a reef, over which the waves wash at high tide. As we have been obliged to give up the idea of cruising northward along the coast, we feel that we can find plenty to occupy us here for a considerable time.

The next day a couple of us hire a boat and go on a dredging and seining trip. Our most notable seine haul is made in a pond into which the high tide flows. It is about a hundred feet across and three times as long, and as my fine-mesh seine just reaches across it, I am able to collect about all it contains. The haul proves to be a very rich one, and is the real beginning of my collecting.

The governor has given us the use of the steamer that met us upon our arrival, and the next day we make a short cruise. The consequence is that I am now lying beside a little stream near the village of Pirangi writing in my journal and trying to recover from a pernicious attack of seasickness, for the waves handled that little steamer in a very careless manner, piling themselves on deck so that we had to stay on top of the cabin to keep half dry. The cool shade of the mangroves is a very agreeable change from the hills and valleys of the sea. Across the stream are other mangroves standing on tiptoe in the water, their exposed roots forming a strange, tangled network. Three long, slender, brilliant green garfishes swim past up stream to get a taste of fresh water, while behind them, paddling ponderously along like old-fashioned ironclads, are some globe-fishes. A flock of yellow and green parrots perch on the trees near me and very frankly discuss me. Though I understand little Portuguese, I comprehend perfectly what they think of me, and the knowledge is not encouraging.

I walk back to the little thatched

village and see a great circle of twenty or thirty men and boys under a big spreading tree that at once reminds me of the council tree where Buldeo told his famous lies. White helmets mark our party in the middle. I draw near and find a couple of natives opening coconuts for my friends to drink the milk.

We are boarded in a little mud hut whose roof and partitions are made of palm-leaf thatch. We are in a condition to eat and appreciate anything that is placed before us, and lucky we are to have appetites to tackle some of the things. Five of us sleep so close together in a room that our hammocks nearly touch, and the other three sleep under a thatched roof supported by poles and without walls. When the people gave up their room to us, they had only themselves and their hammocks to move. It is the main living room of the house, too, and in the daytime the women occupy it, bringing in the cushions on which they make lace, placing these on the ground in front of them.

We are reminded of when the circus comes to town. We are the circus. Our kind never stayed with these people before. Our zoölogical collecting and geological rock-cracking are beyond their comprehension, except that they are sure, of course, that we want fishes and reptiles and insects to make medicine of. They follow us everywhere. When we retire, they look in at the doors and windows in a perfectly frank way. We can scarcely bar them out because, though we are paying for all that we receive, we are their guests.

A couple of days gives us all the village has to offer and we return to Natal over a quiet sea.

The fish market at Natal is very poor for collecting purposes, and though I

frequently visit it, I find little that is good. But I get very desirable specimens from the pools left among the rocks when the tide is low. I poison the pools with chloride of lime, which drives the fishes from the crevices



Portrait of the little blenny, *Salariichthys textilis*, which leaped out of the pool and over the sand to escape capture. After Jenyns

among the rocks so they may be dipped out with a small net. There is one common blenny, however, that never waits to be dipped out, but leaps out of the pool and makes rapid progress over the sand to the sea and is captured with some difficulty.

Owing to the scarcity of fishes, a local merchant has imported from Hull, England, a trawling steamer with its crew. He believes there would be a very good market for fishes, could they be caught. The boat is large, and the trawl is a huge affair with a net made of rope. It weighs tons and is hoisted by a steam winch. In a haul it sweeps the bottom over a space ninety feet wide by about three miles long. A couple of us make an expedition in the trawler on a trial run, but alas, the net catches on a coral reef and is badly torn. A small corner remains, however, full of good things. The entire catch is given to me. A couple of days later we try it again, but this time tons of seaweed fill the net and it splits wide open as it is brought aboard. The trawler does not make another trip during our stay.

We have been given passes on the

two railroads that leave Natal in different directions, and one day we board the train for Lake Extremoz. This is a long serpentine body of water, the remains of a former river, and its isolated fish fauna should be very interesting. We try to leave without letting our departure become known, but some of our friends telegraph news of our coming, with the result that we are met by a civil engineer who makes us his guests. I carry a fine-mesh seine, and we hire the head fisherman and two other natives with their great dugout canoe to help drag it. But our work is futile, for the lake bottom is covered with a mass of half-disintegrated vegetable matter held in suspension that chokes the seine, and we can-



One of the small boys of Ceara Mirim, who was such a good collector



A member of Doctor Starks's party with a crowd of enthusiastic small boys who gave valuable help in collecting at Ceara Mirim

not get it ashore on account of the weight. I capture a few fine specimens in the soft, oozy matter. They are an aggravation in showing what I have missed.

After returning to Natal for a day we make a collecting trip to Ceara Mirim, that lies a few miles farther along the railway from Lake Extremoz. Here we find very good collecting in a little stream with several disconnected ponds. But we very soon find that the unusually abundant small boy can get the specimens we want better and easier than we can.

We keep office hours in our little hotel, and boys are continually arriving with fishes, snakes, lizards, land shells, and insects, as well as with a host of things we do not want. We have made a scale of prices for the things we want and we have to bargain before we get them. It almost causes

heart failure to say "No" to a boy when he wants too much for a desirable specimen and then shut him out of our room. But they always meet our price for they know it is fair, and as they always rush gleefully away to get more of the little beasts (*bichos* is as it sounds), we know they are satisfied. In fact we soon have grown men engaged in the chase.

The whole hotel swarms with men and boys, for everybody comes to look on, and the idle boys have to be continually driven outside. When we wish to work we lock ourselves in, only opening the door for more specimens.

The boys are the best boys we meet with in our travels, as well as the best collectors. Some of them have little guns made of gas pipe, fired by snapping a steel umbrella rib against a paper cap. They use balls instead of shot and shoot surprisingly well con-

sidering the guns. Others are very expert with a sling, or with a bow arranged to shoot stones instead of arrows. One boy who collects lizards for us scarcely ever misses his mark, getting as many with his crude apparatus as we can with a gun.



Water carrier at Ceara Mirim. The water jar rests on a wreath of green leaves twisted about the head to form a cushion

The public well, whence the death-dealing drinking water comes, is the place where everybody meets everybody else. The water is carried by mule power in long wine kegs, or often in picturesque red jars, on the heads of natives—the only head work they ever do. Usually the jar rests on a wreath of green weeds twisted about the head to serve as a cushion. These natives, like all peoples who carry burdens on their heads, have beautifully erect bodies and straight backs.

The tide-pool collecting is the most profitable and pleasant about Natal. The pools are large, with fine white sand on the bottom. The water is warm and clean, and the sun is not too hot. It is great fun wading about in

the pools, scooping up the fishes as they come from the crevices of the rock. One never knows what unusual specimen may next reward him. Occasionally I sit on a rock and describe the brilliant colors of the fishes that so quickly fade after death.

As a result of this exposure to the tropical sun, I am gradually losing my entire skin. First I left my hat off when I was collecting, and the top of my head (*sans* hair) grew rosy red and peeled in a couple of days. Then I worked with my sleeves rolled up, and the skin of my arms followed. Now I peel huge sheets of epidermis from my legs. But one peeling is followed by that part turning black and it does not peel any more. I have about reached the limit of possibilities.

Our next trip is to the town of Itamatahy, 165 kilometers from Natal by rail. We pass first through a region of tangled, scrubby growth among the sand-hills; then through a level plain dotted sparsely with shrubs and trees and covered with bunch grass. It is typical desert land such as we have in Oregon or Nevada. Further on the trees grow higher and more tropical and tangled with vines. Sometimes we look into fertile valleys, green and wild or filled with plantations of cane, cotton, or bananas.

Houses with dull-red roofs cluster in little villages, with the ever-present palm trees. At intervals along the track are little thatched mud houses. Here the whole family turns out to see the train go by; women in slatternly calico dresses, dirty and patched, smoking short black pipes; lazy brigands, leather-hatted, belted and bedagged, ill-favored and ill-flavored; naked bronze "kids" with pot bellies and slender legs; and in the doorway some chick-



"Main Street" in the town of Papary. On the lake of that name was held the fishing *fiesta* which brought so many interesting specimens to Doctor Starks

ens, goats, or pigs: all are equally interested in the only event that breaks the monotony of the day.

We spend the night with an American engineer in charge of the building of a branch railroad. Two of the party, finding here the things they are interested in, conclude to stay longer, but the rest of us return toward Natal by an early train with the intention of visiting Lake Papary for a day or two.

Reaching the town of San José, we leave the train and soon find ourselves tramping along a narrow green pathway lined with tropical shrubs and trees, accompanied by two donkeys and the necessary natives to drive them. Our suitcases, alcohol tanks, and other belongings swing from the side of the donkeys, and a light drizzle of rain keeps us delightfully cool.

Reaching Papary we present a letter from the governor to Colonel Carvalho, *Presidente do Governo Municipal*,

and we at once own the town and all of its inhabitants. It is the best town we have ever owned, and our new friend, Colonel Carvalho—what can I say of him more laudatory than that he is a "brick?" He owns a nearly-new five-room house close to his own, and throwing wide its doors, he asks us to accept it for as long as we can be happy. He wants us to board with him, but when we decline the invitation, he gets us a cook and servant, and so here we are keeping house under our own vine and fig tree.

We are on one side of the village plaza. At the back door stands our moss-covered cistern—a picturesque piece of pottery, about the shape and size of that which Ali Baba used to pack each of his forty thieves in. Several tropical trees grow in our backyard. Corner-wise, with a gate between, is the yard of our host, filled with trees and shrubs among which

wander all sorts of strange animals that he has collected. One, an old monkey, with all the wisdom of the ages behind his gray eyes, gazes over the fence.

My journal contains much of this little town, but I am forgetting my fish collecting. One morning the Colonel takes us on a walk to the lake, where a big canoe manned by some natives awaits us. Low stools are placed for us to sit on, while the men kneel at their paddles. We skim down a long, winding, green lane of oily water, lined on both sides with rushes and with water hyacinths bearing beautiful clusters of big lavender blossoms. It is a glorious ride. We float silently along, not a sound breaking the quiet save the ripple of water under the bow of our boat. Occasionally, as we turn a corner, strange water birds rise and fly ponderously away, and mullet jump all about us. At last we glide out on a beautiful lake that loses itself in the distance among islands and headlands.

Perhaps never before has my soul been so filled with poetry and romance, as when on this cool fragrant morning we glide so smoothly and quietly over miles of glassy water. Even the natives feel the enchantment of it, for no one speaks. Occasionally we stop to draw up one of the poles that here and there stick above the water, and bring to the surface a fish trap of basket work.

After a time, away off against a distant bank of trees, we see moving objects, which, as we draw nearer, prove to be canoes. Soon we see that they are headed for us—canoe after canoe loaded with picturesque barelegged natives. One of them is an expert at blowing a conch shell, and its booming trumpet-note comes echoing across the water, adding a touch of weirdness to it all. When they are all about us, we are the nucleus of a band of a dozen canoes.

They have been fishing and have baskets of specimens from which the Colonel assures me I may select.

We are told that there is a law against a certain kind of destructive fishing, but for our benefit the governing body of Papary has annulled the law for the time being. These fishermen have been brought together not only to get specimens for us, but to entertain us with a fishing tournament. Operations are begun when two big canoes, that have a great gill-net loaded equally in each of them, take their stand at one side, while the other canoes scatter in the opposite direction. The first two paddle away from each other paying out the net in a great circle. When the circle is two thirds complete, and the two canoes are headed toward each other, the other boats begin closing in, their occupants making the greatest noise and commotion possible—splashing, yelling and hammering the sides of the canoes with paddles—evidently with the idea of driving the fish into the net.

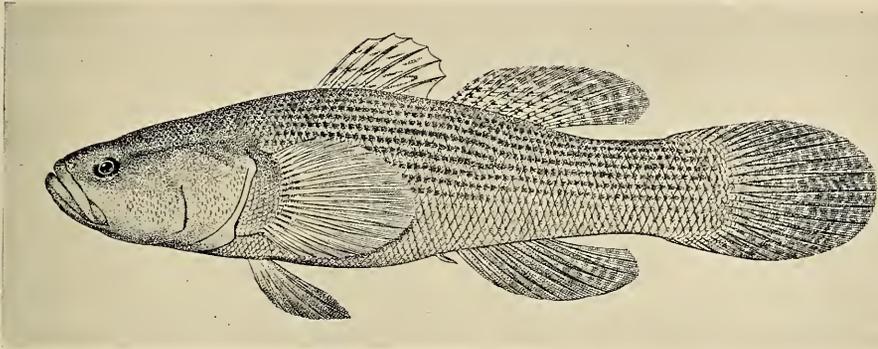
It all looks and sounds very barbaric—South African or perhaps just Brazilian. The circle of gill-net is now complete, and the canoes pass over the floats of the net and are inside, where the men begin using cast-nets. These are the biggest of their kind I have ever seen. They are at least twenty-four feet across and are thrown with great skill and strength. It is a pleasure to watch them in use, the men, straight and erect, swaying their bodies like trained athletes, the muscles of their naked bronze backs standing out, as with a great heave the nets fly into the air, spread themselves, and fall in a perfect circle. Every cast brings in fishes. Those that are not caught in the cast-nets are driven into the meshes of the big net and gilled. The men seem

to be having lots of fun in breaking the law with the *Presidente* looking on. We have all sorts of high jinks and canoe races on the way home, and the men shout and joke with each other in quite a holiday mood. My only regret is that I left my camera at home.

Upon our return we find the whole village out in force to greet us. Each

sweep their walk and generously include ours also. Sugar cane, coconuts, oranges, and limes are sent in quantities by the good people. Our house is a regular museum with iguanas, turtles, snakes, and monkeys running about to the limits of their tethers.

One morning I take a long walk to the railway station to meet some of our



Eleotris carvalhois, a goby taken by Doctor Starks in Lake Papary and named in honor of the genial Colonel Carvalho, who gave such valuable aid in collecting fishes from that lake

man spreads his catch on the shore and I am invited to take what I care for. The Colonel will not allow us to give the men any money, though we try to slip some to them on the sly. The fishes I select are placed in a basket, crowned with a big fish for dinner, and delivered at our house.

The next day a large basket of fish is delivered to me by the Colonel's orders. The men have been fishing all night, and I am told that I now have all but a few of the kinds to be found in the lake. The fishes are mainly strange armored catfishes. On two other occasions baskets of fishes are brought to me. When we try to pay the men something, they make very sure that the Colonel is not in sight before they dare accept any remuneration.

This is a very friendly town. Every passer-by looks in at the window to wish us a good-day. Our neighbors

party who are expected from Itamataty. As I walk along the path, a big black attaches himself to me, sticking close behind, and I remember his long stiletto as we pass through the lonely woods. His bare feet make no noise on the soft path, and I find myself frequently glancing back like the little girl on the dark stairs. It turns out, however, that he is one of our fishermen, and has made himself my protector in quite a feudal way. When we reach the station he makes it very evident that he is with me. When I say "No" to an importunate beggar, my swart friend catches him by the arm, and I understand enough of his tirade to know that he tells the beggar that when I say "No" I am not to be bothered. The people discuss me in a very frank way, taking turns at asking me questions to learn if it is really true that I speak no Portuguese.

After some days we leave Papary with regret, to return to Natal. The very hospitable Colonel seems sorry to see us go and stands waving us farewell as long as we are in sight. What a world this would be to travel in could one always meet such a Colonel!

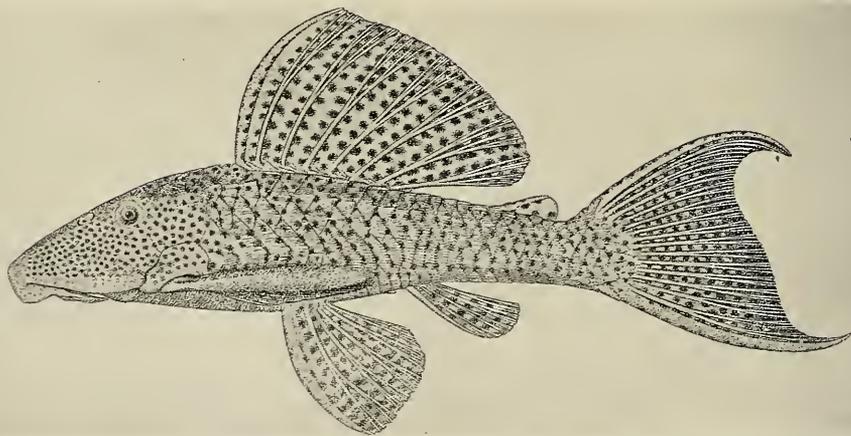
The last collecting trip I make from Natal is to the head of the estuary that forms the harbor. A kind Scotchman who has an establishment for the manufacture of various cottonseed-oil products, has invited a couple of us to go in his big sailboat to visit him. We have a beautiful sail through the mangrove-lined water lanes. We can spare only a couple of days, for the steamer which will take us northward is soon due. I carry my seine and our host loans us a boat and some of his men to help us, and I get a number of specimens that I have not found in the lower harbor.

In July we leave Natal, and after a very fine voyage arrive at Para, where we spend two weeks. The Amazon fish fauna is less well-known than I had supposed, and as the fish market is large I am able to get a very good collection. Every morning I go to the market and hire a man with a tray,

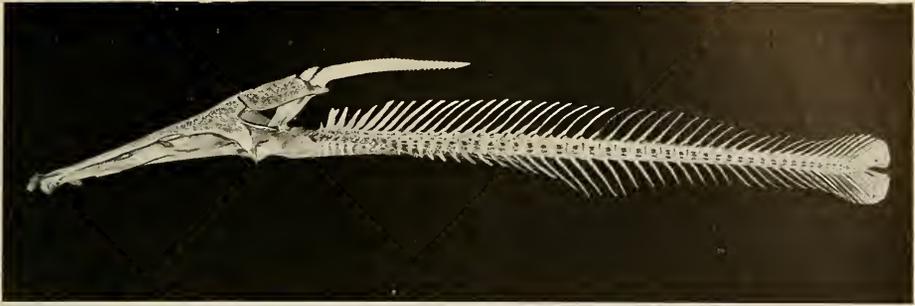
who follows me around from stall to stall and receives the fish as I buy them. Prices are high. Perhaps I am cheated somewhat, but not much, for a friend of the consul's accompanies me the first two mornings, and I get some idea of what the prices should be. Always I have to bargain for every lot.

My specimens from Brazil are representative of a most interesting fish fauna, composed largely of the very strange catfishes that have been more or less familiar to me as pictures. If from all the fishes of the world the most peculiar ones were picked out, they could be matched for strangeness among the catfishes. One feels that if he were living in the Devonian or Carboniferous Age, and were collecting fishes, he would find just such a lot of unfamiliar and strange forms as these.

We have a very delightful voyage northward, and we view with satisfaction the Southern Cross sinking below the horizon and the North Star climbing up toward its familiar place in the sky. But it is with more satisfaction that we at last behold the fair bronze lady who guards our liberty as we sail into New York harbor.



Plecostomus puzarum, one of the strange armored catfishes of the waters of Brazil. This one looks as if it had not descended very far from its Devonian ancestors



Lateral view of the axial skeleton of a crucifix catfish from the West Indies. Photograph of a specimen presented to the American Museum by Mr. George Stone of New York City

The Crucifix in the Catfish Skull

By E. W. GUDGER

Associate in Ichthyology, American Museum

THE early explorers of the New World found it indeed to be a new world in its animals and plants as well as in its lands and peoples. In its fauna they found tapirs, not elephants, llamas and alpacas and vicuñas instead of camels and dromedaries, cougars and pumas in the place of lions and tigers, humming birds contrasted with nightingales, iguanas replacing fence lizards; rattlesnakes taking the place of harmless adders, and—the list might be indefinitely extended. But nowhere perhaps was there greater contrast between the faunas of the new world and the old than among the finny inhabitants of the waters.

Natural history explorations were long confined largely to southern North America, Central America, and northern South America, and in the waters, salt and fresh, of these regions were found fishes of many kinds never before seen by the eyes of white men. Among the fresh-water kinds, this region is especially characterized by members of that group, the *Nematognathi* or whisker-jawed fishes, col-

loquially called catfishes. While in Europe this group is represented by but two species (one of these being confined to Grecian waters), in America there are found at least 250 species or quite one fourth of all the species of catfishes known in the world.

In the tropical and warm temperate waters of the great rivers of America, especially in the Amazon and Orinoco and their tributaries and in the rivers of the Guianas, and also in the salt and estuarine waters of the Caribbean-Gulf region, these *Nematognathi* in vast numbers live, move and have their being. They are rather primitive forms which early split off from the piscine stem and to this day retain many primitive characters. Of these whisker-jawed fishes, the largest family, the Siluridæ, are the ones best known by the name "catfishes." These Siluridæ have broad heads, scaleless slimy skins, fins both pectoral and dorsal provided with large jagged spines, and mouths bedecked with short or long barbels or feelers.

In the salt, brackish, and fresh waters of the countries bordering on the

Spanish Main are found many siluroids of the old genus *Arius* (Greek *areios*, martial, from *Ares*, Mars), so named because they have a bony buckler or shield extending from the base of the skull backward to the strong spine of the first dorsal fin. This may be seen in the lateral view of the skeleton of one of these fishes which forms the headpiece to this article and in the dorsal view of the same skull on page 378. Furthermore, the skulls of many of these fishes show on their ventral surfaces a fairly recognizable representation of a crucifix, and among the inhabitants of the countries referred to above these catfish skulls are held in a superstitious esteem amounting almost to veneration.

In reading books describing travels in South America the present writer has at various times run across accounts of the superstitions of the natives regarding these crucifix catfish skulls but, for the most part, they cannot be recalled now. However, there are one old and two recent references which may be cited. The first of the recent accounts is found in a delightful book by Mary B. and C. W. Beebe,¹ on life in the coastal regions of Guiana and Venezuela. While the authors were anchored in one of the many distributaries of the Orinoco delta, the fishes attracted their attention, and of certain ones they say:

On the bottom our hooks would sometimes be taken by great fierce-whiskered cats, bedecked with long streamers, which gave no end of trouble before they were quieted. They were pale yellow, and head and back were encased in bone; Mæstro (the cook) called them the crucifix fish, and later showed us why. On the under surface of the bony armor is a large cross with a halo about it just above the arms. The crew never caught one of these fish without making the sign of the cross in the left palm.

The figure which they give, and the

one which really prompted me to hunt for other crucifix skulls, is from a photograph of the ventral surface of the skull of one of the catfishes to which they refer. The details of this skull are not sharp and clear because it had suffered considerable abrasion, and hence it does not seem necessary to reproduce it here since other and better figures will be shown later. The fish was unfortunately not identified as to genus and species.

The next account and figures are found in Doctor Eigenmann's great monograph on the fresh-water fishes collected in British Guiana.² He writes:

The skeletons of a variety of *Ariinæ* are prepared and sold as crucifix fishes. The one which is most frequently prepared is *Schiadichthys proöps*. The dorsal surface of the skull and dorsal plate are pointed out as resembling a hooded monk with outstretched arms. The ventral surface resembles the cross. Fancy pictures the dorsal spine as a representation of a spear, while the otoliths, which rattle when the skull is shaken, are dice with which the soldiers cast lots for the garments of our Lord.

Eigenmann's figures are both reproduced herewith. The dorsal view (left) shows the robed and hooded monk with outstretched arms, while above the hood there may be seen the base of the dorsal spine representing the bottom part of the spear. The ventral view shows the crucifix. The stem or trunk of the cross is made up of the main basal bone of the skull, the parasphenoid, and the arms of the cross are composed of the post-temporals. The outer ends of these, expanded to accommodate the articulation of the bones of the shoulder girdle, give somewhat the idea of outstretched hands.

The halo is composed of certain little bones, called the Weberian ossicles after the name of their discoverer,

¹Beebe, Mary Blair and C. William. *Our Search for a Wilderness*. New York, 1910, p. 13, fig.

²Eigenmann, C. H. "The Fresh-water Fishes of British Guiana." *Memoirs Carnegie Museum*, Pittsburgh, 1912, Vol. 5, p. 106, pl. VI, figs. 1 and 2.



Dorsal view (left figure) of the skull of *Schiadeichthys proöps*, a catfish common in the Guianas. Note the resemblance to a robed and hooded monk. The ventral view (right figure) shows the crucifix and the halo. After Eigenmann

which have long been known to connect the air bladder and the internal ear and hence were thought to be homologous with the three auditory ossicles of our ears, and accordingly to play a part in the transmission of sound and in the function of hearing. Now, however, it is pretty well demonstrated that while they do connect the air bladder and the membranous labyrinth of the ear, they are a part of the complicated apparatus having to do mainly with the maintenance of equilibrium in the fish. In position these halo bones lie

ventral to a plate composed of the expanded lateral processes of the coalesced anterior vertebræ. This plate then covers and protects the anterior end and dorsal part of the air bladder. Especial comparison of this structure in this skull with similar structures in other skulls will be made later.

Below the inner or basal portion of each arm is an expanded and rounded region of the skull called the bulla, in which was contained the membranous labyrinth of the auditory organs and in

which are now found the otoliths or ear stones. When the skull is shaken the noise made by these is compared to the rattling of dice as noted by Eigenmann above.

Seeking further data on the crucifix catfish skulls, I wrote Mr. Leo E. Miller, formerly connected with the American Museum, and a traveler and collector of large experience in northern South America. He courteously answered that he had seen these crucifix fish skulls frequently in the Orinoco region, that such were commonly found in the curio shops in the West Indies, and that stories such as Doctor Eigenmann gives were very current throughout the northern part of South America and the West Indies.

These statements are confirmed for the Guiana country by Mr. Herbert Lang, associate curator of African mammals in the American Museum, who on a trip to this region in 1922 brought back from Georgetown such a skull fancifully painted and decorated. Furthermore, Mr. James Rodway, the experienced naturalist of the Guiana Museum at Georgetown, British Guiana, very kindly has written me that "crucifix fishes" are common, and their skulls can be obtained everywhere. the catfish (*Sciadeichthys proöps*) referred to by Eigenmann furnishing the greater number.

Dr. G. K. Noble, curator of amphibians and reptiles in the American Museum, while on an expedition to Santo Domingo during the summer of 1922, saw a crucifix skull in the province of Bara Hona on that island. This was very much venerated by the natives there, being looked upon as a sort of fetish or charm against danger and sickness.

Far earlier, however, than the accounts of any of the persons cited,

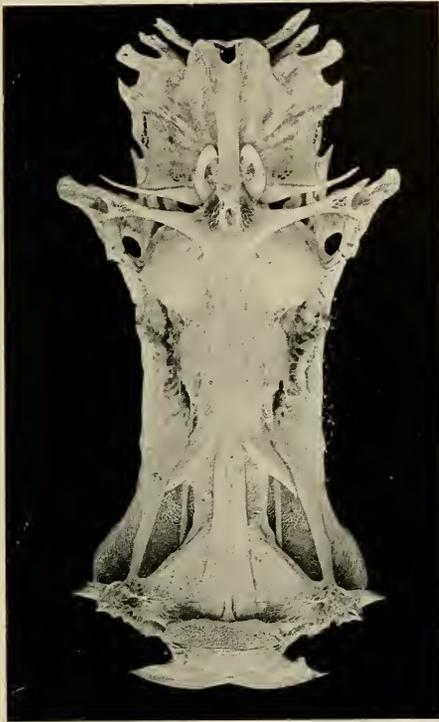
is that by Antonio de Alcedo,¹ long a resident in northern South America. In the appendix to his book (1789) he writes of a catfish called "Capitan" or "Chimba" that it is "found in the rivers of the new kingdom of Granada. It is the *Bagra* of other provinces . . . It has been remarked that, when the bones of the head are separated, each represents some one of the instruments of the passion of our Redeemer, forming the spear, cross, nails, etc."

Such structures as these referred to I have found in two ocean catfishes (*Felichthys felis* and *Galeichthys felis*) which are not uncommon along our Atlantic coast and in our brackish waters certainly as far north as Cape Hatteras. One of these, *Felichthys felis*, the gaff-topsail, is abundant in the summer at Beaufort, North Carolina, and years ago in skulls from which the flesh had been macerated I found the crucifix beautifully delineated.

This skull has been elsewhere figured and described,² but is herein shown again in the ventral aspect. Here we have the main trunk of the cross with the extended arms. Above this is the halo and this, together with certain rugosities just above the junction of the arms of the cross with the main trunk, gives a fanciful representation of the human face. Above, and extending to the right and left, are the ventral edges of the expanded and coalesced anterior vertebræ which, as previously explained, cover and protect the anterior part of the air bladder. These bones will hereafter be called "wing" bones because in their shape and position they

¹Alcedo, Antonio de. "Diccionario geografico-historico de la Indias occidentales ò America." Madrid, 1786-89, 5 vols. English translation with large additions by G. A. Thompson. "The Geographical and Historical Dictionary of America and the West Indies." London, 1812-15. 5 vols. Appendix, p. 25.

²Gudger, E. W. "The Gaff-topsail Catfish (*Felichthys felis*) a Sea Catfish that Carries its Eggs in its Mouth." *Zoologica: Scientific Contributions New York Zoological Society*, 1916, Vol. 2, pp. 148-150, fig. 29.



Photograph by E. W. Gudger

Ventral view of the skull of the gaff-topsail catfish, *Felichthys felis*, of our Atlantic and Gulf coastal waters. Note the crucifix, the halo, the "wing" bones, and the faint resemblance to the human face. Below, note the masses of bony tissue simulating the feet and legs. Also note the tooth pads



Photograph by E. W. Gudger

Ventral view of the skull of the smaller ocean catfish of our south Atlantic and Gulf coastal waters, *Galeichthys felis*. Compare this figure with that on the left as to the crucifix, halo, and position of "wing" bones. Note also differences in anterior region in shape and position of the bones

show some faint resemblance to the "wings" of the conventional angel. Anteriorly on either side a bone reaches out from the median region of the skull and anastomoses with the bones forming the anterior part of the skull. These bones and the others to which they are attached simulate legs and feet pretty well if one exerts one's imagination ever so little.

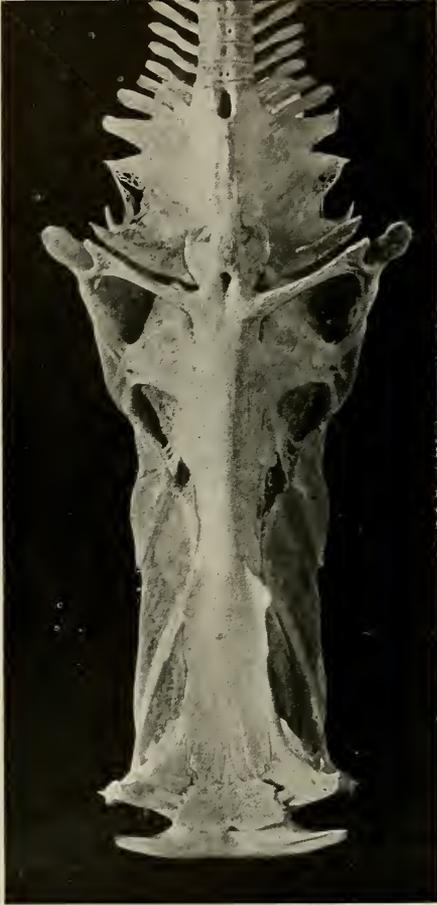
In the lower angle formed by the arms and the trunk of the crucifix are found the bullæ, here very large and prominent—much more so than in the preceding skull. This is due, in part at any rate, to the fact that the skull of *Felichthys* is much wider in proportion

to its length than either of the skulls previously referred to, or indeed in any of those figured later herein.

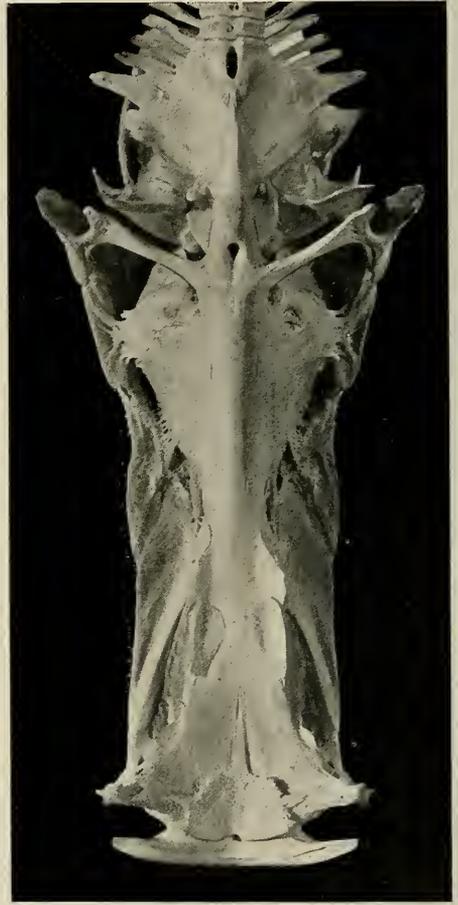
The other ocean catfish, referred to above, is *Galeichthys felis*, a smaller fish, very common along the Gulf coasts of the United States but not so abundant at Beaufort as its congener. Its skull has never been figured before. Not having a specimen of this fish, I procured one through the courtesy of Mr. B. A. Bean of the United States National Museum, and maceration gave the beautiful skull seen in the next figure. Here again the crucifix structures are very clear, especially the face, as shown in the adjoining bones. The

more nearly horizontally placed arms partly obscure the bullæ, which are less prominent than in the preceding figure. The legs are also clearly shown. The anchor-like structure of the anterior part strikes one forcibly, and still

of which, however, are we able to name. The first was presented by Dr. Jonathan Dwight, research associate in North American ornithology in this institution. Doctor Dwight is unable to give the source of this skeleton but the



A West Indian crucifix skull, lacking tooth pads on the roof of the mouth. Photograph of a specimen belonging to Mr. M. C. Marshall, Bellaire, Queens, Long Island



Photograph of another West Indian catfish skull (Mr. Stone's specimen). This differs from its mate chiefly in having tooth pads in the roof of the mouth

anterior to this we have a structure which can only be compared to the "bitts" on the deck of a boat or on a wharf for securely holding a cable.

The American Museum is the fortunate possessor of two fine skeletons of crucifix fishes of another species neither

assumption is that it was secured in the West Indies. The second we owe to the courtesy of Mr. Otto W. Jommersbach of Brooklyn, who tells me that it also came from the West Indies.

While this paper was being written, Prof. M. S. Farr, of Princeton Uni-

versity, came to the department of fishes seeking certain data, and saw my specimens. On his next visit he brought me a fine skeleton of a crucifix fish and this on examination proved to be identical with the two preceding skulls. It is, however, much larger, coming evidently from an older fish.

In addition to the skeletons just referred to, I have had an opportunity to study four others of apparently the same species of catfish. This beautiful series is the property of Mr. M. C. Marshall of Bellaire, Queens, Long Island, through whose courtesy I have been privileged to examine them. As to their origin nothing is known save that they came from the West Indies, and probably from the eastern region. All four seem to be representatives of a single species, the same as that to which the other three belong, probably a species of the genus *Sciadeichthys*.

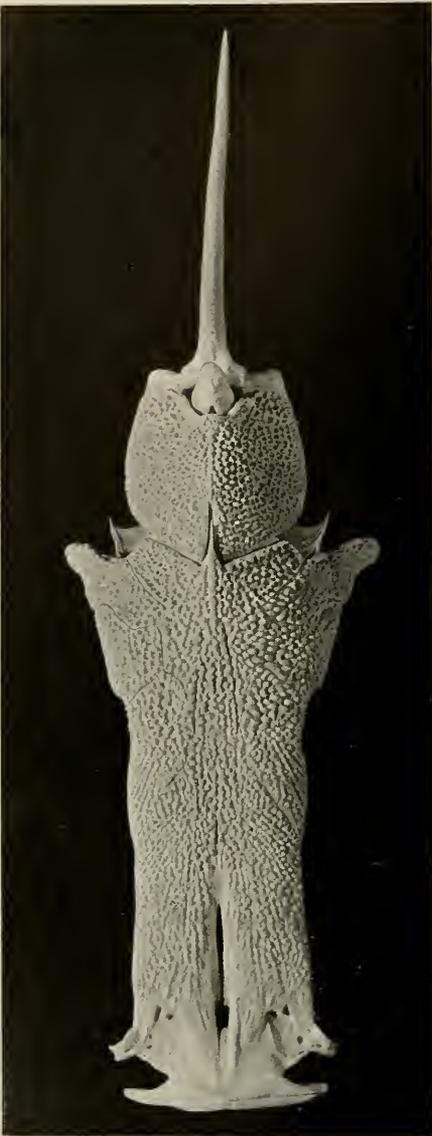
A photograph of the best of these is herewith reproduced. Here we have the same structures that are found in the others, the differences bring in details. This skull is long and narrow, with little difference between the diameters measured across posterior, middle, and anterior regions. Attention is called to the bilateral tooth pad far in front.

The last skeleton, with which I have had the pleasure of working, is by long odds the most beautiful I have ever seen. It was presented to the Museum by Mr. George Stone of this city, and is also of West Indian origin. This skeleton has had the flesh so skilfully macerated and removed as to leave it almost absolutely intact and united throughout so far as the axial portion is concerned (the fin structures are gone, as is to be expected)—all of which may be seen in the lateral view at the head of this article. The subjoined figure shows the skull in ventral view. Here

all the crucifix structures are beautifully shown, so much so as to call for no particular explanation. Undoubtedly this skull is very similar to the preceding, possibly so close as to be put in the same genus, but there is one marked structure in this not found in the preceding—the two tooth pads on the anterior part of the roof of the mouth. These are structures found in only one other skull examined, that previously referred to as brought back from British Guiana in 1922 by Mr. Herbert Lang of the Museum staff. This latter skull shows remains of a tooth pad in the same part of the roof of the mouth where unbroken pads are found in the skull of Mr. Stone's specimen. Since these skulls seem identical in other respects, they are referred to the same species.

The last figure to be given is a dorsal view of this same skull. The robe of the monk, the extended arms with the covering robe, the cowl or hood (the dorsal buckler) and the spear of the Roman soldier (the dorsal spine) can all clearly be made out. This figure should be compared with Eigenmann's portrayal of *Sciadeichthys*, and comparison should also be made of the ventral views of the two skulls. The ventral structures are plainly very much alike. The absence of intermaxillary tooth pads in Eigenmann's figure means nothing, since they have been torn off in cleaning the skull, as they have been in the two skulls referred to on page 376. However, the presence of tooth pads in the roof of the mouth of the Stone specimen, and their absence in Eigenmann's specimen and in all the six just considered, in every one of which there is no trace of them whatever, leads me to make of the Stone specimen a separate species.

Comparison will now be made of the



Dorsal view of the skull of Mr. Stone's specimen. Here the resemblance to the robed and cowed monk is very plain. Note the shoulder and arm region, and at the top of the hood, the dorsal spine simulating a spear

two skulls figured in the dorsal aspect—those of Professor Eigenmann's specimen and of Mr. Stone's. If these figures are carefully studied, we are forced to the conclusion that they are of closely related species of catfishes.

In shape, form, relative measurements, shape and position of the anterior fontanelles (dorsal apertures in the skull), these skulls are apparently identical. In only two respects are they different: Eigenmann's specimen seems flatter, Stone's more curved in the posterior dorsal region (i.e., over the arms); Eigenmann's specimen shows the notch posterior to the junction of the arm region with the skull forming a much narrower U than the similar notch in Stone's specimen. These differences are of course insignificant and of themselves are not sufficient to establish specific characters, but when added to the differences found on the ventral surface, we may be quite sure that the skulls belong to different species.

Comparison of all these various skulls in the ventral aspect reveals, first then, the similarity in that all have the crucifix plainly shown, since in all it is made of the same bones in the same relative position and arrangement. In the second place, the Weberian ossicles (forming the halo) are all practically identical. Finally, all have the "wing" bones (formed of the expanded lateral processes of the first vertebræ) alike in shape and position. However, on careful examination the differences are almost equally plain. The skull of the gaff-topsail (*Felichthys*) differs most widely from the others. It is broader throughout, but especially in the anterior region, where its divergence from the other skulls is most marked. Here also we have two long strands of bony tissue reaching forward and attached to the anterior part of the skull, and bearing a fanciful resemblance to a pair of legs—to carry the analogy still further.

Quite unlike the skull of *Felichthys* and unlike all the other skulls, is that

of the smaller ocean catfish of our southern waters, *Galeichthys felis*. Here we have the cross, the halo, and the wing bones. The latter, however, with reference to the cross are at their outer ends differently placed and markedly unlike any of the others. Even more markedly different is the structure of the anterior part of the skull with its sharp, outstanding anchor-like points right and left, the laterally placed apertures in the roof of the skull, and the most anterior portion shaped like the "bitts" to which a cable is secured on a boat or wharf. Here, also, we have the "legs" previously noted in the skull of *Felichthys*.

Intermediate between these two is the Beebe specimen. This skull is relatively broad throughout but in front lacks the perforations found in the skull of *Galeichthys*. Also, it is not so wide as the *Felichthys* skull. Even more markedly intermediate is the anchor-shaped bone, the ethmoid, terminating the skull in front.

The other three skulls are very similar in general make-up and indicate that these forms are closely related. However, the absence of the tooth pads from the roof of the mouth sets off the Marshall specimens (four) and those of Dwight, Jommersbach and Farr as a separate species. Their presence in Stone's and Lang's specimens, establishes these as another separate species. With regard to Doctor Eigenmann's specimen the careful reader has probably noticed that it lacks the winglike bones extending out from under the halo. Wondering if this could be natural, since they are present in all the other skulls, I asked Mr. A. W. Henn, curator of fishes in the Carnegie Museum, to lend this skull to me. This he kindly did, and examination showed

that these bones had been cut out, presumably to accentuate the crucifix feature, since without them this is somewhat plainer. To see this compare the figure of this particular skull with any other figure given herein.

We have here skulls from six species of catfishes all showing the crucifix on their ventral surfaces. It would be a study of considerable interest to collect a large series of skulls of the various ocean, estuarine, and fresh-water catfishes from all parts of the world and to ascertain how many and what forms have the crucifix. It would seem that this structure must be of considerable taxonomic importance. Further, while there has been some study of catfish skulls, there does not seem to have been any thorough study of their comparative osteology. These skulls are so widely different from those of other teleosts and in their relative proportions so different from each other, that such a study would be a very interesting even if an arduous and puzzling undertaking.

Apart from four or five isolated studies of various catfish skulls, none of which shows the crucifix, there are papers by two investigators in which studies have been made of the Weberian apparatus and of the hinder portions of the catfish skull. The skulls studied for these structures do not, however, contain crucifixes, and hence will not be considered here.

Historical data, additional to that quoted earlier, to form a background for the facts and fancies presented in this article, are almost wholly lacking. However, two brief accounts have been chanced upon referring to fishes other than siluroids.

The first citation is from Robert Blakey¹ who, in his delightfully chatty

¹Blakey, Robert. "Historical Sketches of the Angling Literature of All Nations." London, 1856, p. 84.

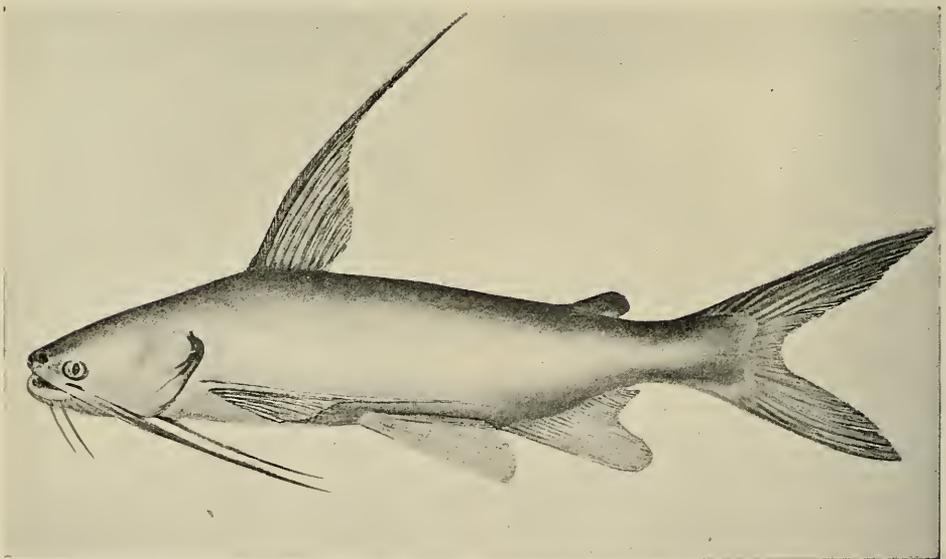
book, says "The pike was long celebrated, in many parts of Germany and France, for its charms and medicinal excellencies. A little bone in the form of a cross, which is said to be discoverable in the head [i.e., skull] of this fish, was long worn by the credulous as a sort of talisman against witchcraft and enchantment."

In the year 1700 Michael Bernhard Valentini¹ published in Latin an article entitled "De virgine in sceleto funduli conspicua." In this he speaks of the figure of a woman plainly to be seen in the skeleton (i.e., skull) of a *Fundulus*,

¹Valentini, Michael Bernhard. "De virgine in sceleto funduli conspicua." *Miscellanea Curiosa sive Ephemeridum Medico-Physicarum Germanicarum Academiae Cæsario-Leopoldinae Naturæ Curiosum*. Decuria III. Annus Quintus et Sextus, 1697 and 1698, (1700), p. 96.

and says that certain bones imitate a form of dressing the hair common at the time. Now what the "*Fundulus*" fish was is a matter of conjecture only, but it was probably some member of the family Cyprinidæ, fishes common in central Europe. The "top knots" to which our author refers were probably the Weberian ossicles above referred to, the Cyprinidæ being fishes which, in common with the Siluridæ, have a well-developed Weberian apparatus.

Just what is meant by these two old accounts is not clear, but it is interesting to find the crucifix structure alleged to be present in the skulls of European fishes, and to find that the accounts go back as far as the year 1700.



A gaff-topsail catfish, *Felichthys felis*. This fish is not only interesting in that it has a crucifix on the under side of its skull, but also because the paternally-minded father takes the just-laid eggs into his mouth and there incubates them until they are hatched



Newts shedding their skins. From the life history exhibit of *Triturus viridescens*

The Department of Reptiles and Amphibians in the American Museum

BY G. KINGSLEY NOBLE

Curator of the Department

MOST museum departments rise from small beginnings. Valuable material is received from expeditions, zoölogical parks, or private individuals. This must be cared for, perhaps studied, and later made known to the world both by publication and by exhibition. A custodian is found to supervise the care and study of the material. As time goes on he gathers about him additional material and other workers. Such museum custodians, or curators, as they are called, have been in most cases naturalists all their lives, and have lived and studied in museums long before they were employed by these institutions. A group of museum custodians and their collections are designated as a department. The history of a department is usually a record of successful expeditions, of increase of material, exhibitions, and publications. A department is like a tree branching out with time in every direction and from year to year adding distinct increments of tissue to the trunk which sustains the branches.

The department of reptiles and amphibians in the American Museum took root as a very small seedling sheltered by the department of invertebrate zoölogy. There was little

exhibition and no publication, but several valuable collections were added to its store. Those of Dr. C. S. Allen from Florida and Colonel Nicholas Pike from Long Island were especially noteworthy. Miss Mary C. Dickerson's superb collection of batrachians, including nearly every species in the United States, was donated at this time. Expeditions sent by the Museum to Mexico, Porto Rico, Alaska, Patagonia, Egypt, and Siberia brought back reptiles and amphibians for the rapidly growing study collections. In 1906 a collection of approximately a thousand reptiles was secured by Dr. A. G. Ruthven in New Mexico and Arizona. In 1909 the department of ichthyology and herpetology was established. This led to the sending of expeditions primarily to collect reptiles and amphibians. The most important work was carried on in Santo Domingo, North Carolina, Mexico, and Porto Rico and, by 1910 the collections had been doubled several times. The exhibitions produced by this time had become recognized as some of the finest in the world. Several important monographs had been published. By 1919 it was deemed advisable to separate the departments of herpetology and ichthyology. The expeditions then sent to

Panama, Arizona, and Santo Domingo, devoted themselves more exclusively and hence intensively to the study of reptiles and amphibians. Today the collections number more than 60,000 specimens, and the researches based on

that Miss Dickerson displayed her real genius. These groups are still among the most admired in the Museum. Thousands of school children visit the Museum during the course of the year to study the groups illustrating the life



A red-backed salamander, *Plethodon cinereus*, brooding her eggs. A new exhibit in the local series

this material form an imposing array of volumes. The tree planted nearly a quarter of a century ago has already borne much fruit.

The greatest achievement of the department during its long period of growth has been the establishing, under the direction of Miss Mary C. Dickerson, of perhaps the finest series of reptile and amphibian habitat groups ever produced. Of all vertebrate creatures, reptiles are perhaps the most difficult to reproduce in a lifelike manner. The "stuffed" lizards and crocodiles with their cracked and woefully distorted skins were soon replaced by mounts that looked startlingly like the living animals. It was in the construction of the several frog groups

story of the bullfrog, the tree toad, and other common Amphibia.

The hall in which these groups were installed was tenanted, from the beginning, by a whole series of cats and dogs, a great elephant, and an enormous "overflow collection" of other mammals. Many of these mammals were necessarily placed on top of the cases and draped in cheesecloth to keep off the dust. There they stood like the departed spirits of their more fortunate brethren within the cases. They cast a most ghostly atmosphere over the reptile hall.

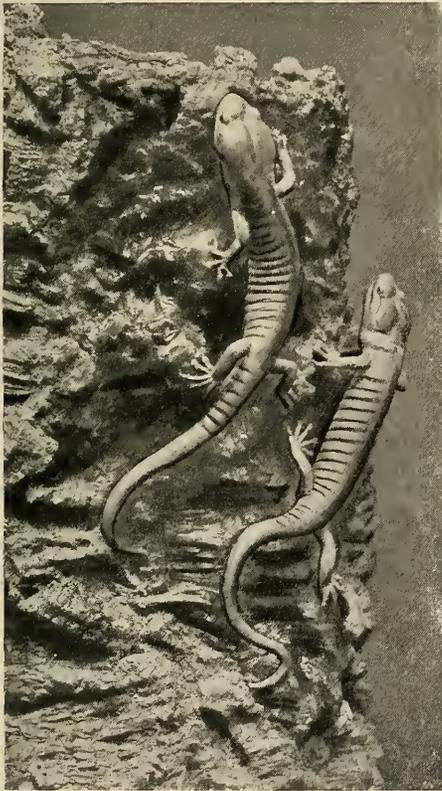
Fortunately, however, all this has now been changed. The entire third floor of the recently-completed east wing of the Museum will soon be

thrown open to the public as a new hall for the exhibition of reptile and amphibian life. In this hall there have been arranged not only Miss Dickerson's magnificent groups, but a whole series of new ones. The new exhibits include groups showing the habits of the Gila monster, the Galapagos land and sea iguanas, the giant tree frogs, the tuatara (*Sphenodon*), and certain sea snakes. Glimpses of some of these new groups are shown in the series of duotone pictures following this article.

Most exhibition halls of natural history are intended for a great



The Surinam toad, *Pipa pipa*, carries her eggs in pouches on her back until they hatch as fully formed toadlets. A model in the synoptic series



Arboreal Salamanders.—The California arboreal salamander, *Aneides lugubris*, spends most of its life in the trees. Its eggs are laid on land and the young salamanders never enter the water. An exhibit in the synoptic series

variety of visitors: artists who come to seek the beautiful in the objects or scenes portrayed; naturalists who hope to find an answer to some question regarding the creatures they have seen in nature; biology students who expect to find illustrated in the most diagrammatic manner principles or facts with which they are engaged; and lastly the great mass of visitors who are merely interested in nature, or let us say in life, and wish to be informed in as many directions as possible. In our new hall we have tried to satisfy all these demands. The habitat groups are arranged in a cloister along the west wall of the hall. The visitor who wishes to study the groups in detail enters one of the cloister doors and leaves behind him all the systematic and "biological diagrams" which occupy the main part of the hall. The exhibition of local reptiles and amphibians has been installed in an alcove provided at the far end of the hall. Such an arrangement helps to keep the different types of exhibits as distinct units.

The greater part of the material

sent to museums is rarely placed on exhibition, but is filed away in what is called a study series. Such material is chiefly used in systematic or zoögeographic studies. It is also available for anatomical or phylogenetic researches. If specimens are captured alive they may be utilized in physiological or experimental work. * Museums for decades have collected and described material, but as a rule, facilities for scrutinizing this material from all aspects have not been available to them. With the enormous strides which were made in all fields of zoölogy during the last decade the limitations of this macroscopic, descriptive method were all too obvious. The recent work on the endocrine system of Amphibia brings to our attention the existence of physiological species, forms which differ in their physiology if not in their structure. The occurrence of races of frogs differing enormously in their sexuality invites the museum curator with his great collections to take up the problem of sex determination. Botanists have already showed us that certain species and genera of plants have arisen suddenly by marked changes in the chromosome member. What is the relation of chromosomes to species in animals? This detailed and experimental method of handling museum specimens did not find a place in the schedule of the older museum workers, but it is being forced upon the modern

curator as the only way of understanding his material. Amphibia have been recognized for a long time as ideal material for such experimental work. Some of our most fundamental advances in the biological field have been gained through the experimental study of these forms. The herpetologist cannot neglect these facts. The most primitive of all terrestrial vertebrates were amphibians. The great groups of birds and mammals sprung from the reptiles. Fundamental problems of anatomy, physiology, and phylogeny confront the herpetologist on all sides.

The department of reptiles and amphibians in the American Museum is at one and the same time a storehouse, a schoolroom, a bureau of information, a research center, and a source of educational and artistic exhibits. A secondary school may take the facts determined by research workers and present these to students, but a museum must work out facts and present them to elementary and advanced students at the same time. Museum curators are therefore confronted with the problem of keeping in the vanguard of biological research without losing their contact with the elementary students. How well the department of reptiles and amphibians has succeeded in this mission may be judged from a study of our new exhibition hall and an examination of our long list of publications.



The midwife toad, *Alytes obstetricans*. Synoptic series

Glimpses of the New Hall of Reptile and Amphibian Life

By G. KINGSLEY NOBLE



THE APPROACH TO THE CLOISTER

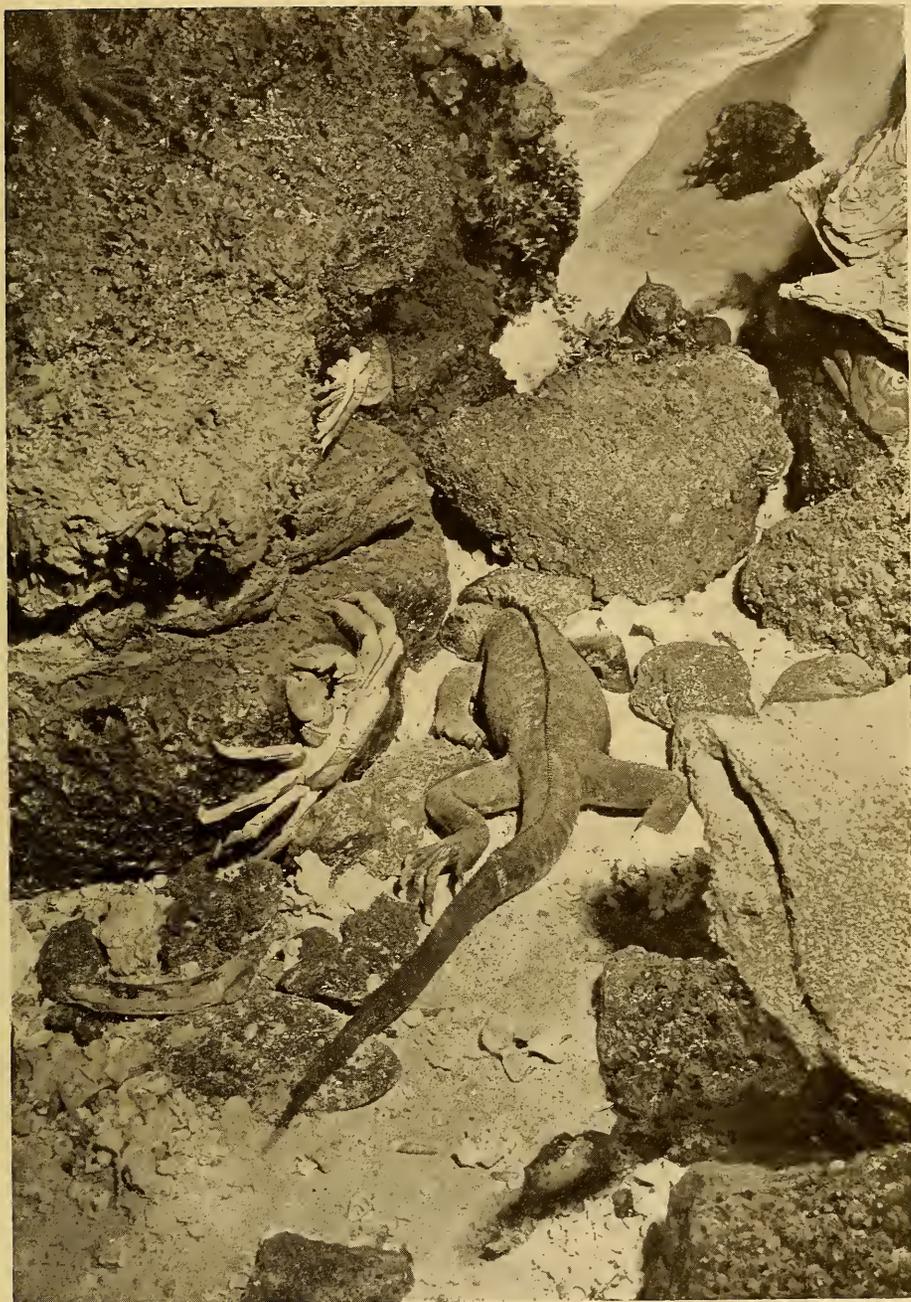
The entire third floor of the recently-completed east wing of the American Museum will be devoted to the exhibition of reptile and amphibian life. A series of habitat groups have been arranged within a cloister along the west wall of the hall. Several of these groups are new and have not yet been shown to the public. *NATURAL HISTORY* has the pleasure of taking the reader for the first time through the new cloister and of pointing out a few scenes of special interest. Most of these views are of the new exhibits. The Lower California and the Galapagos Island groups may be seen above through two of the windows in the cloister. It is planned to open the new hall early in the coming year



MARINE IGUANAS

Grotesque forms in black perched on lava blocks overlooking the sea; a herd of Galapagos marine iguanas awaiting the falling tide to expose the algæ on which they feed. A detail of the new Galapagos Island Group.

The marine iguana, *Amblyrhynchus cristatus* is the only lizard in the world which feeds on seaweed, and is one of the few which are gregarious in habits. The eminent evolutionist, Charles Darwin, was the first to describe the habits of this lizard. The herds of marine iguanas are today much depleted, but fair-sized colonies may still be found on some of the islands of the archipelago. The materials for the group were secured by Mr. William Beebe, assisted by Mr. Walter Escherich, while they were members of the expedition made possible through the generosity of Mr. Harrison Williams. The specimens have been mounted by Mr. Escherich and the background painted by Mr. A. A. Jansen, working under the direction of Mr. James L. Clark



A NOONDAY SIESTA

A marine iguana stretched out in the full glare of the sun to rest while a more ambitious companion in the distance has discovered a fringe of seaweed exposed by the retreating tide. A scarlet crab, *Grapsus grapsus*, has crawled from a damp crevice among the lava to see if any ticks are present on the lizard. Mr. Beebe found the crabs adept at pulling these tasty morsels from the reptiles' skins. A small detail from the Galapagos Island Group



OUT OF THE PAST

Iguanas with their scaly coats, powerful muscles, and sharp claws resemble the dinosaurs of old. A closer examination, however, reveals that they are essentially modern reptiles closely related to the Florida "chameleon" and "horned toad." The Galapagos land iguana, *Conolophus subcristatus*, unlike its relative and neighbor, the marine iguana, is strictly terrestrial, feeding on desert flowers, cactus fruits, and other vegetation. The alert creature portrayed above is one of the central figures of the Galapagos Island Group



A SECLUDED RETREAT

A Galapagos land iguana seeking what shade a xerophytic vegetation affords has plunged headlong into a scrubby thicket. The land iguanas of the Galapagos are not sociable, and rarely do two individuals seek the shade of the same tree. When two of them come together by accident, they are often pugnacious. One such reptilian duel was witnessed by Mr. Beebe. A detail from the Galapagos Island Group



AMID AISLES OF SWAYING TILLANDSIA

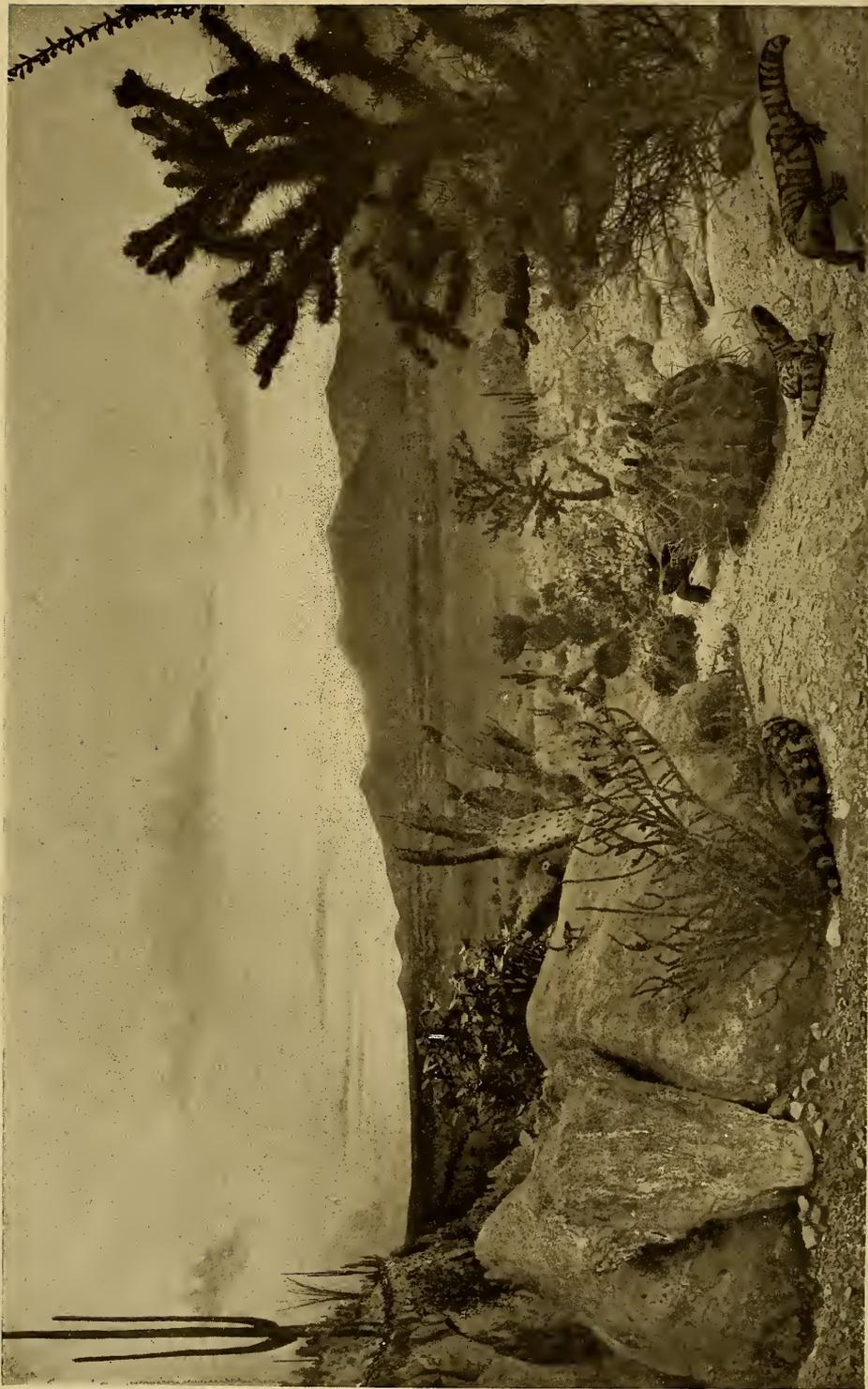
A cypress swamp and river cove of northern Florida in September, the home of the alligator, numerous turtles, lizards, snakes, and frogs. In this, the largest and last group built under the supervision of the late Miss Mary C. Dickerson, a whole array of biological facts are demonstrated. The life history of the alligator, the mimicry of poisonous snakes by non-poisonous species, the feeding habits of serpents, the variation with age in lizards and snakes, are among the features illustrated



The Giant Salamander Group.—A pool in a rocky stream in Pennsylvania showing *Cryptobranchus* feeding, fighting, and brooding its eggs

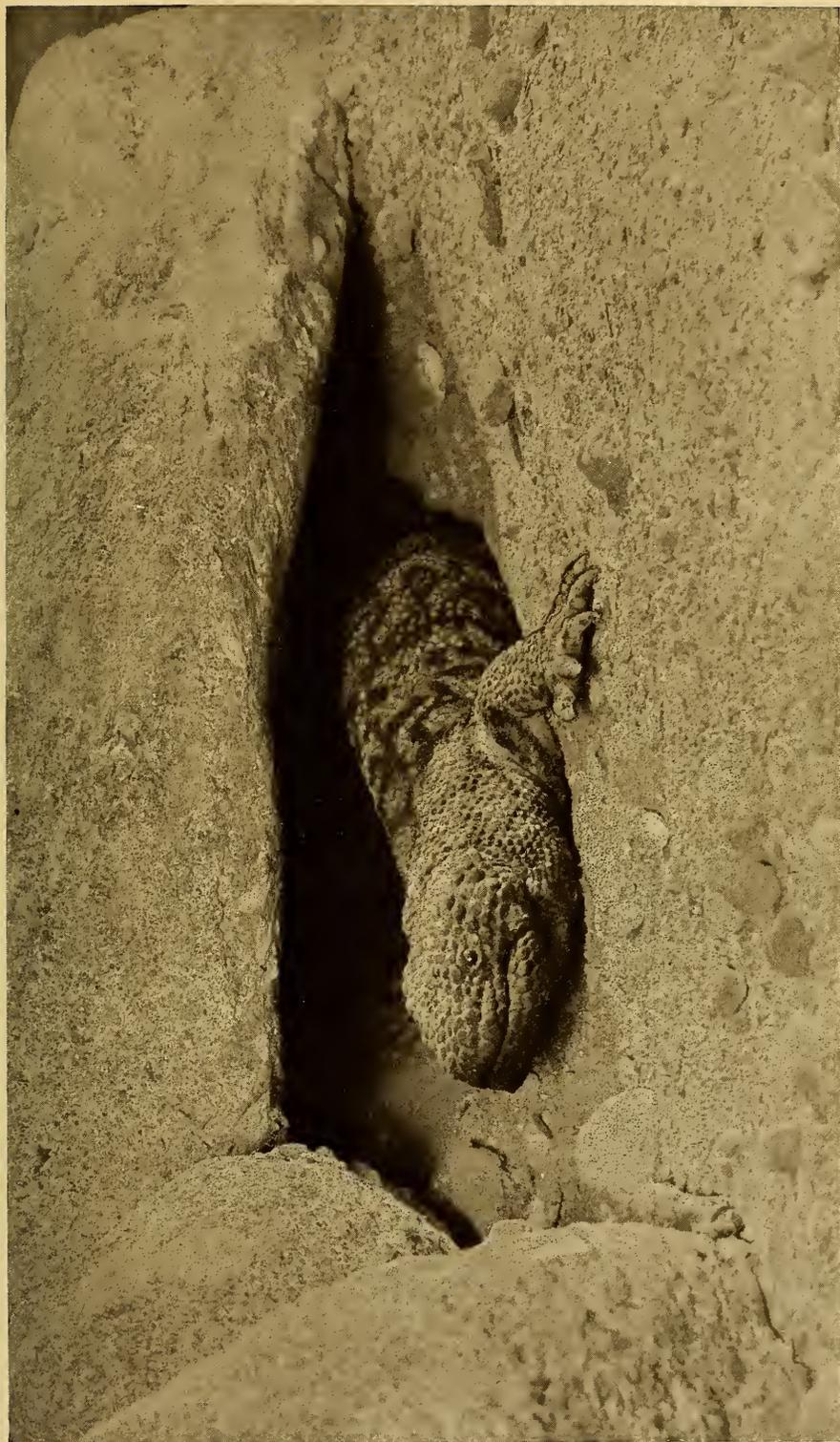


The dawn of parental instinct; a small section of the group.—The duty of guarding the spawn is assumed by the male *Cryptobranchus*, who valiantly defends his nest against all intruders. This worthy habit is not so altruistic as it would seem, for in guarding the nest the male protects his own food supply. Both sexes eagerly devour the eggs. Fortunately digestion is slow, and the male can eat only a small proportion of the eggs he guards. The greater number develop undisturbed, and the guarding habit is an advantage to the species



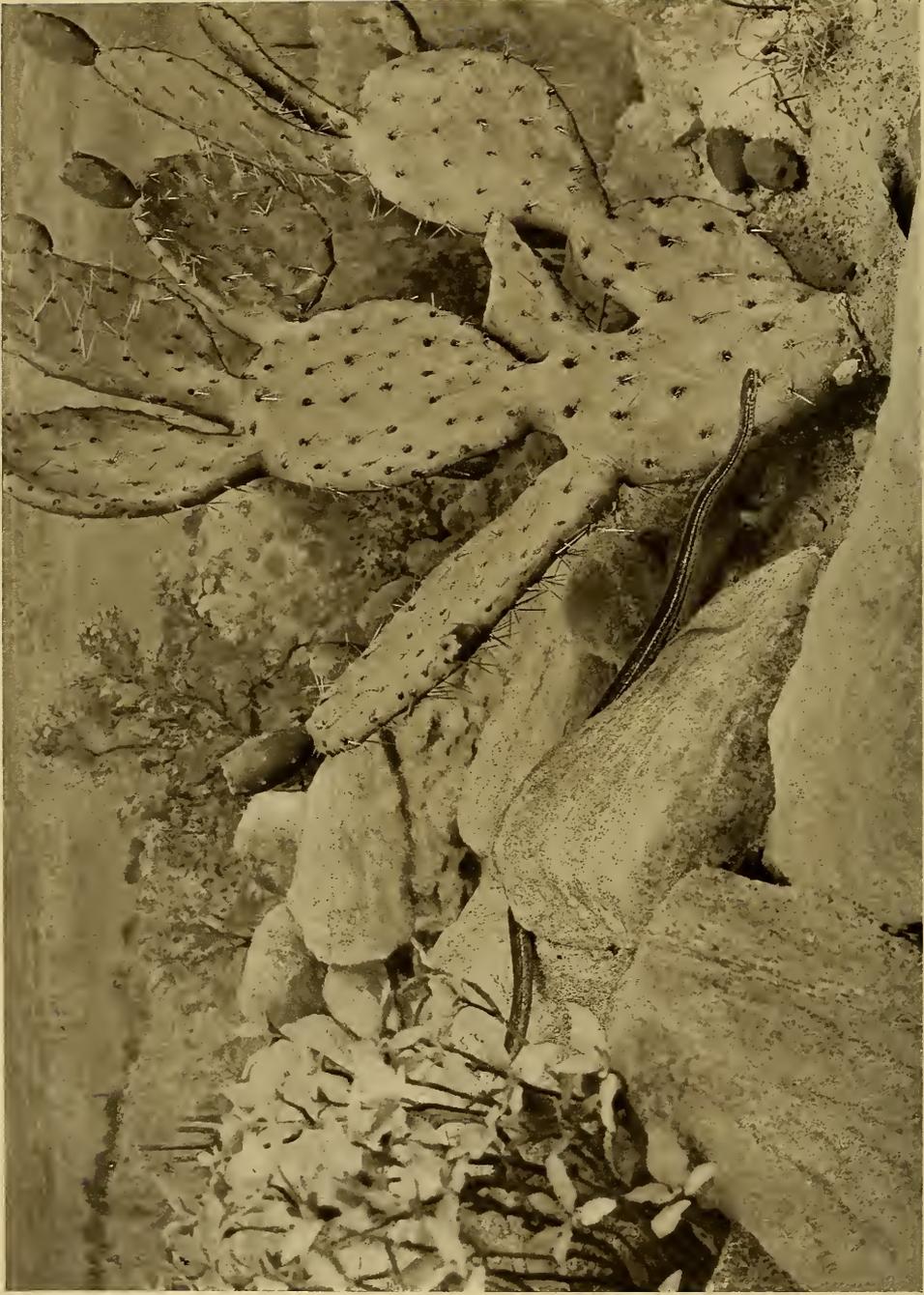
SUNSET ON AN ARIZONA DESERT

The new Gila Monster Group, illustrating the feeding habits of *Heloderma suspectum*.—The Gila monsters are stalking the lizards which have not yet retired for the night. One has spied a quail nest beneath a cactus and is about to steal the eggs. The accessories for this group were secured by Dr. A. I. Ortenburger and installed by the department under the direction of Mr. James L. Clark.



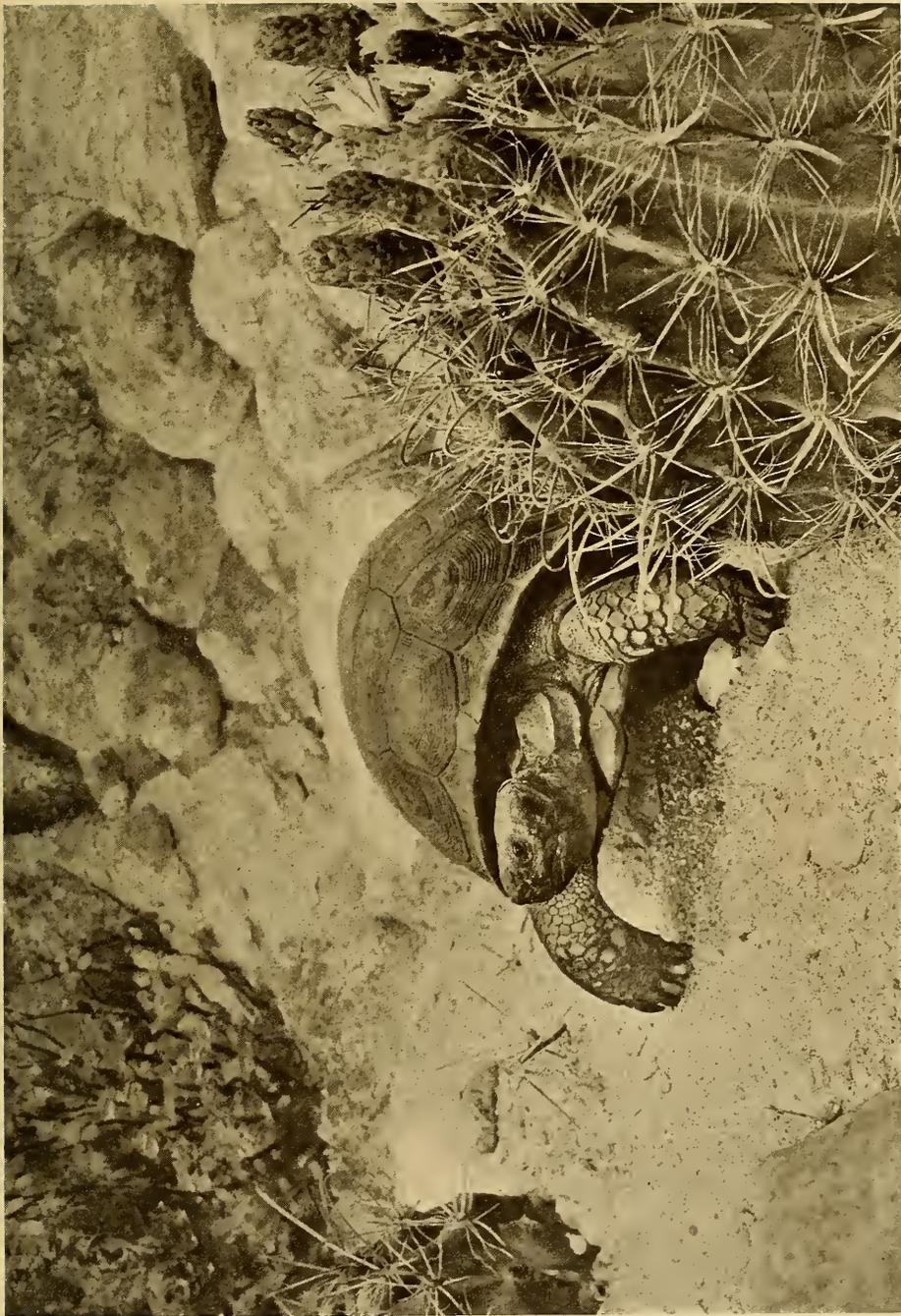
THE GILA MONSTER

In the evening the Gila monster, the only poisonous lizard in the world, emerges from its shelter among the rocks and prowls about in search of prey. A detail from the Gila Monster Group



A SNAKE OF THE DESERT

The sonoran racer, *Masticophis lateralis*, glides rapidly over the rocks, seeking some favorite crevice for the night. A section of the Gila Monster Group



A DESERT DWELLER

Life in a waterless desert may seem impossible for a turtle, but the desert tortoise, *Gopherus agassizii*, selects these wastes of sand and thorn in which to dig a burrow and to pass a peaceful existence. A portion of the Gila Monster Group



Sunset shadows.—The band-tailed, earless lizard, *Holbrookia texana*, basking in the last rays of the sun, unaware of the presence of a hungry Gila monster. Detail from the Gila Monster Group



The fate of many a lizard.—The poison-channeled teeth of the Gila monster closed about a *Holbrookia*. Detail from the Gila Monster Group

The Life of the Red Salamander

By SHERMAN C. BISHOP

Zoologist, State Museum, New York

THE life history of an animal is sometimes pieced together from the scattered notes of many observers. Often, however, the discovery of some essential feature is the reward of long hours in the field over a period of many years. The red salamander (*Pseudotriton ruber ruber* Son-nini) is widely distributed and locally common in the east, and zoölogists have long been familiar with the adults and larger larvæ. Nothing, however, has been written concerning the eggs and early developmental stages, and conjectures on the breeding habits have been based on knowledge of related forms.

The brilliant coloring of the newly transformed salamander marks it as one of our most beautiful species. The ground color is a clear coral-red with numerous small, rounded black spots scattered irregularly over the back, head and tail. The belly and sides are lighter and comparatively free from darker markings. In some, the skin of the underparts is so transparent that the pulsations of the heart may be observed, and the position of the liver is indicated by an elongate brownish patch. But with all its brilliancy, this salamander never forces itself upon the attention, and one who finds it must search the clear streams and springs, or turn the logs and stones in cool ravines and swamps. It may be found at all seasons of the year, but in winter it is less active and hides beneath stones and rubbish below the surface of the water. If it wanders abroad, the venture is made during the warmer months, and at night, when there is less

possibility of the skin becoming dry; for this species belongs to a group whose members are without lungs. The necessary oxygen is obtained through the thin, moist skin of the body and the membrane of the throat. Hence drying means suffocation.

The eggs of many of our common salamanders are deposited in the spring or summer, but those of the red are laid in the fall (in the north at least). The young hatch in early winter. The eggs of a single female may number seventy or more. They are attached to the under surface of stones buried deep in the bed of a spring or stream, where they may be bathed in the coolest waters. The individual eggs, enclosed in gelatinous envelopes, are suspended on slender stalks, which flatten out at the point of contact with the stone to form an attachment disk. The eggs are clustered in little patches of a dozen or more, and the entire complement may cover an area several inches across.

As the young embryos develop, they gradually take on some semblance of the adult form. The more evident changes are those which involve the molding of tissue to form the head, trunk, and tail. Then the development of the gills and fore legs may be observed, and the first blush of color other than that imparted by the yolk. The gills and legs appear first as simple budlike projections; but development is fairly rapid, and the buds elongate to form, in one instance, the delicately fringed gills, and in the other, the legs with their slender toes. The hind legs develop more slowly than the fore. In



Photograph by S. C. Bishop

The home of the red salamander.—The red salamander frequents the springs and brooks of our northeastern states. At the base of the Helderberg escarpment in Albany County, New York, many such springs bubble forth and furnish hiding and breeding places for both red and purple salamanders

this respect the salamanders differ from our common frogs and toads.

At the time of hatching, the young salamander is scarcely half an inch long. It is endowed with stubby legs and small gills, and a belly full of yolk to carry it through the first few months of its existence. The mouth is rudimentary and incapable of functioning, the eyes are indicated by pigmented spots, and the tail is provided with a broad keel. At this stage the tail is the most important appendage, for it serves in the wriggling process which enables the larva to make its way under the stones and rubbish of the

spring bottom. Here, through the cold months, it may rest almost inactive, developing its eyes and legs and mouth at the expense of the yolk, and acquiring the color and other characteristics of its kind. The yolk is lighter than the other body tissues and its buoyancy often as not turns the larva upside down.

In the early spring following the winter period of relative inactivity, the young salamanders acquire a new interest in life. The yolk which sustained them has been absorbed, and they are forced to undertake foraging expeditions of their own. At this time

the food consists largely of water fleas (*Entomostraca*) and the smaller worms and larvæ of insects, which are captured by quick, sidewise movements of the head. The feeding grounds are likely to be thick beds of cress, *Chara*, or other water weeds. To salamanders only an inch in length they are veritable jungles. Here the nymphs of dragon flies and beetle larvæ lie in wait and accept young salamanders as delicate additions to their diet. Newly hatched larvæ scarcely resemble the adults in color, for at this period the

body has scattered fleckings of brown and black over a dull white ground color. This is a transient stage, however, and as the larvæ grow, the color becomes brighter and the spots more prominent. The ground color gradually changes from dull white to brown.

To determine the length of the larval period, it is necessary to measure a considerable number of specimens taken at approximately the same time of the year. When selected according to size, they will form groups which will in most cases, indicate the annual



Photograph by E. J. Stein

The eggs of the red salamander.—The female red salamander attaches her eggs to the under surface of stones in springs. The eggs shown above are in an advanced stage of development. Photographed under water. Slightly enlarged



Photograph by S. C. Bishop

THE RED SALAMANDER

The old red salamanders lose the bright coral-red color of youth and become considerably darker with age

increments of growth. In the case of the red salamander, the larvæ which hatch in November reach a length of about one inch by April or May. Other salamanders collected at this time of the year will measure about two inches in length and represent the growth of eighteen months. The largest larvæ will have a length of four inches or more and be about thirty months old.

The most distinctive features of the larvæ are, of course, the gills. The broadly keeled tail is also a character which, in the red salamander, reaches its best development in the larvæ. As the time for transformation approaches, the larvæ gradually lose their juvenile characters and take on those of the adult. The brownish ground color gradually becomes red, the gills shrink to mere stubs, then disappear, and the tail becomes more rounded as the keels are absorbed.

These striking external changes are accompanied by others as important to the animal but much less conspicuous. The teeth, the lips, and the tongue, are involved in the changes which transform a strictly aquatic larva to the adult capable of living on land or in the water. How long the bright coral-red of the newly transformed individual is retained is a question not yet answered, but it is certain that the animal is fully adult in this stage, for specimens have been found with mature eggs.

Those who are acquainted only with the brightly colored form would scarcely recognize the individuals which have taken on the more somber colors of age. The rounded black spots spread and fuse and richer tones of

purple and brown replace the coral red. Small flecks of pigment spot the lower sides and venter and the lower lip may bear a narrow band of black.

The adult salamanders are not usually social in their habits, but occasionally several will share the same small spring, and two may sometimes occupy a hollowed-out retreat beneath some log or stone. Worms, insects, and other salamanders are the chief items in the diet of the adult. They feed readily in captivity and thrive on earth worms and bits of fresh meat.

The full-grown salamander may measure six inches in length, but many are smaller. In fact some adult specimens are considerably shorter than the largest larvæ.

The enemies of this salamander are many and its life is constantly threatened from egg to old age. The eggs are sometimes eaten by other salamanders and are destroyed by fungi and molds. The young larvæ are the prey of older members of their kind and of aquatic insects. The adults may serve to eke out the meal of an owl.

This, in brief, is the history of one of our common salamanders near the northern limits of its range, one whose life story was previously not known. Further study of the salamander in regions farther south and the discovery of additional egg masses will doubtless show that the period of egg-laying extends over several months, and that the time of laying is more or less controlled by the temperature of the water.¹

¹Mr. M. K. Brady, of Washington, D. C., has informed the writer that females dissected in December had mature eggs in the ovaries and that he found a batch of eggs in the field on February 10, 1915.



THE MARAUDER OF BITTER GUANA CAY

The natives of this Bahaman isle were forced to abandon their homes because of the depredations of the iguanas. Here one of the marauders is shown hesitating before approaching the bait of dried fish placed in the open by the camera man

The Iguanas of Bitter Guana Cay¹

By ALFRED M. BAILEY

The Colorado Museum of Natural History, Denver, Colorado

OFF the Florida coast lie the Bahamas—small coral islands set apart from the mainland by a deep channel of the Atlantic, with its ever-flowing, warm Gulf Stream. They are an ideal spot for a month's cruise over shallow waters, with their gleaming sands reflected in a myriad of colors, extensive coral reefs, interesting invertebrates, and wealth of fishes. The wild life is varied, and a collector finds himself in a new world, seemingly. Native houses of coral rock glisten in tropical settings of coconut palm, palmetto, and fields of sisal. Bands of genial colored folk welcome the stranger to their out-of-the-way homes.

We had been collecting for the Colorado Museum of Natural History along the small islands making up the Exuma Chain, working as far south as Seal Cay. Many of the dark-skinned people had spoken of the "guanas" on Bitter Guana Cay, and I had promised myself a few hours ashore there on the return trip toward Nassau. After finishing my work on Seal Cay, we turned northward and crossed the deep channels between the various islands, our little gasoline launch "Friendship" rolling like a barrel in the big swells.

The weather had been blustery in the early morning, with intermittent rain squalls, and a waterspout came uncomfortably near, traveling slowly with the wind. It was a relief when, toward noon, the wind dropped, and a "slick calm" prevailed. We pounded on over the shallow waters of the extensive banks, and never have I seen such a dearth of life, even in arctic

Alaska. An occasional barracuda took our spoon trailing aft, and two small sharks cruised inquisitively alongside for a while, but the bottoms seemed curiously clear—just great expanses of sand, and not a bird dotted the sky.

We dropped anchor that night at Farmer's Cay and visited the settlement there. Next morning, as the sun lighted the topmost leaves of the palms, we were on our way to Black Point Village, on Great Guana Cay. We found this little town a picturesque and pleasing place, with native boats tugging at anchor in the harbor, or pulled up on the shining beaches. The whole village offered to show me the "guanas," so, after choosing two men, we were soon on our way.

Bitter Guana Cay proved no different than the many other sandy-beached coral rocks so numerous in Bahaman waters. A rather high hill of pure white wind-blown sand, gleamed in the semitropical light, the heights crowned with the same dense, impenetrable thicket of wiry bushes. Huge cacti and prickly pear projected over deep water along the ocean front. A few laughing gulls and royal terns explored near-by waters, and a band of man-o'-wars, mere dots high up against the blue, sailed on motionless wing. Altogether, it was a delightful spot.

Our barefooted guides led the way over the needle-like rocks, even those leather-footed boys walking gingerly until they reached the drifted sand. Scarcely had we reached shore when we saw our first iguana, a large one about three feet in length, high up in a bush, with his head and fore legs silhouetted

¹Photograph by the author



The eroded and pitted limestone of the Bahamas affords innumerable subterranean retreats into which the iguanas can escape when hard pressed by the natives



A young iguana working its way under the palmettos peered inquisitively at the intruders

against the horizon. He was a weird-looking fellow, and it was not difficult to imagine him magnified many times, and thus to envisage what primitive man, if he had existed then, might have seen in the days of the dinosaur.

■ We worked along an open sand ridge and occasionally caught a glimpse of other iguanas as they scuttled from our path into huge, crater-like holes in the solid coral rock. The iguanas were not wary, however, and I had no difficulty in securing a few specimens for our habitat group. The vegetation was so thick it was next to impossible to secure pictures, so we tied a piece of dried fish in an open space, and on our return an hour later, found a grand old fellow waiting to be photographed. As I maneuvered for a clear view, a young iguana scarcely a foot in length worked his way from the débris at the base of a palmetto and peered inquisitively as his portrait was added to the collection.

The natives value the iguana highly for food. They told me the animals were easily caught in baited crayfish pots. They have made a practice of killing them for years, but there is apparently no decrease in the number. That these lizards are able to hold their own is demonstrated by the fact



A Bahaman home

that the blacks have endeavored to farm a portion of Bitter Guana Cay and were unsuccessful because the iguanas ate the crops, this in spite of all the precautions the natives could take. The farmers finally abandoned the island in favor of the iguanas.¹

¹The iguanas collected on this trip were new to science and were described by Dr. Thomas Barbour in the *Proceedings of the New England Zoological Club*, Vol. VIII, pp. 107-09, and named for Mr. J. D. Figgins, Director of the Colorado Museum of Natural History, Denver, Colorado.



A Bahaman "chameleon" investigates. *Anolis* is everywhere abundant in the Bahamas. Dozens of bobbing heads greet the visitor to these isles



THE ANACONDA

The anaconda, *Eunectes murinus*, is the largest serpent in the New World, and is second in size only to the reticulated python of the Malay region. It may reach a maximum length of thirty feet. Snakes more than thirty-five feet long exist only in the imagination

Big Snakes in Captivity¹

BY W. HENRY SHEAK

Lecturer on Natural History Subjects

THERE is a common popular belief that every big snake is a boa constrictor. This is far from the truth. The typical boas are confined to tropical America and fall far short of some of the Old-World pythons in both length and weight. As a matter of fact, the boa constrictor rarely exceeds twenty feet in length, and one twelve or fifteen feet long may well be considered a large specimen. Most of them fall below these figures. The "tree boas" are smaller still.

The largest member of the true boas (Boinæ) is the anaconda (*Eunectes murinus*), an arboreal and aquatic species, well adapted to life along the rivers of South America. The largest preserved specimen known to scientists is a skin twenty-nine feet long in the British Museum, but thirty-foot specimens have been recorded. It is probable, however, that the average length is nearer twenty feet. Probably the largest anaconda ever shown alive in the United States was one exhibited a few years ago in the New York Zoological Park. It measured 18 feet, 6 inches.

The showman knows full well that most people are looking for a monster in size when he exhibits a boa, so he is going to show them a *big* snake for a boa. Consequently, in most traveling menageries, the gigantic pythons of Africa and Asia are represented as "boa constrictors." Aside from the greater size to which they attain, and their distinctive markings, the pythons differ from the boas in certain skull and scale characters.

The largest serpent known to science is the reticulated python (*P. reticulatus*), sometimes known as the royal or regal python on account of its very great size, sometimes as the rainbow python from the rainbow-like tints seen on the scales in certain lights, especially immediately after shedding the skin. It sometimes attains a length of more than thirty feet, and specimens measuring from twenty-five to twenty-nine feet are by no means uncommon. This is the most beautiful of the big snakes. It is a native of Siam, Sumatra, Burma, Borneo, the Philippines, the Malay Peninsula, and some of the East Indies.

The pythons, like all the other snakes, shed their skin periodically. The interval between molts depends upon the age of the snake, whether or not he is growing rapidly, his health, and the temperature in which he is kept. A young snake growing rapidly will, of course, shed much more frequently than an older one growing slowly, or not growing at all. The skin does not expand with the growth of the body, and must be shed and replaced by a larger integument, or growth is impeded. A snake in poor health will, at least sometimes, shed oftener than one in good health. A snake kept in a high temperature will shed more often than one kept too cold. Our small native American snakes frequently creep out of a skin and leave it entire, and this may be true of the pythons in a state of nature, with the normal amount of exercise; but in the close confinement of the cage the skin generally comes off in frag-

¹Negatives of illustrations used in this article are the property of the New York Zoological Society, and NATURAL HISTORY is indebted to the Society for the use of the prints.

ments and usually not without assistance from the keeper. Never during my connection with the Edwards' Animal Show, have we succeeded in taking a skin entire from either the rock python or the reticulated, but often have been successful with the Indian. This required time, patience, and labor. The snake was put in a bath of warm water for ten or twelve hours, after which four or five keepers held the reptile while one of us spent three or four hours carefully stripping the delicate skin from the body. Mr. Edwards donated several of these skins to different scientific institutions. This "skin" is, of course, not the true skin, but only the superficial layer of the epidermis, and is thin and fragile. The true skin, out of which ladies' belts, pocketbooks and the like are made, can be obtained only after the death of the reptile, as in the case of any other leather.

There is a widespread belief that snakes must be kept on ice. On the contrary, it is necessary to keep them warm, and this is especially true of the tropical species. If, for the latter, the temperature sinks much below 70° F., the food will not digest, but will ferment in the stomach. I have seen a big reticulated python swell to nearly the size of an old-time beer keg, as a result of getting cold after a heavy feeding. With the Edwards' menagerie we had oil heaters on all the python dens. Another persistent belief is that the big snakes are drugged—"doped," to use the common vernacular. I have never known a keeper or "charmer" to use any kind of opiate. Big snakes are naturally sluggish.

There is nothing in man's or woman's ability to "charm" snakes. No snake has enough intelligence to discriminate one person from another.

The only secret is in treating the snake with kindness and accustoming it to being handled. Neither is there anything in a snake's ability to "charm" birds or other creatures. It is said that most creatures, including man, are born with a fear of snakes. Experiment, however, has proved this to be untrue. Many birds flutter before snakes merely to attract them away from their nestlings.

The forked tongue of the serpents, so often protruded, is not a "stinger" as many people suppose. It is perfectly harmless and possessed by the non-poisonous as well as the poisonous species. It is merely an organ of taste, but possibly so well equipped with sense buds that it can detect odors in the air.

None of the boas or pythons are poisonous. They will bite, and bite savagely, but the bite is not poisonous and usually heals quickly, as there are no decaying food particles on the teeth to produce blood poisoning. The teeth are used to catch and hold the prey, not to masticate it. Hence they are simple and smooth in structure. They are pointed backward, and when a snake closes his jaws on any creature, it is next to impossible for that creature to get away. Should a big snake ever catch your hand, do not attempt to pull away from him, as that would only drive the teeth deeper into the wound, but push your hand down his throat. This will make him let go. It is a mistake to think a snake *cannot* let go. I have seen them let go and disgorge at any stage of the process of feeding. They seize the bird or mammal with the teeth wherever they happen to strike, throw one or more coils about it, and crush it till it is dead. Many of the smaller snakes swallow their prey alive, but the big constrictors always kill it.



Something to frighten the timid.—The anaconda's eyes lie nearly on the top of the head, for the creature is a river snake and must look up as well as around in search of prey

A forty-pound pig, or even a five-pound chicken, alive, would prove too active and uncomfortable a morsel for the stomach of even a thirty-foot python. But it is a mistake to think they crush the bones or reduce the prey in size. The constriction is merely for killing. They may break the ribs, but that is only incidental. When the victim is dead, they take it by the head and begin swallowing. Now and then a snake will unwisely begin to swallow at some place other than the head, but unless the prey be very small for him, he will fail to get it down.

They do not cover the food with saliva before beginning to swallow it, but it is moistened and lubricated by a

very copious flow as it enters the mouth and passes down the throat. They are capable of swallowing prey at least four times the normal diameter of the throat. The articulations of the jaws are very loose, and the connecting tissues of the two halves of the lower jaw are very elastic. I have seen the anterior ends of the lower jaws separate nine or ten inches in a large python when feeding.

There are many marvelous stories concerning the swallowing capabilities of these great serpents. There is no doubt in my mind but that a twenty-five- or thirty-foot python could easily crush and kill an animal the size of a horse or ox. The constricting powers are almost beyond belief. In feeding,

sometimes one has wrapped its tail about my ankle, and it was necessary for me to take both hands and use all my strength to uncoil just the tail. A man who had been a soldier in the British army in India, told me he once saw a big python coil about a horse. The ribs snapped and the horse dropped dead almost instantly. But no snake could swallow so large an animal. I see no reason, however, why one of these monsters could not swallow an ordinary man. Carl Hagenbeck, from whom we purchased the big reticulated python known as "Long Tom," measuring a trifle more than thirty-two feet in length, an unusually fine vigorous specimen, declared he had a photograph of this snake swallowing an Indian antelope weighing sixty-seven pounds. When in our possession, "Long Tom" swallowed a pig weighing forty-five pounds.

But these monsters rarely attack man or the larger mammals; in fact they never do so unless they are provoked or molested. They confine their depredations to animals that they can swallow without much inconvenience,—birds, and mammals weighing from about twenty-five to forty pounds, or considerably less. When captured, one of these snakes will fight most savagely and is likely to smash almost anything that offers resistance. But he fights because he is afraid he will be hurt. When he learns man is his friend, he becomes gentle and usually remains so. Now and then, however, a specimen continues mean.

It is erroneously supposed that these big snakes will not take anything but living prey. It is probably true that in a state of nature they will not eat anything but what they themselves kill. But after they have been in captivity awhile and have become

accustomed to being handled, and to taking food from the hand of man, they will learn to take their prey after it has been killed for them. When we feed them in public, we always kill the prey before offering it to the reptile. We dangle the bird or mammal before the eyes of the serpent. He thinks it is alive, coils about it in the belief that he is killing it, and then swallows it. In fact, we have fed to our snakes rabbits killed in Australia and shipped to America in cold storage. However, they are very particular as to the condition of the food. If it be the least bit tainted, or the fur or feathers bear the least bit of foul matter, or they bite into the sour crop of a chicken, they will drop the prey and refuse to take it again. I have known a snake to vomit from tasting something foul. The sense of taste, as well as that of smell, is very acute.

When one of these great pythons has been fed all he cares to eat at a meal, from five to seven large chickens or rabbits, he will not eat oftener than once about every seven to ten days. In order to get snakes to eat more frequently, that is, to provide a daily exhibition of feeding, we would give them but one chicken or rabbit at a time. In this way we could get them to eat at much shorter intervals. We once fed a big Indian python five times in two days. It requires from five to seven days for the food to digest. The bones are digested, but not the hair or feathers or any grain that may be in the crop of a chicken. During the process of digestion the snakes are extremely sluggish, lying coiled in a heap most of the time. When they are hungry, they become more active and move about, often with the head raised a considerable distance above the ground. Some snakes have been known

to live from one to two years without feeding.

It now and then occurs that one of these big snakes refuses to feed in captivity. This is particularly true of the reticulated python. Not that he deliberately makes up his mind to starve himself to death, for no snake has intelligence enough for that; but the long sea-voyage to America and the conditions of captivity take away the appetite. What do we do in a case like this? Sometimes we can save them, even bring back the appetite, by injecting into the stomach eggs beaten into milk. This is done by means of a rubber tube. Some menagerie men force guinea pigs or rabbits down the throat of a snake that has gone on a hunger strike. We used a similar treatment.

We took a piece of calfskin, fresh from the calf, and, with the flesh side out, sewed it together in the form of a tube about two and a half feet in length and four inches in diameter. This we stuffed with beef and ox-tail, or other pieces of bone, making a huge sausage. When all was ready, the sausage was fastened to the end of a twelve-foot section of gas pipe, the reptile was taken from the cage, held straight by from eight to twelve keepers, and the sausage thrust down his throat. It was heroic treatment! Occasionally a reptile was fatally injured in this way, but usually the operation was successful. In some cases, after forceful feeding once or twice, the appetite would come back and the snake would begin taking nourishment in the normal way.



The end of a hunger strike.—Mr. Ditmars and several keepers at the New York Zoological Park engaged in feeding a rabbit to an obstinate inhabitant of the Zoo



EYES OF RED FIRE

The alligator floats with only eyes and nostrils above the surface. In this position it can see without being seen. At night the eyes, reflecting back the light of the headlamp, shine like two flames of red. Alligators are usually afraid of man and the fiery eyes vanish at his approach. On one occasion they did not disappear. What would you do if attacked by an alligator in a swamp at night?

The Tale of "Old Fire Eyes"

AN ENCOUNTER WITH A GIANT ALLIGATOR IN THE SWAMPS OF
LOUISIANA

BY PERCY VIOSCA, JR.

Southern Biological Supply Co. Inc., New Orleans, La.

I DOUBT if anyone has ever seen "Old Fire Eyes" by daylight, and few indeed are they who have had dim visions of her fleeting form in the blackness of night. Nothing is known of her pedigree or her age, and even her sex is a matter of conjecture, although her femininity might have been presumed because of the very question of her age. Even her size can only be surmised, and her whole life history is enshrouded in the darkness and seclusion of her chosen haunts. In strong contrast to her surroundings is the brightness of her eyes, for no dragon of an older day could boast such orbs of red flame. Few indeed are they who have looked into those fiery eyes, but I am one of them, and in those fleeting glimpses, I have gathered the story of her life.

Fringing the north shore of Lake Ponchartrain between Mandeville and Lewisburg, Louisiana, lies a strip of wooded swamp land, which, in its primitive state, was heavily forested with tupelo gum and cypress. The arched branches, draped with Spanish moss, met overhead, shielding the darkly tinted water below from the direct rays of the sun. To one not inclined to appreciate the beauty of such surroundings, it might truly be called a dismal swamp. The whole area, approximately two miles long by one-quarter mile wide, is bordered in the rear by the virgin pine forests of the coastal plain,—on the front by the waters of the lake, from which it is separated by a sand ridge and beach only a few yards wide. It was in this virgin swamp that "Old Fire Eyes"

must have chased her first minnows and crayfish among the cypress roots as she began to learn the ways of her kind, for she had been destined to begin life as a baby alligator.

As alligators are chiefly nocturnal in their habits, it was not paradoxical for her days to be brightened by the darkness of her surroundings, and the first real darkness came into her life with the cutting of the marketable timber. She soon came to distrust Man, and her survival is proof that with age came wisdom. Only during the hours of darkness did she find complete safety from the lead-spitting weapons of her greatest enemy. But Man in his greater wisdom came to learn that a light worn on his head makes the eyes of all nocturnal creatures shine in the dark. One by one she learned to elude these devices, the pine torch, the coal-oil headlamp, the brilliant acetylene searchlight, while her less wary brothers and sisters were converted into pocket books.

My first knowledge of "Old Fire Eyes" dates back about fifteen years. While camping in the vicinity of her swamp during my college vacation days, it was customary for our party to "shine" frogs whenever our meat or fish supply ran low. Occasionally tenderloined alligator tail varied our menu.

On these midnight raids, made primarily to satisfy the inner man, it was soon discovered that we had in our headlamps a powerful instrument for the study of natural history. The eyes of all of the larger nocturnal creatures, and even many of the smaller, reflected bril-



IN THE DEPTHS OF THE SWAMP. CYPRESS AND TUPELO GUM ARE THE DOMINANT TREES OF THIS AREA



THE EDGE OF LAKE PONTCHARTRAIN WHERE THE HUNT BEGAN. DWARF PALMETTO AND SCRUB OAK MAKE TRAVELING DIFFICULT

liantly the light of our headlamps. We soon came to recognize the different creatures, often at a distance, by the color of their eyes, and many were even fearless at close range with the light flashed fully upon them. The bullfrog, with its eyes of opalescent green, was more easily approached, and we soon came to bag a high percentage without the use of a gun or other device. The eyes of alligators shine a brilliant ruby red. From time to time we took an occasional specimen, for mascot or for meat, from the Mandeville swamp.

On some of these trips we would catch glimpses, at perhaps a hundred yards, of a pair of rubies much larger than the rest, or again we would see a single ball of fire darting across the surface of the swamp to vanish into the night. Tree trunks, stumps, logs, cypress knees—none were an impediment to this orb of red fire. For several successive summers the same thing was observed. We realized then that we had in that swamp a monster that defied every instrument civilized man had contrived for its extermination.

In the course of time my natural-history studies took on a more serious turn. During an investigation into the habits and distribution of the southern bullfrog, *Rana grylio*, which I found to be a co-habitant in parts of this state with the common bullfrog, *Rana catesbeiana*, I was to become more intimately acquainted with "Old Fire Eyes." One night during the summer of 1917, I set my course for the Mandeville swamp in the motor boat "Amœba," my only companion being a young friend whom we nicknamed "Leech," not because of his stick-to-itiveness, but because his bare legs proved to be a great attraction for those annelids. A dry squall from the southeast made the lake uncomfort-

able, and as it was risking the boat to enter shallow water because of cypress stumps in the lake at that point, we attempted to seek refuge at about 11 P.M. in the canal of a lumber company near Lewisburg.

Having brought the "Amœba" to safe anchorage, we entered the swamp armed only with headlights and flour bags. Locomotion was as good as could be expected in eighteen inches of water studded with cypress knees and strewn with all manner of logs and branches, some afloat and some water-logged. We could not operate to advantage near the lake, because the strong wind there made the lights flicker, and since best results are obtained when collectors separate so as not to cast the rays of their lights on each other, "Leech" went toward the rear of the swamp and I remained nearer the middle.

Collecting conditions were almost ideal, and by 1 A.M. I had bagged about as many frogs as I could carry. Three species were represented, the two bullfrogs, *Rana catesbeiana*, and *Rana grylio*, and the smaller swamp frog, *Rana clamitans*. "Leech" had made a good catch, too, but about this time was having trouble with his light, which needed a fresh charge of carbide. Unfortunately, the latter was in my pocket, and "Leech" had begun to make his way slowly toward me when his light suddenly went out. In those days we did not carry pocket flash lights for such emergencies and he was left in a blinding darkness.

In the meantime, not knowing of "Leech's" predicament, because we were out of earshot, I had decided to make my way toward the beach to rest while waiting for him to finish his hunt. During the night I had seen a number of alligators of sizes varying

from one to four feet. Some were wary, others more easily approached, while others had to be kicked out of the way. "Old Fire Eyes" had not been sighted, and I imagined she had seen us first. No attempt had been made to catch any alligators, as it is not wise to put them in the same bags with the frogs.

Mamma, to leave you all alone?" They answered merely with the "umph umph" characteristic of their kind. Immediately I heard a loud splash among the cypress ten yards away, and I think a louder "umph," but my memory is not entirely clear on this point,—for, upon swinging my head



An alligator hole.—The retreat of the mother and several generations of young in time of danger

However, two baby alligators each a foot long, with their four little jewels glittering in the darkness, were too tempting to leave alone. As it is my habit to catch frogs with my left hand, I was carrying my heavy bag over my right shoulder. To free my left hand I held the bag of smaller frogs under my right arm during the moment of a catch. In this manner I approached the unwary infants, and as they were side by side, I snapped them up with one swoop of my left hand, thinking to myself—"Where is

around, I saw two balls of fire, and the massive outline of a large black form darting at me with the speed of a locomotive and the fury of a tiger. A sickening fear seized me. Without knowing what I was doing, I threw the two children into the infuriated mother's face and started off on a wild race across the swamp, only an alligator nose in the lead.

I had not gone far when the race ended. It seems that some years before, just at that very point, a cypress knee happened to sprout. By the time I

reached that place in my wild race, it had not quite reached the surface of the water, but interfered with my progress to such an extent, that frogs and all, I fell flat on my chest in eighteen inches of water, extinguishing my light and thoroughly wetting my matches. Visions of conical teeth, crushing bones, and limbs twisted off at their joints - scrambled through my mind.

When I found my feet and recovered my sanity, all was silent but the plunk of *clamitans*, the grunt of *grylio*, the hoot of the barred owl, and "Leech" calling for help in the distance. The old alligator had again vanished into the night, and I had missed the opportunity of determining her size.

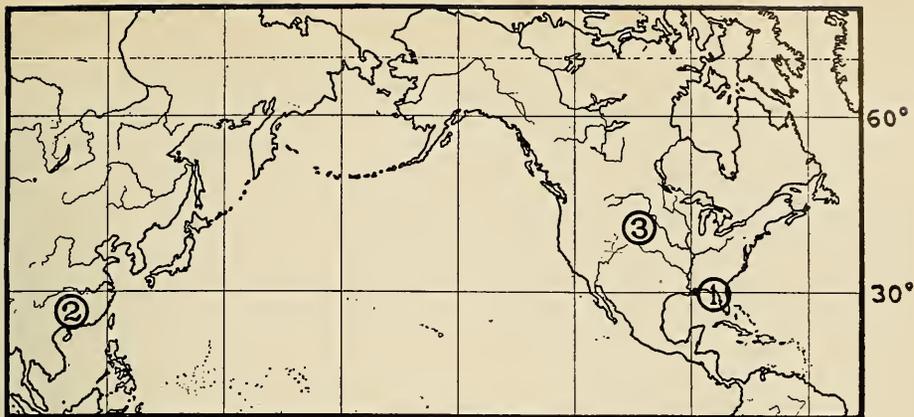


"Visions of conical teeth, crushing bones, and limbs twisted off at their joints." A close view of an old alligator

One feature of this experience which I could not explain was that I found myself still clinging tightly to the open ends of my bags. Not a frog was lost. It was uncomfortable to realize that my headlight and "Leech's" dry matches were separated by nearly a thousand feet of alligator heaven. As he had the lighter load and I was closer to the lake shore, I shouted to him to come. This he did eventually,

after feeling his way inch by inch in the direction of my voice. It was fortunate that I did not communicate my experience to him for he probably would have climbed a tree and waited for daylight. At any rate, we are none the worse for our adventure of that night.

Many times since then I have turned over in my mind the behavior of this old reptile. Fear of man is usually the dominant instinct in an alligator. My experience with these creatures leads me to believe that "Old Fire Eyes" was hiding in her submerged subterranean tunnel and did not realize it was a human molesting her young, for she probably would have retreated upon this realization, even if her young had not been returned to her. Three generations of young alligators are usually found in or near the hole dug by the mother, and the catchers take advantage of this in securing them. Nevertheless, I have yet to hear of another such charge by an alligator. A still greater difficulty in accounting for my experience of that night is the fact that, while all crocodilians, so far as known, probably assist their young in hatching from the egg or at least in escaping from the nest, it is by no means certain that alligators pay any attention to their young after they make their way into the water. The evidence given above would lead one to believe that there may be a certain amount of parental care, but such evidence need not be interpreted in this way. My assumptions as to the sex and maternal instinct of "Old Fire Eyes" affords at least one explanation for the happenings of that night. It is hoped that these experiences will lead to further observations, before the possibility of true parental care in crocodilians, after hatching, is finally accepted or rejected.



The distribution of the alligators.—The fossil species (3) recently found in Nebraska is the direct ancestor of the Chinese form (2) and represents an interesting stage in the evolution of alligators from crocodiles. The alligator (1) living in America today has a very limited range

The Ancestry of the Alligators¹

By CHARLES C. MOOK

Associate Curator of Paleontology, American Museum of Natural History

TWO species of the genus *Alligator* are living at the present time: one, the alligator of the southeastern portion of the United States, whose habitat is indicated by (1) on the accompanying map; the other, an inhabitant of eastern China (2). A fossil species of somewhat primitive character from the Oligocene beds has been described by Loomis.

During the summer of 1921 a fossil alligator skull was included in the collections made by Mr. Albert Thomson, in charge of the Museum's field expedition near Agate, Nebraska (3). The skull was collected from the Snake Creek beds of Middle Miocene age.

The detailed characters of the skull indicate clearly that it is a true alligator and not a crocodile, using the latter term in a restricted sense. When the skull is compared with that of a Florida alligator, decided differences are noticeable. The fossil skull is relatively broader and shorter, the lower jaw has a

more wavy outline, and the teeth are much stouter. On the surface of the snout is a U-shaped structure, with the two arms of the U consisting of low ridges extending forward from the orbits. This character is not present in the Florida alligator but is present in the South American jacares.

A comparison of the skull with that of a Chinese alligator (*Alligator sinense*) shows much less difference. The resemblance in fact is remarkably close. It is only by making careful studies of the details of the skulls and jaws that the fossil skull can be distinguished from the Chinese alligator. Small differences do exist, however, indicating that the fossil skull belongs to a new species. This species has been named by the writer *Alligator thomsoni* in honor of its discoverer.

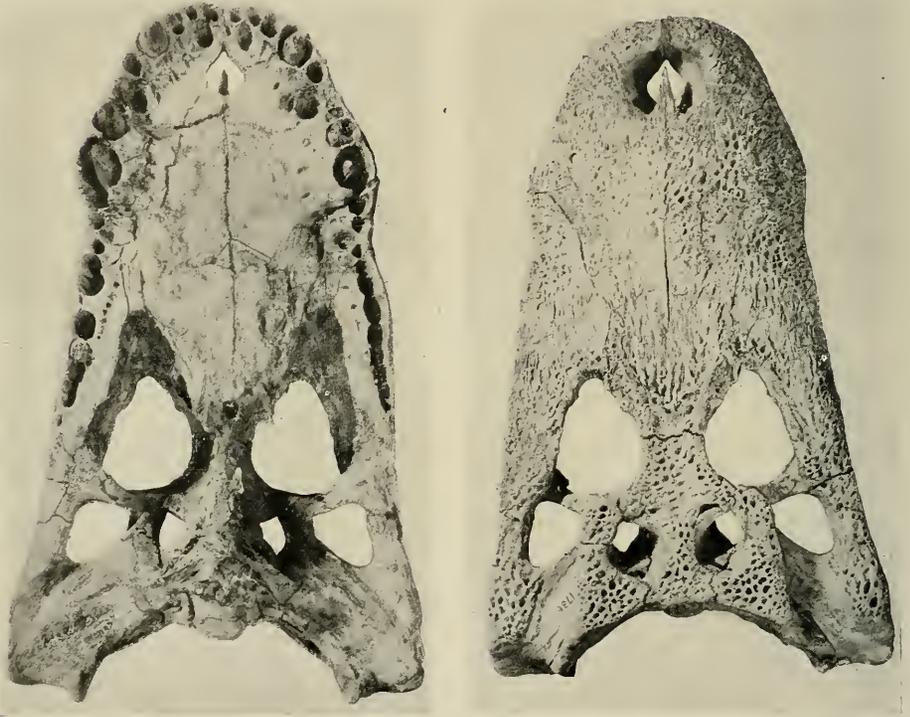
This species may be considered as a direct ancestor of the living Chinese alligator. It is intermediate in structure between both of the living alliga-

¹(Contributions to the Osteology, Affinities and Distribution of the Crocodylia, No. 17).

tors and some of the early Eocene crocodiles of Wyoming.

The crocodiles with their narrow snouts and conspicuous front teeth are more primitive than the broad-snouted alligators. The steps by which the

alligators were evolved from crocodiles is not fully represented by the fossil record. The discovery of this skull in the Snake Creek deposits adds one more link to our chain of evidence as to the ancestry of the alligator.



The skull of the fossil alligator from Nebraska, as viewed from below (left) and above (right).—The resemblance between this skull and that of the Chinese alligator is very close in spite of the great distance which separates the known ranges of the two forms. Alligators have evolved from crocodiles and differ from them most conspicuously in their broader snouts

On the Newly Discovered South African Man-Ape

BY ROBERT BROOM

NOTE.—Readers of *NATURAL HISTORY* are fortunate in having a first-hand description of the famous *Australopithecus* skull by one of the ablest living palæontologists. Dr. Robert Broom, F.R.S., is well known to friends of the Museum from the valuable collections of South African fossil reptiles that he has secured for us, and from the brilliant series of papers, mostly technical,—yet suffused with his capacity to make technical studies clear and interesting—in which he published the results of his researches here upon the ancient fossil reptiles of Texas and South Africa.

The present description, for which we are indebted to Doctor Broom's long-standing friendship for the Museum, and also to the liberality and good will of Professor Dart, will be of particular interest, as it shows very clearly the comparative relations of the new find to "missing links" previously discovered. It also gives a detailed account of the teeth, which are perhaps the most reliable guide to the affinities of the animal. Third, and perhaps most important, Doctor Broom makes clear the real geological conditions of the find. The early accounts were very vague on this point, merely stating that it was found "in solid limestone fifty to seventy-five feet below the surface." Doctor Broom explains that it was really a cave or fissure specimen (as I had suspected from the first newspaper accounts) and probably not of any very great geological antiquity. There is no warrant, it seems, for referring to it as Pliocene; it is probably Pleistocene, perhaps quite late Pleistocene, but the geological age is not very exactly determinable. This has an important bearing on the problem of where man originated. Professor Elliot Smith regards this discovery as evidence that it was in Africa, and Doctor Broom apparently indorses this view. But the survival of a primitive "missing link" in South Africa to a comparatively recent date, long after such primitive and intermediate types had disappeared from central and northern Eurasia, might seem to be evidence not for but against Africa as the center where man originated. It accords with the "Rhodesian man," a survival of the Neanderthal species in Africa long after it disappeared from Europe, and with a good deal of other evidence along the same line. Whatever its age, and whatever its bearing on the place of man's origin, the new discovery is clearly one of the most important of the various intermediate types, no longer "missing links," that connect man with the higher apes.—W. D. MATTHEW

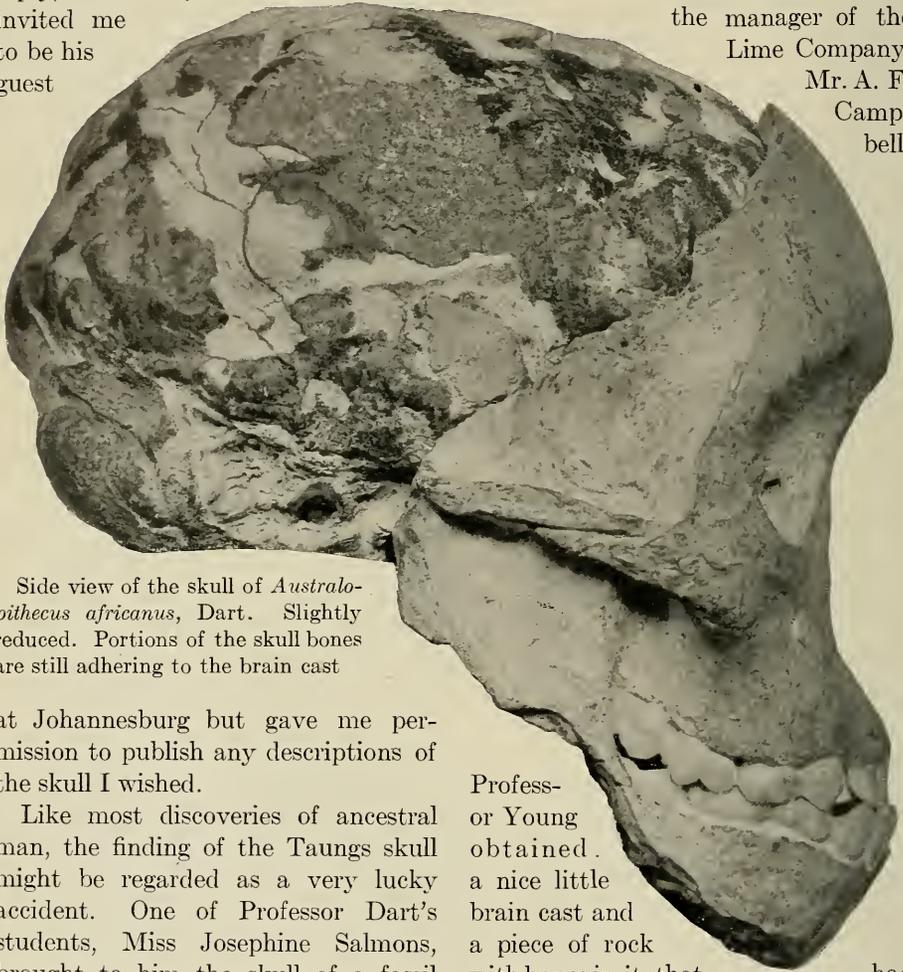
EARLY in February, 1925, the world was startled by the announcement of the discovery in South Africa of the skull of a young manlike ape, by Professor Raymond A. Dart of Johannesburg. A short account of the find appeared in *Nature*, where it was boldly stated that the skull was that of a man-ape, which in structure was intermediate between living anthropoids and man, that, unlike the living anthropoids, it had lived in the open plains, that it had walked more erect than the living forms and was thus more manlike; and in short that it was the long-sought "missing link." The daily press immediately took the matter up

and gave the discovery wide publicity. Somewhat similar announcements have been made before, which, when investigated, resulted in disappointment, but Professor Dart had been for three years assistant to Professor Elliot Smith, the world-famous anthropologist, and is himself an eminent anatomist, so his announcement was accepted by all scientists as worthy of the most respectful consideration. Professor Dart will in due course give to the world a very detailed account of the discovery with sufficient illustrations, but this must take time and the matter is of such great importance that the world clamors for more facts.

Knowing how interested the Ameri-

can public is in the question of the origin of man, I at once wrote to Professor Dart asking him if I might examine the skull and write a short semi-popular paper on it for NATURAL HISTORY. In reply, he not only invited me to be his guest

picked up already. Fortunately Professor R. B. Young, a colleague of Doctor Dart's, was going to a neighboring farm on a geological investigation, and Doctor Dart asked him to look out for any further bones. From the manager of the Lime Company, Mr. A. F. Campbell,



Side view of the skull of *Australopithecus africanus*, Dart. Slightly reduced. Portions of the skull bones are still adhering to the brain cast

at Johannesburg but gave me permission to publish any descriptions of the skull I wished.

Like most discoveries of ancestral man, the finding of the Taungs skull might be regarded as a very lucky accident. One of Professor Dart's students, Miss Josephine Salmons, brought to him the skull of a fossil baboon that had come from the limestone workings near Taungs. Similar heads have from time to time been discovered and a number are in the Cape-town Museum, where they have been examined by Doctor S. H. Haughton, who has described them as *Papio capensis*. Doctor Dart thought that human remains might be found, as numerous human implements had been

Professor Young obtained a nice little brain cast and a piece of rock with bones in it, that had been blasted out just recently. These, when examined by Professor Dart, proved to be the brain cast of an anthropoid ape-like form, and the almost perfect face of the same individual imbedded in limestone. With amazing skill Professor Dart has removed the whole of the hard limestone from the face, palate, and teeth, and there remains the most interesting fossil ever discovered.

Before speaking of the fossil skull it may be well to say something of the geology of the spot where it was found.

On any good map of South Africa there will be seen, about forty miles west of Kimberley, the lower portion of the Vaal River, and north of it will be seen part of the Harts River and still farther north, the Dry Harts. These parts of the three rivers lie in one valley of great antiquity and very great interest. It was down this valley that the great Dwyka glaciers slid in Upper Carboniferous, or the Coal age—perhaps twenty million years ago. If the valley was not originally formed by the Dwyka glaciers, they certainly had much to do with its excavation.

For some millions of years after the glaciers melted, a great Amazon-like river flowed down the valley, and the mud which it brought down and scattered over what is now the center of Cape Colony, formed the shales of the Karroo Beds, which are so rich in fossil reptiles. Gradually the valley itself became filled, in Jurassic times, with shales to a depth of perhaps two thousand feet. Then a change set in and the valley was re-excavated and today it is in a condition not unlike that of Dwyka times. At Douglas and in many other places, we see exposed the ice-scratched rocks as they were left when the last glaciers melted. All along the west side of the valley ten or twenty miles from the rivers of today, there can be seen standing up like a huge black wall the escarpment or cut face of the high dead-level inner tableland, the Kaap plateau. This Kaap plateau is mainly formed of thick layers of magnesian, or Dolomitic limestone. Rogers estimates the thickness at between two and three thousand feet, but in most places the escarpment is from a few hundred to about one

thousand feet high. Along the black wall-like face are to be seen, every five or ten miles, light-colored patches, which examination proves to be great masses of calc-sinter or lime deposit, from lime-charged waters that have issued out of the Dolomitic rocks or flowed over their face. Some of these masses of secondary lime are as high as the whole escarpment and in some places some hundreds of feet deep. Occasionally, caves are formed in these large limestone masses.

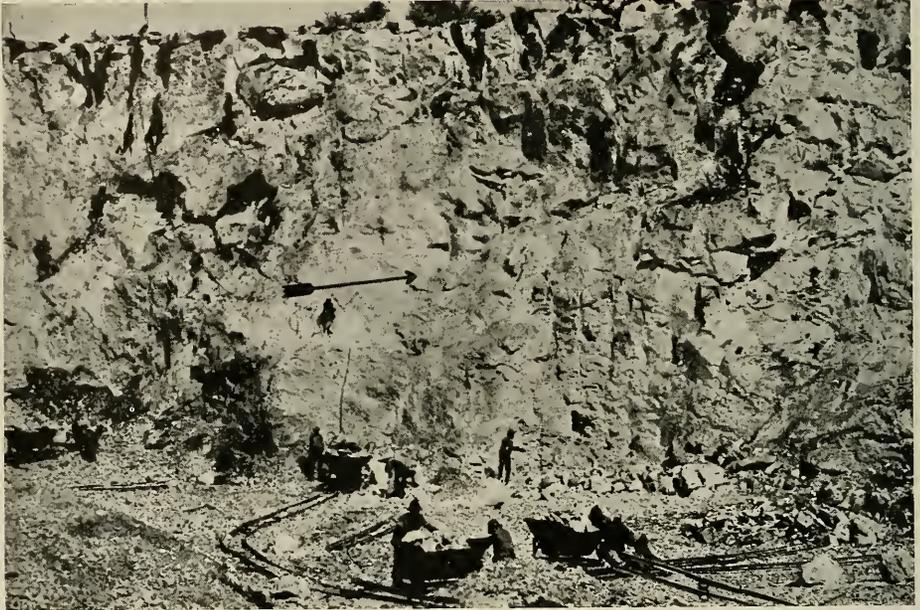
At Buxton, near Taungs, there is a large mass of this secondary limestone, which has been quarried for some years. Already the mass has been quarried into for two hundred and fifty feet from the original face. The face at present being worked is seventy feet high. About fifty feet from the top there is a cut across an old cave, which has been filled up with sand, now largely cemented with lime. It is from this old cave that the man-ape skull comes.

As will readily be seen, it is quite impossible to give more than a rough guess at the age of the fossil. The masses of limestone must have been formed at a late date geologically, certainly in Tertiary or even more recent times,—probably more recent. They must have been formed when there was more rainfall than now; otherwise, the conditions probably did not differ greatly from the present. Certainly there could not have been a heavy rainfall with the existing forest conditions of that time. The only associated mammal bones described are of a baboon fairly closely allied to the living form. And I think we are safe in assuming that the cave and its contents belong to the Human period. But whether the man-ape lived one hundred thousand years ago or ten

thousand, the evidence at present does not show.

Professor Dart has named the little animal *Australopithecus africanus*. The face may be regarded as perfect, and the side view (p. 410) shows the brain cast attached to the face. It will be under-

with milk teeth in a stage corresponding to that of a human child of six years. The side view shows a number of interesting features. If compared with young skulls of the gorilla, chimpanzee, orang, and Bushman, it will be seen that the resemblances are



The quarry at Buxton near Taungs where the skull was found. The exact spot from which the skull came is indicated by the small arrow on the face above where the men are working

stood that the brain is not fossilized. What happened is, that when the brain rotted away, the brain cavity gradually filled up with lime which in time hardened into a mass of solid limestone. When the specimen was blasted out, most of the brain-covering bones were shattered, but a nearly perfect cast of their inner surfaces has been preserved, and most of the sutures between the bones can be traced. We have only to allow a certain thickness for the bones destroyed and we can make a perfect restoration which leaves nothing to the imagination.

The skull is that of a young animal

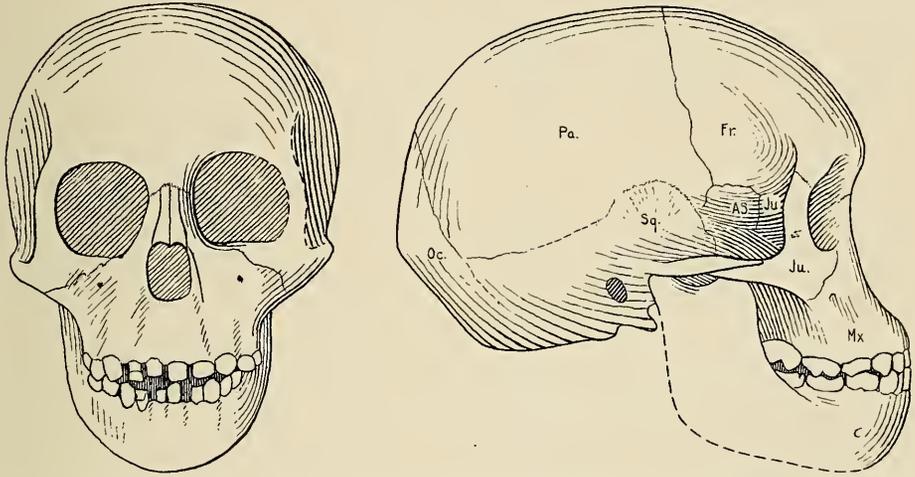
much more with the anthropoid apes than with man, and yet *Australopithecus* is more manlike than any of the known higher apes. The brain is relatively much larger and, as Professor Dart has pointed out, the poise of the head must also have been more manlike. He takes certain measurements, giving roughly the proportion of brain before and behind the supporting point of the vertebral column, which he calls the "head balancing index." The baboon provides a value of 41.3, an adult chimpanzee 50.7, Rhodesian man 83.7, a dolichocephalic (or long-headed) European 90.9, and a brachiocephalic

(or short-headed) European 105-8. In *Australopithecus* the index is 60.7. And he concludes that this new form had "an attitude appreciably more erect than that of modern anthropoids."

There are many points in the structure of the side of the head of interest to the anatomist, to which attention need not be called in a paper primarily intended for the general public. But

agrees with the condition in the gibbon and man, but differs from the condition in the gorilla and the orang. The young chimpanzee skull has a nose more closely approaching that of *Australopithecus*.

The teeth are of exceptional interest. There are preserved the practically perfect milk set, with the first upper and lower permanent molars.



(Left) Front view of skull of *Australopithecus africanus* Dart. (Right) Side view of skull of *Australopithecus* Dart. As., Alisphenoid (Sphenoid); Fr., Frontal; Ju., Jugal (Malar); Oc., Occipital; Mx., Maxilla; Pa., Parietal; Sq., Squamosal (Temporal)

it may be well to note that the arrangement of the bones in the temporal region agrees more with that of man than with that seen in the gorilla and the chimpanzee.

The side view of the skull shows the small flattened nose characteristic of the anthropoid apes and of the Bushman, and the close approach to the human mouth, with the small front teeth which meet each other, almost end on instead of at an angle, as in the anthropoids.

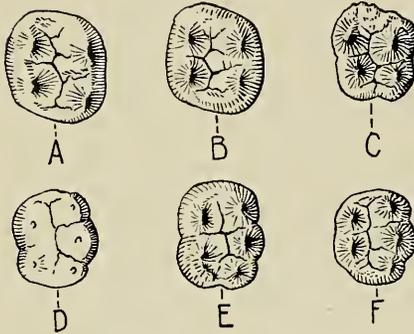
The front view of the skull shows other interesting human resemblances. There is the broad human-like nose with the nasal opening partly between the lower part of the eye sockets. This

The incisors are small; in this respect they agree with man and differ from the higher apes. The upper milk canine or eye tooth is also small and not unlike that of the Bushman child. In all anthropoids the canine has a greater antero-posterior length than the first milk molar. In the Bushman child the antero-posterior length of the canine is to that of the first milk molar as 75 is to 90. In *Australopithecus* the canine has an antero-posterior length of less than three fourths that of the molar.

The milk molars agree much more closely with those of man than with those of any of the anthropoid apes.

The first true molar is preserved in perfect condition and is quite un-

worn. Though in the nearly closed condition of the jaws a full view cannot be had of the crown, it is possible from measurements of the cusps to give a drawing that can be fully relied upon. There are the four large cusps seen in all the anthropoids and in man. In man the molars vary greatly, owing to degeneration, but if a perfect undegenerate molar such as one finds in



Molar teeth of *Australopithecus africanus* Dart, with others for comparison. All natural size. A.—First upper right molar of orang. After Röse. B.—First upper right molar of *Australopithecus africanus*. C.—First upper right molar of Bushman child. D.—First lower right molar of chimpanzee. After Miller. E.—First lower right molar of *Australopithecus africanus*. F.—First lower right molar of Bushman child. The close agreement of the molars of *Australopithecus* with those of living anthropoids and man is striking; also the large size of the molars, showing that it was probably considerably larger than the chimpanzee

the Bushman child be compared with the molar in *Australopithecus*, the close agreement is striking, though the tooth of the latter is appreciably larger. The molars of the chimpanzee and the gorilla differ appreciably from that of the fossil form.

The lower incisors much more closely resemble those of man than those of the higher apes.

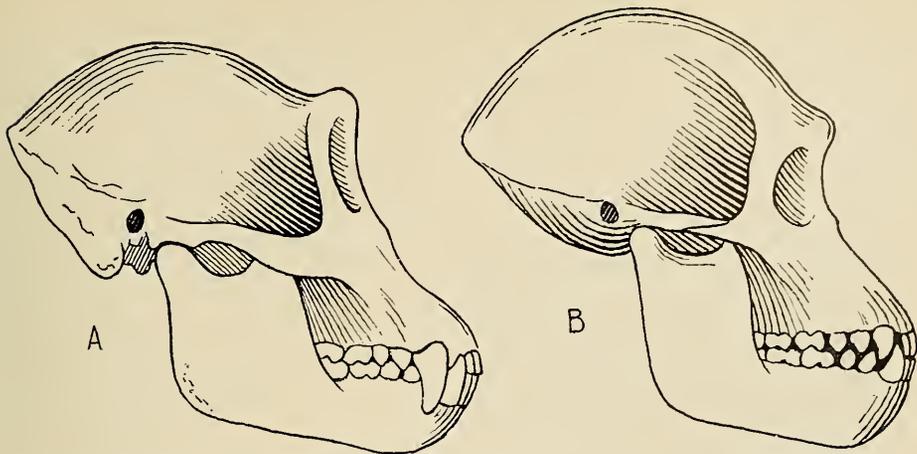
The canine is fairly large and pointed, resembling more closely that of the chimpanzee than that of man. But the milk molars, on the other hand,

agree much more closely with those of man than with those of the chimpanzee.

The first true molar is well preserved and though a good view of the top of the crown cannot be had, the drawing I give is essentially correct in all details. In the anthropoid apes and in man there are two large cusps on the outer side and two large ones on the inner, generally with a fairly well-developed fifth cusp—the hypoconulid, as it is called—at the posterior and outer corner. In the gorilla and orang this fifth cusp is well developed on the second and third molars, but only very slightly developed on the first molar. In the gibbon and chimpanzee the fifth cusp is well developed in the first and second molars and only slightly developed in the third. In man it is generally present in a fairly well-developed condition in the first molar and usually very feebly developed, if at all present, in the second and third molars. But in some primitive races of men the fifth cusp is present in a fairly well-developed condition in all the lower molars. In *Australopithecus* the first molar is considerably larger than in man. On the outer side the three cusps are all well developed and subequal in size, and on the inner side the two are also well developed. The tooth thus makes a close approximation to the first molar of the chimpanzee, though considerably larger. It is also not unlike the first molar of man, though the fifth cusp is rarely, if ever, as large as in *Australopithecus*.

The study of the teeth renders it pretty certain that *Australopithecus* stands somewhere between the chimpanzee and man.

We know that the brain in the apes and in man grows comparatively little after the stage when the first molars appear,



A.—Skull of chimpanzee, *Pan vellerosus*. After Elliot. B.—Attempted reconstruction of the adult skull of *Australopithecus africanus*

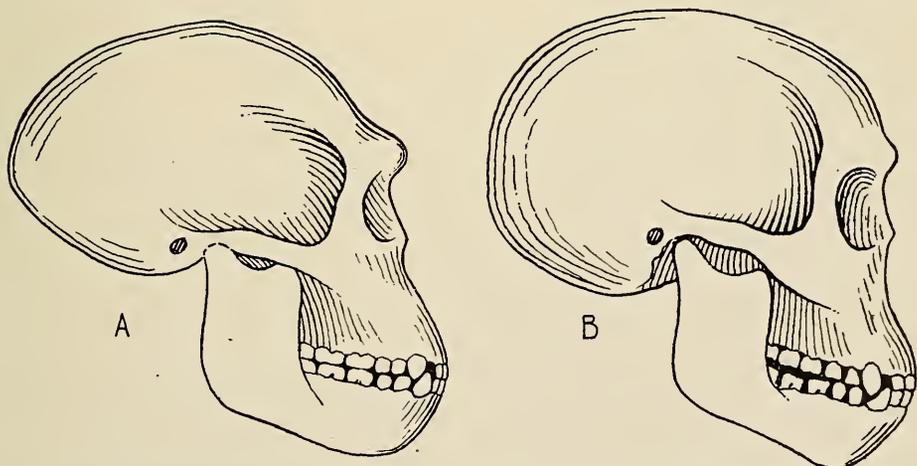
and that most of the changes are due to the great increase in the size of the jawbones to accommodate the large teeth and the greater development of the facial bones. It is thus possible to reconstruct the adult skull with almost perfect confidence when we know the brain in the half-grown animal and the size of the molar teeth.

When the adult skull is reconstructed, as in the figure I give, it is seen that we have a skull a little like that of the chimpanzee but with a relatively much

larger brain and with smaller canine teeth. We know that there must have been enlarged canines from the presence of the well-marked gap between the canine and the second incisor, and the canine must have been smaller than in the chimpanzee, for a portion of the permanent canine can be seen in the fossil jaw.

The likeness to the adult gorilla and orang is much less striking than to the adult chimpanzee.

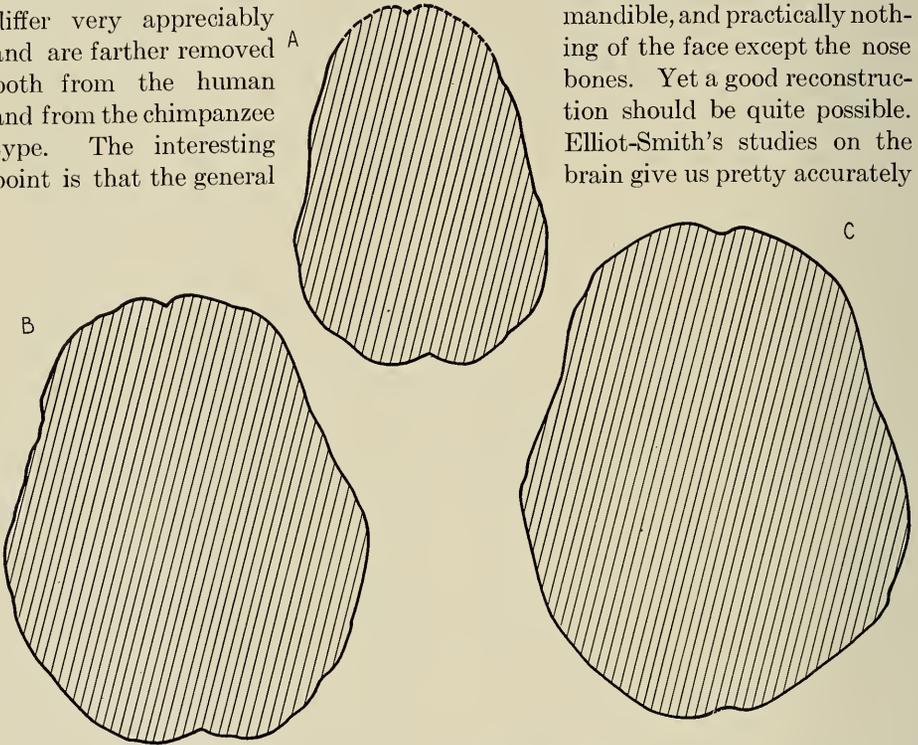
The reconstruction I give at once



A.—Restoration of skull of *Pithecanthropus erectus*. After McGregor. B.—Restoration of skull of *Eoanthropus dawsoni*

calls to mind that made by Professor J. H. McGregor of the Java ape-man, *Pithecanthropus erectus*. Unfortunately, of this type we know only the top of the skull and two teeth. The brain is very appreciably larger than in *Australopithecus* but rather more flat. The teeth also differ very appreciably and are farther removed both from the human and from the chimpanzee type. The interesting point is that the general

1913, various reconstructions have been made, the most important being those of Smith Woodward, Keith, McGregor, and Hunter, and the layman must feel a little worried that the reconstructions should differ so considerably. We have only, it is true, most of the brain case and much of the mandible, and practically nothing of the face except the nose bones. Yet a good reconstruction should be quite possible. Elliot-Smith's studies on the brain give us pretty accurately



Brain outlines of (A) *Australopithecus* (juv), (B) *Pithecanthropus*, and (C) *Eoanthropus*. The last is from Professor McGregor's restoration

resemblance is so striking as to suggest the possibility of a type like *Australopithecus* being the ancestor of a type like *Pithecanthropus*.

The next primitive human type with which a comparison must be made is the Piltdown skull, *Eoanthropus* of the south of England. Here we have a form with a moderately large human-like brain and a jaw which closely resembles in many ways the jaw of the chimpanzee.

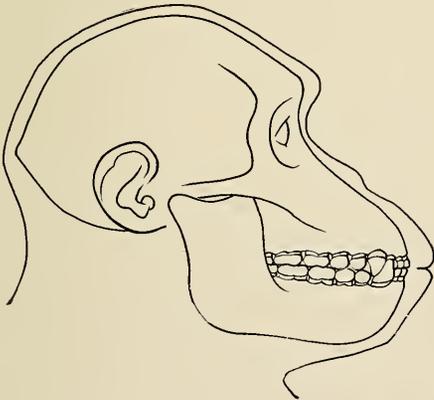
Since *Eoanthropus* was discovered in

the structure of the brain case and we have thus only the face to reconstruct, and though the jaw is nearly perfect, it is surprising how different are the results that have been given us. As in South Africa, where I am writing, I have neither the bones nor casts, I must give a figure for this paper founded on one of those already published, and the one which seems to me the most satisfactory is Smith Woodward's. I have therefore taken Smith Woodward's restoration as a basis, but altered slightly his restora-

tion of the front of the jaw and greatly altered the restoration of the face to put it in keeping, as I believe, with the jaw.

When the skull of *Eoanthropus* is compared with that of the adult *Australopithecus*, it will be seen that we have here a still farther step from the pre-chimpanzee to man. The brain has gone on enlarging and is now practically human. The face, however, is still ape-like. There is still the large canine of the ape but the molars are more human than ape-like.

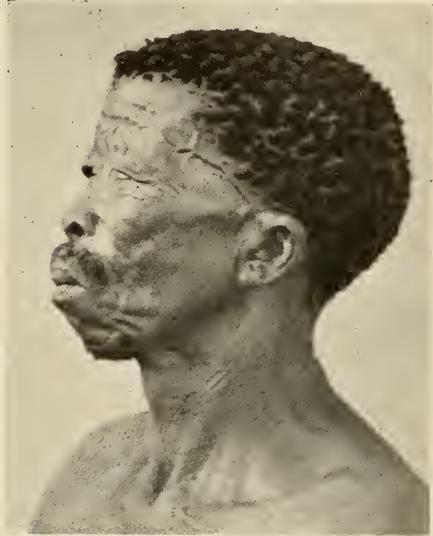
All the other known pre-human or aberrant human types, such as the Neanderthal man, the Rhodesian man, the Heidelberg man, have a dentition that is not primitive, and though the skulls and brains show characters that differ considerably from the modern European type of *Homo sapiens*—large brow ridges like the gorilla, massive faces, and a less erect attitude—it is doubtful if these are really ancestral to ourselves. For many years I have regarded them as much modified side branches and I am pleased to see that



Head of adult *Australopithecus*.—This skull of adult *Australopithecus* is founded on the child brain with the jaw restored from the two first molars, which measure 14 mm. to 16 mm. The jaw must therefore be much as indicated and the whole skull cannot differ greatly from the restoration given

Elliot Smith in his recent book *The Evolution of Man* also puts them in side branches.

It will be seen from what has been said that *Australopithecus* forms a most satisfactory connecting link between



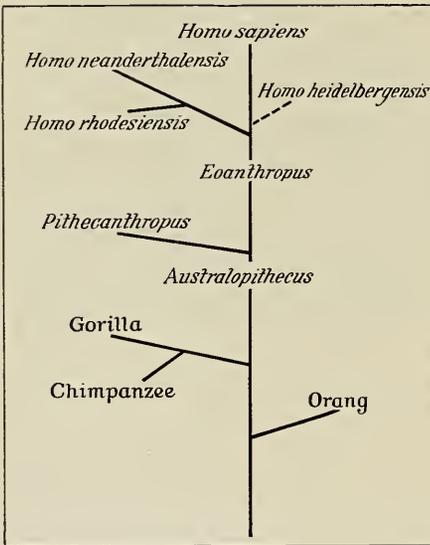
Photograph by A. M. Cronin
Pure Bushman, "Dial," one hundred years old, showing apelike face somewhat resembling the Piltdown man

the anthropoid apes below and the various human and sub-human types above. And if the discovery results in the universal acceptance of the belief in man's evolution from the lower forms, the discovery of *Australopithecus* may have nearly as great an influence on human progress as the publication of Darwin's *Origin of Species*.

In the table on p. 418 an endeavor is made to show what may be the relationships of the higher apes and man and the connecting links and side branches, and the importance of *Australopithecus*, which may be regarded as the chief connecting link.

This table makes no attempt at giving the geological ages of the forms, and though *Australopithecus* may have

lived quite recently and thus could not have been the ancestor of *Pithecanthropus* or *Eoanthropus*, the endeavor is to show that these latter and the higher human types have all been descended from an *Australopithecus*-like type but not necessarily from *A. africanus*. *Australopithecus* may rather be regarded as a representative, probably of a group of large-brained anthropoids, from one of which the higher types have descended.



In connection with the discovery of the Taungs skull, Professor Elliot Smith regards the discovery as “the first definite confirmation of the opinion expressed by Darwin, which most people since his time have discredited—that Africa is the original home of the human family.” The discovery no doubt confirms Darwin’s opinion and we have herein another marvelous

evidence of his insight. But it is interesting to note that nearly one hundred years before Darwin published *The Descent of Man*, the famous Scots evolutionist, Lord Monboddoo, wrote in his great work *Origin and Progress of Language*, published in 1774, as quoted by W. L. H. Duckworth: “From the South Sea, I will come back again to Africa, a country of very great extent; in which, if it were well searched, I am persuaded that all the several types of human progression might be traced, and perhaps all the varieties of the species discovered.” Lord Monboddoo not only boldly maintained the descent of man from the apes but believed that the orang-utan was a degenerate human being. “That my facts and arguments,” he writes, “are so convincing as to leave no doubt of the humanity of the Orang-utan, I will not take upon me to say: but this much I will venture to affirm, that I have said enough to make the philosopher consider it as problematical, and a subject deserving to be enquired into.” Though this remarkable Scotsman failed to persuade his contemporaries, and his name would today be forgotten but for his association with Boswell, Johnson, and Burns, one feels it almost a patriotic duty to claim for him a place which is deservedly his as one of the pioneers of human evolution.

It seems to me not at all improbable that an adult *Australopithecus* will yet be obtained, and possibly a perfect skeleton. Should such a discovery be made, it would be difficult to overestimate its importance.



Louis Robert Sullivan 1892-1925

By CLARK WISSLER

Curator-in-Chief, Division of Anthropology, American Museum

DR. LOUIS ROBERT SULLIVAN, a young anthropologist of unusual promise and a member of the American Museum scientific staff, died in Tucson, Arizona, on April 23. He came to the Museum in 1916 as a student and assistant in the department of anthropology, and later was placed in charge of the anatomical collections. In 1920 the Museum was invited to join the Bernice P. Bishop Museum in Hono-

lulu in an anthropological survey of the Polynesian Islands, and to Doctor Sullivan was given the racial problem. In the inauguration of this work¹ he spent eighteen months in the Islands, where he made measurements and photographed a large portion of the native Hawaiian population. Some account of this work was given in the January-February, 1923, issue of this journal. Later, Doctor Sullivan prepared a memoir on "Marquesan Soma-

tology, with *Comparative Notes on Samoa and Tonga*," issued by the Bishop Museum. In this publication he made a general comparative study of the races in the Pacific, and formulated a working hypothesis as to the original elements entering into the mixture. At the time of his death he had well on the way to completion a second memoir on the Hawaiians.

Also, while in Honolulu, permission was given to him to examine the children in the public schools. In all, about 8000 persons were studied, and data collected as to their ancestry. Since a number of races attend these schools and intermarriages are frequent, these data were preliminary to a study of race mixture. Though Doctor Sullivan was not able to put this material in form for publication, the data will not be lost, but will serve as the basis for future studies in this field.

Doctor Sullivan returned to the Museum in 1921, but his failing health soon made it necessary for him to try a different climate. He took up temporary residence in Tucson, Arizona, and while there engaged in studies of the Mexicans and Indians attending the various schools. Later he made a general study of the Indian children in the Reservation schools of all the western states. He completed this work and tabulated the results in a form suitable for publication.

Doctor Sullivan was born at Houlton, Maine, in 1892. He was graduated from Bates College, Lewiston, Maine, in 1914. He taught biology in Tilton Seminary, 1914-15, then entered Brown University as a graduate student and as assistant in zoölogy under Professor H. E. Walter. From there he came to the American Museum. During the first years as a member of the Museum staff, he prepared himself

for a career in anthropology by intensive studies in general biology, palæontology, and anatomy. The war broke in upon his scientific activities, for he felt the call to service, and was appointed First Lieutenant in the Section of Anthropology, Surgeon-General's Office, in 1918. While on duty at headquarters, he assisted in the compilation of the reports on Defects Found in Drafted Men and Army Anthropology. His special contribution was the determination of the 156 standard population sections, based upon the census returns of 1910, according to which the published studies of the Surgeon-General's Office were made. The section map and population table prepared by Doctor Sullivan in the course of this investigation give an adequate picture of the geographical distribution of the several national strains entering into the population of the United States. After the completion of this task Doctor Sullivan was assigned to Camp Grant, where he began an anthropometric survey of the recruits stationed there, but before the work was completed his quarters were destroyed by fire and his records lost. Then came the influenza, to which he fell a victim. This illness permanently impaired his health. Shortly afterward the war came to an end and he returned to the Museum. During the following winter he suffered a long and serious illness, and from that time on his vitality steadily weakened.

In all phases of his work at the Museum and elsewhere, Doctor Sullivan showed conspicuous ability and fine judgment. When recommending his appointment to the Museum staff in 1916, Professor H. E. Walter of Brown University, his teacher in biology, wrote, "He is a quiet fellow, sane, clear-eyed, persistent, not afraid

of work, with a scholarly mind and a lot of native ability. He makes good with monotonous certainty in every proposition he takes up. I am sure that he will make good somewhere." That these words were prophetic everyone acquainted with Doctor Sullivan will agree. His untimely death is

not only a great loss to the Museum but to anthropology in general.

Though granted but a few years of mature professional life, his bibliography covers twenty-five titles reporting upon original work, and ten important reviews of publications in his field. His major contributions are noted below:

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NOTES

ASTRONOMY

ASTRONOMICAL EXHIBIT.—On exhibition in the astronomical and memorial halls of the American Museum, May 13 – June 15, were paintings, photographs, and drawings of the solar eclipse of January 24, 1925, as well as those of 1900, 1901, 1905, 1918, and 1923. Among these were paintings by Mr. Howard Russell Butler, of the eclipses of 1918, 1923, and 1925, and of the Northern Lights which were observed in August of the year 1919. There were also paintings of the eclipse of 1925 by Mr. Aleth Bjorn, Professor Baker, and Professor Fuentes, of Cornell University. A lecture on "The Recent Total Eclipse of the Sun" was delivered on the opening night by Professor John A. Miller, director of Sproul Observatory, Swarthmore College.

The photographic transparencies recently installed in permanent exhibition cases in the astronomical hall, picturing Halley's comet, meteorite showers, astronomical instruments, observatories, etc., attracted the attention of many Museum visitors.

The exhibit was made possible through the courtesy of the United States Naval Observatory, Fuentes Observatory of Cornell University, Vassar College Observatory, Yale University Observatory, Sproul Observatory of Swarthmore College, Van Vleck Observatory of Wesleyan University, Yerkes Observatory of the University of Chicago,

Mt. Wilson Observatory, Maria Mitchell Observatory, Lowell Observatory, Lick Observatory, the Smithsonian Institution, the New York Edison Company, and amateur astronomers.

The Museum architects, Messrs. Trowbridge and Livingston, are collaborating with Mr. Howard Russell Butler of Princeton, New Jersey, in the preparation of plans for the proposed astronomical hall which is to occupy the place of the present auditorium. This hall will include five floors, and will cost \$2,000,000. The first floor will be devoted to the Museum's large collection of meteorites. On the second floor will be a great hall, extending through the third floor, for astronomical models and exhibits, while the astronomical hall proper will extend from the fourth floor through the fifth and sixth floors and will be capped with a huge dome, which will represent the heavens with the constellations.

On August 20, Dr. G. Clyde Fisher leaves New York to visit Jena, Berlin, Munich, Vienna, Zurich, Paris, and London, for the purpose of observing astronomical apparatus in these cities.

COMPARATIVE ANATOMY

THE UNIVERSITY OF TASMANIA RECEIVES MAMMAL COLLECTION.—A note recently received from the Registrar of the University of Tasmania states that the valuable collection

of mammals recently sent to the Biology Department of the University from the American Museum has arrived there safely. This is one of a series of exchanges which the American Museum has arranged with the museums in Australia, Tasmania, and Polynesia.

EXTINCT ANIMALS

THE STRUCTURE OF THE DINOSAUR EGG SHELL.—Some pieces of the famous dinosaur eggs secured by the Third Asiatic Expedition have been sent by Professor Henry Fairfield Osborn to Professor Victor Van Straelen of the Université Libre, Brussels, Belgium, for micro study. Professor Van Straelen has just published a short preliminary statement of his finding in *Novitates* (No. 173). He concludes: "Thus there are striking differences between the eggs of Shabarakh Usu and those of Iren Dabasu. The first-named cannot be correlated with any of the actually known eggs, either living or fossil. The second-named have a structure similar to that of the supposed eggs of *Hypselosaurus priscus*, the dinosaurian of Rognac, which themselves have a structure that partakes of the characters of both the palæognathic and neognathic birds. But the Iren Dabasu eggs differ essentially from the Rognac eggs in the shape of the aëriiferous canals."

The fossil eggs secured by the Third Asiatic Expedition were believed to be those of dinosaurs because of their association with the remains of certain dinosaurian fossils. They exhibit a general resemblance in form to the eggs of crocodilians, which is, perhaps, only natural, for crocodiles and dinosaurs have sprung from the same stock of reptiles. Some of the eggs possess fragments of the embryo skeleton within them but these parts have not been fully studied as yet. It is therefore of great interest to see exactly what light the microstructure of the egg shell throws upon the identification of the eggs as dinosaurian.

The eggs of turtles, crocodiles, and birds resemble each other superficially but differ in their form and microstructure. The dinosaur eggs secured by the Third Asiatic Expedition agree with crocodile eggs not only in form but also in the great variability of surface texture. They differ strikingly, however, from crocodile eggs in the great thickness of the middle or so-called "prismatic layer." A second difference lies in the form and arrangement of the fine tubules which perforate the entire shell permitting the young dinosaur to respire before

hatching. In the crocodile there are two kinds of tubules of different sizes, the larger being visible to the unaided eye. In the dinosaur eggs there is only one kind of tubule of very small diameter. This tubule has a different form in the eggs collected at Iren Dabasu than those from Shabaraku Usu. Thus, Professor Van Straelen was able to confirm the observations of Professor Osborn that at least two types of eggs were represented in the collection.

The dinosaur egg shells differ from those of birds not only in form but also in thickness. In the primitive ostrich-like birds, (except *Apteryx*) the respiratory tubules ramify in the prismatic layer terminating on the surface in a group of pores lining a single depression. In the dinosaur eggs the tubules do not ramify, but are straight as in the case of the higher birds.

In detailed structure, the dinosaur egg shell differs from those of crocodiles, birds, or turtles, and agrees only with an egg shell of uncertain origin found in the upper Cretaceous of Rognac, France. In the light of the discoveries of the Third Asiatic Expedition, it is now highly probable that all these eggs are dinosaurian.

FISHES

The editors of the *National Geographic Magazine* interpret the function of their journal in so broad and liberal a spirit that they win the hearty commendation of all nature lovers, for they include in its columns from time to time articles on various natural history subjects. Furthermore, they add to their good deeds by collecting such articles and issuing them as books. For instance, one recently appeared, embracing certain articles by E. W. Nelson entitled, *Wild Animals of North America*, and illustrated with many photographs and wonderful color plates by Louis Agassiz Fuytes.

For some years past the souls of ichthyologists have been rejoiced by the publication in the *Geographic* of excellent and beautifully illustrated articles on the fishes and fisheries of North America. These articles have now been issued in book form under the editorship of John Oliver La Gorce, and bear the title *The Book of Fishes: Game Fishes, Food Fishes, Shellfish and Curious Citizens of American Ocean Shores and Rivers*.

In this handsome royal octavo volume of 243 pages are brought together articles in the *Geographic* from the pens of J. O. La Gorce,

C. H. Townsend, L. L. Mowbray, J. T. Nichols, H. M. Smith, and F. W. Wallace. These articles are not merely interesting but are valuable because authoritative. Not the least striking part of the book are the 134 illustrations from photographs and the 92 color plates of familiar salt- and fresh-water fishes *made from life* by that skilful artist, Hashime Murayama. The value of these color plates cannot be overestimated. The department of fishes in the American Museum is frequently asked "Where can I get an accurate figure—colored if possible—of the (here naming some certain fish)?" The answer is before us for 92 kinds. In publishing these articles, and especially in having had made and in issuing the color plates, the *Geographic* and its editors have done the science of ichthyology no small service.

INSECTS

FIELD STATION FOR THE STUDY OF INSECTS.
—Last winter visitors to the American Museum were attracted by an unusual exhibit,—a case containing not mounted specimens but live insects engaged in preying upon other insects, chewing tobacco (for some insects, like men, are fond of the weed), egg-laying, crawling, flying, jumping, or oaring their way over the smooth surface of a bowl of water. Only a few, however, of a vast number of interesting forms of insect life could thus be shown and the setting was necessarily artificial. Today, thanks to the coöperation and courtesy of the Commissioners of the Palisades Interstate Park and the generosity of Mr. William Averell Harriman, the Museum has had placed at its disposal a forty-acre tract near Tuxedo, New York, where a field station for the observation and study of insects is being established under the direction of Dr. Frank E. Lutz.

Although facilities for research students are contemplated, it is the great interested lay public that will be the immediate beneficiary. The tract will be virtually an insect zoo. Instead of walking from cage to cage in an enclosed building, the visitor will follow a path through the open, leading past this group of insects and that, each properly labeled so that an insight may be had into the life history of these little creatures which in spite of their diminutive size play a rôle in the affairs of the globe that rivals that of man, and upon whose conflicting or complementary interests the

fate of man is in no small measure dependent.

A brook traverses the tract, and some of the aquatic insects that live on its surface and below will be shown in glass bowls. Thus the station will combine the attractions of an aquarium with those of a zoo.

An interesting educational feature of the station will be the unlabeled exhibits, paradoxical as this may at first seem. After the visitor has followed the route by a number of described exhibits and has imbibed the knowledge that is spread out for his eye to read, the opportunity will be given, should he so elect, to demonstrate what he has learned by following a route in which similar but unplaced exhibits appear, and these, as a test, he will be asked to name and describe.

Young assistants, working under Doctor Lutz, will replenish the exhibits as new live specimens are required and will assist also in making the sojourn of visitors as profitable and enjoyable as possible.

The tract is located at the intersection of the proposed Bear Mountain-Greenwood Lake and the Tuxedo-Southfield highways, just at the point where one leaves the latter road when going through the Park to Bear Mountain, and it is hoped that all who read this Note will avail themselves of the opportunity of visiting what is in several respects a unique undertaking.

PREHISTORY OF MAN

THE WORD *PITHECUS*.—We may quote from an interesting note in *Nature*, June 6, 1925, page 875, by Raymond A. Dart, on the proper use of the Greco-Latin word *pithecus*:

"It has been stated by several critics that the word 'Australopithecus' is a hybrid (Latin-Greek) term. I am indebted to my colleague Mr. T. J. Haarhoff, professor of classics in the University of the Witwatersrand, for the information that *pithecus* was a recognized naturalised Latin word in Rome. It was used by Cicero's own secretary, Tiro, and by other accredited writers, and more than a century before Cicero's time Plautus employed the diminutive *pithecium*. It is, therefore, not surprising that both of these words are to be found in a standard Latin dictionary, such as that of Lewis and Short. The still commoner *cercopithecus* is found in Pliny, Varro, Juvenal and Martial, to the last-named of whom (Book XIV, Epigram 202) we owe one of the most pleasing examples

of the indiscriminate juxtaposition of the two words used by polished Romans for a monkey:

Callidus emissas eludere simius hastas
Si mihi cauda foret cercopithecus eram.

'A monkey, cunning to avoid darts, hurled at me
(the charge that)
I should be a tailed ape, had I a tail.'

Naturally, *pithecus* has been the classic term availed of over and over again by zoölogists to designate fossil or recent members of the Primates. Among the anthropoid apes, for example, the chimpanzee and the gorilla were long deemed so closely allied and so imitative of man that they were placed in the single genus *Anthropopithecus*. When some generalized Pliocene apes were found in France and in Asia, they received the jungle name *Dryopithecus*, signifying "Ape of the Forest." Recently, Raymond A. Dart proposed the named *Australopithecus*, or "Ape of the Southern Hemisphere," for the newly discovered Taungs skull. Gregory suggested to the writer the well-chosen term *Hesperopithecus* signifying "Ape of the Western World," for the already famous Nebraska tooth.—H. F. O.

LOST FOXHALL JAWBONE.—Our readers will recall Professor Osborn's article on Pliocene man in Great Britain in *NATURAL HISTORY* Nov.-Dec., 1921, in which was described "The Pliocene Man of Foxhall in East Anglia," the human jawbone said to have been found in the Foxhall beds with these great upper Pliocene implements. This jawbone was described and figured by Dr. Robert Collyer, with whom it seems to have disappeared; vigorous search has since been made for the life history of Dr. Collyer in the hope of locating the fossil jawbone. In the April *Scientific American* there was published a notice in this connection, of which Mr. Moir in his letter of May 3 says: "I am glad to see that the Foxhall jawbone was again mentioned in a recent number of 'The Scientific American.' I thought Hřdlicka's criticism following my paper in the American Journal of Physical Anthropology rather in the nature of begging the question." In response to the article in the *Scientific American* two letters have been received, from which we quote:

"A Dr. Robert Collyer (an uncle of mine), was an Englishman and moved to Philadelphia from London, England. I think he spent most of his life in England. He died in New Orleans about twenty years ago, at the English Colony's Home, aged about ninety years. I think he is the doctor you are trying to locate."

"In Dickson and Montgomery Counties in Tennessee some thirty years ago I met the descendants of 'the Collyers,' and Van Leers, who came from England or Scotland about 1800. . . They made sugar kettles for the planters of Louisiana. General (afterward President) Jackson knew them; they made cannon balls for him with which he fought the British at New Orleans in 1812. . . The Collyers still probably live at Charlotte. . . I've heard some people speak of a Doctor Collyer about the Civil War times, 1861 to 1865, and about his interest in 'the fossils' that I understood they found in the iron ore beds in the surrounding country."—H. F. O.

BEGINNINGS OF INTELLIGENCE.—In an article in the February *Forum* Professor Osborn observes that it is not man's physical structure which makes him human, but his moral, intellectual, and spiritual nature alone: "Regarding intellectual evolution, the case immediately becomes more difficult. I was never so impressed with this fact as in my journeys among the former habitations of the cave men in northern Italy, France, and Spain. I soon conceived a great admiration for these men because of their undoubted intellectual powers as observed not only in the superb development of the brain, but also in the high observational and artistic powers manifested in their art. I am perhaps more proud of having helped to redeem the character of the cave men than of any other single achievement of mine in the field of anthropology. The cave man bore, and still bears, an evil reputation of being a brute."

On this article a correspondent, Mr. A. H. Chisholm of Sydney, Australia, comments:

"Certain of your observations regarding the brain power of primitive races agree largely with certain instances that forced themselves recently under the notice of the ornithologists of New South Wales, of whom I am chairman. There came to us one David Unaipon, a full-blooded aborigine, who had been taken young and educated, and who pleads the cause of his vanishing people at every opportunity. The man himself is his best argument. He speaks most fluently, yet never rants and never needlessly weeps. Some of his points as to the psychology of aborigines and animals were arresting. (Dr. Basedow has something to say on the same point in his just-published book.) To back Unaipon there was Douglas Grant. Douglas is a full-blooded aborigine

from North Queensland (Unaipon comes from South Australia) where he was rescued during a massacre by one of our ornithologists, Robert Grant. Mrs. Grant cared for the little two-year-old black, checked his eating raw meat, and eventually brought him to Sydney. He grew to be a fine lad (with an amusingly Scotch accent acquired from his foster-father), went through the Great War well, and is now back as a draughtsman in a small arms factory. No mean performance, I suggest, for a member of probably the most 'primitive' race now living." H. F. O.

MEN OF THE OLD STONE AGE.—The well-known book by Professor Henry Fairfield Osborn, of which three editions have been published in America, has recently appeared in Russian. The translator, Dr. B. N. Wisniewsky, anthropologist of the Russian Academy of Sciences, says in his preface that this book is "the best popular statement of the theme." The original text is supplemented by two articles by the translator. One of them, "Ancient Man in the Light of Latest Studies," gives a review of the latest contributions to the subject up to 1923, most widely known in America and Western Europe. Another article, "Prehistoric Man in Russia (The Stone Age)" is based mainly on the literature published in Russian, and consequently a review of this will be interesting to American readers.

Man seems to have appeared on Russian territory comparatively late. The most ancient, somewhat doubtful, findings of the stone implements on the Kuban River, southeastern Russia, show implements of Mousterian type belonging presumably to the last or fourth glaciation (Würm stage). Better known, and rather plentiful, are findings of a somewhat later date referred to the end of the fourth glaciation. All belong to the southern half of Russia, the most northern lying about 55° N. latitude, and are scattered in the basin of the Dnieper River, at the sources of Prut and Bug, on the Oka River, Don, and in central Transcaucasia. In Siberia, vestiges of the Old Stone Age have been found near Tomsk, near Krasnoyarsk, on the upper course of the Yenisei River, and near Irkutsk.

Owing to the prevailing character of the country, most of the findings represent camps, and cave dwellings are rare. Very interesting is the camp near Kostenki on the middle course of the Don River. It shows three layers with the implements of the Solutrian and Magda-

lenian types. Here has been found a beautiful statuette, made of mammoth's tusk. Unfortunately, the head is missing. The statuette represents a pregnant woman, without stylized exaggeration of the sex characters which is usual in the figures found in western Europe, and showing no steatopygia, or accumulation of fat generally. Absence of these features in the statuette may express a racial characteristic of the people who occupied this Kostenki region. The camp found on the territory of Kiev (so-called Kirilovski) had been occupied three times at least, and part of the implements belong to the Aurignacian type. Remains of mammoth, woolly rhinoceros, cave bear, lion and hyena, partly fire-burnt, have been found, and also wood of nut pine and spruce which now are found much farther north. A camp near Mesino, province of Chernigov, about 150 miles farther north, belongs to the Magdalenian epoch. Here, remains of the mammoth, horse, and also of northern mammals, such as arctic fox, musk ox, and reindeer have been found. Discoveries of cultural interest in this camp are pierced shells of Tertiary mollusks, used as adornments, while the implements are represented by a big store of reindeer antlers, mammoth tusks, and flints. The only cave deposit of this age in Russia has been found quite lately in Crimea near Simferopol. This may have been only a temporary refuge and not a regular dwelling. Of the implements all that is known is that they belong to the Old Stone Age. The accompanying fauna shows a form of the mammoth, woolly rhinoceros, cave hyena, the saiga antelope, and two species of horses, one of which is middle-sized, and the other about the size of a small pony. Quite recently, a discovery of human remains has been reported which, according to the newspapers—perhaps too sanguine—belong to the Heidelberg race.

Near Tomsk, western Siberia, vestiges of a meal around the carcass of a young mammoth have been discovered—burnt and split bones, ashes, and plenty of stone splinters which served as table knives. The time is described as late Palæolithic.

The findings near Krasnoyarsk are referred to the Aurignacian culture. Noteworthy among the animals that were hunted by prehistoric man is the argali, or giant mountain sheep, which now lives no nearer than 400 miles south. It is extremely interesting to learn that ancient inhabitants of Siberia seem

to have been much less endowed artistically than their western European and Russian contemporaries. No objects of adornment at all, nor scarcely any ornamentation of the implements have been discovered thus far in Siberia, among the remains of this age.

Much more plentiful, and better known, are the vestiges of the New Stone Age, from Crimea up to the White Sea, and in many places in Siberia. Well known are the remains referred to the late date of 3000-2000 B.C., found near Hadago Lake, with two races of domestic dogs, and with a dolichocephalic, or long-headed, human race which may have been the ancestral stock of the Velikoross, or Great Russian, tribe. Of cultural interest should be mentioned excavations near Tripolie, province of Kiev, containing ornamented pottery of the type spread from the Balkan Peninsula to Transcaspia (Anau) and Afghanistan; and excavations near Bologoïe, halfway between Moscow and Petrograd, where the use of pigments and indications of cannibalism have been discovered.

Unfortunately, little is known about the anthropology of the Old Stone Age in Russia. In Piatigorsk, North Caucasus, remnants referred to the Neanderthal race have been found. Their geological age is conjectured as fourth glaciation but they have not been studied *in situ* by an expert. This has also been said of the alleged discovery of a very ancient race in Crimea. Deposits of later Old Stone Age cultures for Russia are practically unknown; only near Krasnoyarsk, scanty remnants, not yet determined, have been discovered.—PETER P. SUSHKIN.

REPTILES AND AMPHIBIANS

DR. G. KINGSLEY NOBLE, curator of the department of reptiles and amphibians in the American Museum, will sail for Europe on August 5 to visit the various foreign museums with a view to arranging a series of important exchanges. While in England, he will address the Zoological Society of London, and the British Association for the Advancement of Science.

Among the researches just published by the department there are several of general interest. In two of the recent numbers of *Novitates* Doctor Noble has attempted to trace out a phylogeny of life history within the Amphibia. It is only during the past few years that a natural classification of the Amphibia has been established. Doctor Noble was able

to show that there is a close correlation between the mode of life history and the phylogenetic relationships of a genus.

In a paper recently published in the *American Naturalist*, Doctor Noble has considered "The Evolution and Dispersal of the Frogs." This represents a defense of the thesis advocated by Dr. W. D. Matthew in his paper "Climate and Evolution" that the Amphibia arose in the north and spread southward to occupy their present ranges.

One of the most curious specializations found among the Amphibia is a growth of hairlike structures found on the sides of the thighs and body of the "hairy frog" of Africa. These structures have been studied microscopically by a number of investigators, but no satisfactory explanation of their significance was hitherto obtained. In the current number of the *Journal of Morphology and Physiology* Doctor Noble has showed that these are supplied with an extraordinary blood supply and apparently function as accessory breathing organs. The development of the villosities is correlated with the reduction of the lungs. The paper includes an investigation of the vascularization of the integument of a large series of Amphibia. The changes which take place in the skin and heart of all Amphibia when the lungs are reduced are described. The paper is entitled: "The Integumentary, Pulmonary, and Cardiac Modifications Correlated with Increased Cutaneous Respiration in the Amphibia; a Solution of the 'Hairy Frog' Problem."

THIRD ASIATIC EXPEDITION

MR. CLIFFORD H. POPE assistant zoölogist of the Third Asiatic Expedition, is continuing his brilliant researches on the life histories of Chinese Amphibia. He has proceeded to Yenping, in the province of Fukien, and writes from the field under date of April 25:

"After exactly three months of more or less steady traveling, I reached this city April 11. At Shanghai the joys of travel were left behind and I went from bad to worse until at last I came up here from Foochow packed like a sardine in a tiny launch with forty Chinamen and two Russians.

I arrived in the field too early in the season and found the weather very cold and rainy. Although we have been here two weeks it is still raining. Specimens are just coming out. I plan to work here a month and then to go

up to the northwest border of the province and try my luck there for another month, leaving two men here to purchase specimens which may be brought in by the collectors. In the late summer I hope to work near the coast for a month.

The mountains near Yenping are about as high and wild as any in the province and the safest to work,—in other words most free from bandits. We are living in a temple ten minutes from the city and among wild, steep mountains. Here we can secure specimens from all altitudes from three hundred to four thousand feet. The temple is about a thousand feet above sea level. I have quite a crowd of Chinese at work. Yesterday I went up into the highest mountains and there in a small cold stream found *Pachytriton* abundant but saw no sign of eggs. In high streams we found a frog which appears to be La Touche's *Leptobranchium boëtgeri* and also *Microhyla* tadpoles with the strange mouth parts.

I have not tried the flash-light work so far, but hope to begin before long. It is no small matter to keep the three local collectors and the three Peking men all at work. Today I have visitors,—two small boys from the Yenping mission. That makes ten here in the temple. They have come to stay over the week end.

One of the local collectors in our group is a famous tiger hunter who has shot seventeen tigers and several dozen leopards. He is a fairly good general collector and a thoroughly responsible fellow.

The only misfortune so far this trip was the result of a poorly placed load of dynamite. Twenty-five feet of mountain scenery are no more! The load did not sink straight."

NEW MEMBERS

At recent meetings of the Executive Committee of the American Museum of Natural History, the following resolutions were unanimously adopted:

Resolved, That the Trustees desire to express to Professor Eugene Dubois their deep appreciation of his gift to the Museum of the first casts of the original specimens of *Pithecanthropus erectus*, which makes such a precious and important addition to the Museum's series illustrating the evolution of man, and in recognition of his gift and of the great importance of his scientific discoveries take pleasure in hereby electing Professor Dubois an *Honorary Fellow* of the American Museum of

Natural History—the highest scientific honor in the power of the Trustees to bestow.

Resolved, That the Trustees desire to express their appreciation of the achievements of Mr. Francisco Ballén and Mr. J. A. de Lavalle y Gareía in preserving and in developing the Guano Islands of Peru and in building up the greatest industry ever based upon animal conservation. In recognition of their contribution to science and to the cause of conservation, the Trustees take pleasure in hereby electing them *Honorary Life Members* of the American Museum of Natural History.

Resolved, That the Trustees desire to record their appreciation of the faithful and sympathetic manner in which Doctor Dana W. Atchley is safeguarding the health and well-being of our employees, and in recognition of his services to the Museum take pleasure in electing him an *Honorary Life Member*.

SINCE the last issue of NATURAL HISTORY the following persons have been elected members of the American Museum, making the total membership 8273.

Patrons: MRS. WILLIAM BOYCE THOMPSON; MR. GUERDON S. HOLDEN.

Honorary Fellow: PROF. DR. EUG. DUBOIS.

Honorary Life Members: DR. DANA W. ATCHLEY; MESSRS. FRANCISCO BALLÉN, AND JOSÉ ANTONIO DE LAVALLE Y GARCÍA.

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PILEATED WOODPECKER
(Courtesy National Association of Audubon Societies)

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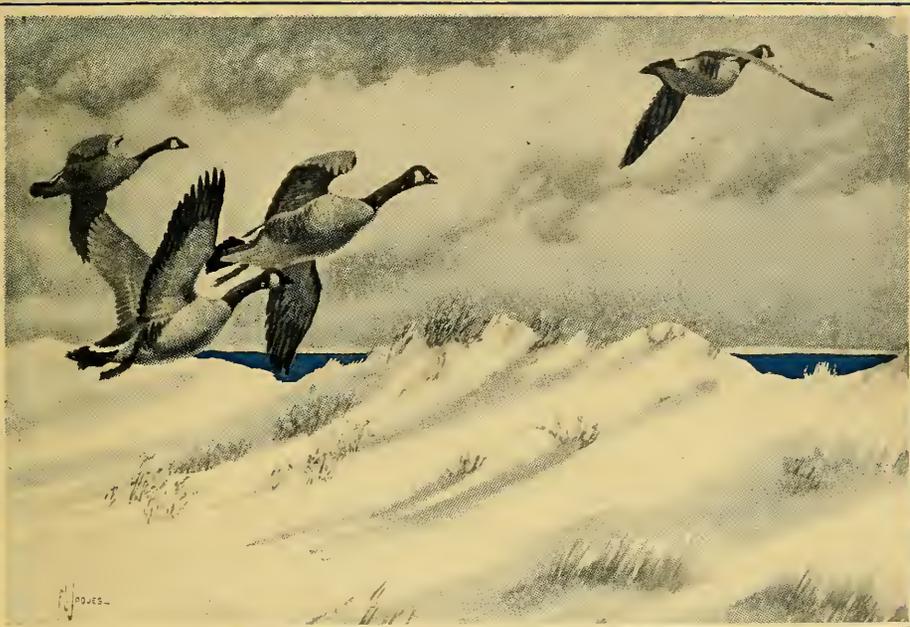
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FRANK M. CHAPMAN, EDITOR

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PINK-HEADED DUCKS
Male (left) and female
Gift of the Faunthorpe-Vernay Expedition

Equatorial Vignettes

IMPRESSIONS OF THE COASTS OF PERU AND ECUADOR, 1925¹

By ROBERT CUSHMAN MURPHY

Associate Curator

I. EL NIÑO

IN early January the weather and the ocean along the coast of Peru had all the characteristics which an experienced seafarer would have expected. Sunshine, wind and water, clouds and temperature, all were seasonable; all, indeed, were probably very much as they have been during the greater part of time which has no record in human history and which goes back ages before the Spaniards or the builders of Pachacamac.

The breezes came steadily, sometimes briskly, from the southward, and thick mists veiled the windward headlands of high islands. The cool waters of the Humboldt Current rolled along their wonted, leisurely course toward the Line. The Pacific was here and there reddened by acres of living jelly, or streaked with a Milky Way of swimming crablets perhaps no less numerous than the stars. And the unbelievable flocks of guano birds, always the same yet never monotonous, spread out over the coastal ocean and gorged upon its harvest. For five days I skirted the long shore from Mollendo to Point Pariñas, while every sign held. If the Inca Sun God had walked as a cosmic watchman along the wall of the cordillera, he would have cried each hour, "All's well"!

On January 17, when we began our marine work at Talara, six miles north of Point Pariñas, the weather

was only slightly less equable. Here there had been experienced during the preceding week brief spells of north-easterly winds, with uncomfortable increases in heat and humidity; but so near the equator such vagaries are not considered remarkable at the New Year season. At any rate, when we first put out to sea, the environment was in all respects substantially normal for the month and the latitude. Southerly winds, with the usual diurnal swing and cycle of velocities, still prevailed; the ocean waters along the northerly border of the Humboldt Current were of temperatures close to 65° F., with higher ranges offshore; and all the species of guano birds, except the Peruvian pelican, had worked northward to Point Pariñas, the westernmost projection of the continent, or had rounded this frontier mark to feed along the coast toward Cape Blanco. Except for the abundance of man-o'-war birds, the bird life off Talara was, in fact, not very different from what one would encounter south of the Lobos Islands.

By January 19, familiar weather conditions had altered more definitely; the wind was blowing from the west, and the cessation of upwelling of water from deeper and cooler layers of the ocean, together with the inward drift of warm water from offshore, were reflected in higher surface temperatures, which averaged above 72° F. through-

¹The author, together with Mr. Van Campen Heilner, conducted field work in Ecuador and northern Peru during a winter which proved highly exceptional from a meteorological point of view.



Southwestern Ecuador and northwestern Peru.—From the American Museum's map of Ecuador and contiguous regions

out a wide expanse off Talara and the coast to northward. A great flock of guanayes, or Peruvian white-breasted cormorants, guano birds peculiar to the cool waters of the Humboldt Current, and which are, indeed, a visual index of its extent, was observed off

Point Pariñas, where large numbers of the birds spent the night on the rocky shore. With the advent of unfavorable circumstances, however, they all moved off to southward on the morning of January 20, and, except for a few individuals, some of which were sick,



Point Pariñas, the western extremity of the South American continent, with oil derricks close to the surf

no more appeared in these latitudes through the winter. The reactions of the guanayes were doubtless more delicate than any human premonitions. Their departure, as we later realized, coincided with the beginning of a change of such magnitude that it occurs but once in a generation, a change which endured from that date until the end of May, and which had a profound, even though temporary, effect upon the whole climatic character of the Peruvian seaboard.

By this time it was evident to local mariners and fishermen that El Niño was flowing—El Niño, “The Child,” even though Christmas was nearly a month behind us—El Niño, the warm current from the north, which rarely keeps its seasonal appointment precisely, but which may come at any time between December and April, and occasionally at other periods of the year. Its arrival is usually associated with northerly winds, and when it has raised the temperature of the surface waters until they are warmer than the air, rain is likely to follow along the desert coast. Moreover, its warmth brings sickness and death to the population of the Humboldt Current, beginning with the annihilation of vast

numbers of microscopic organisms which cannot endure the rapid heating of the sea, and culminating in the destruction of such guano birds as fail to retreat to safer regions down the coast.

On January 20 the fickle winds were back in a southerly quarter, but the prodigious oceanic movement which had set in was not to be stemmed by any transitory counter breeze. El Niño was running southward past Cape Blanco, past Point Pariñas, and the temperatures of the ocean for a distance of twelve miles from shore averaged above 76° F. Now we encountered the first flying fish, which are always common in the outlying tropical waters but which are rarely or never seen close along the Peruvian coast while the Humboldt Current prevails. On the same day, too, the hammer-head sharks appeared in exceptional abundance. Five miles from the beach we entered a zone which seemed to be filled with them, for thousands upon thousands crossed our course. Their line of march was perhaps two miles broad and of indefinite length, for we cut through it at widely separated points when outward bound and upon our return to port. Scores of fins were visible at a glance, the whole legion



A guanay, separated from its flock, which rested on the "Silver Spray" off northern Peru. The visitor remained six hours, seemed to enjoy being caressed, and playfully bit the fingers of its human hosts

moving down the wind, or against the current, the fishes paying little attention to the launch until it was upon them. Finally, on this same afternoon, we met with sea birds from the more northerly ocean—species rare in these waters or even, so far as the records go, new to the Peruvian coast.

On January 21 we put our scales upon El Niño. At noon we anchored the 86-foot launch "Chiralite," courteously supplied by the International Petroleum Company, in nine fathoms of water a mile west of Point Pariñas, well clear of any coastal influence upon the oceanic circulation. A fresh breeze from west of south covered the Pacific with whitecaps. To our surprise the vessel immediately began to swing about before the strong current from

the north, and within a few minutes she was resting with her stern directly against the wind. At the same moment we noticed a group of laughing gulls sitting on the water offshore, and, as we watched them, they too drifted southward into the breeze. It seemed remarkable that the current should have more power than the wind upon the light-bodied birds.

As soon as our craft had steadied to thirty fathoms of cable, we put into operation the current-recording log line, and made ten readings during the course of an hour, which showed a southward flow of the water ranging in rate between one and one and one-quarter knots. Following these measurements, we weighed anchor and headed due westward to a position nineteen miles

from the Point. The southerly wind increased slightly in strength during the afternoon, but by the bearing of Pariñas Light we were able to determine that the launch was being deflected to southward by a current approximately the force of that at the anchorage. The same procedure was followed and the same effects observed on the return trip, and the continuous records of more than ten hours prevented the confusion of possible tidal movements with those of a demonstration of El Niño. The action of the wind, whatever it may have been, was obviously against that of the current.

How can I picture the dramatic accompaniments of such a great reversal of generally stable oceanic conditions as we so fortunately witnessed off the oil fields of Pariñas? The first, amazing enough to one who has been afloat for weeks at a time in the phenomenally cool and little-varying waters which bathe the sunburnt shores of Peru, was the rise in ocean temperature, amounting to an increase of 10° F. within forty-eight hours, and a subsequent rise of at least six degrees more which endured throughout the remainder of the winter. No less remarkable, particularly in central and southern Peru, was the replacement of the reliable southerly winds, upon which seafarers have banked from immemorial time, by fitful and yet recurrent rain-bearing winds from the north. And finally, most impressive of all, were the changes in the oceanic life which no naturalist could overlook—the immigrating cohorts of hammer-heads, the jumping mantas or giant rays, the schools of large flying fish pursued by equally alien tropical dolphins, and the presence far down the coast of such novel birds as migrant laughing gulls and royal terns from North America,

and of Ecuadorean white boobies and tropic birds from the island of La Plata.

From the middle of January gossip at the Talara club house related chiefly to the weather. The counter-current was scarcely above the commonplace, for El Niño was expected to make at least a brief visit almost every year. But the breathless days, and the gathering of clouds, dark as volcanic smoke, above the Amotape Mountains, turned back men's thoughts to greater rhythms of time. Engineers who had been long in the petroleum service spoke vaguely of the wet, seventh year. Weather-beaten skippers and port masters, who had spent most of their lives on the West Coast, turned back their memories still farther, and talked about the season of 1891—of deluges, lightning and thunder, and other impossible things, of the washing away of buildings and oil derricks, of the cutting out of new rivers, and of the *año de abundancia* which followed, when cotton crops were grown on the bare desert.

The first spatter of rain at Talara occurred on the evening of January 19, after the wind had switched to east of north, parallel with the main trend of the coast line from the Gulf of Guayaquil. For a week it had been raining in the Amotapes, fifteen miles inland, and the pall of stormy clouds had worked down the Pariñas and Máncora valleys toward the sea. The upper trails were already flooded, and by January 25 water had reached the Pacific through *quebradas*, blocking the road between Talara and Lobitos, and limiting transportation to the sea route.

What followed is now history. The real rains began at Talara about day-break of January 27, before a northerly wind, the fall continuing until nearly noon, and then resuming at sunset. The baked soil became a horrible,

gluey mess, and large ponds rapidly accumulated. Then, southward along the flat shores and the arid slopes of the Andes, the precipitation followed in the wake of El Niño to unheard-of latitudes, until cities and haciendas which are content with their normal abundance of river water became glutted and laid waste with the excess. The mountain railroads were swept into the gullies, and the bridges carried away. Ocean temperatures rose to 79° F. at Mollendo, and to 70° F. at Antofogasta. The Indian fishermen found their livelihood gone. Dead fish, mingled with untold numbers of birds, strewed the tide lines for hundreds of miles as the ocean turned sour, and thirty-five thousand tons of new guano were washed from the islands by falling water. The northern coves became choked with flotsam from engorged stream beds, and sea snakes, alligators, and strange lizards were cast upon unfamiliar strands. Mulletts came out of the ocean to swim about in the squares and roadways of the petroleum towns, and, when the rains began to diminish, mosquitoes, and the *caballitos del diablo* or dragon flies which prey upon them, were engendered in such swarms as had never been known.

All of this, however, is ahead of my story. What I saw of the great rains and their results was reserved for a second visit to northern Peru, in March. When we sailed from Talara in the "Silver Spray" on the evening of January 27, rain was falling, and all night it pattered on the shelter above the afterdeck. But next morning we knew that the deluge had not quite come, for the sky over the Pacific was clearing, and a sunrise of pure gold was breaking above a gray cloud bank beyond the northern Amotapes.

II. THE MOUTH OF THE CHIRA

The Chira comes down behind the Amotape Mountains, turns westward at the southern end of the range, and weaves a broad green ribbon through the desert. Upstream, fine haciendas draw upon its muddy waters; nearer the mouth the banks are swamp and jungle, bordered in places by groves of large and evenly spaced algaroba trees which spread back across the flood plain to the edge of the valley.

When the river approaches the sand dunes of the shore, it breaks into streamlets like the veins of a leaf. Each little capillary shoals rapidly, seeming to climb with effort over the



Photograph by Van Campen Heilner

Crossing sand dunes on the way to the Chira

crest of the beach before it tumbles down a pebbled sluiceway into the surf of the Pacific.

A feeble rivulet is the Chira in the eyes of the horseman who crosses its bubbling outlets without a thought of danger. Yet it is, after all, more mighty in effect than many a prouder stream. The only through-flowing river in the northerly Peruvian desert, it supports the agriculture of a populous and historic valley, while its trickling waters give to the ocean mysterious nutriment which enables marine life about its mouth to develop with a richness noteworthy even in the richest of seas. It is as though the river were a gland in the physiological make-up of the coastal Pacific; all the teeming chemicals and foodstuffs of the ocean avail nothing until life is quickened by enzymes from the water of soil and melted snows.

We reached the mouth of the Chira in a Ford on the morning of January 24. The name of the motor car should, perhaps, be qualified by adding that it had been rebuilt to pioneering specifications in the shops of the International Petroleum Company at Negritos. Its body was a buckboard, covered with a tropical top of white canvas; a windshield it had never had; the springs and axles were wound with twisted rope snubbers; and each tire was covered with an extra shoe, which not only gave security against punctures but also furnished a broad tread for running upon sand. Equipped with a fleet of such conveyances, the oil engineers wander merrily over the pathless desert, climbing the dunes to gain the hard highway of the beach, or wriggling up the arroyos of the Amotapes into places where most travelers would hesitate to ride a horse.

The one rule of the road, as we

learned on the way to the Chira, is to keep going at all costs. With headway you may surmount anything; if you stop, you will sink to your hubs and remain. So across the crusty tops of natural salt pans, through caravans of frightened and scattering burros, or among hummocks and windrows of the back-beach, our host pressed the accelerator and jerked the double-sized steering wheel until we all but hurdled obstructions. Two or three times we had to unload our duffle, build a short corduroy road of driftwood, and apply our shoulders, until we had crossed the last dune and skirted the last lagoon to the firm strand of low-tide zone. Then came the flying stretch to the Chira, with millions of red crabs dodging first one way and then the other in front of us. Far, far ahead, the crabs, which seem always to be scudding, looked like spindrift from the breaking waves, but when the strange, roaring devil bore upon them, their frantic and indecisive reversals made one fairly dizzy.

Near the northern mouth of the Chira, bands of naked Indians were hauling their seines in pockets of the beach. A hundred yards upstream we met others carrying casting nets along the banks and upon the exposed bars—splendid, bronze, broad-chested men from Vichayal or sunny Colán, going about their business with all the incurious dignity which seems to be characteristic of primitive toilers. The fish that they were taking, in the terminal pools of the river, were of such salt-water sorts as flounders and mullets, and the explanation of their presence in the fresh water came unasked, for of a sudden the Pacific breathed a deeper, ninth-wave swell, and a seething layer of brine slid up against the outgoing stream, over the wave-built barrier, and on and on until



Photograph by Van Campen Heilner

Atarrayas, or casting nets, in action

it disappeared among reedy channels. Forty minutes later a second wave followed the first, and the line of demarcation between river and ocean was soon lost. Such tiny tidal bores had but a four-inch front, but they were, none the less, expressions of a movement which goes around the world.

On the sand bars of the Chira, or floating upon the surface of the diffuse streams among which we slopped, was an assemblage of birds the sight of

which paid well for the exertions of the journey. Brown pelicans, the identical species of Florida shores, were packed shoulder to shoulder near the middle of little islands, while black cormorants, with wings spread to the morning sun, stood in single rows along the river's brim. Both pelicans and cormorants were evidently resting, perchance waiting for the tide to lure new schools of mullets into the estuary. A stone's throw across a branch of the river were



Photograph by Van Campen Heilner

Indian fishermen on a sand bar of the Chira

a hundred or more egrets, with plumes at the peak of luxury, and near by, partly mingling with them, half their number of roseate spoonbills. As we walked over a steep-shored rise of the bank, we came upon four of the latter exquisitely colored waders feeding at the margin of the shallow water only a few paces away. Our presence caused no interruption in the snapping of their double spades, and we watched, spell-bound. A wrinkled, white-haired fisherman, observing that one of us carried a gun, and not appreciating that at the moment our interest was prompted by admiration and sheer delight, whistled through his teeth to attract our attention and, while he coiled his net for a cast, called significantly that the *cuchareta* (which also means spoonbill) is "very rich eating, like a pullet."

On flats beyond the egrets and their rosy companions we saw clusters of wood ibises, many standing with legs in a figure four. Upstream, against a background of green vegetation, were more of these great white, black-headed, black-legged creatures which, despite the inconsequential fact that they are storks rather than true ibises, can hardly fail to conjure up an image of what the Nile ought to be like. When a flock in Indian file flew close overhead with stately wing-beats, it created in my imagination the latest of many resemblances between the old empires of the Incas and the Pharaohs.

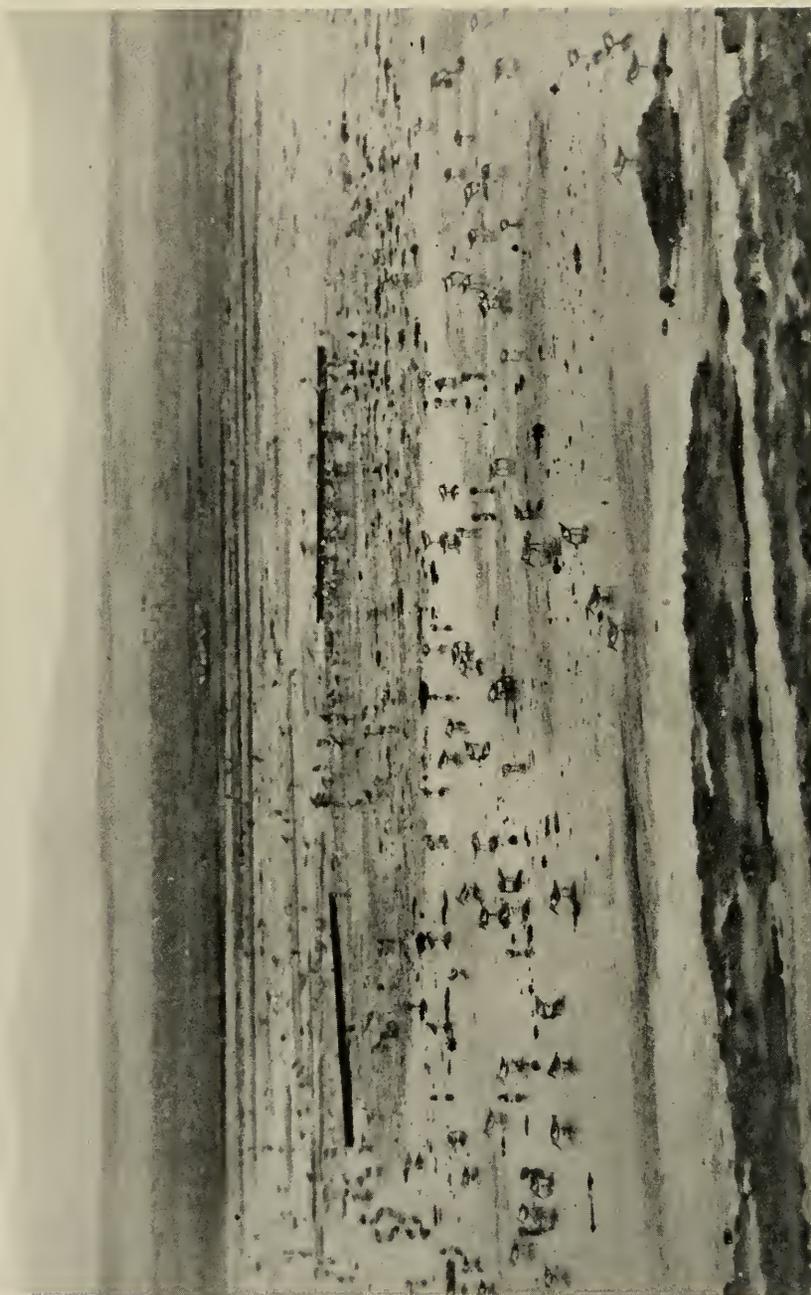
For a time the striking and somewhat unfamiliar marsh fowl absorbed us to the exclusion of other observations, but as soon as we were in a mood to make a complete census of the visible bird life, it was quickly impressed upon me that the mouth of the little river beside which we stood was near the corner post of four great realms of life—two of the land and two of the



A *piquero*, or Peruvian gannet (*Sula variegata*), the northernmost breeding grounds of which are on cliffs near Talara

sea. Over the Pacific, in plain view, were groups of various guano birds, which go northward but a few miles beyond the Chira, and which are attracted by banquets due in part to precious compounds poured out of its horn of plenty. Among these sea birds was the huge pelican of the Humboldt Current, which here meets the West Indian pelican at the southern limit of its range, but which, unlike the latter, clings exclusively to the salt sea. Here, too, the Peruvian and the blue-footed gannets, birds which mingle throughout a broader belt of latitude than the pelicans, were in the air together.

Spotted sandpipers, an osprey, laughing gulls, and royal terns from North America; tropical man-o'-war birds, the range of which is one with that of the brown pelican; both the black and the turkey vulture; a condor soaring over the yellow upland beyond the vegetation of the river valley; kelp gulls flying in from the Pacific and up



NORTH AMERICAN MIGRANT SHORE BIRDS IN A PERUVIAN COASTAL LAGOON

Most of the birds shown in the photograph are semipalmated sandpipers (*Ereunetes pusillus*) and western sandpipers (*Ereunetes mauri*)

the Chira on their maraudings—all these, and more, we could see by merely turning on our heels. Years before I had found the nests of the kelp gulls in the snow, beside the bleak borders of antarctic glaciers. How strange it now was to watch one of the oceanic freebooters alight beside a wraithlike egret on the mud of an equatorial river!

The contrasts might be continued, for scarcely less startling was the meeting of brown pelican with Andean condor, or that of Peruvian booby with roseate spoonbill. Nor did the birds which we saw complete the picture entirely, for up the valley of the Chira, so near that we might almost have heard the songs and bell-like calls, we knew that the musical *chalala* or ovenbird (*Furnarius*) was building its adobe nest in the great algarobas, and that parakeets, woodhewers, and green and azure jays came down in thickets of the river border that led back through mountain passes and, ultimately, to forests of the Amazon. Here we were as close as one can come to the magical contact of desert and jungle, to the junction of the warm ocean water with the cold.

Before noon we left the mouth of the Chira, just in time to prevent the flooding tide from imprisoning us on the beach. Had the Indians, who signalled farewell with a single gesture while they busily flung and drew their nets, been watching the dark clouds above the Amotapes, and had they sensed the portent? Or did they realize no more than the birds that a few weeks later the now gentle river would rise as it had not for a lifetime, swelling until its torrent gouged anew into the old cutbanks of the desert, battering down the wide dam of the beach, and carrying crops, trees, cattle, and buildings, all swirling into the Pacific?

III. THE GUAYAS

The Guayas is a small mark on a map of the Americas, yet it is the greatest river of Pacific drainage between the Colorado and Cape Horn. On the narrow western watershed of the Andes it is a sort of counterpart in miniature of its big transmontane neighbor which carries, it is said, one-fifth of all the running water in the world. As the Amazon and its tributaries spread a network throughout the grandest of alluvial basins, so the system of the Guayas deploys on the shorter slope of western Ecuador, and few hamlets in the lowlands are remote from waterways navigable for launches and barges. If, for example, a steamer is lacking to carry you from Guayaquil to the coast of Manabí, you have the choice of an inland passage up the Daule and the Puca, or some other branch, then taking a short land trip which will bring you to backwaters of the western coast. By this route the mail is not infrequently transported.

When you first enter the Guayas by ocean-going steamship, the river is sure to seem impressive beyond expectation. A vast volume of water evidently flows in the wide channel between the corridors of forest or the low-lying savannahs on either hand; the floating tree trunks and the numberless rafts of water hyacinths and other green plants, which rush down toward the Gulf only to return with the incoming tide, help further to invest the stream with the appearance of a main artery of the continental tropics. And when, after thirty or more miles of wilderness, you approach the long and bustling waterfront of Guayaquil, with ten-thousand-ton ships at anchor and the dwellings of Las Peñas and Santa Ana piling up above the business structures of the Male-

cón, you can look on up the still broad belt of shining water and almost believe it as endless as the Mississippi.

It was in the blackness of early morning that I arrived at the mouth of the Guayas after an absence of five years. Rain was falling thickly but softly—without being torrential, it was peculiarly soaking. The “Silver Spray’s” whistle shrieked, her engines slowed and stopped, her head swung toward the lighthouse and the luxuriant woodlands of Puná Island.

As darkness began to fade, the river turned milky yellow. Leaden clouds, with every indescribable wash of silver and gray, closed in the whole horizon. Islets appeared in the scene much as images burst into view during the development of a photographic plate. The low mangroves on bars and spits loomed up like tall trees, each with its magnified reflection. Pointed canoes, which had begun to sally forth from misty shores, also were enlarged and lifted into the air by the peculiar light.

Other vessels were waiting with us for their respective customs guards from Puná; a native sloop or two, the crews asleep; a quaint, brightly painted little river steamer from Santa Rosa, with women passengers gazing wearily out of the ports as they rested on their arms; and, downstream, a diminutive green fisherman of Yankee rig, which proved to be the “Sea Lion,” just from San Francisco.

The east now brightened quickly, and wonderful blue mountains in the direction of Cuenca reared above the lower layers of cloud. Man-o’-war birds, blue-footed gannets, pelicans, herons, and laughing gulls dotted the sky, and black skimmers plowed along the tidal rips. *El arador*, the plowman, they call this bird in Ecuador, with an imagery better than our

own. It seemed to us in the early light that extraordinary numbers of humming birds were likewise darting about above the river, but they soon resolved themselves into powerfully flying crickets of a kind all too well known at certain seasons in Guayaquil.

The impatient whistling of the “Silver Spray” at length produced the desired result; our guard came out from Puná before the sun was in sight, a dark little man under a dripping umbrella, without a collar, but tenderly perfumed. His duty was doubtless to see that no smuggling took place during the journey up the Guayas, but, once aboard, he passed into a slumber resembling æstivation, reviving only at meal times until we anchored in the rushing current off our destination.

The rainy season was in full swing at Guayaquil, and the city was a steam bath. About half past five of every afternoon the skies opened and the rain dropped straight down, with no breath of air to impart an angle. Even if a gale had been blowing, the stirring atmosphere could hardly have penetrated the fine screening of the hotel bedrooms and the close bar of netting which one tucked carefully around the mattress. All night the unvarying downpour continued, the streets disappearing under a welter of water in which giant toads barked. About dawn, however, the rain ceased, and the dull canopy was soon more or less broken up by the sun which, before noon, shone with a blasting glare. But always certain woolly masses of cloud remained, endowing the Guayas with a mirror-like sheen, and seeming to press low upon the perspiring earth. It was pleasant, at least, to listen to tales of the dry season, when the air is relatively bracing and when, on rare occasions, the snow-capped pile of

Chimborazo, rising above the emerald hill at Durán, can be seen in full glory from the Malecón.

Guayaquil is an inland seaport, and its life centers about the river front. Merchants look to the daily printing of the schedule of steamers, many of which come and go with exasperating irregularity, but which, nevertheless, connect the country with all the earth. Humbler trade of great volume is carried on in coastal sailing craft from the north and the south, queer *balandras* of sloop or schooner rig, rough-planked, high-sided, clumsy, but bearing evidences of having been furbished at least once in their lives with the most brilliant of pigments. Some of them display painted ports, and look as though they might be as bristling with hidden cannon as a Lascar pirate.

Still stranger hulls occasionally come in from the Pacific—balsas from Sechura, bringing fish, and working up the Guayas in six-hour, flood-tide stages which, if luck is poor, may last ten painful days. Once we passed a balsa inbound along Puná, a weird, junklike raft, with an elongate square sail, moving with majestic slowness before the wind. It was made of nine enormous logs, and on the crudest of masts the sail hung from a long, bowed yard. Seven Indians were visible on board, and others may have been sleeping in a canvas tent which occupied a raised platform of smaller logs. Toward the bow, if either extremity deserved the name, two men were cooking over an open fire on a hearth of stones. The bold and ingenious mariners had been, perhaps, for weeks on the high sea, curing their fish on an open raft through which the water swished with every swell!

From upstream, under power of sweep and paddle, the food of Guaya-

quil comes to the steps of the river-side market. It is interesting to see that the iron lighters are exact replicas in form of the slender, spoon-ended canoes



Photograph by Dr. Herman C. Parker
A balandra on the Guayas

which lend so much charm to all quiet waterways—the canoes which the marsh birds and the alligators completely disregard, although they are quick to seek concealment at the approach of a white man's launch. In such bottoms come the cacao, the bananas, the papayas, and a thousand other products of the tropics, to port.

In the colorful market, heaps of fruits, fish, and fowl, and the handicraft of the country are mingled indiscriminately. Mussels and mangrove oysters lie beside the pitiful, plucked carcasses of purple gallinules. Here a basket of luscious avocado pears, there a pile of glistening catfish, or of the slimy *boca*



A balsa from Peru, bound toward Guayaquil

chica, the name of which wakes you at dawn as the hawkers sing it mournfully through the streets of Guayaquil. On the next table, perhaps, are tiers of pale, uncanny land crabs, held together in geometric masses by a sort of master string. Grotesque toucans with clipped quills hop about over the sacks and stalls, and parakeets chatter from overcrowded splint cages.

Of the birds which live in the environs of Guayaquil, we saw during our brief stay chiefly those of the river and its sloughs. About the slaughter house the vultures and the man-o'-war birds make an amicable division of the spoils, the former taking whatever is cast on shore, the others swooping upon all that floats in the stream. Across the river, in full view of the docks, wood ibises and a multitude of shore birds feed on the flats at low tide, and in all wet meadows flocks of jacanas flash their pea-green wings. Martins and other insect-hunters fly in the main thoroughfares, but the most attractive of all the urban residents are the vermilion flycatchers. These feed in part upon great dragon flies, which they capture not by speed but by stealth. With the setting of the sun the dragon flies become lethargic and rest on telephone wires; then the gorgeous flycatcher and his mate, which look the same color in the evening light, scout silently along the wires and pick off the hapless insects without the necessity of a chase. It is amazing to see them swallow creatures almost as large as themselves, crunching back the four hard wings as they gulp them down. Thus might a modern Sinbad picture the roc devouring airplanes.

All journeys in the tropics have a way of starting either after dark or before daylight. In keeping with the custom, we boarded the launch "Cypress" on the evening of February 10, and chugged away toward Salinas with the beginning of the ebb. The small vessel swarmed with people—Ecuadoreans, Jamaican negroes, Germans, and gringos—who occupied nearly every foot of the deck, and the interstices between the human passengers were filled with chickens, turkeys, dogs, and cats.

For once, in place of the usual

evening rain, stars were shining above the Guayas, but lightning was flashing upstream and over the hill at Durán. We glided past the long liners just as they were commencing to swing their sterns toward the sea. Guayaquil looked black and half submerged, the only lights high above water level being those of Las Peñas, and these soon shone very faintly. The heavy air was stifling, and it was horribly hot in the two-berth cabin which three of us were fortunate to share while most of our shipmates sprawled upon the luggage that covered the forward deck. When we had decided on the disposal of our accommodations for the first half of the night, I stretched out in the upper berth with the sweat oozing from every pore and yet my stomach cold with the unaccountable tropical chill. The paradoxical heat and shivering, and the thirst, which flat, boiled water could not satisfy, put sleep out of the question, so I lay watching floating islands and bushy banks seem to slip back past the still river until, at the end of the Morro Channel, the longed-for fanning of sea air brought oblivion.

IV. SANTA ELENA

Westward over the Andes from rain forests of the Oriente, the territory of southern Ecuador first shares two alternating seasons, wet and dry, which in the extreme west give way to a climate only slightly less arid than that of the not distant Peruvian desert. The peninsula of Santa Elena, and the coast which stretches straight northward, lie partly in the zone of long droughts; farther south, the boundary of this zone bends eastward into the funnel-shaped Gulf of Guayaquil to strike the Peruvian shores near Tumbéz. From some undetermined point at the northern end of the Amotape

range we can draw a line across country to the delta of the Tumbéz River, thence by a water loop between the islands of Puná and Santa Clara (which are but eleven miles apart), and, finally, across the base of Santa Elena and northward close to the ocean toward Cape San Lorenzo. East of this line there is an annual rainy season; west of it rain falls in appreciable quantity only at intervals of years.

The meteorological frontier is very exact, however imperfectly its course has yet been traced, for on the coast between Santa Elena and San Lorenzo are communities, separated only a mile or two, in which the respective climatic distinctions hold. Moreover, the animal life reflects the differences, and the plants still more so. To select but one subtle example among the birds, we may note that the race of turkey vulture which inhabits the far-away Falkland Islands, and the coasts of Chile and Peru, extends northward west of the rain line as far as La Plata Island, while east of the line, in the region of yearly precipitation, it is replaced by a distinct form of turkey vulture which comes down to the mouth of the Guayas from humid forests of northern Ecuador and Colombia.

Regarding the interval of the rainfall cycle on the semi-arid portions of the mainland, and the outlying islands, opinion differs. It is commonly spoken of in the country as a seven-year period, but it may sometimes be a little shorter or a little longer. In any event, we came to Santa Elena on February 11 and found the rains in progress.

At three o'clock in the morning, long after the appointed hour, I suddenly awoke in my berth on the "Cypress" and hastened to the open afterdeck, where my companion lay asleep in a steamer chair with the rain pounding



Photograph by Van Campen Heitner

HAULING THE SEINE AT SALINAS

Just outside the gentle swell is the bongo used as a net boat, and in the background are the lighthouse and the Punta of Santa Elena.

on his oilskins. Several corpselike figures, wrapped in thoroughly drenched white sheets, were slumbering round about. A young German, wearing a starched collar, a serge suit, and a stiff straw hat, was sitting with no protection whatsoever and puffing a cigar as nonchalantly as though, as the old song has it,

'Twas off the blue Canary Isles, one
glorious summer day—

I took my turn in the steamer chair, swaddled in a large poncho, and felt the cool water sliding down the outside while I remained perfectly dry. The "Cypress" was rolling terrifically in the notorious broadside swells of Chanduy, with nothing this side of the South Pole to break the onshore wind and seas.

When I awoke again, it was light enough to reveal porpoises racing the launch, and many sea birds, including a great flock of small fluttering terns which annoyed me in a manner that only a naturalist can fully appreciate—I could not identify them in the air, and there was no possibility of shooting and recovering a specimen.

About nine o'clock, with slopping decks, and the cases of freight toppling over from our heavy wallowing, we came off Ancón, on the south side of the peninsula. Here, during the course of many hours, we discharged most of our passengers and their belongings in two big *bongos* or dugouts sent from shore. Children, dogs, boxes, sacks, oil tins, bottles, furniture, bunches of plantains, and packages bound up in newspaper were all lowered gingerly over the side until the *bongos* were loaded like the ark. Fortunately, the captain invited us to breakfast during the long delay. The majority of our fellow travelers had no food and wanted none, but the babies who were nursing all over the baggage piles were an exception.

Rarely could one find a more unhappy assemblage of human beings than these who huddled under the dripping awning of the "Cypress" through this soaking, riotous night and for half of the day that followed. Most of them were landmen, and the experience must have been one of unalleviated misery, as it doubtless was also to the unfortunate turkeys, tied by one leg on deck, utterly dejected from galline seasickness, and rocking back and forth to maintain a standing posture while water from the gushing scuppers swashed across their toes.

The "Cypress" rounded Point Santa Elena, and the calm waters of the lee side put an end to twelve hours of battering. The peninsula was green for the first time since 1919. A month before the whole country had been burnt up with drought, and burros, cows, and goats, reduced to hide and bones, had gathered daily about the cable station to fill their bellies with bushels of discarded paper tape. Then came the first showers, and many cattle died in the new mire because they lacked strength to extricate themselves. Now the survivors were living in what was beginning to be a green land of plenty. During a month on the coast we experienced but one entirely rainless day (February 21) and one rainless night (February 24–25). The middle land of the peninsula became a great morass; grass and shrubs sprang up everywhere from what had been bare ground; verdant lines worked down the seams of cliffs facing the sea. The captain of a steamer, which came close in shore while rounding Santa Elena on the route to Guayaquil, remarked that but for confidence in his own navigation, supported by his recognition of the wooden lighthouse, he would have believed himself in another part of the

world. "The lighthouse is the same," he said, "but the country is new."

From the hospitable residence building of the International Petroleum Company, headquarters for all of our excursions up the coast, the pleasant beach of Salinas curves out to the flat-topped promontory of Santa Elena, the haunt of hawks and lizards, and stray songbirds. The beach is a popular seaside resort for citizens of Guayaquil. Many of the better cottages are half hidden by high palings of split bamboo which completely enclose the grounds. It is as if each owner regarded his home as a castle which required also a wall; and now the rains had come to add a moat as well. Scattered along shore among the more pretentious dwellings are the shacks of the Indian fishermen, comfortable enough, no doubt, in most years, but ruinous to contentment now. In fact, one of the best testimonies to the prevailing dryness of the climate of Santa Elena is the total lack of provision against rainfall in the construction of practically all buildings.

Our home, for the duration of our visit, was ventilated under the northerly gable by one of the wide lattices so characteristic of the region; but alas, it was from the north that the greater part of the precipitation came. On certain nights the slanting rain pelted through the entire house so that there was absolutely no escape from it. Floors and tables, beds, books, and all other valuables became drenched. One could only cover his possessions with ponchos and go to sleep for lack of other occupation, while Piper, our hosts' great Dane, went whining through the reeking rooms in sheer despair.

And now, following the soaking of the soil and the sprouting of vegetation, came the plague of insects—not mos-

quitoes or other biting pests, but merely flies and bugs, beetles and moths, which obscured the bright electric bulbs and peppered the walls and tablecloths with moving specks of various sizes and modes of progression. Water beetles plumped into the soup plates; large, metallic bombardier beetles, or carabids, which prey upon caterpillars, dashed about the lighted rooms in the evenings, filling the air with their squirts of iodine. And the caterpillar-producers, too, flocked to the lights—numberless brown sphinx moths belonging to a cosmopolitan species (*Celerio lineata*) which is distributed in America all the way from Canada to the southern tropics. At Santa Elena, it is probable that the pupæ had slept for seven long years in the ground, biding the millenium.

The rains had no apparent effect upon the sea birds in Santa Elena Bay, unless the absence of petrels can be attributed to this cause. All other expected kinds were common everywhere along the coast, besides being absurdly tame, as birds always are on a fishermen's shore. The brown pelican was the most conspicuous species close to human settlements. In the outermost cove on the lee side of the point, where a seine was hauled each afternoon, the pelicans plunged all day regardless of the number of balandras at anchor or of small boats at work. They dropped sometimes from as high as fifty or sixty feet above the water, ungainly creatures at the start but twisting with a certain grace during the descent so as to be gliding upside down at the instant before they disappeared beyond the tips of their long wings. Sometimes a dozen tumbled together, half of which might barely miss the bongo which had, perhaps, startled their prey into view from aloft

Reminiscences of this open coast would be incomplete without a word about the bongos, which here largely replace the low-sided canoes of sheltered waters. In digging a more or less seaworthy boat out of a gigantic tree trunk, the Ecuadorean no doubt performs a creditable feat, nor is it to be denied that he has developed high skill in managing the craft in rough water. If it were not exceedingly well handled, indeed, it would turn turtle in a moment. And yet, not being able to accept with the equanimity of an Indian (who wears but two garments and carries no watch in his pocket) the experience of pitchpoling in high surf on a steep and treacherous shore, my memories of bongos are none too kindly nor my trust in them more than that of necessity.

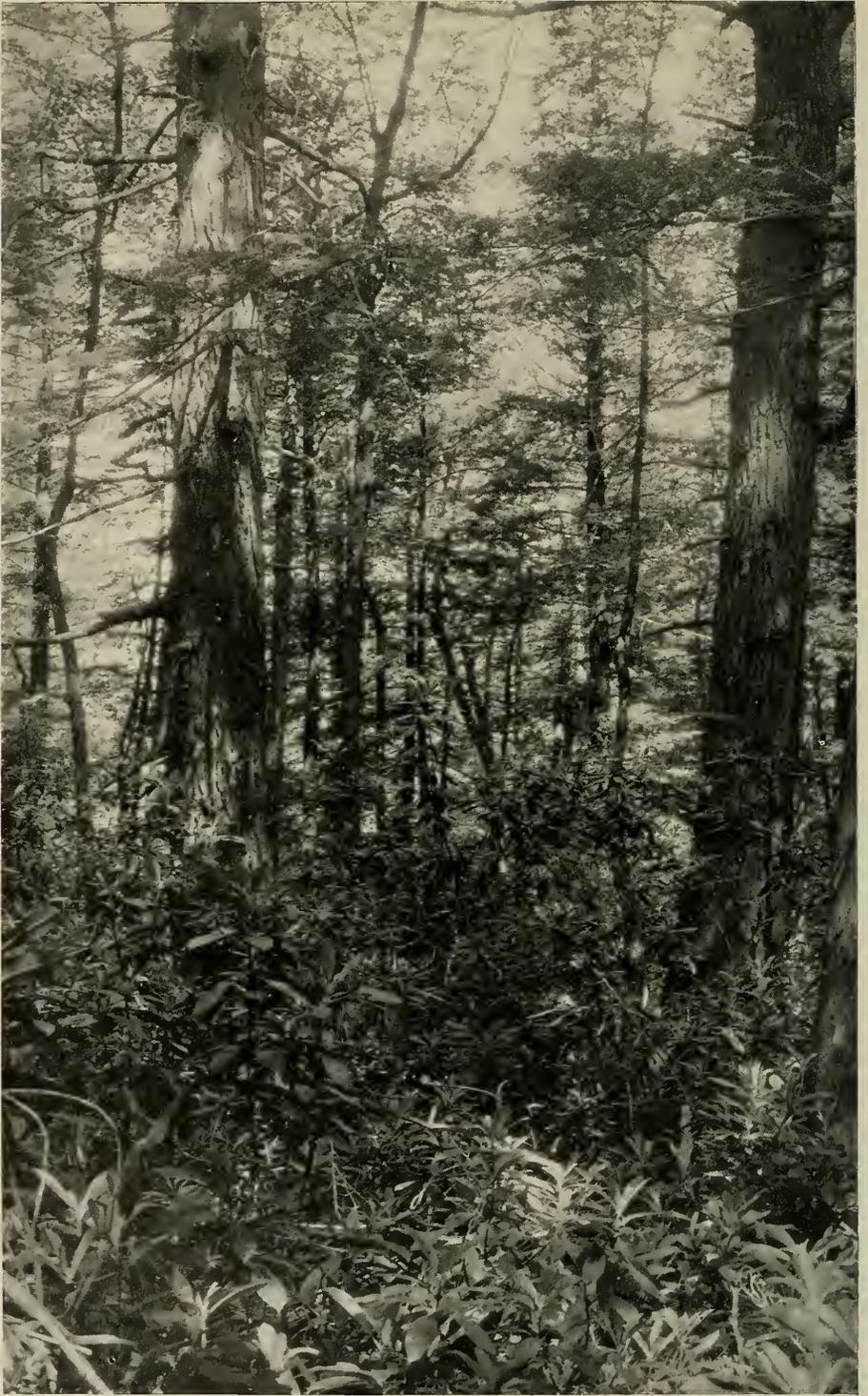
How often our hearts stood in our throats as we rode through the breakers in the only possible manner, with the heavy hollow log full of specimens, guns, cameras, or still more delicate instruments! And disaster came sufficiently often to make each landing and launching an ordeal. Late one evening we returned by launch to Salinas from Pelado Island, and prepared to make our way ashore by the beams of four electric lights cast out from the house across the water. The day had been gusty and the sea rugged, but the bongo was manned by two trustworthy boatmen, and, at any rate, we had no choice save to spend the night without supper on board a tossing launch.

We could hear the pounding of surf, but, for all we could make out in the black water, it seemed quite navigable. Now we were near the beach where the swell was ominous, and back and forth we oscillated, again and again, while Pedro peered around like a cat in the darkness.

“Espera—por atrás, por atrás! Vamos—ya! ya! ya!”

We spurted forward behind a line of foam. In front, not far, was the dark slope of the strand, and waiting Indians thigh-deep in white water. But just before we reached them, the stern heaved up to perpendicular and then jerked aside. The detonation of ponderous waters elanged in my stunned ears, and sand-ground into my nostrils as the bongo and its erstwhile occupants rolled ashore together.

Old Pancho, a lean, grizzled Indian whose home stood outside the enclosure of our headquarters, owned the best and largest bongo on the beach. Its gunwales were lined with buoyant balsa wood, and to Pancho and his stalwart sons was entrusted all the lighterage of the petroleum station. The whole family shared a pride, an independence, and a suppleness, which apparently distinguish the Indian who lives beside salt water from his servile and seemingly stupid compatriot of the mountains. Pancho rejoiced in surf. He had the enviable reputation of never having allowed his bongo to capsize while bearing a passenger. He possessed an innate sense of responsibility, for no matter how gloriously drunk he chose to make himself, he was never incapacitated for the most exacting boat service at any hour of the day or night, and he could, moreover, shoulder a heavy crate as well as the strongest of his sons. Yet, for all his skill and noble bearing, he was a mean old scoundrel. When I gave him a parting gift of many *sucres*, he had the effrontery to remind me that I still owed him ten centavos for a miserable fish; but when I laughed in his face, he forgot his importunities and waved a smiling farewell.



PRIMEVAL HEMLOCKS ON WAWAYANDA MOUNTAIN

The dense undergrowth of great rhododendron is the haunt of the Canada warbler

The Summer Birds of Northern New Jersey

BY WALDRON DEW. MILLER

Associate Curator

THE study of ornithology in the eastern United States dates back to colonial times, for almost two hundred years ago, long before the days of Wilson and Audubon, Catesby's great work on the *Birds of the Carolinas* was published.

It is a far cry from the days of these early pioneers to the present widespread interest in bird life. All of our eastern birds have long been described, their songs recorded, and their nests and eggs discovered, yet regarding the local distribution of many species even in the region about New York City we still have much to learn. Until a few years ago we were wholly ignorant of the summer bird life of certain sections of northern New Jersey within two or three hours' travel from the metropolis.

In 1904, the American Museum of Natural History issued Doctor Chapman's *List of the Birds Known to Breed Within Fifty Miles of New York City*, and two years later his *Birds of the Vicinity of New York City*, essentially a revision of his 1894 list. Here are recorded the regular breeding of the alder flycatcher, which the present writer had found near Plainfield, and the discovery by Mr. B. S. Bowdish of the nest of the black-throated green warbler at Demarest, on the Palisades. Meanwhile Mr. P. B. Philipp had found the brown creeper nesting regularly in a swamp near Newton, Sussex County, and with Mr. Robert H. Southard and others had established the regular breeding of the prairie horned lark on the bare, rolling hills

near the same town. None of these species had previously been known to nest within the limits of the State.

The year 1909 saw the publication of Doctor Stone's *List of the Birds of New Jersey*, issued by the New Jersey State Museum. The preparation of this work had emphasized our almost complete ignorance of the bird life of this section. To fill in this important gap in our knowledge of the local avifauna, three members of the Delaware Valley Ornithological Club, Dr. William E. Hughes and Messrs. S. N. Rhoads and W. L. Baily, made a week's trip early in June, 1909, through the highlands of Passaic and Sussex counties, touching Macopin or Echo Lake, Greenwood Lake, and Wawayanda, Mr. Rhoads continuing on to Beaver Lake and the Walkill Valley. An account of this trip, written by Mr. Baily, with an annotated list of the ninety-four species observed, is to be found in *Cassinia*, 1909, pages 29-36.

The most notable results of this trip were the black-throated blue warbler, a single male observed, and the Canada warbler, found commonly in three localities, both new to the known summer avifauna. The alder flycatcher, golden-winged warbler, parula warbler, and black-throated green warbler were also recorded, as well as the chat, hooded warbler, worm-eating warbler, and Louisiana water-thrush. Mr. Baily expresses surprise at the number of Carolinian species observed, even at the higher elevations, and at the very weak Canadian element, opining that the altitude is just below

the limit to attract such Canadian species as breed in the Pocono region of Pennsylvania.

For a number of years past the writer has made frequent trips to the mountains of northern New Jersey to study their plant and animal life. The Canadian tinge indicated by the few records of earlier observers has been found to be stronger than Mr. Baily suspected. Nevertheless, it is largely restricted to the most favorable situations, and can be easily overlooked if the right localities are not visited and thoroughly searched. This is well shown by the experience of the three Delaware Valley Club men who, in their trip through the heart of the most Canadian section, missed several of the northern species since discovered there.

The most important finds since 1909 may be briefly mentioned. In 1915 and 1916 a pair of nesting Canada warblers was found by the writer at Budd's Lake, Morris County. This is still the only known breeding station in the State, outside of Sussex and Passaic counties, not only for this warbler but for any Canadian zone species.

On May 30 and again in early July, 1919, Mr. Ludlow Griscom and the writer visited Bear Swamp in the Kittatinny Mountains near Lake Owassa. Here the Canada warbler proved to be actually abundant, ten adult males and six females being counted in a walk through the swamp. Several northern water-thrushes were also found on each visit, the evidence indicating that they were breeding.

In June and again in July, 1920, Mr. Griscom visited Lake Mashipacong in the Kittatinny a few miles south of the New York line. The Canada and Nashville warblers and the northern water-thrush were found, all evidently

settled for the summer, the Canada warbler being especially numerous.

Meanwhile the writer had made several trips to the mountains southwest of Greenwood Lake, and had found the Nashville, Blackburnian, black-throated blue, black-throated green, and Canada warblers, the northern water-thrush and the hermit thrush, all summering in the region. These are recorded in *The Auk* for 1920 and 1921. Continual investigation during the past three years has yielded further returns, and there can now be recorded from the same region, the purple finch, blue-headed vireo, magnolia warbler, and brown creeper, all presumably breeding.

East of Bearfort Mountain, in a mountainous section known as the Wyanokie Plateau, Professor Will S. Monroe has for some years conducted an early June bird census in which a number of local naturalists have participated. Though this region is somewhat less elevated than Bearfort and Wawayanda mountains and with less coniferous growth, its summer bird life is not so strongly Canadian, yet such species as the Nashville, Canada and black-throated blue warblers evidently breed there, and, there is reason to suspect, also the northern water-thrush and the hermit thrush. Our knowledge of the Kittatinny region has been increased during the present year by a trip to Lake Mashipacong on June 14 and 15, by members of the Linnæan Society, including Messrs. Griscom, Howland, Urner, Weber, and others. Five separate routes were covered and eighty-nine species observed. With the exception of the magnolia warbler and the hermit thrush all of the northern species of the central highlands were recorded.

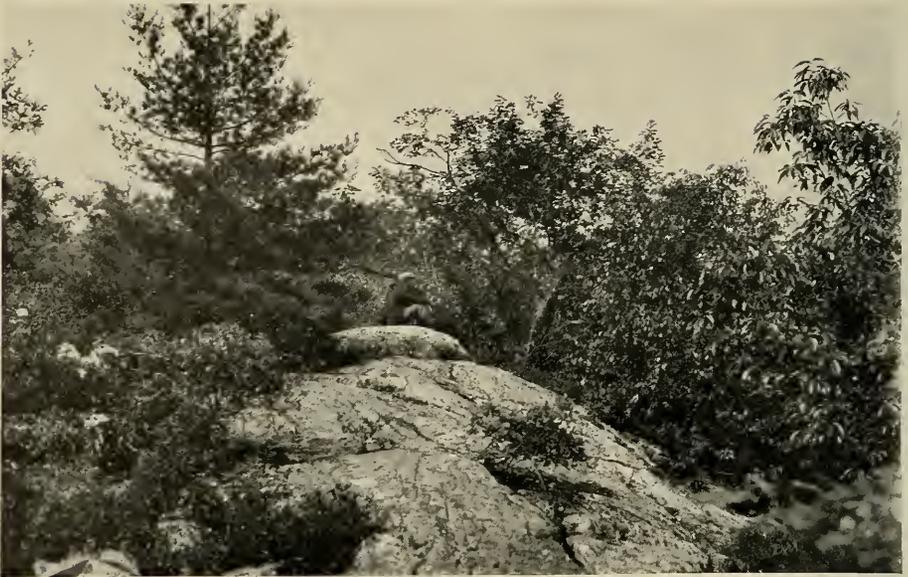
This brief sketch brings up to the present time the ornithological history of the long-neglected mountain regions of northern New Jersey. We have gradually discovered in the last twenty-five years that the Canadian fauna, although not in its full development, must be indicated on our faunal maps of the state. The avifauna is decidedly less boreal than that of the Pocono region of Pennsylvania or the Catskills in New York, and is comparable to that of northwestern Connecticut. Other northern species may yet be discovered in some unexplored section, such as the junco or the winter wren, while it is highly probable that the saw-whet owl has been overlooked because of its secretive habits.

The salient topographical features of New Jersey may be briefly indicated. The southern half of the state is mainly a low sandy plain, the greater part occupied by the well-known Pine Barrens, with a very characteristic flora and thoroughly Carolinian fauna. Immediately above the contracted middle of the state, the north central portion is occupied by a broad belt of Triassic red shale and sandstone which runs diagonally from northeast to southwest. Prominent features of this area are several ridges of trap rock including the familiar Palisades of the Hudson and, farther southwest, the Watchung or Orange Mountains. These hills rarely exceed a height of six hundred feet, an altitude insufficient to effect any change in their plant or animal life. Accordingly their birds are essentially the same as those of the surrounding country, a mixture of Carolinian and Alleghanian forms. Here we find such transition species as the black-capped chickadee, veery, chestnut-sided warbler, rose-breasted grosbeak, and least flycatcher, asso-

ciated with typically Carolinian birds such as the tufted tit, blue-winged warbler, cardinal, and others that range somewhat farther north, as the white-eyed vireo, orchard oriole, chat, worm-eating warbler, and Louisiana water-thrush.

The northern part of the state above the red shale belt is the true mountain section. Two parallel ranges of mountains enter the state from southern New York, cross the northern counties diagonally and continue across the Delaware into Pennsylvania. It is only in these mountains that we find any suggestion of the Canadian fauna and flora, and even here only in the higher and ecologically favorable portions.

Traversing the two northwestern counties, Sussex and Warren, is the Kittatinny range, a familiar feature to all who have crossed the Delaware River at Dingman's Ferry or visited the Delaware Water Gap, yet, until recently, almost unvisited by ornithologists. These mountains attain their greatest elevation at the north, High Point, a few miles south of the New York line, reaching a height of about 1800 feet, the highest point in New Jersey. Scattered ponds and swamps on the summit of the range or in the hollows are the headquarters of most of the more interesting birds. Toward the southwest the range becomes dryer and less productive, but unfortunately this section is almost wholly unknown. We now know in a general way the character of the summer bird life of the northern part of the Kittatinny, but further field work will doubtless add a few additional Canadian species. The Canada warbler is one of the most abundant species in favorable localities, while the northern water-thrush, Nashville, Blackburnian,



A rounded outcrop on Bearfort Mountain. Laurel and a young white pine on the ledge, scarlet and chestnut oaks surrounding it. The nighthawk lays its eggs on these bare ledges and rattlesnakes find refuge among the rocks

black-throated green, and black-throated blue warblers, the blue-headed vireo, and the brown creeper have all been recorded.

The second mountain range, known as the Highlands of New Jersey, is a system quite distinct geologically from the Kittatinny and notable for its great antiquity. This range enters the state on both sides of Greenwood Lake and following along the southeastern borders of Sussex and Warren counties, extends into Pennsylvania as far as Reading. In the northern portion, the mountains reach an elevation of more than 1400 feet. Farther south the altitude decreases and conditions are less favorable for northern birds, but until this section is more thoroughly searched we can say little regarding its summer bird life.

In the northern part of the Highlands, I have, in recent years, in spring, summer, and early fall, spent many

days exploring the swamps and forests of Bearfort and Wawayanda mountains and have acquired a fairly complete knowledge of the summer bird life of the region. This is essentially like that of the northern Kittatinny, already described. Judging by our present information, the Canadian element is slightly stronger in the Highlands, for the two birds occurring here, the magnolia warbler and the hermit thrush, have not as yet been found in the Kittatinny.

Bearfort Mountain is a picturesque ridge locally known as Rough or Rocky Mountain, a succession of parallel outcropping ledges of lichen-covered conglomerate, separated by narrow bushy depressions often only a few yards in width. Much of the forest growth is of rather small deciduous trees chiefly chestnut, oak, and other species of *Quercus*, with stunted pitch pines on the rocky outcrops. In spots

where soil conditions are favorable there are groves of hemlocks and occasional white pines, while near Cedar Pond there is a small swamp of spruce, larch, and white cedar.

Wawayanda Mountain, on the west, is geologically different from Bearfort Mountain, and lacks the very rugged character of the latter. Here on the northwest slopes and bordering the swamps are fine groves of hemlock, which evidently find ideal conditions of growth, for scattered individuals attain a large size.

Visiting these shady coniferous woods in June we are greeted with the voices of warblers which, in the lower parts of the state, we know only as migrants to and from their summer homes. From the graceful sprays of the hemlock, almost hidden by the intervening foliage, the wiry song of the Blackburnian warbler may be heard at short intervals, while the listener below cranes his neck to catch a glimpse of the elusive songster. One glimpse of his flame-colored throat not only serves to identify him but is ample reward for one's patience.

From lower down in the deciduous growth comes the drawling and unmusical, yet curiously pleasing, song of the black-throated blue warbler, and we may get a view of the small performer in his refreshingly simple and individual dress of slate-blue, black, and white. Dense thickets of the great rhododendron fill the swamps and often invade the lower slopes under the hemlocks. In midsummer their regal blossoms of white and rose present a spectacle long to be remembered. These thickets are the chosen home of the Canada warbler, probably the most numerous of all the northern birds of the region. Its southern relative, the beautiful hooded warbler, is often

heard and seen at the same time, but, unlike its congener, is not confined to the rhododendrons, its favorite haunt being the rocky deciduous woods with an undergrowth of mountain laurel.

Another southern species frequent on the rocky slopes is the plain-colored worm-eating warbler, while the black and white warbler and the ovenbird are found everywhere in the woods and the somewhat local redstart is of common occurrence.

In the cold swamps where the wild calla and the *Naumburgia* flourish, the liquid song of the northern water-thrush greets one at intervals. At lower altitudes this species is replaced by its southern congener, the Louisiana water-thrush, which, as a rule, affects rapid, rocky brooks rather than swamps.

Wherever there are white pines we are sure to hear the pleasing song of the black-throated green warbler. At a distance only the one or two louder notes of the song are audible; the effect is curious and will puzzle one until he has learned their source. Two common breeding warblers of rather northerly range are birds of the margins of the woods or swampy openings rather than true forest species, the Nashville and the golden-winged. The former is particularly fond of the groves of white birches, and when not in song may be easily overlooked. The goldenwing's *zee zee zee zee*, one high and three lower notes, is one of the characteristic sounds of country roadsides. This species entirely replaces its close relative, the blue-winged warbler at higher altitudes. Lower down, as in the Wyanokie foothills, the two occur together and hybridization is frequent.

Another warbler, the jaunty chestnut-sided, an Alleghanian species reaching its southern limit at sea level in the

central part of the state, is here one of the most abundant birds, as many as thirty-five adults having been counted in a day's trip. Like the preceding, it is a bird of young second growth and roadside and its strongly accented *very, very glad to meet you* is even more frequent than the insect-like song of the goldenwing.

The rarest of all the northern warblers here is the dainty magnolia, which has been found at only three spots in the Highlands and is unknown in the Kittatinny. There can be no reasonable doubt, however, that it is a regular summer resident in the northern highlands.

Excepting the ubiquitous red-eye, vireos of all kinds are scarce. The yellow-throated species has been met but a few times above an altitude of 1000 feet, where it is replaced by the blue-headed or solitary vireo, which, however, is a scarce bird in this region. The brown creeper is another local and uncommon bird. Twice I have met a brood of young, not long from the nest, attended by their parents.

It was long before I learned of the occurrence of the hermit thrush in these mountains. Finally, in 1921, a pair was discovered on the top of Bearfort Mountain above Cedar Pond. Single birds have been met a few times since, and probably a few pairs breed each year. The hermit thrush, while mainly a Canadian Zone species, summers in the low pitch-pine woods of Long Island. It is, therefore, strange that it should be so scarce in the Highlands and thus far unrecorded in the Kittatinny at this season.

The Wilson's thrush, or veery, is very common in the swamps and lower woods, while the wood thrush appears less numerous than in many localities, owing partly, no doubt, to its very

retiring habits and the fact that its song is seldom heard except toward evening.

An anomalous case of distribution somewhat like that of the hermit thrush is presented by the purple finch, which is a regular summer resident, even at sea level, in Connecticut and Rhode Island. There were a few summer records of single individuals at Englewood and Plainfield, but until two years ago, there was no evidence that the species bred in New Jersey. On August 13, 1923, I met a family of six birds including an adult male, in a bushy swamp near Dunker Pond, feeding on the fruit of the chokeberry (*Aronia melanocarpa*). Presumably this family was raised in the vicinity, but as Dunker Pond is only a few miles from the New York State line, it is possible that the birds may have wandered this short distance. The Linnæan Society's census in the Kittatinny in June of the present year recorded five purple finches, four males and one female, in three spots. It cannot be doubted that this attractive songster nests in the extreme northern part of New Jersey.

Comprising as it does one of the wildest and most heavily forested regions in the state, it is not surprising that the Highlands should be a refuge for certain animals that have disappeared from the more settled sections. Rattlesnakes and mountain black snakes are not uncommon, the native wood rat lives in the caves among the rocks, deer are fairly common, and wild cats are occasionally shot by hunters. The ruffed grouse which has been extirpated over considerable portions of the state and barely manages to survive in others, is here numerous. To the ornithologist, perhaps the most interesting inhabitant of these wilds is

the pileated woodpecker or logcock, the largest of our northern woodpeckers and a truly notable bird. Long supposed to have disappeared from the state, it is now known to be a permanent resident in the Kittatinny, in the wilder sections near Andover, and in the Highlands. In all probability it has never been completely extirpated from New Jersey, for evidence of its existence for many years back is to be seen in the great oblong "mortise holes" in dead chestnuts, so characteristic of the logcock. Some of these were evidently made many years ago. At the same time testimony of the more observing inhabitants indicates that in recent years there has been a decided increase in the numbers of this fine bird. Even where common, however, it is, owing to its shyness and its fondness for dense forest, by no means easy to observe, and its flicker-like call or loud tattoo may be heard on many occasions before an individual is seen.

The raven, the bald eagle, and the great blue heron may all nest in very small numbers in these wilder regions. Mr. Justus von Longerke saw a pair of ravens near Culver's Gap in the Kittatinny on September 21, 1918, and secured one. Possibly these birds were natives of the locality, but since that date, none has been seen there. Both in the Kittatinny and in the Highlands the turkey vulture, long regarded as a typically Carolinian species, is daily in evidence soaring over the summits of the mountains. Loose parties of six or eight birds are commonly observed, and occasionally several times this number. They are rarely seen alighted and how they find sufficient food to keep themselves alive is a mystery.

It is unnecessary to mention all of



Holes in a dead chestnut made by the pileated woodpecker in securing wood-boring grubs. The largest cavity is eight inches high, four and one-fourth inches wide and fully six inches deep

the species that have been recorded from the Highlands in the breeding season. The greater number are birds of more or less general distribution in New Jersey and such as are found in the immediate vicinity of New York City. On the higher plateaus as, for example, the elevated valley between Bearfort and Wawayanda mountains, more than 1000 feet above sea level, not only are such typically Carolinian species as the cardinal, tufted titmouse, and

blue-winged warbler absent, but the orchard oriole, white-eyed vireo and, surprisingly enough, even the yellow-billed cuckoo, have not been recorded. The wood pewee is inexplicably scarce in this region, while a curious case of local absence in the valley mentioned is that of the meadow lark.

To the botanist these mountains are as fascinating as they are to the bird lover. Scores of characteristically Canadian plants have been found here

and others are constantly being discovered. Among them are the striped maple, painted *Trillium*, bunchberry, *Clintonia*, fringed *Polygala*, and several species of orchids.

It is to be hoped that these mountain forests with their ancient hemlocks will long endure to afford protection to their animal and plant inhabitants, which present so interesting a contrast with those of the lower portions of the state.



A waterfall by the roadside above Greenwood Lake. Hooded and Canada warblers nest in the vicinity



An adult crowned eagle, in defiant attitude, at the New York Zoological Park. The dark-barred breast indicates maturity, and the size of the feet suggests their great strength. Photograph by E. R. Sanborn, supplied by the New York Zoological Society

The Crowned Eagle, Ogre of Africa's Monkeys

By JAMES P. CHAPIN

Associate Curator

EAGLES always appeal strongly to the imagination. They serve as symbols of courage and prowess in the countries of the north; and as powerful birds of prey they arouse the admiration of the natives of the forested tropics, where often there are large eagles that feed on monkeys or other mammals. *Pithecophaga jefferyi*

is the little-known monkey-eating eagle of the Philippines; tropical America has the imposing harpy eagle, *Thrasaëtus harpyia*; New Guinea has the *Harpyiopsis novæ-guineæ*, which devours wallabies; and a corresponding bird in equatorial and southern Africa is the crowned eagle, *Stephanoaëtus coronatus*.

From time to time zoölogical gardens in Europe and America exhibit this bird alive. Though it is not quite so large as the harpy, one is impressed by the great size and strength of its claws and feet, the latter being feathered down to the bases of the toes, and differing in this regard from those of the other species mentioned above. While

still immature, the African crowned eagle is a gray, white and buff nondescript; but, reversing the common rule among birds of prey, it becomes less uniformly colored when adult. Then the upper parts are mainly slaty black, while the breast is heavily barred and the legs thickly spotted with black. The quills of the wings and tail are broadly barred with gray and black. The back of the head is adorned with a flattened crest, more or less divided in the mid-line, from which its common name has arisen.

Judging from the frequency with which live birds reach Europe, and the fact that this species, like the harpy, was named by Linnæus more than a century and a half ago, it might seem that its habits in the wild state would be well known. As early as 1799 François Levallant¹ recounted his observations on a nest in South Africa, but he mistook the newly fledged young in its gray and white dress for the adult, as did Sir Andrew Smith in 1844. Near Grahamstown in Cape Colony a pair,

so it is said, nested in the same tree for thirty years, and their aerie was visited by many South African ornithologists; but nearer the equator, where the species is probably most numerous, very little has been learned—or at least written—of the occurrence and behavior of Africa's monkey-eating eagle. While searching the literature that deals with the birds of the Belgian Congo, I have found but two references to specimens having been procured in that vast area of approximately 928,000 square miles, the greater part of which is undoubtedly inhabited by this bird.



A young crowned eagle with head turned so as to show the form of the crest

The reason is not far to seek. The living examples sent home to animal dealers and menageries are taken from the nests by blacks, their history is soon lost, and they do not figure in technical articles or books on bird distribution. The white collector in Africa, on the other hand, seldom secures a skin for his collection, so wary are the birds when once they have left the nest. He is lucky if he even sees the eagle alive. To this I can testify from my own experience while with Lang in the Congo, during our six-year expedition for the American Museum. Of the two published records from the Belgian Congo, one is of a skin from the Itim-biri River in the Brussels Museum, the other an account in the notebooks of Emin Pasha of three young birds received from the Mangbetu country and kept in captivity at Lado on the White Nile.

¹*Histoire Naturelle des Oiseaux d'Afrique*, Vol. I, pp. 12-16, Pl. III.



Chief Senze of the Mangbetu tribe wearing feathers of a crowned eagle

The following is an unvarnished account of our protracted efforts to observe and capture what I regard as Africa's noblest bird of prey. Lang and I had already spent about six months in the rain forests from Stanley Falls to the northern Ituri district, when one day we observed a gigantic bird-claw strung on a woman's necklace. To our inquiry she replied that it came from a large bird known to the Medje tribe as *netumu*, the feathers of which were

eagerly sought by the men of the tribe. Months passed, however, and neither we nor any of the native hunters with us succeeded in finding the bird.

Then we traveled northward to the country of the Mangbetu,¹ who live

¹The term Mangbetu is here used in its broad sense to include the mixed population of the region just south of the post of Niangara, where Bangba, A-Madi, and other tribes live mingled in the same villages with the Mangbetu clan, earlier rulers of the district. The Mangbetu dialect is still the most important in use there. Okondo, as is well known, was a Bangba, though in many ways the true successor of the old Mangbetu king, Munza. My black assistant Nekuma, from Okondo's village, would describe himself as a Madi.



Senze and a few of his people. One woman is wearing a hat with the long white tail feathers of the paradise flycatcher

just beyond the border of the forest country; there we began to see feathers of our long-sought eagle adorning the hats of some of the men. They called it by the same name as did the Medje. Here only the "nobility," the chiefs and their relatives, were permitted to display these feathers, which were split down the middle of the shafts and hung in loose bunches from the brimless straw caps. This restriction on the wearing of certain feathers, an old custom among the Mangbetu, was noted by Emin Pasha during his visit in 1883. Other feathers which the common people were not permitted to wear, were those of the large fishing owl or *nebi* (*Scotopelia peli*), the red wing-quills of plantain-eaters or *nombo* (genera *Turacus* and *Musophaga*), and the long, white tail-feathers of the paradise flycatcher or *māndalungwe* (*Terpsiphone*

viridis). Red tail-feathers of the gray parrot, of wide popularity in the Congo, were less jealously regarded by the Mangbetu chiefs.

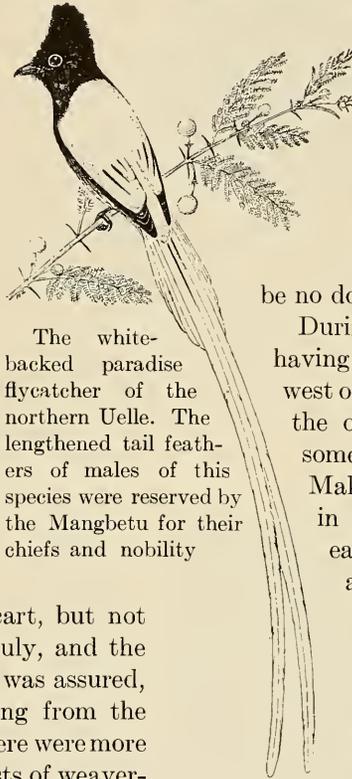
Everywhere we asked about the *netumu* and how it could be found. Okondo, one of the most important chiefs of the region, told us he had one alive which had come from a forest to the south; and it was proudly brought forth in a large basket carpeted with the feathers of chickens on which it had been fed. The light-colored plumage betrayed its youth, but Okondo wished to present it to his guests, and we were glad to have it. We could not, however, carry it along in its cage, and the quickest way to prepare it for skinning was to offer it a bit of meat containing strychnine. Okondo was tremendously impressed with the efficacy of the poison. No gifts would he

have in exchange unless they included a phial of the deadly poison. After long argument and many solemn cautions, Lang presented to him a tiny bottle of powdered boric acid. Let us hope that Okondo never tried to poison an enemy with it.

For the next couple of years we were hunting in the more open grass country to the northward, the home of the white rhino and giant eland. The crowned eagle was heard of no more until we returned to the forest. I had scarcely entered its borders near the Bomokandi River when my guides led me off the road to show me a tree with which they were familiar, where the *netumu* had built two huge nests, masses of sticks that would fill a cart, but not then in use. It was in July, and the birds would come back, I was assured, later in the year. Hanging from the boughs of this same tree there were more than a hundred empty nests of weaver-birds, placed there doubtless for the protection the eagles would afford.

Continuing southward to Avakubi, only one hundred miles from the equator, I made frequent efforts to locate another nest, or to see the birds themselves. But though all the tribes encountered were familiar with them, I was unsuccessful. The Mabudu name for them was *inju*, and that of their neighbors the Balika, *windi*. The Wabali on the Ituri River knew them as *ndūa*, but during my prolonged stay at Avakubi they did almost nothing to aid me in locating a nest. Once I

believe I saw the bird circling over a clearing, but a long way off, too far even to identify with my bosom companion, an eight-power glass. I was shown feathers of one that had been killed up-river near Penge, and a flat native-made skin from the River



The white-backed paradise flycatcher of the northern Uelle. The lengthened tail feathers of males of this species were reserved by the Mangbetu for their chiefs and nobility

Lenda. Monsieur Bernard, the gracious administrator then in charge of the country round Avakubi, assured me he had once received young birds alive at Makala, so there could

be no doubt of their presence.

During this time Lang was having better fortune at Niapu, west of Medje, while studying the okapi. In November some Pygmy hunters of a Makere chief began to bring in young of the crowned eagle, which were kept alive for some time and photographed. In response to Lang's presents the hunters proceeded to capture several old birds, two of them on the ground, in traps baited with

dead monkeys. Lang went out to see the nests, but was too busy with large mammals to investigate further. Now at last we had satisfactory specimens, but my own desire to know the birds in life was unappeased.

The native population along the Ituri River is mixed, for in addition to the original tribes, Wabali, Bandaka, and the elusive Mambuti or Pygmies, there are large villages of Bangwana, remnants of the black slave-raiders formerly led into the country by Arabs, and joined by the accumulated riff-raff of the



A young crowned eagle reared by Herbert Lang in the Congo

country itself. Few of the Bangwana are hunters. They trade, and they grow rice—besides wearing white clothes and professing the faith of Mohammed. They do not eat wild



A hunter of the Makere tribe carrying a dead crowned eagle

pig, but are not loath to trap this unclean ravager of their farms, to smoke its meat and sell it to their heathen neighbors, whom they regard as *washenzi* or barbarians. The most influential chief of these Bangwana in the vicinity was Kalonga, an elderly man of Bakusu origin, who remembered Stanley and his early visit to the Man-yema district. Kalonga and I had known each other for more than four years, and he had given me one amusing instance of his views on unclean meat. A hippo I had killed at Avakubi was cut up and divided among our workmen and those of the government post, without a thought of offering any to Kalonga. Soon afterward he complained of my stinginess. I replied that the creature could surely not be eaten by a Moslem. "No, not if it had died on land," said Kalonga, "but you killed it in the river; and that made it just like a fish. We are very fond of fish."

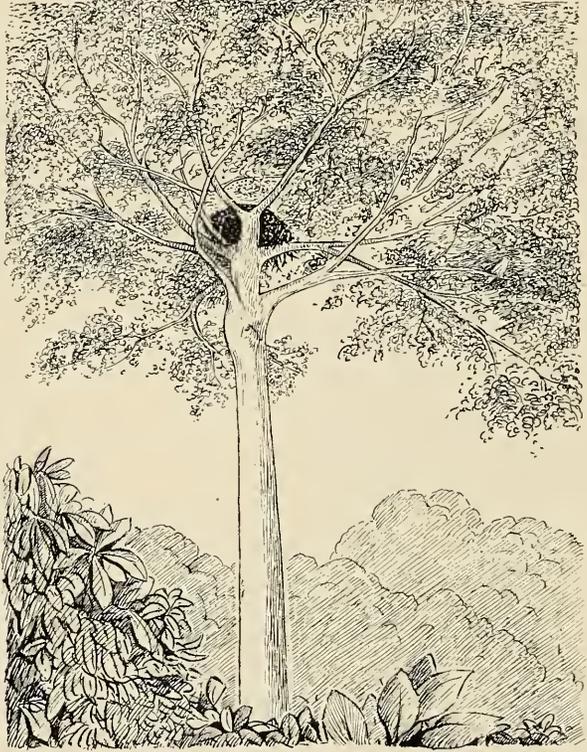
To Kalonga I often confided my longing for the eagle, and eventually he announced that one of his men had located a nest, and had fired his muzzle-loader ineffectually at one of the birds. Both statements made me happy. Lang's experience a little farther north indicated that eggs were laid in October. It was now early March, so even allowing for a prolonged stay in the nest—and eagles grow slowly—the breeding season must be finished. James Barnes and Cherry Kearton were in Avakubi at the time, on their way across the continent after filming the big game of East Africa. On March 9 we bade one another good-bye, and I set off for a tiny village some five hours to the southwest. The night was passed with some Wabali who specialized in drop-spears for elephants. Early the next morning we stood beneath a gigantic tree in the forest, somewhat isolated

from all its neighbors, bearing the eagles' nest. As we approached, we heard the call of the young bird, high-pitched notes strung out nearly to a trill, when they did not sound more like *ki-ki-ki-ki-ki*— or *kwě-kwě-kwě-kwě*—. Practically full-grown, it still sat on the boughs of the tree where it had been hatched, moving about occasionally, yet not following its parents on their hunts.

The nest was an enormous pile of dry sticks and pieces of lianas, placed in one of the great forks near the middle of the tree, which was absolutely free of epiphytic plants or creepers. Later on, when I watched a man climb up beside it, I realized for the first time how large it was, and judged it to measure six feet, if not more, across the top. The distance above the ground was about thirty-five yards. Determined to see and, if possible, to shoot one of the old birds for our collection, I spent most of the next three days watching the nest. The young bird seemed still attached to the spot, flying only occasionally to neighboring trees, and calling frequently. Sometimes it would sit on one foot, resting the other heel on the branch, or would extend a wing and the leg of the same side simultaneously, as well as spreading the tail. Storks and many other birds stretch in this same way.

Rifle in hand, with Nekuma, a young Mangbetu who accompanied me

as "assistant ornithologist," I sat on the ground in an elephant path at a spot offering a view through the foliage up to the nest. Nekuma was the son of Okondo's old witch-doctor, and his name was the Mangbetu word for rain, in allusion, he told me, to the



Nesting tree of crowned eagles. From a pencil sketch made by the author as he sat on the ground waiting for the old bird to visit it

tears he shed in babyhood, perhaps while his head was wound with cord to give him a stylish, lengthened skull. This negro bird student was almost as keen as I to see a *netumu*. I doubt if the old birds normally returned more than once or twice a day, at this stage, to feed their offspring. They certainly knew we were there.

The first afternoon I was lured away by the yelling of a band of chimpanzees

feeding in the trees, and succeeded in bagging their hoary-backed patriarch. Most of his companions were down on the ground before the echoes from the rifle had died away; but as I reached the fallen leader, a shaggy, black "boy-chimp" came sliding down the trunk of a near-by tree. I hadn't the heart to raise a gun in his direction. Once these apes have reached the ground in the heavy forest, one may give them up as lost. It is with strangely mingled feelings that one looks upon a fine dead chimpanzee such as this one, with chest deflated measuring forty inches, and a spread of arms of six and a half feet. My first experience in shooting monkeys almost wrung my heart, and I know of nothing closer to murder than the killing of a chimpanzee. Would that those who ridicule the idea of any possible relationship between the apes and man could know a little of anthropoids in their natural environment.

Back at my post nothing had changed, and nothing happened till nightfall sent us stumbling back over roots and rivulets by candlelight to our lodging in the forest hamlet, five or six mud-walled huts. Mine contained an interesting array of iron spears to be inserted in logs of wood and hung over the paths through the forest, as traps for passing elephants—making passage rather risky for visiting naturalists.

The whole of the following day was spent beneath the nest. Only once, toward eleven o'clock, did an old bird visit it. Natives had often told me that the ground beneath the nesting tree would be littered with the bones and skulls of victims. Much the same assertion was made by Paul Du Chaillu,¹ who saw a nest of this

monkey-eating eagle in the Gaboon between 1855 and 1865.

In spite of all my endeavours during my former and this last journey, I have been unable to kill the guanonien, a most formidable eagle; but several times I have been startled in the forest by the sudden cry of anguish of a monkey who had been seized by this 'leopard of the air,' as the natives call it, and then saw the bird with its prey disappear out of sight.

One day, hunting through the thick jungle, I came to a spot covered with more than one hundred skulls of monkeys of different sizes. Some of these skulls must have been those of formidable animals, and these now and then succeeded, it appears, in giving such bites to this eagle that they disabled him. For a while I thought myself in the Valley of Golgotha. Then I saw at the top of a gigantic tree, at the foot of which were the skulls, the nest of the bird, but the young had flown away. I was told by the natives that the guanonien comes and lays in the same nest year after year. When an adult specimen will be procured, it may be found to rival in size the condor of America.

Though he did not realize it, Du Chaillu had already secured a specimen of the eagle for the Academy of Natural Sciences in Philadelphia. The name he gave, "guanonien," was surely not a native designation, but more likely meant for a French word derived from *guenon*. This passage well illustrates the usual truthfulness combined with literary color of Du Chaillu's observations. Messrs. Haagner and Ivy² have stated that on one occasion fifty-eight skulls of small antelopes and rock-rabbits were found beneath the South African nest mentioned above, but that in later years bones were seldom dropped there. In the present case I could find practically no bones beneath the tree; but since the nesting season was virtually at an end, it may be that the many animals roaming the forest floor had had time to carry off all such

¹1890, *Adventures in the Great Forest of Equatorial Africa and the Country of the Dwarfs*, pp. 246, 247.

²1923, *Sketches of South African Bird-Life*, 3rd Edition, p. 96.

refuse. Mongooses there are aplenty, and even a squirrel appreciates a bone to gnaw on.

It happened on this day that just while I was examining the ground at the base of the tree, where some low boughs impeded my view upward, a change in the voice of the eaglet warned me that something was going on. Before I could reach the lookout, Nekuma told me, an old eagle had come and gone. Its flight was so nearly noiseless as to escape my ear. This must serve the bird well in its hunting. The rounded form of the wings is what one might expect of a bird that pursues its prey through the dense foliage of a tropical forest. This time food was left on the nest, and the youngster sat there a long time. At twilight it settled down to roost on a horizontal limb, without further attention from its parents.

Arriving at 6:30 on the third morning, we found the young eagle alone on the nest, eating. Later on, as it sat in the tree, it would call frequently, surely not from hunger, and was continually twitching its head. Through my glass the reason was evident: six to a dozen insects of some sort were always buzzing about its mouth. Perhaps they were honeybees, like those which were making it uncomfortable for us on the ground. In these forests the bees are extremely fond of human perspiration, and love to crawl over one's face and hands. We had long since discovered that the ground where we sat swarmed with tiny brown ticks, which climbed all over us, hooking in securely on the tenderest spots of our skin. They were favored, as we were too, by three days without rain. Such a dry spell is none too common in the Ituri forest after January.

The third day was running its course. At about four o'clock the young eagle

had not returned to the nest, and I was reading an ancient London newspaper, or rather studying it—in order to make it last longer. Of a sudden I was aroused by the eaglet raising its voice excitedly, and jumped to my feet. The old bird had already reached the nest with a foreleg of a monkey, and was immediately joined by the young one. A glance through the glass showed me the adult, with tail toward me on the rim of the nest, taking a good look at me over its shoulder. My gazing was finished, and the muzzle of a Winchester returned the bird's stare. As bad luck would have it, my shot dropped the old eagle right on the nest, and before anything could be done twilight would be upon us again. Had there been any possibility of more prolonged observation, it would have been a great mistake to shoot; but the young bird was too old to serve as a good decoy. That very evening, in fact, it took its departure and was not seen again.

In my boyhood I was counted a good climber, but these African forest trees baffled me completely. Even with climbing irons I would have been helpless on any of the larger trunks. But the natives had better means, and the only way to get my bird was to enlist a skilled climber. Luck was with us now, for two of the elephant-trappers promised their services. Early the next morning they began by stepping into a thicket to get their "climbers." The stout green stems of some huge canna-like plants were twisted into a pair of short cables. These were looped so as to encircle the tree, and then the man's thigh or foot. Now for the ascent.

Two miles through the forest brought us again to the base of our tree; but this was so large, though not buttressed, that six feet above the ground

it was still twelve feet in circumference. Higher up it tapered only gradually. Poles had therefore to be lashed to the bole for a distance of ten yards before the loops for climbing could encircle it. One of the men then passed his right thigh into one ring, and with the left foot in the other, "hitched" his way up the smooth trunk, resting his weight alternately in one ring or the other as he lifted the opposite, free loop a little higher.

All went well until he reached a swelling of the trunk only a little below the nest and found it too large for the loops. So up went the second man with a rope of long creepers, to pull up more lashings and poles to be made fast against the trunk. From the ground I sternly urged the climbers to stick to their job—and secretly marveled at their perseverance. To shorten the story and to spare my readers the anxiety I felt that day, it may suffice to say that the assault began at 7 A.M. and my bird was not lowered from the tree until 11 o'clock. I find no record of how I rewarded my human squirrels, but they certainly received all they had stipulated, and more. Nekuma and I stood in admiration before the hard-won prize, an old female with a spread of some seventy inches, despite the relatively short, rounded form of the wings. We raised her crest, pulled open the stocky toes and hooked claws, and recalled how his people would have prized the large, black-banded quills.

On the top of the nest the only conspicuous remnants of food were a leg of a monkey, a bleached tibia of

another, and a few large pellets of fur, disgorged as owls would do. The size of these pellets was impressive. We had not been the first to shoot at a bird on this nest, and one of the climbers pulled an old arrow out of the bottom of it.



Sketch to illustrate the method of climbing a large forest tree

In the present tree no weavers had built nests, but while watching under it, I noted that small birds were continually feeding in its leafy crown, and that they showed not the slightest fear of the young eagle even when it called. It might be supposed, moreover, that monkeys would come to fear the vicinity of such a nest, yet we heard them frequently during our waiting. The black mangabey, *Cercocebus albigena*, called near by, and once we spied on a band of guenons composed of two common species, *Lasiopyga ascanius* and *denti*, going by through the trees about eighty yards off.

These eagles had shown the usual preference of large forest-nesting birds for a tree set off slightly from its fellows, which might thus be better protected from arboreal mammals. Yet they make monkeys their principal food, and are able easily to kill adult guenons with their powerful feet and talons, the largest claw reaching a length of $3\frac{1}{2}$ inches. When the young eagle sat on a bough, its most prominent features were the enormous legs and the long tail. The young bird of which photographs are shown was not fully grown, hence the shorter tail. I did not see the crest raised, but Lang tells me that in the adults brought to him alive the crest was erected so that there remained

a strong dip or gap in the middle, the long feathers at each side of the occiput standing somewhat higher.

Strangely enough, I cannot state positively the number of eggs usually laid by the subjects of my tale. In South Africa it is said that there may be as many as four. I am sure this is not the case in the Congo, but whether one or two is the usual brood still remains somewhat doubtful. We do know from a specimen in the British Museum that the egg is dull white, measuring close to three inches in length and about two and one-eighth in its short diameter. Young nestlings, secured by Lang, show that when first hatched they are densely clothed in pure-white, cottony down.

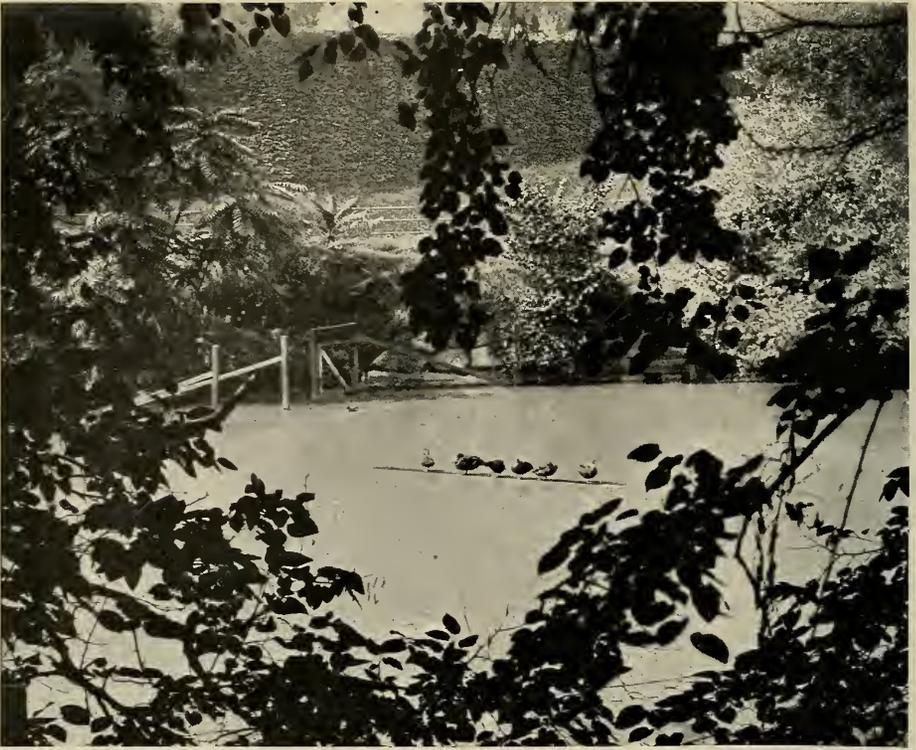
In South Africa, naturally enough, *Stephanoaëtus coronatus* preys largely on small antelopes; and it seems equally fitting that in the Congo forests it should be primarily a monkey-eater, as shown by our examinations of crop and stomach in eight cases. Five of the birds had been eating monkeys of the genera *Colobus* ("guerezas") and *Lasiopyga* ("guenons"). In four instances the bones showed that the monkeys were immature, but one was a fully adult *Lasiopyga*. Other prey is not disdained, for the forelimb of a mongoose and the remains of two birds were taken from the three remaining eagles. Mr. G. L. Bates in the Cameroon has recorded the eating of a hyrax (*Procavia dorsalis*) and an attack upon *Lasiopyga cephus*.

The man who got my eagle down from the tree related that once he had come upon a crowned eagle on the ground with a monkey it had slain. Setting a trap he secured the bird when it returned to its kill. There can be little doubt that such large prey, captured in the trees, is regularly borne to earth

to be torn asunder and then carried off in parts. Less than two months after shooting my specimen, I received another from a black hunter who had surprised it with a dead monkey on the ground. It flew up into a tree and was brought down with an arrow.

In the meantime my helper Nekuma had settled the identity of the weaver that nests near the aeries. He was sent to look up another nest of the eagle reported by natives near Avakubi, but found it already abandoned. It was in a high tree, and near it there hung about twenty weavers' nests whose owners had not left. Specimens secured by Nekuma proved to be *Malimbus erythrogaster*, a brilliant scarlet-and-black species, of which I had found a single pair the year before, weaving a new nursery in a tree where there was already a nest of the great blue plan-tain-eater (*Corythaeola cristata*). Some four years earlier near Medje I had found nests of the same weaver in trees unoccupied by any large bird, so they seemed to seize the protection when available, but were not wholly dependent upon it. It may be added that another kind of weaver in the grasslands of the northern Congo nests near the homes of buzzards, vultures, or marabou storks; along the Congo River I found some also building under the jealous eye of *Gypohierax*, a vulturine bird of prey.

Not long ago I revisited the Antwerp zoölogical gardens, and there saw an adult crowned eagle perched sedately in its cage, surveying me with its cruel yellowish eyes. My pulse must have quickened as I paid my respects to an old and esteemed friend from the Congo—it doubtless came from there—and I longed to be standing again under Africa's giant trees with my veteran binocular fixed on this notable bird in its haunts.



Black ducks on one of the smaller ponds. They are descended from wild birds

Bird-hunting in Central Park

By LUDLOW GRISCOM

Assistant Curator

FEW people without experience, would suppose that a park in the heart of a great city was an excellent station for the study of birds during the migration period. Bradford Torrey, years ago, used to tell the story of a friend who inquired of a distinguished ornithologist where he should go to obtain a sight of certain rare warblers. Much to his surprise, the advice was, "Go to Central Park, New York," though an undistinguished friend had already recommended precisely the same place! The writer has visited the Ramble in Central Park daily in spring and fall during the past eighteen years and can fully endorse the excellence of

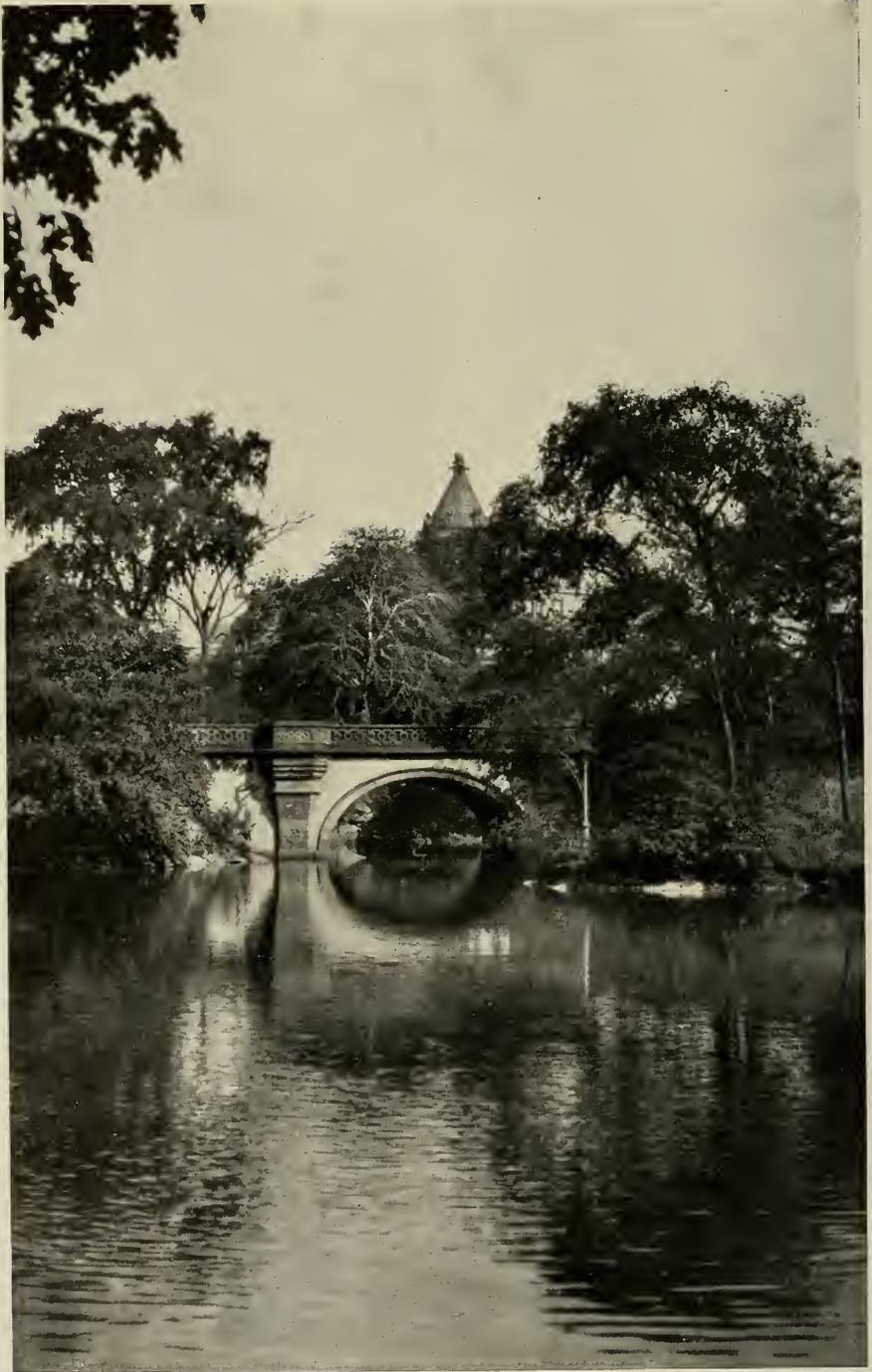
this advice. It is, indeed, an ideal place for a close study of migration. The reason is comparatively simple. The greater number of our local birds migrate at night. The electric lights of the city have a certain fascination for these little travelers, just as lighthouses are well known to have, and they fly lower, particularly on foggy nights. Secondly, the Park is a haven of refuge, a veritable oasis in a vast desert of city roofs. As day breaks, the tired hosts must alight to rest and eat. How gloomy those individuals must feel who see nothing but the roofs of Newark or Hoboken beneath them by the dawn's early light, and how inviting the lakes,

lawns, and verdure of the Park must seem in the distance. Many indeed are forced by fatigue to alight almost anywhere. Washington Square has a notable list of birds, and a friend has recorded more than thirty species in a back yard on Tenth Street, which boasts one sickly little tree, surrounded on all sides by tall apartment houses. Any-one who stands on the bridge over the lake in Central Park at daybreak on a warm May morning will be able to appreciate for himself the force of this attraction. Calls of various species can be heard showering out of the blackness of the night in every quarter of the sky. As day breaks it is obvious that the birds are flying lower and lower, then they become dimly visible, less than a hundred feet overhead, and finally they can be seen pitching into the nearest trees. During the next half hour the chorus of song gradually swells as the travelers find food and rest, and the observer can set about recording the extent of the flight, and the new species which have arrived from the south. It also follows, parenthetically, that once having alighted, there is no special inducement to move on, as there is no suitable adjoining territory to go to. The smaller birds at least are caught until nightfall at the earliest, or until the instinct of migration inspires them to proceed another lap on the return journey to their breeding grounds. It frequently happens, therefore, that individuals of rare or uncommon species will remain for several days, or even a week, and give the student a real opportunity to cement a chance acquaintance.

It must not be supposed, however, that Central Park is an Eden for all the species of birds in the New York City region. The causes which attract night-flying birds do not apply, for

instance, to those which migrate by day, and their one desire is to leave the dust and noise of the city behind them as rapidly as possible. As there are no marshes or feeding grounds for water birds, these are of purely casual occurrence. Similarly the absence of grassy fields and pastures deprives the park of any attraction for birds like meadow larks and vesper sparrows, which consequently are very rare. Few indeed are the birds which can endure the noise of the summer crowds, and the breeding species are steadily decreasing. Very few species now spend the winter unless a feeding station is started early enough in the fall and consistently maintained, as in late October the ground is carefully raked over and the shrubbery is trimmed to insure a good growth the next season. But these operations inevitably destroy part of the food supply and eliminate shelter and cover, so that the Park has no attractions as a winter resort. But the Park does offer a suitable habitat to the great majority of woodland and thicket-loving species which migrate by night, and they are as common, or even more common, than anywhere in the vicinity of the city.

Some figures might be of interest. Fifty years ago, when the park was on the outskirts of the city, nearly sixty species nested and many were common all winter. In 1908, eighteen species nested and twenty-two spent the winter. Last year, but eight species nested and a very few individuals of three native species spent the winter. This decrease was inevitable and was to have been expected, though bird lovers regret the disappearance of the cardinal and warbling vireo, and miss the friendly chickadees which used to snatch peanuts from between their lips in the winter time. The regular tran-



Photographed by Edmund O. Hovey

THE LAKE FROM THE RAMBLE

Swallows skim over its surface, the kingfisher watches in the overhanging trees, and the water-thrush trips along the bank

sient species have not been affected, however, and a daily visit from April 1 to May 30, and from August 10 to the end of October is certain to repay the student. The average list for such a series of visits is about 110 species per year. At the end of this article will be found a list of all the birds recorded from the Park, divided into two categories, (a) those of more or less regular or normal occurrence (116), and (b) those of very rare or casual occurrence (75). What usually happens is that some of the species belonging in list *a* are missed in any given year, and these are compensated for to a certain extent by two or three species belonging in list *b*. May is the star month, when the maximum number of species and individuals is present. There is always the possibility that a great "wave" of migrants will arrive overnight with favorable weather conditions. Such an occasion took place on May 10, 1922, when 66 species and thousands of individuals were observed in the Ramble. This is the record, but fifty species at least can usually be counted on, one or two days each season. Conditions are somewhat different in the fall, when the migration is protracted over a far longer period, and the birds move south in a more leisurely manner. The record list in fall is only 52 species on October 4, 1907, when a sudden cold snap, after a mild September, forced many laggards to rush south pell-mell. Indeed, it is exceptional to record more than 40 species in any one day. When we consider the absence of song and the change to a more obscure plumage, it is small wonder that the average bird lover is discouraged, and the swarm of observers in May is conspicuously absent in fall. Nevertheless, at least twenty-five of the rarer species are far more likely to be seen in fall than in

spring, and a few are beyond the bounds of reasonable hope in May. During the past eighteen years, the writer has seen 160 out of the 191 species recorded since 1875.

How do these figures compare with the country outside the city limits? They are, of course, very much lower. If Sunday and holiday trips are intelligently planned, it is quite possible to see 225 species in a year in this vicinity, and I have seen 280 species in all, in the same eighteen-year period. A good May-day list will exceed 100 species and a good day in fall will yield 70 species or better. Why then, it may be asked, go to Central Park, where the variety is so small and the number of species so relatively few. The main answer has already been given. More of the rarer transients will be found in Central Park during May than anywhere else. There is another purely practical reason. The average dweller in Manhattan can only look for birds in the country on Sundays, and on week days it is Central Park or nothing. When we consider that only one or two individuals of the rarer species will occur a season, the chances against their being obliging enough to be present on a Sunday are at least seven to one. These two factors combined demonstrate excellently the advisability of visiting the Ramble at least six mornings a week. Next to Central Park the best place for warblers in this region is Englewood, where I have been going every Sunday during May, year after year. I have seen the Cape May warbler there only six times in twelve years, and the mourning warbler never. In Central Park during the same period I have seen the Cape May warbler more than twenty times, and the mourning warbler twice. But it is a general law of life that it is almost impossible to get



A splendid covert for warblers, thrushes, and sparrows. The swans are a domesticated European variety

something for nothing. Hunting rare warblers in Central Park is no exception to this rule. He who, yawning portentously, lurches into the Ramble two or three times before breakfast some May, expecting to see all the rare transients, will be very rapidly and completely undeceived. The prizes come only to the energetic and the persistent, and what is fairly earned is the more thoroughly enjoyed.

Bird lovers may be divided roughly into three classes. The beginner, to whom all species are new and strange, is advised to begin in Central Park. The difficulties of identification are greatly reduced, when the number of possible species is also greatly reduced. With a hundred species learned the country outside will yield its greater wealth of

treasures with less confusion and fewer errors. The next stage in progress is marked by the desire to wander farther afield and gain an acquaintance with as many species as possible, and field trips to special places are undertaken with the main hope of seeing some new rarity, or obtaining a large list. This stage is a necessary and valuable experience, and must be passed before the amateur ornithologist really becomes capable of contributing to local ornithology. The Park has little appeal for such people. But when the making of large lists palls, and the chances of seeing a new species locally have become exceedingly remote, the opportunities of the Park as a station for studying that most fascinating phenomenon, the migration of birds, is urged

upon those desiring to make something constructive out of their hobby. Every individual bird can be determined with certainty as a transient, or can be definitely known not to be one, something which is utterly impossible in the country, where there are large numbers of permanent, summer, or winter residents to obscure the issue. Consequently the migration periods of species which nest in this vicinity or which are found throughout the year can be determined with more certainty in the Park.

But there is also an element of sport and enjoyment which no account of bird-hunting in a city park should omit. After all, the satisfaction to be derived from a given course of action is directly in proportion to the expectation preceding it. It is possible to see one hundred species in a day in winter in southern California, and it is practically impossible to see more than forty in the vicinity of New York. Yet I never heard of a local bird lover who abandoned his observations during the winter on the ground that bird life was comparatively meager, or who failed to be delighted at seeing thirty species. His expectations were reasonable and controlled by the known facts. The same philosophy can be applied to advantage in Central Park, and many delightful week-day hours each spring and fall are shared by a band of fellow enthusiasts and friendly rivals. We are as pleased with fifty species in the Ramble as we would be with one hundred in the country. There the crow is utterly despised and ignored; here it is a rare visitor to be greeted with enthusiasm. The morning hours are as cool, the songs are just as sweet.

And then one can never tell exactly what is going to happen next. No two spring or fall seasons are exactly alike.

There are lean years like 1924, and very good years like May, 1925, when birds were present almost daily in unusual variety and abundance. There are lean days when almost nothing can be found, and good days, when the Ramble is crowded with multitudes. We have never yet learned how to predict a big flight with absolute certainty. They fail to materialize when the weather conditions seem just right, or they arrive quite unexpectedly. One can never tell just which ones of the rarer species will appear, or when. Once in a great while there are the red-letter days when some bird of extraordinary rarity is detected. I well remember the glowing orange prothonotary warbler which was detected on the "Point" in the lake on May 3, 1908, a wanderer from the cypress swamps of the south. It remained a whole week, sang freely and was absurdly tame, so that it could literally be surrounded by enthusiastic nature study classes, without turning a hair, or more correctly, ruffling a feather. Quite a number of people began to study birds, thanks to the general atmosphere of excitement over this warbler.

Surprising as it may seem for so small an area, nobody ever saw all the species present in the Ramble on any one day, when birds were at all common. The writer, among others, has made repeated and earnest endeavors, but has never succeeded. One pair of eyes cannot hope to equal the combined results of ten or twenty other pairs, as keen or even keener. The following incident is a generalized picture of this state of affairs. I have spent two hours in the Ramble before breakfast entirely alone, and have had a very successful morning. Several new species have arrived over night and one or two rarities have

fallen to my glasses. I return at noon knowing that a group of sharp-eyed friends have spent the entire morning in the Ramble, and I wish to check up on the extent of the flight. We meet and compare notes. I find that they have not seen one or two of my best discoveries. I listen with a certain discreditable satisfaction to their yelps of disappointment, but the situation is immediately reversed, as they reel off so long a string of species, that it seems almost incredible that anyone really interested could have overlooked all of them. Sometimes we scatter in a frantic search for the species missing on our respective lists. Again, if nothing of special note has been reported, we combine forces and go around together. This nearly always results in the discovery of a third group of species, which nobody had seen previously.

I cannot forbear to say a few words in closing about the bird hunter, in relation to his environment, as well as the

birds, and more particularly respecting his relations with his fellow citizens, who use the Park for other purposes. It makes me happy to report that in the last twenty years we have gradually become more sane and normal, and we are now almost like ordinary people. Nowadays everybody understands what the bird hunter is about, and is tolerant, or even sympathetic. People will now often stop and ask intelligent questions, or they will try and see the bird for themselves, and even the Park policeman is becoming an enthusiast, the hours on his beat passing more pleasantly than before.

So I can the more cheerfully recommend pleasant and instructive hours of fresh air to city dwellers. Doctors are now advising overworked and nervously fatigued patients to study birds in Central Park. It is a healthy hobby, and with a little skill and experience, the time spent on it can be made of constructive scientific value. The lists



Canada geese on the Park lake. They are domesticated birds but perfectly able to fly, resulting in numerous reports of wild geese alighting in the Park. Real wild geese are seen about once in ten years flying over at a great height

at the end of this article give a good idea of the possibilities as regards the variety of species. With modifications depending upon the size of the Park and the extent to which its grounds imitate the country, these lists apply fairly well to any park in the northeastern states. The more general reasons for the excellence of a park as an aviary for migratory birds hold true for every city in the United States. The reader is cordially invited to make the experiment for himself.

ANNOTATED LIST OF THE BIRDS OF CENTRAL PARK

A.—Species of Regular or Normal Occurrence (116)

Pied-billed Grebe.—Rare on the park lakes, chiefly in April and October.

Herring Gull.—Common in winter on the reservoirs.

Black Duck.—Descendants of wild birds are resident on the lakes.

Green Heron.—Uncommon, but regular in May, August, and September.

Night Heron.—Seen annually between late April and October.

Solitary Sandpiper.—Rare in May, August, and September.

Spotted Sandpiper.—Common around the lakes and reservoirs in May and August.

Sharp-shinned Hawk.—Every year in late spring and early fall.

Duck Hawk.—A possibility throughout the year on pigeon hunting excursions.

Pigeon Hawk.—Recorded almost every year in late April or early May.

Sparrow Hawk.—Found throughout the year.

Fish Hawk.—Recorded almost every year, chiefly in May.

Screech Owl.—Several resident pairs.

Yellow-billed Cuckoo.—Once or twice a year in late May or early fall.

Black-billed Cuckoo.—Once or twice a year in late May or early fall.

Kingfisher.—Common around the lakes, chiefly in May and August.

Hairy Woodpecker.—Rare in fall, sometimes spending the winter.

Downy Woodpecker.—Permanent resident.

Sapsucker.—Uncommon in spring (April); common late September and early October.

Red-headed Woodpecker.—Rare in May and September.

Flicker.—Common summer resident.

Whippoorwill.—Occasionally found in May.

Nighthawk.—Common all summer, roosting on dead branches.

Swift.—Common all summer.

Hummingbird.—Seen every year in late May and August.

Kingbird.—Seen every year in May and August.

Crested Flycatcher.—Seen every year in May and August.

Phoebe.—Common in early spring and late fall.

Olive-sided Flycatcher.—Rare in late May and August.

Wood Pewee.—Regular in May and early September; one or two pairs breed.

Yellow-bellied Flycatcher.—Every year in late May and August.

Least Flycatcher.—Common in May and August.

Blue Jay.—Uncommon in early May and October.

Crow.—Occurs every year, chiefly in late April and August.

Fish Crow.—Occurs nearly every year, chiefly in May and August.

Starling.—Common permanent resident.

Red-winged Blackbird.—Seen every year in spring and fall.

Baltimore Oriole.—Regular summer resident.

Rusty Blackbird.—Seen annually in April or May, sometimes in October.

Purple Grackle.—Common summer resident, late February to November.

Bronzed Grackle.—Occasional in early spring or late fall.

House Sparrow.—Common permanent resident.

Purple Finch.—Uncommon in spring, common in fall.

Goldfinch.—Common both spring and fall.

Pine Siskin.—Irregular, chiefly in May and October.

Savannah Sparrow.—A few nearly every spring and fall.

White-crowned Sparrow.—Seen nearly every year in May or October.

White-throated Sparrow.—Very common both spring and fall, sometimes wintering.

Chipping sparrow.—Regular in April and October.

Field sparrow.—Common both spring and fall.

Junco.—Abundant on migration, sometimes wintering.

- Song Sparrow.—Common on migration; sometimes nesting and wintering.
- Lincoln's Sparrow.—Seen every year in May.
- Swamp Sparrow.—Common both spring and fall.
- Fox Sparrow.—Usually common in early spring and late fall.
- Towhee.—Very common, spring and fall.
- Rose-breasted Grosbeak.—Common in May, rare in fall.
- Indigo Bunting.—Regular in late May, rare in fall.
- Scarlet Tanager.—Common every spring and fall.
- Barn Swallow.—Common both spring and fall.
- Tree Swallow.—Seen every spring; common in August.
- Bank Swallow.—Seen nearly every year in May.
- Cedar Waxwing.—Irregular in spring, often common in fall.
- Red-eyed Vireo.—A few pairs nest; common on migration in May and September.
- Yellow-throated Vireo.—About one a year in May.
- Solitary Vireo.—Common both spring and fall.
- White-eyed Vireo.—Uncommon in May.
- Black and White Warbler.—Abundant in May, August and September.
- Worm-eating Warbler.—Seen almost every year in May and August.
- Blue-winged Warbler.—Uncommon May, common August.
- Golden-winged Warbler.—Rare in May and August.
- Nashville Warbler.—Common in May and September.
- Tennessee Warbler.—Irregular in May; common in August and September.
- Parula Warbler.—Abundant in May, common in fall.
- Cape May Warbler.—Seen annually in May, August and September in varying numbers.
- Yellow Warbler.—Common in May and August, a pair usually nesting.
- Black-throated Blue Warbler.—Common both spring and fall.
- Myrtle Warbler.—Abundant both spring and fall.
- Magnolia Warbler.—Very common in May, common in early fall.
- Chestnut-sided Warbler.—Common in May and early September.
- Bay-breasted Warbler.—Common in late May and August.
- Blackpoll Warbler.—Common in May, abundant in fall.
- Blackburnian Warbler.—Common in May, uncommon in early fall.
- Black-throated Green Warbler.—Abundant in May, common in fall.
- Pine Warbler.—Common in April; very rare in fall.
- Palm Warbler.—Rare in spring, regular in fall.
- Yellow Palm Warbler.—Common both spring and fall.
- Prairie Warbler.—Common in May and September.
- Ovenbird.—Abundant in May, rare in fall.
- Water Thrush.—Common in May, August and September.
- Louisiana Water-thrush.—Rare both spring and fall.
- Mourning Warbler.—Rare in May and August.
- Maryland Yellow Throat.—Abundant both spring and fall.
- Yellow-breasted Chat.—Seen every year in May; very rare in fall.
- Hooded Warbler.—Uncommon in May and August.
- Wilson's Warbler.—Common in late May, rare in fall.
- Canadian Warbler.—Very common in May, August and September.
- Redstart.—Abundant both spring and fall.
- Catbird.—Very common both spring and fall.
- Brown Thrasher.—Very common both spring and fall.
- House Wren.—Seen every spring in late April and May; rare in fall.
- Winter Wren.—Rare in May and October.
- Brown Creeper.—Common both spring and fall.
- White-breasted Nuthatch.—Uncommon in fall, rare in spring.
- Red-breasted Nuthatch.—Irregularly common in fall, rare in spring.
- Chickadee.—Uncommon in October, sometimes wintering.
- Golden-crowned Kinglet.—Uncommon in April, common in October.
- Ruby-crowned Kinglet.—Very common both spring and fall.
- Gnatcatcher.—Rare in spring, very rare in fall.
- Wood Thrush.—Seen annually in May, and sometimes in fall.
- Veery.—Fairly common in May, rare in fall.
- Gray-cheeked Thrush.—Common in May and September.
- Olive-backed Thrush.—Very common in May and September.

Hermit-thrush.—Common in April, early May and October.

Robin.—Common summer resident.

Bluebird.—Uncommon in early spring and late fall.

B.—Species of Very Rare or Casual Occurrence (75)

Holbøll's Grebe.—Casual on the reservoir; twice.

Horned Grebe.—Casual on the reservoir; three times.

Loon.—Occasionally noted flying over; once on the reservoir.

Iceland Gull.—Once on the reservoir in winter.

Great Black-backed Gull.—Once on the reservoir in winter.

Laughing Gull.—Casual on the reservoir in late summer.

Common Tern.—Once in late summer.

American Merganser.—Four winter records on the reservoir.

Red-breasted Merganser.—Twice on the reservoir, April and October.

Hooded Merganser.—Once in late November.

Green-winged Teal.—Once in fall.

Wood Duck.—Formerly rare in spring and fall; only one record in the last ten years.

Redhead.—Casual; once.

Scap Duck.—Casual; twice.

Ruddy Duck.—Casual; twice.

Canada Goose.—Tame birds are resident; wild birds on migration are seen flying over about once every ten years.

American Bittern.—Very rare in spring; five records.

Great Blue Heron.—Casual; three times.

Coot.—Once many years ago.

Woodcock.—Now casual; three times in the last twenty-five years.

Least Sandpiper.—Once in May.

Greater Yellowlegs.—Twice.

Killdeer.—Once many years ago.

Bob-white.—Formerly resident; long since extirpated.

Ruffed Grouse.—Formerly resident; long since extirpated.

Mourning Dove.—Very rare on migration.

Turkey Vulture.—Once.

Marsh Hawk.—Casual; no record in twenty years.

Cooper's Hawk.—Very rare; five times in past eighteen years.

Red-tailed Hawk.—Casual, no recent records.

Red-shouldered Hawk.—Casual, no recent records.

Broad-winged Hawk.—Very rare, only once in past twelve years.

Rough-legged Hawk.—Once.

Bald Eagle.—Twice.

Long-eared Owl.—Four times in winter.

Barred Owl.—Formerly resident; extirpated years ago.

Saw-whet Owl.—Three times in winter.

Snowy Owl.—Once in winter.

Red-bellied Woodpecker.—Once.

Acadian Flycatcher.—Rarely identified in spring.

Alder Flycatcher.—Rarely identified in spring.

Bobolink.—Very rare in May and August.

Cowbird.—Very rare in April and October.

Meadowlark.—Casual.

Orchard Oriole.—Very rare in May.

Pine Grosbeak.—Two winter records.

American Crossbill.—Very rare and erratic visitant.

White-winged Crossbill.—Twice in winter.

Redpoll.—Very rare and irregular in winter.

Snowflake.—Twice in winter.

Vesper Sparrow.—Casual; twice in last twenty years.

Grasshopper Sparrow.—Once.

Seaside Sparrow.—Once.

Tree Sparrow.—Very rare in winter.

Cardinal.—Formerly resident, now extirpated.

Dickeissel.—Once.

Purple Martin.—Only five records.

Cliff Swallow.—About once in five years in May.

Rough-winged Swallow.—Once.

Northern Shrike.—Very rare in winter.

Migrant Shrike.—Once.

Philadelphia Vireo.—Twice in September.

Warbling Vireo.—Now very rare in May.

Prothonotary Warbler.—Three records in spring.

Orange-crowned Warbler.—Once in September.

Cerulean Warbler.—Once in May, once in September.

Yellow-throated Warbler.—Once in spring.

Kentucky Warbler.—Very rare in May.

Connecticut Warbler.—Twice in May; four times in September.

Pipit.—Casual on migration; four records.

Mockingbird.—Casual; five times.

Carolina Wren.—Rare and irregular visitant.

Long-billed Marsh Wren.—Three times in May.

Tufted Titmouse.—Once in May.

The European Starling as an American Citizen

By FRANK M. CHAPMAN

Curator

THE American Museum may claim the doubtful honor of being the birthplace of the first European starlings to be born in this country. It was soon after their release in Central Park in 1890 that William Richardson, then of the department of taxidermy, found a starling's nest under the eaves at the northeast corner of the north wing.

Since that date, the Museum has extended its area from Columbus Avenue to the park, but in the same period the starling has extended its range, locally, from Montreal to Florida and Ohio. The one hundred birds freed in 1890 and 1891 now have millions of descendants. The starling has come to stay. Nature has accorded him his "papers" and he exercises all the privileges of citizenship.

It is a singular thing that both the starling and English sparrow were introduced into New York City by the same person. Impressed by the abundance of birds in England and by what he believed to be their comparative scarcity in this country, Eugene Schieffelin determined to make good the deficiency.

Inspired by the highest motives, he might, under proper direction, have become the father of bird conservation in America and have saved for us species we shall never see in life again. But like many another pioneer reformer, he blazed a false trail. Organizing and incorporating at Albany a society for the importation of foreign birds into New York State, he followed the introduction of the house sparrow with that of song thrushes, chaffinches,

bullfinches, skylarks, nightingales, and finally the starling. Only the first and last of his attempts to transplant European birds to our shores were successful and in them he took no small amount of pride. Often, after the release of the starlings, he came to the bird department to ask whether any had been seen recently, and he was particularly pleased when he learned that a pair had nested in the building.

These observations, made immediately following the introduction of the starling, when its future in this country was still uncertain, recall the experiences of an earlier generation of ornithologists who, with equal interest, reported seeing English sparrows! I quote from the annals of the *New York Lyceum* for 1867, page 287, where George N. Lawrence wrote:

This familiar European species has been successfully introduced in New York, and colonies have been established at several distant points, where they could have been seen during the past winter. After the extreme cold of last January (1866), when the thermometer marked ten degrees below zero, I noticed them in their usual quarters, apparently unharmed. In Jersey City, also, they are quite numerous. I first observed them in the spring of 1865. A friend, conversant with our local native birds, informed me that he had seen a species in the shrubbery around the church on the corner of 5th avenue and 29th street, with which he was not familiar; on going to ascertain what they were, to my surprise I found them to be house sparrows; they were domiciled in the ivy which grew on the walls of the church, and were quite gentle and fearless, some alighting in the street and dusting themselves quite near to where I stood. I afterwards learned from our associate, Mr. Eugene Schieffelin, that he had been looking after them with much interest; in fact he is entitled to the credit, in a great



STARLING

(Courtesy National Association of Audubon Societies)

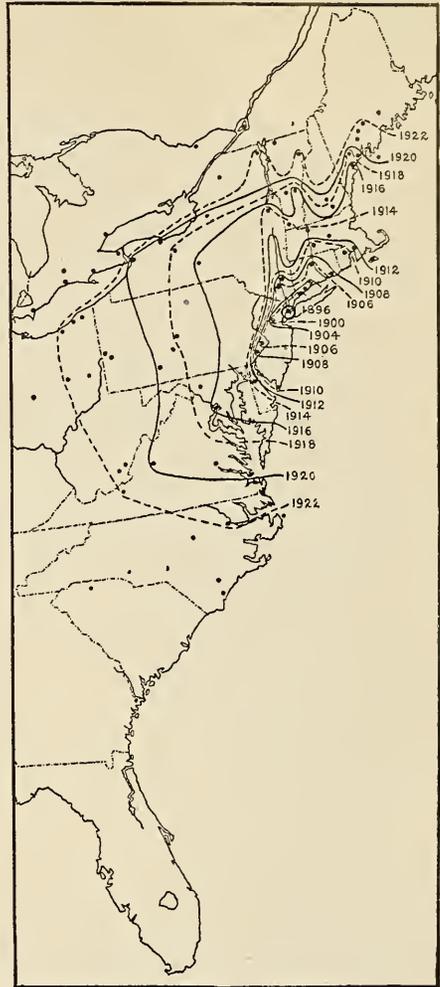
measure, for this important acquisition to our city. In 1860, and for three years thereafter, he yearly set free five or six pairs, mostly in the neighborhood of Madison Square; seven pairs were let out in the Central Park by the Commissioners, in 1864.

After becoming thoroughly established in the upper part of New York City, the starling began the campaign for the acquisition of territory which is still in progress. Following shore lines it spread north, east, and south, and within ten years appeared at Ossining, New Haven, and Bayonne. Another ten years saw it near Providence and Philadelphia and in 1920 it was known from Maine to Virginia.

Having colonized the coastal region, like other emigrants from over seas, it began to penetrate the interior. It reached Ithaca, New York, in 1916, and the same year was found at West Lafayette, Ohio, the first known appearance of the species west of the Alleghenies.¹

The Plains, the Rockies, and the Sierras will probably prove obstacles in the starling's course, but no doubt he will surmount them and sooner or later establish himself throughout the greater part of the country.

During the thirty odd years of the starlings' residence in America, none of our native land birds has appreciably increased in numbers. How, then, has the starling, starting from a few pairs, become more abundant than many of them? In attempting to answer this question we discover some of the factors governing the comparative abundance of species. In the first place, it is evident that the starling has filled a place (technically, an "ecological niche") not occupied by a native species. Without in any way



Breeding range of the European starling in eastern North America. Areas successively covered in two-year periods shown by alternating broken and continuous lines. Spots outside the 1922 line indicate isolated records, mainly in winter. From Dept. Circular 336. U. S. Dept. Agr.

disparaging the American Museum as a home for birds, indeed we always welcome them, what American bird, left to its own resources in Central Park, would have reared a family under our eaves? The European house sparrow (which we insist on miscalling the "English" sparrow) could and does, and like the starling it has succeeded. It is this ability to adapt themselves to circumstances which, primarily, has

¹See "Spread of the European starling in North America" by May Thacher Cooke, Department Circular 336, U. S. Department of Agriculture, Washington, D. C. 1925.

enabled these aliens to survive and flourish in America. Again, like the sparrow, the starling is hardy and non-migratory. This means that he can withstand wide climatic variations and, in default of an inherited habit which would lead him over routes followed by our birds, that he runs no risk of flying out to sea, or to some other place whence he might never return. It is true he wanders about after the nesting season, but his movements are largely governed by a search for food and, probably do not carry him far from his nesting place.

When, therefore, he does have to compete with flickers, or bluebirds, or other hole-nesting species, for a home, he is generally first to arrive and the nine-points of possession are usually in his favor. Moreover, he is pugnacious and not averse to asserting his rights. Also, he is prolific, raising, as a rule, two broods, of which, because of the protective character of the nest-site and defensive ability of the parents, a comparatively large percentage doubtless reach maturity. Need of only limited territory when nesting is also presumably responsible for the starling's rapid increase. In some birds sexual jealousy is so highly developed during the season of reproduction that they will not permit another pair of their own species to nest near them. But, I have recently heard of five pairs of starlings nesting simultaneously in the hollow limbs of a single willow tree. Add to these various traits, omnivorousness in feeding habits, and we have some of the reasons why the starling has multiplied and spread.

Having with thoughtless hospitality accorded the starling, house sparrow, San José scale, gypsy moth, and other pests, including certain members of the genus *Homo*, free and unchallenged

entry to our ports, we now ask (if to our sorrow, we have not already learned), "Are they desirable?" So far as the starling is concerned the question is not to be answered in a word. It can, however, be answered for we have to thank American economic ornithologists for the most exhaustive study of the starling's food habits which have as yet been made.

The first of these, by Edward Howe Forbush, State Ornithologist of Massachusetts, coöperating with the Biological Survey, was published by the State of Massachusetts in 1915;¹ the second, by E. R. Kalmbach and I. N. Gabrielson, was published by the Biological Survey in 1921;² I quote here from the latter. The conclusions therein presented are based on the work of Forbush as well as on much original research including the analysis of the contents of 2466 "well-filled" stomachs and detailed observations of the bird in nature.

The starling is here considered under three counts: (1) its food habits, (2) its relation to other species, (3) its direct relation to man. The study of the starling's food has been conducted with great thoroughness and the results reached doubtless adequately express the bird's economic status at this period of its American history. They are summarized as follows:

As an effective destroyer of terrestrial insects, including such pests as cutworms, grasshoppers, and weevils, the starling has few equals among the bird population of the northeastern United States.

¶ The most serious objection to the starling on economic grounds arises from its destruction of cherries. When its work is combined with that of the robin, which is fully as destructive and much less easily frightened, the chances for a successful crop of cherries, especially of early varieties, are poor.

¹Circular No. 45, State Board of Agriculture, Boston. Svo. 23fpages.

²Bull. No. 868. U. S. Dept. of Agriculture. Svo. 67 pp.

The starling's work on apples is confined largely to isolated trees and to small, old orchards. Late varieties suffer more than those which mature at a time when there is still a great abundance of wild black cherries available. In the aggregate the apple damage is not great and is practically absent in young, well kept, productive orchards. Injury to peaches and pears is negligible, and the damage to grapes is at present confined to small arbors—the large vineyards suffering very little. . . .

results. The decidedly beneficial character of the food habits of one, two, or sometimes three broods of nestlings, numbering 4 to 6 to the nest, adds materially to the favorable economic status of the species.

The starling's competition with American birds is largely restricted to those that nest in holes and similar sites. This includes chiefly the blue-bird and flicker. The former is no

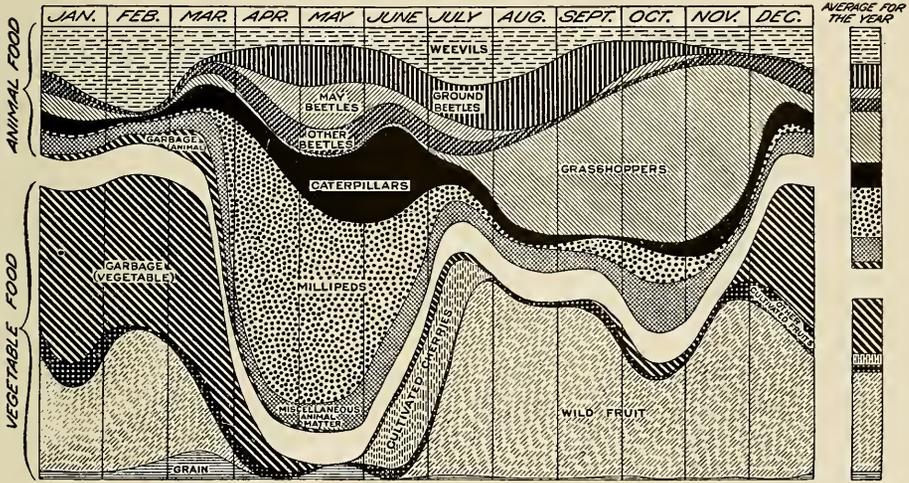


Chart of food of 2157 adult starlings, showing the varying quantities of the principal items from month to month, and the relative monthly average of each item. From Bulletin 868, U. S. Dept. of Agriculture

In the small city or suburban garden the starling's fondness for green stuff in spring and early summer has been the cause of some complaint, but in large truck-crop sections where the bulk of such produce is raised, the aggregate loss is trivial.

An idea of the economic significance of the starling's food habits is gained by comparison with the food habits of certain well-known native birds, with some of which it frequently associates. A thorough consideration of the evidence at hand indicates that, based on food habits, the adult starling is the economic superior of the robin, catbird, flicker, red-winged blackbird, or grackle. It is primarily a feeder on insects and wild fruit—less than 6 per cent of its yearly food being secured from cultivated crops. What damage it does inflict is due not so much to the character of its food habits as to the fact that the flocking habit has allowed some minor trait to be emphasized to a point where local damage

match for the relentlessly persistent alien and even the flicker's larger size does not always prevail against the starling's aggressive tenacity.

Conflict over the food supply is negligible in summer, but serious in the autumn and winter. For example, a dogwood bearing a crop of berries sufficient to supply a group of gentlemanly hermit thrushes with food for a fortnight will be stripped by a flock of starlings in a day. As a result, the thrushes continue their migration southward to winter beyond the present range of the starling. But it is apparently only a question of time when the starling will be abundant in winter at least throughout the Gulf States where

it will claim no small part of the food supply of our native species.

There are times when the starling makes such strong demands upon our hospitality that even its friends resent its presence. This is during the late summer and early autumn when the vast flocks of birds select some city park or village lawn as a roosting place. Grackles, robins, and martins are often associated with them and the whole may number many thousands. To the ornithologist such gatherings possess great interest, but the tired business man, who has come home to sleep, not to study avian communism, sees in them only a source of noise and filth, and spares no effort to induce the birds to move elsewhere. Frequently, however, he finds it difficult to convince them that they are not welcome. The usages of civilization forbid the murder of even the most undesirable guest, and in default of firearms, Roman candles have been effectively employed. Discharged into trees laden with sleeping birds, they create consternation without fatalities and finally make it plain to the feathered throng that, while we may encourage their coöperation in our gardens we can dispense with them after nightfall. But the direct contact of the starling with man extends far beyond its roosting habits. These other relations, however, belong among those "imponderables" which science can neither weigh nor measure. They have to do with the personality of the starling, with its standing as a citizen and as a neighbor.

When a stranger enters an established community, he is bound, more or less, to disturb existing conditions, and the extent and nature of the local reaction to this disturbance determines his community status.

Viewed from this standpoint the

starling is heavily handicapped. In the first place he is a foreigner. Now whatever we ourselves may be, whether our forbears came over in the Mayflower or on the *Mauretania*, there can be no doubt that our birds are Americans. As such they are not only the products but expressions of their environment. When, in early March, a moving nebulous blur resolves itself into a flock of redwings, they are less birds than the Spirit of Spring. But if the hurrying smudge becomes a passing troupe of starlings, we regard it with disappointment or indifference. It has no seasonal significance.

So the notes of the wood pewee voice the dreaminess of a mid-summer day,—uttered by the starling, they are a mimetic travesty. But, after all, it is only the chosen few who cherish these intimate associations with nature that resent the starling's violations of them. To by far the greater number of those who notice him at all, a starling he will be and nothing more.

Considered, therefore, merely as a bird, the starling has much to recommend him. He is trim in form and attractive in color. His summer dress of black with iridescent sheen has claims to real beauty, and the change of plumage which gives him a polka-dot costume in winter increases our interest in his appearance.

As a member of the small group of walkers, (as opposed to hoppers) among perching birds, he has further claims to distinction. We follow with approval his rapid steps as he zigzags his busy way across the lawn, probing to right and left in his stride.

I have often thought that if the house sparrow could sing, he would have attained a popularity he can never hope to achieve—so great is the power of a pleasing voice. While the

starling may not claim high rank as a songster, at least he has a pleasing voice and a wide variety of notes. His most characteristic note is a long drawn, cheerful whistle, human-like in quality and easily imitated.

Less often heard is the starling's musical soliloquy which, with fluttering wings, he delivers, from a more or less exposed position. I heard it on one occasion from a thatched roof beneath which I had slept when every straw seemed vocal, each in its own way. It is a curious melange of chuckles, guttural gurgles, and low whistles, often interspersed with imitations of the notes of other birds.

It is said that more than twenty of our birds are mimicked by the starling, but I sometimes wonder whether some of these alleged imitations are not really resemblances between the starling's natural notes and those of the American bird they recall. I find it difficult, for example, to believe that the starling whistle, which is so remarkably like the call of the wood pewee has in truth been acquired from that bird. It is heard so frequently at such widely separated places, and in localities not frequented by wood pewees that, if it has been learned in America, one must almost believe that it is now an inherited part of the bird's repertoire.

But if the notes of adult starlings have merit, the voice of young starlings uttering their food call is exceedingly disagreeable, harsh, rasping, and insistent; inspired by no higher emotion than that which arises from an apparently unfillable stomach, it rends the air with discord. Nesting among the earliest of our passerine birds, the young of the first brood take wing about May 15, and with ceaseless cries

appeal to their long-suffering parents for food and still more food.

As soon as they have learned to feed themselves the young begin to gather in flocks, while the parents produce a second family. This appears late in June or early July, and when it, too, has been weaned, both young and old join the flocks of the first-born, forming those tremendous gatherings, the aerial evolutions of which constitute the chief claim of the starling to a place in the birds Hall of Fame.

Seen in the spring, we should associate these remarkable activities with some function of the mating season. Occuring in the autumn, not even a latter-day novelist could successfully attribute to them a sexual significance.

A thousand, five thousand, ten thousand birds mount to the sky, animated by one impulse,—the flock becomes a ball symmetrical as a globe in outline; suddenly, with no suggestion of disorder, it lengthens to an ellipse which a moment later, narrowing in the middle and concentrating at the ends, simulates a dumb-bell in form. Again a change, and a dusky snake undulates across the heavens only to telescope on itself and become a ball again.

All these movements are performed with marvelous precision. The thousands of birds act as one individual. There appears to be no leader; no word of command. How can we explain the community of feeling which controls them? It is a dance in the clouds to the music of the winds,—a pure expression of a *joie de vivre*, which raises the industrious plodder of our lawns to an ethereal realm where nationalities are unknown and the glorious heritage of flight is the universal emblem of bird life.



Underwood & Underwood

The Epstein Panel in the Hyde Park Sanctuary Dedicated to the Memory of W. H. Hudson

IN erecting a memorial intended to symbolize the work of one whom we would honor, it is eminently fitting that, theoretically at least, the designs under consideration should be submitted to the memorialized. It is difficult to believe that those responsible for Mr. Epstein's contribution to the Hudson bird sanctuary can have followed this plan. One can imagine Hudson's sensitive nature recoiling from Epstein's strange concept as he would shrink from the publicity which it has aroused.

Bernard Shaw has expressed vigorous approval of this tablet, but he seems as much out of place here as a critic as Epstein does in the rôle of sculptor. Rather should we seek the opinion of Hudson's friends who have an understanding sympathy with his work, and this we find in the appended quotation from the current issue (Vol. XI, No. 6) of *Bird*

Notes and News, the organ of the Royal Society for the Protection of Birds, an organization with which Hudson had the closest association.

"Round the merits and demerits of Mr. Epstein's characteristic panel controversy has raged. The real point, however, is not concerned with Epstein at all, but with the question of an appropriate memorial to Hudson. And the one thing certain is that in order to consider its claims as Art, it is necessary to put away every thought of the man it commemorates and every recollection of the elusive and mysterious maiden of his imagination—'singularly delicate in figure and features,' 'small and slender,' 'with delicately shaped little hands and feet'; 'nimbus of misty hair and silky robe'—so monstrously associated with the figure carved on this Portland stone. Dissociate it from 'Rima' and from W. H. Hudson; regard it only as a representative production of Epstein's peculiar genius; and artistic controversy as to its meaning and merits might be left to work itself out."



ROOSEVELT MEMORIAL BIRD FOUNTAIN

By Bessie Potter Vonnoh, whose design expresses the child's love of birds as symbolic of the ideal relations between birds and man. This fountain, the gift of hundreds of Mr. Roosevelt's friends and admirers, will be placed by the National Association of Audubon Societies in the Roosevelt Bird Sanctuary at Oyster Bay to commemorate Mr. Roosevelt's love of birds and his work for their conservation

Meetings of Ornithological Societies in the American Museum

THE American Ornithologists' Union will hold its Forty-second Annual Congress in the American Museum November 10-12 next, and on the evening of October 27 and the following day the National Association of Audubon Societies will hold its annual meeting here.

In view of these two coming events it will be timely to say a word here concerning these two organizations and also to speak of the Linnæan Society (in effect, a local bird club) which meets in the Museum bi-weekly from October to May.



THE AMERICAN ORNITHOLOGISTS' UNION

The American Ornithologists' Union¹ was organized in 1883 and its first meeting was held in the American Museum on September 26, of that year. The call for this meeting was signed by J. A. Allen, Elliott Coues, and William Brewster, all officers of the Nuttall Ornithological Club of Cambridge, Massachusetts, the parent organization from which the Union sprung.

Forty-eight of the more prominent ornithologists of the United States and Canada were invited to attend this meeting and of this number twenty-one were present. From this beginning the Union had, on January last, a total membership of 1637. Comparison of these figures gives us some conception of the growth of the interest in birds

during the past forty years, a growth for which directly, or indirectly, the Union is largely responsible.

To the Union and its members we owe the formation of the Biological Survey of the United States Department of Agriculture and the inauguration of organized bird conservation through the establishment of the Audubon Societies. The three stand respectively for the Science, Economics, and Sentiment of Ornithology, and cover effectively the principal relations of birds to man.

The annual meeting of the American Ornithologists' Union is an event which no bird lover should miss if he can possibly arrange to be present. The days are devoted to the presentation and discussion of bird studies made in field and laboratory, the evenings to social gatherings where the members have an opportunity to meet and exchange experiences.

The program of the meeting for 1924, which was held at the Carnegie Museum in Pittsburg, included the titles of fifty-six papers. They were based on observations made throughout the greater part of the world. Many were illustrated with lantern slides and one whole afternoon was devoted to the showing of motion pictures. There was also an exhibition of paintings of birds in which thirty-one artists were represented by 140 subjects. It is proposed to hold a similar exhibition in connection with the Congress this year.

The Union changes its place of meeting each year and probably will not visit New York City again for six years or more. Local bird lovers,

¹An article on the history of the Union, by T. S. Palmer, was published in the October, 1918, issue of the AMERICAN MUSEUM JOURNAL. The facts in relation to the Union's formation are taken from Doctor Palmer's article.

whether or not they are members of the Union, should not fail, therefore, to attend the Congress of November next. Information regarding the program, hours, etc., may be obtained by addressing the A. O. U. Committee of Arrangements, care of the American Museum.



NATIONAL ASSOCIATION OF AUDUBON SOCIETIES

The Twenty-first Annual Meeting of the National Association of Audubon Societies will be held in the American Museum of Natural History on Tuesday, October 27, 1925. A public meeting will be held in the main lecture hall the night before. On this date, as at former annual meetings of the Association, there will be gathered here from many parts of the country, people interested in the study and preservation of wild birds and wild animals. The reports and addresses, especially those made at the night session, are of popular interest, and the general public is cordially invited to attend.

The officers and directors of the Association will have to report a very large volume of activities in various fields of the Association's endeavor. In the Junior Department, for example, the extension work among the children has been unusually successful during the year, nearly 300,000, having been enrolled throughout the United States and Canada as members of bird-study clubs, where, under the guidance of teachers, and by means of the literature supplied by the Association, they have been taught the great lessons of the beauty and value of America's wild bird life.

These clubs of young people have

built and erected tens of thousands of bird boxes; have given hundreds of entertainments where programs have been rendered to the delight of their fellow-students and visiting parents; feeding shelves by the thousands have been put in position at schoolroom windows or on the snow-covered lawns at home, and the cause of bird protection throughout the country has been stimulated by the activities of these keen, youthful observers.

The Association has maintained its far-flung line of wardens who guard colonies of water birds along our coast from the Canadian line to Mexico and in many of the interior swamps of the Southland.

Five lecturers have been supported in the field. A representative working for game protective measures was kept in Washington throughout the session of Congress.

The work of the International Committee for Bird Protection, an outgrowth of the Association's effort started three years ago, has now spread to fifteen countries, and the New York office at 1974 Broadway, is in constant touch and exchanging ideas with workers in the field of bird protection in many European countries, as well as in South Africa, Australia, and far-off Japan.

The Association has continued the enlargement of its series of colored pictures of birds, reproduced from original paintings by America's leading bird artists. Two of the plates accompanying this issue of *NATURAL HISTORY*, are samples of the pictures issued by the Association to the extent of two million or more annually.

The National Association of Audubon Societies has for many years been the largest institution in the world devoted to the protection of wild life, and its

influence during the twenty-one years of its incorporative history has been written large upon the minds and hearts of mankind.



THE LINNÆAN SOCIETY OF NEW YORK

The Linnæan Society of New York was founded on March 7, 1878, by ten young men, most of whom in later years became distinguished naturalists. While the name suggests that the founders aimed to develop a general society of natural history, their professions soon scattered them to various parts of the United States, and this aim was never fulfilled. In the meantime the strongest interest of the Society had been ornithology, and the new members that have joined have been attracted by the emphasis laid on this particular branch of zoölogy.

For many years the Society was exceedingly small, and it was somewhat surprising that the largest city in the country produced far fewer amateur ornithologists than much smaller places. Had it not been for the devotion of Dr. J. Dwight, the Society would probably have expired. He did not retire from the presidency until a group of active students had grown up competent to direct its activities.

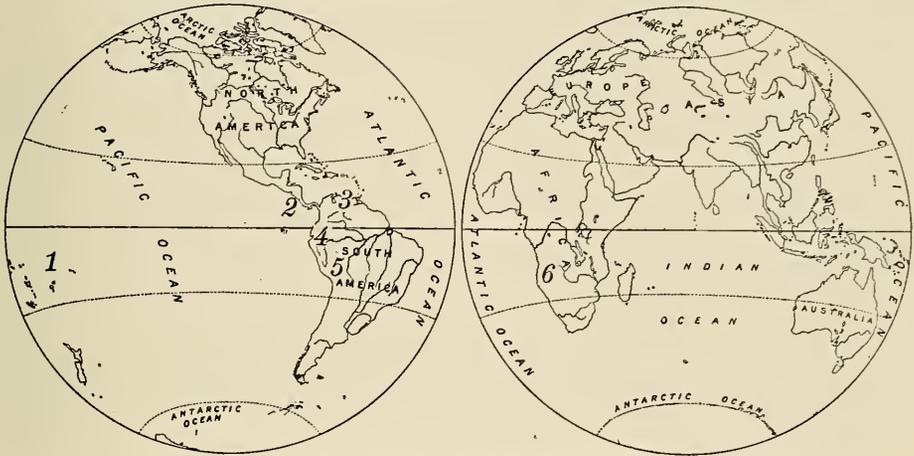
During the past five years under the

presidency of Mr. J. T. Nichols of this Museum, the active membership has greatly increased, the average attendance at meetings being forty or more, and in addition to the presentation of a formal paper, the reports of field work often consume an hour. The Society coöperated with the Museum in the preparation of a detailed *Handbook of the Birds of New York City Region*, and the members of its Local Avifauna Committee rendered important additional assistance. A recent *Abstract of Proceedings No. 36* gives considerable supplementary information. Those parts of the "Local Region" where detailed knowledge of the bird life was particularly defective are now being especially investigated by competent members, as Mr. Miller shows in his article on the bird life of northwestern New Jersey, in this number of NATURAL HISTORY.

All those interested in birds in the vicinity of New York City are urged to affiliate themselves with the Linnæan Society. The meetings are held the second and fourth Tuesday evenings of each month from October to May inclusive at the American Museum of Natural History. The dues are only three dollars a year. The meetings will stimulate the interest of all bird lovers, and they will find companions to share it. They will gain information, new ideas, and a broader viewpoint.



REPORTS FROM THE FIELD



LOCATION OF MUSEUM EXPEDITONS

1. Beck 2. Benson 3. Tate 4. Ollala 5. Watkins 6. Boulton

BECK IN THE FIJIS

After four years among the islands of Polynesia, travels which have been described from time to time in *NATURAL HISTORY*, the Whitney South Sea Expedition nearly a year ago transferred its base to the Fiji group. Here during many months Mr. Beck and his associates have painstakingly worked not only the larger high and forested islands but also a good proportion of the outlying more or less uninhabited islets of this Melanesian archipelago. The expedition has recently moved on once again, this time to Tonga, or back from the territory of the frizzly-haired oceanic negroids into that of one of the tallest and handsomest branches of the brown-skinned Polynesian people.

In the meanwhile, the collections obtained in Fiji, assuredly the finest representation of the land and sea birds of these islands ever brought together, have reached the Museum and have been made available for study.

The wealth of Fijian land bird fauna proves to be surprisingly great. In Suva, the capital of the Fijis, as in Papeete, the metropolis of French Oceania, the introduced Asiatic starling or minah is usually the first bird which the visitor encounters. Other imported and now well-established species, moreover, are likely to come to his attention before he

has seen or heard the first native Fijian bird. The pleasant notes of an Indian bulbul or the cooing of the ringdove, for example, may be the first bird music to strike his ear. When one gets farther afield, however, foreign birds are no longer in evidence except at a few of the islands into which the owners of plantations have introduced them. At Thithia Island, for instance, Mr. Beck was surprised to find a considerable flock of minahs which, however, clung chiefly to territory within a hundred yards of the dwelling and out-buildings about which they lived.

Fiji has a far larger and more varied land bird population than the Pacific islands more remote from the Asiatic continent and the Malaysian region. Gorgeous parrots, pigeons clad in orange or golden plumage, native weaver birds, and a variety of species of hawks, thrushes, old-world warblers and flycatchers combine to lend great charm and importance to the bird life of the group. One of the features in distribution which impressed Mr. Beck is the extremely limited range of certain birds which would seem to be well equipped for flying from island to island. At Matuku Island the expedition first made the acquaintance of the so-called barking pigeon which, according to Mr. Beck's notes, has the voice of "an aged, well-fed, medium-sized dog."



Photograph by R. H. Beck

Visitors to the "France." Dancers of a Fijian chief brought on board the Museum schooner to render a *meke* or native dance, during the performance of which the participants remain seated

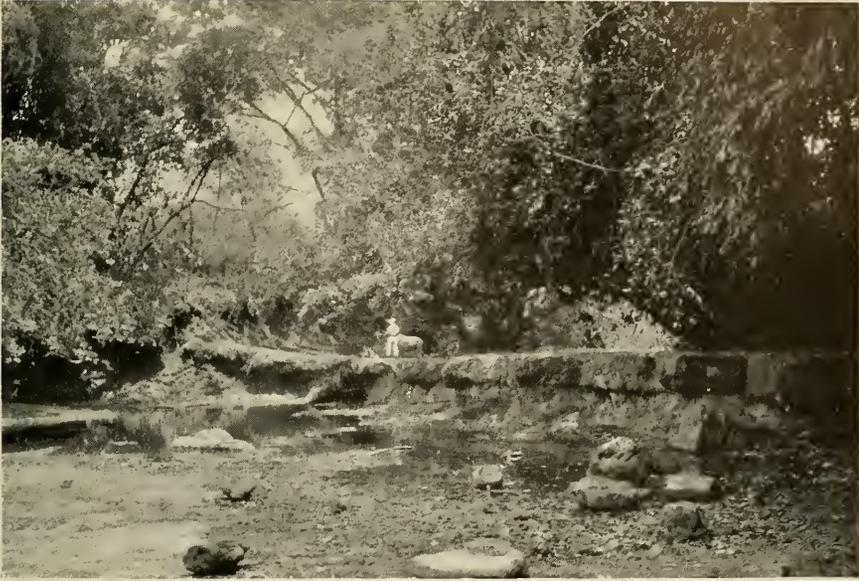
To certain other islands within sight of Matuku, however, the barking pigeon apparently never makes its way. Again, the islands of Totoya and Kambara are but forty-five miles apart, and yet each harbors a different species of pigeon. Sixty miles to the northward is Naiau where both the Totoya and the Kambara species, as well as the barking pigeon, all occur together, and yet the last has never worked its way along the adjacent string of apparently suitable islands, no two of which are separated by a greater distance than sixteen miles.

Some of the smaller land birds are still more sedentary residents of their respective islands, while in some other cases the expedition found evidence of very wide-spread range in the search for a well-suited environment. The small, clear-voiced whistler, which is common on Wangava Island at the south end of the Lau division of the Fiji group, cannot be found either on Kambara, three miles away, or on Marambo, six miles away. But why the mottled honeyeucker, common to Tonga, Samoa, and many islands of the Fijis, should elect to thrive on Marambo and avoid the much larger and more attractive island of Kambara, which is but six miles away, passes the understanding of the naturalists of the

"France," and why from Marambo and Fulonga, which are twelve miles apart, the same species should jump over Namuka only to reappear on Mothe, residing there as well as on half-a-dozen successive islands for fifty miles northward to the village of Loma Loma, on Vanua Mbalavu—these are among the puzzling field problems. Moreover, this temperamental honeyeucker apparently finds the northern limit of its range within the borders of the village of Loma Loma, with ten miles of what would seem like perfectly adapted country stretching on beyond. Finally, it seems to avoid Kanathea and Naitamba, respectively ten and twelve miles west of Vanua Mbalavu Island, only to reappear on Yathata, thirty miles beyond.

Such are only a few examples of one special group of problems in the most fascinating insular region of the earth.

Mr. and Mrs. Josè G. Correia, who have for several years been associated with Mr. Beck in the South Pacific work, continue to render the Museum splendid service—often under very difficult conditions. Mrs. Correia, who had had no previous experience, has developed into an unusually skilful preparator; her bird skins, for example, are among the best specimens ever received from the field.



Photograph by Rudyerd Boulton

Typical river scene in the semi-arid country near Santiago, Panama

BENSON IN PANAMA

Mr. R. R. Benson, whose explorations in the field are being financed by Mr. Griscom, has recently returned to Santiago, Veraguas, after spending the dry season in the mountains back of Santa Fé, where he secured more than one thousand specimens in a little over two months. He writes on April 1 as follows: "Seven hundred and ninety birds made up and boxed, ready to ship, since I arrived on February 14, is my main excuse for not having written since leaving Santiago. But there have been other reasons also; rain every day except the last week, an eternal wind, a heart-breaking hill to climb every day, and the never-ending battle to keep the two boys I have with me from deserting. However, am still going and have three hundred shells left, so hope to complete up to a thousand skins in the next ten days. . . From what I have seen and learned of the country I am satisfied that the division point (between the faunas of western Chiriqui and Veraguas) we are looking for is far from Santa Fé. To get to Calovevora will be impossible this summer. It is more than two days from here, and no horse can get there; everything must be packed in by men. . . There are quetzals (paradise trogons) only a short distance east of Santa Fé. I did not see them, but they are well

known there and I am perfectly satisfied with the evidence. . . The highest point here approximates the highest point we reached on the Cerro Flores; a little less moss and an occasional patch of earth underfoot. But very few birds on the summit, high wind and always wet and cloud-bound. As to climate, you would enjoy it. I use a sweater after night fall and sleep in a sleeping bag."

Mr. Benson's hope that his collection would contain some interesting things has been amply justified. It contains several new subspecies, one cactus wren new to the avifauna of Panama, and many rare and little-known species discovered here sixty years ago by Arcé, whose collections are in Europe. Mr. Benson could hardly be expected to obtain in one season all the species which Arcé obtained in several, but a year's work has added many which Arcé never found, and the American Museum already has 398 species represented in a region from which only 400 have been recorded. Scarcely fifty species were previously represented by specimens in American museums from this section. Mr. Benson is now in Santiago, Veraguas, outfitting for a trip south into the Macaracas region in the center of the Cape Mala peninsula. Altitudes are reported as high as 4000 feet and no collections exist from this section.

TATE IN VENEZUELA

Between February and June, 1925, G. H. H. Tate, accompanied by H. J. Clement, collected birds and mammals in northeastern Venezuela securing nearly 1000 of the former and some 400 of the latter.

Their collecting stations in the Tropical Zone were at Cumanacoa (700 ft.), a small town in a flat arid tropical plain; San Antonio de Maturin (1800 ft.); Neveri Valley (2400

OLALLA AND SONS IN EASTERN ECUADOR

Until Joseph H. Sinclair visited eastern Ecuador in 1921, the existence of Mount Sumaco was semi-mythical. It appears on the map of Villavicencio (1858) but is not included in the far more authoritative map of Wolf (1892). When, therefore, Sinclair returned with an actual photograph of the mountain and a statement that it attained an



Photograph by G. H. H. Tate

A part of the summit of Mt. Turumiquire, the highest mountain in northeastern Venezuela

ft.), where they first found humid forests; and Cocollar (2600 ft.) in the arid uplands. At Carapas (5600 ft.) Mr. Tate writes: "Here and in the adjacent coffee plantation of La Trinidad, on the flanks of Mt. Turumiquire, we found the first tree ferns and met with many subtropical birds. This is the upper limit of cultivation and from this point five days were required to cut a trail through the tangled vegetation and up the precipitous slopes to the unexplored summit of Mt. Turumiquire. This, according to our aneroid, has an elevation of 9750 feet. We camped at 7900 feet. The summit of the mountain is covered with brush immediately below which there is heavy forest. Life, however, is scarce and we secured here only nine species of birds and two of mammals."

Before leaving New York Mr. Tate had been urged to reach the summit of Turumiquire and only those with experience can realize the persistence and determination which were required to enable him to attain his objective.

elevation of 12,700 feet, our interest in its fauna was at once aroused.

Sinclair writes:¹ "Forty-four miles below Napo we observed a lofty cone-shaped peak about 30 miles to the northwest, which we were told was named Sumaco. Vertical angles and intersections to this from several places on our traverse determined the exact location and gave its elevation as 12,700 feet above the sea. Sumaco is beyond all question the most remarkable physiographic feature we saw on the Amazon plain. We believe our expedition is the first to locate it accurately and to obtain its elevation."

Prior to the publication of his observations Sinclair had told us of them, and during an expedition to Ecuador in 1922, I casually inquired of Ramon Olalla, a native collector in our employ, if he had ever visited Mt. Sumaco. To my surprise he promptly replied that he had and followed this statement with convincing evidences of its accuracy. Asked if he

¹Geographical Review, 1923. p. 196.

would go there for the Museum, he said, "Si, señor," and when I added "When?" without hesitation he responded "Mañana."

Ramon's father, Carlos Olalla, vetoed so early a departure, but in due time he, with Ramon and two other sons, for whom we suggested the firm name, "Olalla e hijos," agreed to visit Sumaco and collect its birds from base to summit.

Within two years they had fulfilled their contract, and we now have in the museum a collection of beautifully prepared birds' skins which adequately illustrate the avifauna of the region from which the mountain rises and also the life zones on its slopes. Among them are members of species not before contained in the Museum, and several, including one genus, new to science.

Knowing that the Guacamayo range which connects Sumaco with the main Andean chain does not rise above subtropical elevations, we had hoped that the Temperate Zone on Sumaco would prove to be wholly insular in character. But its bird life is practically identical with that of the corresponding zone on the eastern Andes and this close faunal affinity implies near orographic relationship.

We supplied the Olallas with a thermometer and requested them to make daily records of the temperature at sunrise and at sunset. These records, in connection with their collections, give us a fairly accurate conception of the limits of life zones. When, for example, in ascending the Rio Suno, they reached the old town of San José on the flanks of Sumaco, the birds sent to us indicated that they had reached the lower borders of the Subtropical Zone, and this supposition was supported by the temperature record which shows a fall of 4 degrees centigrade (from 18° C to 14° C = 64.4° F. to 57.2° F.) in the morning and of 5 degrees (from 21° C to 16° C = 69.8° F. to 60.8° F.) in the evening.

Similarly, at the localities from which were sent birds characteristic of the Temperate Zone, the morning temperature fell to 6° C (42.8° F.) and the evening temperature to 10° C (50° F.).

The Olallas also kept a record of their itinerary. It gives, as a rule, only a date and place, or the briefest explanation of the cause of some delay, but one familiar with the conditions they were obliged to encounter, can read between the lines the story of events which less-seasoned travelers would have made the basis

of tales of hardship and adventure. Here, for example, is a quotation from the account of their return from the Rio Suno, near the base of Sumaco, toward Quito.

"El veintiseis de Abril emprendimos viaje para Quito haciendo las jornadas siguientes. El veintiseis llegamos al Rio Huataraco, el 27, el 28, el 29, nos detuvo dicho rio ha motivo de la creciente. El treinta llegamos al Rio Tucuno. El 1, el 2, el 3 paramos detenidos por este caudaloso rio. El cuatro llegamos a un lugar llamado Huayrachina. El cinco llegamos al Rio Cotapino. es decir a las cabeceras, el seis llegamos al Rio Bueno. El 7, el 8, el 9, el 10, el 11, nos detuvo este mismo por sus fuertes crecientes. . . "

Which freely translated reads: "April 26, 1923, we began our trip toward Quito, making the following daily journeys: The 26th, we reached the Rio Huataraco. The 27th, 28th, and 29th, we were detained by flood in this river. The 30th, we reached the River Tucuno. The 1st, 2nd, and 3rd of May we were detained by this great river. The 4th, we reached a place called Huayrachina. The 5th we reached the headwaters of the Rio Cotapino. The 6th we reached Rio Bueno. The 7th, 8th, 9th, 10th and 11th we were detained by heavy floods in this river."

These entries show that eleven of the first sixteen days of their journey were passed waiting for rivers to fall to fordable depths. Doubtless the only shelters available were palm-thatches erected by themselves. The country offers no dependable food supply and a five-day journey which is expanded to sixteen days, implies, where one's back is the only means of transportation, an uncomfortable shortage of rations.

Reaching Archidona May 17, they were detained for lack of carriers until June 6 and finally reached Quito on June 14.

On April 25, 1924, Carlos Olalla fell while crossing a river on the flanks of Sumaco and severely injured his leg, forcing them to leave hurriedly for Quito. Baeza was reached on May 6, but the "inflamación gravísima" in the injured member and the almost impassable condition of the trails, forced them to wait here until both the patient and the going had improved.

Their work on Sumaco finished, the Olallas are now collecting for us in other parts of eastern Ecuador.



Photograph by H. Watkins

Some natives of the Marañon at Pomará, Perú

WATKINS ON THE RIO MARAÑON

After two years' constant field work, Harry Watkins, who has so effectively represented the Museum in Peru, has completed a section from the arid coastal region near Payta to the humid Amazonian forests on the Marañon at Pomara above the Pongo de Manseriche. For the first time, the bird life of this region of exceptional faunal importance is adequately represented by specimens. While Watkins secured an unexpected number of new species, his collections are chiefly valuable for the information they afford concerning the origin of many species of the equatorial arid fauna of the Pacific Coast and of the relationships of this fauna to that of the Marañon valley.

At Porculla, not far south of the trail between Piura and Huancabamba, the summit of the western Andes attains an elevation of only 7078 feet, the lowest point between Pacific and Amazonian drainage in the Andes, making it probable that the ranges of certain birds characteristic of the Marañon Valley and Pacific Coast may still be continuous.

The last state of Watkins' journey down the Marañon to where Amazonian forests are first

encountered, was made with no little difficulty. Watkins writes: "The natives of Jaen are so afraid of entering the Indian territory on the Marañon that I was quite unable to get even a boy to accompany me as *arriero*. Fortunately, I have my own animals and I was able to entice an American missionary and his wife to join Mrs. Watkins and me on the expedition. They had been some time in Jaen and wanted very much to know that country but had no means of getting there. He helped me with the mules and, after quite an exciting trip over trails that were never meant for large animals, we accomplished our object."

With that take-it-for-granted spirit which sees in risk and adventure only the day's work, Watkins says nothing about the Indians, but that he found them is evidenced by his photographs, of which we here reproduce one.

Returning from Pomará, Watkins made a shipment of 800 birds from Piura and then went back to Jaen to travel up the Uteubamba with the especial object of learning the northern limit of the humid temperate zone in the East Andes of Peru.

At the very beginning of this journey, in

crossing the Marañon, he had the misfortune to lose his saddlebags containing about one-hundred dollars in silver and, what was even more valuable, his aneroid barometer. He writes: "The river was very high and the only means of crossing it was by *balsa*, or rather, what the people at Bellavista call a *balsa*, consisting of six small logs roped together. As this contrivance would hold only 200 pounds, we were from 6 A.M. to 9 P.M. in making the many crossings necessary and dragging the animals over . . .

"As I was holding on to the bit of one animal with one hand and leading two full-laden cargo animals with the other, and it was almost dark, I did not see the saddlebags drop or notice that they had fallen until we crossed other branches and were unloading."

The presence of bubonic plague prevented Watkins from reaching Chachapoyas where it was reported that 400 Indians had died. Meanwhile he had found heavy Temperate Zone forest where, he writes, he found many birds new to him.

The animals, he reports, are all in good condition, and adds that the "natives think it wonderful they could have traveled so far, as their beasts are rarely able to make the journey from Jaen. After this trip I believe that they can get over anything, for they are now well-trained at climbing, swimming rivers, fording, and balancing along two-pole bridges." Supplies sent to Watkins by way of Pacasmayo have unfortunately been held up on the coasts by the phenomenal rainfall in western Peru this past spring, but with his usual resourcefulness, we know that in some way he will get them.

BOULTON IN ANGOLA

Mr. Arthur S. Vernay, who has already done so much to enrich our collections with mammals and birds from India and Siam, has recently turned his attention to Africa, a

continent unrivalled for its big game. The main purpose of the Vernay Angola Expedition is the securing of specimens of the giant sable antelope. A general collection of vertebrates is also being gathered; and Mr. Herbert Lang, formerly in charge of the Congo Expedition and now acting as general manager of the Angola expedition, is accompanied by Mr. Rudyerd Boulton, who will devote special attention to the birds of the region traversed. Last year he was a member of Mr. Ludlow Griscom's party in western Panama. Messrs. Lang and Boulton sailed from New York on March 14th, to be joined by Mr. Vernay in June.

Work was begun at Lobito Bay on the coast of the province of Benguella, and continued along the railroad that penetrates the interior highlands. News has already come of the success of the party, and their collections include several hundred birds from country that was hitherto a total blank on our operations map.

The highlands of Benguella offer a peculiar interest for the zoogeographer in that they harbor many species closely allied to those of the East African plateaus, there being a continuous highland connection by way of the Upper Katanga. The fauna is at the same time much less like that of the more humid and lower district of northern Angola which resembles the western Congo basin. It also differs widely from that of the drier country of Damaraland to the southward.

Some forty-five years ago a notable collection of Benguellan birds was made for the Lisbon Museum by Senhor Anchieta; but since that time almost the only collection of any size was gathered by Dr. W. S. Ansoerge for Lord Rothschild and the British Museum. A number of peculiar species of birds are known to be restricted to the region, and it is with pleasant anticipation that we look to their being procured for the American Museum through the generosity of Mr. Vernay.



NEWS FROM THE STUDY



THE STAFF OF THE BIRD DEPARTMENT

Front row, sitting, Griseom, Miller, Chapman, Murphy, Chapin

Back row, standing, O'Brien, Mrs. Fraser, Dwight, Mrs. Naumburg

(The framed picture in the background is that of D. G. Elliot, founder of the Museum's department of birds.)

Recent Additions to the Collections

PINK-HEADED DUCKS

(See Frontispiece)

AS announced in the March-April number of *NATURAL HISTORY*, Mr. Vernay and Colonel Faunthorpe have obtained for the American Museum the skins of a pair of the very rare pink-headed duck of India, *Rhodonessa caryophyllacea*. The specimens have now reached the Museum, and have served as models for the colored frontispiece by Jaques in the present issue.

For some years past it has become increasingly difficult to secure specimens of this duck, and it has been suspected that it is on the verge of extinction. Nowhere was it ever known in great numbers, though the range extended from the base of the Himalayas south to Madras on the eastern coast of the Indian Peninsula. The district whence our specimens came, north of Kheri in the province of Oudh, about ninety miles from Lucknow, is probably one of its last retreats.

Not long ago Mr. E. C. Stuart Baker, than whom no one is better posted today on Indian birds, wrote us as follows:

"I am afraid cultivation is pushing the pink-headed duck back and back into the swampy, feverish country at the base of the eastern Himalayas, where Europeans only go for shooting trips, and which is a country not beloved by Mahomedan bird-catchers. I cannot think the birds are exterminated, yet no one ever gets any; and at one time they were quite plentiful in Purnea, Malda, and the adjoining districts of eastern Bengal. Even then, however, no one ever saw them except when out tiger shooting; and now most of their haunts are drained and deforested in these districts. Their young perhaps have had to seek pastures new."

The unusual coloration of the adult male and female is shown very adequately in the plate. To what other genera of water fowl *Rhodonessa* is most closely allied is a difficult question to decide. It has been more or less customary to place it in the subfamily Plectropterinae, along with other tropical species such as the spur-winged goose, the comb-ducks, and the muscovy duck. It is very probable that some day this assemblage will be broken up, and its members redistributed. Certainly the pink-headed duck has several external similarities to diving ducks like the pochards and our own canvasback. Because of this unsettled systematic position, it is all the more satisfying to have the bird so splendidly represented in the collection of the American Museum.

THE CALDWELL COLLECTION OF BIRDS

The most notable recent addition to the African bird collection is a series of 3268 specimens purchased by the Trustees of the American Museum from Captain Keith Caldwell, of Entebbe, Uganda. They were obtained at many widely separated localities in Kenya Colony, and include representatives of approximately 630 species or subspecies—fully one half the species known to inhabit the area formerly called British East Africa. Many of them are exceedingly rare, and not a few have been discovered only recently. Very important contributions to the ornithology of eastern Africa have been made of late by Dr. V. G. L. van Someren, and it was with his list of the birds of East Africa and Uganda that the skins in the present collection were provisionally identified.

A large proportion of the species, and some even of the genera were hitherto unrepresented

in the American Museum collection. Among the latter are the lesser flamingo, *Phaeniconaias*, and among the Passeres, *Liopitilus*, *Calamonastes*, *Aegithospiza*, *Speculipastor*, and *Galeopsar*. About a year ago Captain Caldwell also presented us with our first specimens of the genus *Tmetothylacus*, a rare pipit, all but unique among the Passeres of the world in having the lower portion of the tibia scutellate like the tarsus. *Muscisaricola*, a small terrestrial bird of the Andes and southern South America, is its only parallel in this respect.

Our earlier bird collections from East Africa numbered less than 700 specimens, having been procured mainly by Herbert Lang, Jenness Richardson, Carl Akeley, James L. Clark, and Arthur Loveridge. It is well-nigh impossible to study the avifauna of one section of a continent without having representative material for comparison from adjacent countries. For some time past Doctor Chapin has found valued assistance in a part of the Caldwell Collection which had been loaned to the Museum, and the acquisition of the entire series will greatly facilitate the completion of the Congo bird report, as it will also aid in the determination of the birds now being collected in Benguela by the Vernay Expedition.

FATHER CALLEWAERT'S BIRDS FROM THE KASAI DISTRICT OF THE CONGO

One of the very last regions in the Congo to be investigated ornithologically was the basin of the Kasai River, in its south-central portion. This country was a well-known field of missionary activity and had been visited by several anthropological expeditions, but one can hardly say that its birds had been studied until 1921, when Dr. H. Schouteden of the Congo Museum in Belgium paid it a special visit. Except for three or four small lots of birds received by European museums, no collecting in this branch had been done there previously.

Inasmuch as the Kasai district lies just south of the Congo forest belt, the general nature of its fauna could be inferred from what was known of the countries to the west and the east—the Lower Congo and the vicinity of Lake Tanganyika. Doctor Schouteden's collection of birds, in the main, confirmed this prediction. After Doctor Schouteden's visit, Father R. Callewaert of the

Mission of St. Joseph near Luluabourg, offered to collect some birds and mammals for the American Museum. Thus far we have received from him some 1290 specimens of birds, including about 216 species, many of them of real rarity, and several previously unknown from the Belgian Congo, such as *Francolinus shelleyi*, *Anthoscopus ansorgei*, and *Fringillaria impetuani*. *Erythrocnus rufiventris*, a small heron, was not only new to the Congo, but represented a genus lacking in the American Museum. Father Callewaert also re-discovered a swallow, *Phedina brazzae*, previously known only from a single specimen taken by J. de Brazza in 1885 on the middle Congo River.

The present knowledge of the avifauna of the Kasai, due almost entirely to the work of Doctor Schouteden and Father Callewaert, reveals a surprising intermingling of the Congo forest fauna with grassland species of Angola and the Lower Congo. This helps in explaining the occurrence of many forest types in the Kwanza River district of Angola; and it is readily correlated with the nature of the vegetation in the Kasai, a savanna country with extensive "gallery forests" along some of the rivers, and scattered patches as well of true equatorial forest.

GROWTH OF THE OLD WORLD COLLECTION

On the completion of the new northeast wing, a room formerly devoted to mammals became available for the study collection of birds from the Old World, where they have all been arranged in systematic order so as to be readily accessible. Early in 1923 a list was compiled of all the living genera of birds from the eastern hemisphere not represented either in the exhibition collection or the study series. Sharpe's *Hand-List* was taken as a standard, as it had been for a similar purpose by some of our sister museums. At the outset it was found that we lacked 435 genera from the eastern hemisphere, and by gift, purchase, and exchange this figure was reduced to 324 before the beginning of 1924, and to 261 on July 1, 1925. The number of New World genera lacking is less than 20; and among all the families of existing birds commonly recognized, only two—the *Atrichornithidæ* or scrub-birds of Australia, and the *Paramythiidæ* of New Guinea—are now unrepresented in this museum.

A COLLECTION FROM NORTH- EASTERN VENEZUELA

Through the generosity of Mrs. E. M. B. Naumburg, the Museum has purchased from Mr. G. H. H. Tate a collection of somewhat more than 650 birds from northeastern Venezuela which throws much-needed light on the life-zones of this region and enables us to correlate them with those of the main Andean system.

The discovery of distinct new species of *Diglossa* and *Premnoplex* in the Subtropical Zone of Mt. Turumiquire is of especial faunal significance. Few birds are better indicators of faunal boundaries than *Diglossa*. The nearest point at which the genus has heretofore been found is the Silla de Caracas, distant some 250 miles to the west, whence Hellmayr has lately described a slightly differentiated form of *Diglossa abilatera*, a species ranging thence to northern Peru. While the bird discovered by Tate is very distinct from the race described by Hellmayr, its discovery emphasizes the close relationship of the subtropical life of Caracas and northeastern Venezuela, while the extension of the range of the genus adds another faunal island to those which mark its distribution from Mexico to Argentina and Roraima.

TWO BIRDS FROM THE GALÁPAGOS

Two marine birds of exceptional interest have recently been added to the Museum's exhibits, namely, the Galápagos penguin and the Galápagos flightless cormorant. Both were among the collection of living creatures brought to New York on board the yacht "Noma" when Mr. William Beebe and his associates returned from their cruise to the Galápagos Archipelago in 1923. Both species were formerly common inhabitants of this notable group of islands, but both are, at the same time, represented in few museums. The specimens which have now been mounted are the first examples to be shown in the bird hall of the American Museum.

The cormorant, single survivor of a pair of these birds, lived for many months at the New York Zoological Park. The penguin, not thriving in the fresh-water environment of the park water-fowl enclosure, was transferred in July, 1923, to the Aquarium, at the Battery. Here, for nearly two years, it occupied one of the salt-water pools, became delightfully tame, learned to answer to the name of

"Charlie," and, naturally, proved one of the greatest attractions in an institution of perhaps unequaled popularity.

The Galápagos penguin (*Spheniscus mendiculus*) is one of the smallest examples of its order, which numbers some sixteen or seventeen extant species. It is chiefly notable for its geographical position, since it is confined exclusively to a small cluster of islands which are crossed by the equator, whereas most other penguins are of antarctic or south temperate distribution. The explanation has to do with the influence of oceanic circulation upon sea life, for, from a presumably antarctic source, penguins have been led northward through the tropics by the cool Humboldt Current, which bathes the western shores of South America. The ancestors of the Galápagos species arrived so long ago that it is now very distinct from its nearest relatives, although it belongs to the same genus as the three larger species of "jackass penguins," so-called from their braying voices, which inhabit respectively the Cape of Good Hope, the Magellanic region, and the coast of Peru.

The flightless cormorant (*Nannopterum harrisi*) is one of the most remarkable of adaptations to sea life among birds, for, like the



Galápagos penguin



Flightless cormorant

extinct great auk, it has completely lost the power of flight. The course of its evolutionary history has not taken it in the structural direction of the penguins, the wings of which have been modified to form efficient "flippers" covered with minute scalelike feathers. The wings of the flightless cormorant have retained feathers of normal type, but the quills, as well as the bones of the limb, have been reduced to so great an extent that the wing is practically useless, and the bird progresses exclusively through the action of its large and powerful webbed feet. In general build it is reminiscent of the extinct *Hesperornis*, one of the toothed water birds of the latter part of the Age of Reptiles. In external appearance, especially as regards the elongation of its body and the hairlike character of its dull-brown plumage, it might be called otter-like rather than bird-like. It is found only at the Galápagos Islands, where, in fact, it was not discovered until recently. Neither Darwin nor any of the other early naturalist-voyagers saw it. Its relationships are far less clear than those of its neighbor, the native penguin, but there are reasons for believing that its ancestors came from the northern hemisphere rather than from the Far South.—R. C. M.

THE ANDEAN FLAMINGO

Flamingoes are widely known birds and as widely associated with tropical regions. It will surprise most people therefore to learn



Andean flamingo

that of the six existing species of flamingoes one half nest in the Andes of southern South America above an elevation of 10,000 feet. One of these, the Chilean flamingo, (*Phaenicopterus chilensis*) descends to sea level in southern Patagonia, where it has been found nesting on the shores of Santa Cruz River, laying its eggs on the ground.

The remaining two, James' flamingo (*Phaenicopterus jamesi*) and the Andean flamingo (*P. andinus*), are known only from the Paramo Zone of northern Chile and adjacent Bolivia, where they rarely occur below 12,000 feet.

Until recently neither of these birds was included in the Museum's collections. Now, thanks to Mr. Frederic C. Walcott, we are in possession of a beautiful specimen of the

Andean flamingo, which he collected on Laguna Colorada, Bolivia, at an altitude of nearly 14,000 feet.

In an article of *The Geographical Review* for July 1, 1925, Mr. Walcott states that he saw approximately 20,000 flamingoes and fully 7000 nests on this lake. The nests, however, had been robbed by the Indians, who gather the eggs and bake them for sale in villages at lower altitudes. As a result of this persecution the birds are rapidly decreasing in numbers.

RARE AUSTRALIAN PARROTS

Among the few widely distributed groups of birds that reach their greatest development in the Australian region, the parrots are no doubt

the most notable. South and Middle America are rich in species of parrots, but while these are conspicuously varied in size and color, they are all rather closely allied.

In the Australian region in its broader sense, including New Guinea, New Zealand, and Oceania, there is much greater diversity in external appearance, while important structural differences divide the numerous species into several family groups. Tiny spine-tailed parrotlets only as large as our red-breasted nuthatch and with similar habits, brush-tongued, honey-eating lorises of most gaudy red, blue, and green plumage, great crested white cockatoos, and even larger jet-black species with bare cheeks, and enormous bills, flightless nocturnal ground parrots of finely mottled greenish hues, together with many other striking forms abound in this region.

A noteworthy group almost entirely confined to Australia itself includes the broad-tails and their allies, of which the beautiful rosella and the undulated grass, or shell parakeet, are well-known examples. These birds are remarkable for their light build, their relatively long, slender legs and toes, and for the absence of the furcula or "wishbone." Their plumage is less "hard" in texture than that of most parrots, and in delicacy of coloring they surpass all others. Unfortunately many species of this group are decreasing in numbers, several of them being very rare or even wholly extinct.

The night parrot (*Geopsittacus*), a native of southern Australia, much like the owl parrot of New Zealand in miniature, is almost certainly extinct. Few specimens are preserved in collections, and one in the Museum of Comparative Zoology in Cambridge is probably the only example in this country. The somewhat similar ground parrot (*Pezoporus*), remarkable for its long slender claws, still exists in greatly reduced numbers.

The scarlet-chested grass parakeet, a beautiful species with green back, blue head and wings, bright red chest and yellow underparts, is probably entirely gone.

In the last few years, the Museum has received from the New York Zoological Park specimens of several of the rarer Australian parakeets, which were brought to this country by the veteran collector of live animals, Ellis S. Joseph.

The golden-shouldered parakeet, fortunately less rare than some of its relatives, is one of the most distinctively colored, its turquoise blue

underparts and large yellow wing patch being in marked contrast to the dark earthy-brown back and the black cap.

A much rarer bird and one in imminent danger of extinction is the blue-vented or Bourke's parakeet, one of the most tastefully dressed members of the whole tribe. The dark brown upperparts and wings are given a scaled appearance by the pale yellow margin of each feather, the under parts of the body are soft rose-pink and the lower tail coverts turquoise blue. Two related species, the blue-winged parakeet and the red-shouldered grass parakeet are mainly green above and yellow below with blue wings. Mathews in his great work on the birds of Australia (1917) stated that the latter was probably extinct, but fortunately his surmise has proven incorrect.

Another species that for a time it was believed had disappeared is the paradise or beautiful parakeet, one of the most attractive members of the group. Probably no live examples of this bird have ever reached America, but the Museum has recently acquired a fine male specimen in exchange. In an interesting article in the *Emu* for July, 1922, Mr. A. H. Chisholm announced the gratifying news of the rediscovery of the paradise parakeet. Photographs show the live birds at their nest in a hole dug in a termite hill.

Three larger Australian parrots not distantly allied to the broad-tails, and almost of the size and form of our extinct Carolina parakeet have also been received from the Zoological Park. These are the green leek, the black-tailed parrot, and the Alexandra parrot, the last a very delicately colored species with a rose-colored throat. All three are birds of restricted range and increasing rarity.

We wish the bird lovers of Australia all success in their efforts to preserve these charming members of their avifauna, but it is almost too much to hope that all of them can be saved.—W. DEW. M.

THE VANISHING HEATH HEN

The American Museum has recently received a most welcome gift of five heath hens from Mr. Arthur Sharp of Boston, Massachusetts, which were shot on Martha's Vineyard about 1896. The heath hen is a very close relative of the prairie chicken of the West, and both are noted for the booming noise made by inflated air sacs, the erectile ear tufts, and the antics or dances of the males during the mating season. These character-

istics are well-shown in the habitat group of the prairie chicken on the third floor of the Museum.

The heath hen formerly occupied a limited range in the Middle Atlantic States, and was found only in extensive pine and scrub-oak barrens. Absolutely sedentary in habits, it was mercilessly shot for food throughout the year, cultivation and settlement still further restricting its range. It became extinct in Connecticut about 1832, on Long Island about 1840, and in New Jersey about 1870 at the latest. The only place where it did survive was on Martha's Vineyard, where thousands of acres of ideal country afforded it ample protection even when hunted. But cats and foxes introduced on the island became an increasing handicap, and severe forest fires on several occasions decimated its numbers. Since 1906 when only 27 birds were found living, the state of Massachusetts has made earnest efforts to preserve the remnants. The birds increased, until at times there were between 800 and 2000. In the last few years there has been a rapid and alarming decrease. Severe forest fires, the depredations of cats and other vermin, and an apparent excess of males seem to be the chief causes which threaten another North American game bird with extinction. Mr. Keniston, the caretaker of the reservation, recently counted 8 in a careful census, and Doctor Gross, who has been carrying on an extensive investigation for two years, could only find 3 in May of this year.

As it has long been impossible to acquire specimens, it is to be hoped that the example which Mr. Sharp has set be followed, and that all specimens in private hands will be bequeathed to museums at a proper and convenient time, for permanent preservation.—L. G.

THE PACIFIC GULL

A single genus of the gull family, *Gabianus*, was lacking until recently from the collection of the American Museum. It includes but one species, *G. pacificus*, inhabiting the eastern and southwestern coasts of Australia, and remarkable for the extreme depth of the beak. The tail, even in the fully adult plumage, is always crossed by a black band. Though not particularly rare about Australia, the Pacific Gull is represented by only six or seven adult specimens in all the museums of the United States and Canada. Ours is the gift of the

New York Zoological Society, in whose gardens it was for a time exhibited alive.

THE DWIGHT COLLECTION OF CENTRAL AMERICAN BIRDS

The American Museum has long possessed collections from Panama and Nicaragua which represent their bird life with a fair degree of adequacy. The now historic explorations of McLeannan in the Canal Zone went in large part to George N. Lawrence, and this institution inherited many of the types of new species discovered by this energetic engineer. This basic collection has since been supplemented by the work of J. H. Batty in Chiriqui, and notably the large and valuable collection made by Messrs. Anthony, Ball, and Richardson in the mountains of Darien. In the last year more than 2000 skins have been received from eastern Chiriqui and Veraguas through the Griscom Panama Expedition, and Mr. Rex R. Benson will remain in the field until all the gaps in the Pacific slope of western Panama from the Costa Rica boundary to the Canal Zone have been filled. Our collections from Nicaragua are the largest and the most comprehensive in the world.

Guatemala and Costa Rica were, however, the areas which received the most attention at the hands of the early explorers and ornithologists, largely because of their greater accessibility and more healthful climates. Eighty years ago a flourishing industry in trade-skins sprang up in Guatemala, and thousands of skins reached the museums of Europe. This auspicious beginning was supplemented by the expeditions of Osbert Salvin, the great British ornithologist, to such good effect that more than 600 species were recorded from this little country by 1860. Curiously enough exploration ceased at this time. No adequate biological reconnaissance of this country, with its excessively diversified topography, has ever been made, and no adequate representation of its bird life exists in America. Costa Rica, on the other hand, is the most thoroughly explored section of Central America and very fine collections exist in this country.

The result has naturally been that Guatemala and Costa Rica are the type localities for numerous genera, species, and subspecies of birds. No collection from any other part of Central America can be critically determined, unless adequate series from these two countries are available. The American Mu-

seum has a mere handful of old trade-skins from Guatemala, and a few hundred skins from Costa Rica received in exchange.

It is with the greatest pleasure, therefore, that we can report that Dr. J. Dwight has made every effort to remedy this situation. One of the most energetic of American collectors, Mr. Austin Paul Smith, has been in residence in Costa Rica for the past five years and has visited every section of the country. No less than 4000 skins are now in the Dwight Collection, and more than 90 per cent of the resident species recorded from the country are represented by perfectly prepared specimens. Not only has Mr. Smith found many of the rarest and least known birds, but he has discovered several new species and forms previously overlooked, and has added others to the avifauna of the country. Two at least are additions to the fauna of Central America.

Doctor Dwight has had much greater difficulties in acquiring collections from Guatemala. Destructive earthquakes and revolutions have rendered conditions so unsettled that collecting has until recently been financially impossible. However, Mr. A. W. Anthony has been working for the past year chiefly in western Guatemala, and Mr. Smith made a small collection prior to the earthquake. Nearly 2000 specimens have been

acquired to date. These are all from historic collecting localities, but several forms are new to Guatemala, and at least three subspecies are undescribed, a graphic illustration of the need for careful and systematic exploration



Pacific gull

These collections are on deposit in the American Museum and thanks to the generous policy of their owner, are available to the staff of the bird department in their research work.

Departmental Activities

I. ROUTINE WORK

A NEVER-ENDING demand upon the time of the department is made by the care of our collections. Specimens when received must be entered in our catalogues, identified, and placed where they belong in our collections in order that they may become an available part of our working equipment. Furthermore, constant care must be exercised to guard the collections from the attack of insect pests. It is a pleasure to report that all but the most recently received specimens have been catalogued and that our collections are free from insects.

The acquisition of new specimens from our collectors, by purchase, or through exchange, implies a wide correspondence. Collectors are dependent upon us for supplies, equipment, and funds, and look to us for instructions concerning their routes, the localities we wish explored, the birds we especially desire. We

must supply them with credentials and secure for them permission of the authorities to pursue their calling, all of which implies contacts apparently far removed from pure ornithology.

It is also part of our routine work to act as an ornithological Bureau of Information, and in this capacity we respond to requests of a surprisingly varied nature. Strange birds "not in any bird book" are to be identified, artists to be supplied with material, customs authorities and game wardens to be advised concerning the applicability of the laws designed to prohibit the importation of foreign birds and protect native ones. As these lines are being written calls come for the loan of a penguin to pose in a Barrie motion picture scenario, and for a game cock to be used in designing a heraldic device, and they will doubtless be followed by others equally unexpected.

In short, there appears to be no limit to man's relations with birds or to the variety of ways in which the Museum aids in defining and establishing them—all of which means a heavy correspondence and a long list of callers.

II. EXHIBITIONS

Lack of space has for some time prevented us from making important additions to our exhibition collections. Individual specimens, as mentioned above, have been added to the systematic series, but with the opening of the new wing an opportunity is afforded for the development of plans long held in abeyance.

First among these is the arrangement of the main bird hall for the display of birds in flight. Here we propose to place species which are usually seen on the wing, like wild ducks and geese, the condor, albatross, frigate-bird, and eagle, showing characteristic poses, from the top to the bottom of the wing stroke, and the "formations" of those species that travel in flocks. It is hoped that this exhibit will be opened to the public in November.

Material has been collected for the first of a series of habitat groups designed to illustrate the major faunal regions of the world, and their installation will begin as soon as cases are supplied.

III. RESEARCH WORK

Each member of our scientific staff is engaged upon some definite piece of research work to which he devotes all the time not required by other departmental duties. Doctor Murphy, who has recently returned from an expedition to the coasts of Peru and Ecuador to make additional field studies for his monograph on the marine birds of South America, has now resumed his study of the Sanford-Brewster Collection on which this monograph is based.

Mr. Miller has collaborated with Mr. Griscom in the study of Nicaraguan birds, and with Doctor Alexander Wetmore in preparing a new classification of the birds of North America for use in the revised edition of the American Ornithologists' Union's *Check-List*. In his own special field he has made an exhaustive examination of wing-ptyriosis and various other features of the external anatomy of all the specimens of birds received in the flesh from the New York Zoological Society and other sources. He has also examined certain features of the internal anatomy of this material, particularly the

viscera, carotids, ambiens muscle, and deep-seated plantar tendons.

Mr. Griscom (with the collaboration of Mr. Miller) has completed the systematic and faunal portion of their work on the distribution of bird life in Nicaragua from which region they record 610 species of birds. The introduction to this work remains to be written. He has also prepared a *Check-List of the Birds of Panama* as a basis for an extensive report on the distribution of bird life in that country. With Doctor Dwight he has prepared a report on certain of the Costa Rican birds which the former has received from Austin Paul Smith, a collector resident in that country.

Doctor Chapin is putting the final touches on his report on the Birds of Belgian Congo. His field work began in the Congo sixteen years ago, and since the latter part of 1920 he has been busied principally with the preparation of this report. At that time our Congo collections of birds had been identified provisionally, but these identifications were verified and corrected during a visit to a number of European museums in 1921. Meanwhile, a systematic search of ornithological literature was carried on, and all references to specimens secured in or close to the borders of the Belgian Congo were noted on small sheets of paper of uniform size and arranged as a card-index. Since it was proposed to treat the species of the whole Belgian Colony, this index would furnish distributional data to supplement that secured by the Congo Expedition.

From this index, moreover, in 1922, a preliminary list of the birds of the Congo was drawn up, with their ranges in that area briefly stated with reference to a key map. It was found that some 1050 species could be listed, whereas in Reichenow's *Vögel Afrikas, 1900-1905*, only 610 species were reported from the same area. The American Museum Congo Expedition alone in traversing the colony from Banana to Aba secured 640 species of birds.

Since the preparation of the list the status of each species and race has been re-investigated, and brief systematic remarks prepared for the report, as well as a statement of range, notes on life histories, haunts, and nesting and food whenever available. This will make it of use as a book of reference on African ornithology, while dealing mainly with Congo ornithology. Many maps and illustrations have been prepared to explain the next.

Doctor Chapman, continuing his studies of the origin and distribution of Andean bird life, has completed his review of the more than 1450 species of birds found in Ecuador, of which all but 30 odd are contained in our collections, and is now preparing an introduction to this work which promises to exceed in size his *Bulletin* on the "Distribution of Bird Life in Colombia."

Meanwhile in the intervals not devoted to editorial labors in connection with this issue of NATURAL HISTORY a brief report is being prepared on the Tate Venezuelan Collection.

Doctor Dwight, research associate, is revising proof of his monograph of the gulls of the world, and Mrs. Naumburg, research assistant, is bringing to completion her report (in collaboration with George K. Cherrie) on the birds of Matto Grosso, Brazil.

THE STUDIES OF PROFESSOR SUSHKIN

During the past spring and summer, Professor Peter Sushkin, of the Academy of Sciences at Leningrad, made an extended visit to the United States with his wife to study our museum methods and collections, especially paleontological and ornithological. After a little more than two months spent at Harvard University and the Museum of Comparative Zoology, Professor and Mrs. Sushkin came to the American Museum, and for seven weeks divided their time mainly between the Permian fossils and the bird collection.

The finches and their allies have interested Professor Sushkin particularly of late, and at the Museum of Comparative Zoology he found alcoholic material and skeletons of *Geospiza* and other American genera which had not been available in Europe. At the American Museum he continued these investigations, paying special attention to a number of African weaver-birds brought home in fluid by our Congo Expedition. The results have been embodied in a valuable paper for the American Museum *Novitates* entitled "Con-

tributions to the Anatomy and Classification of the Weaver-birds."

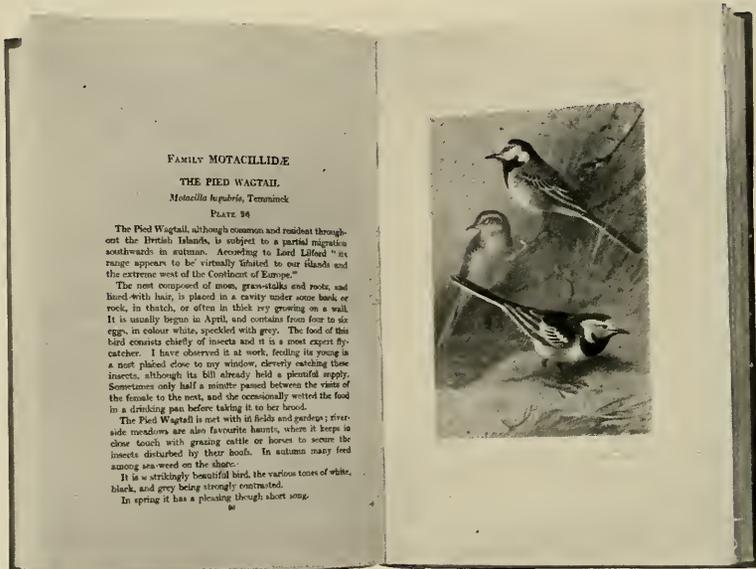
One of the surprising conclusions reached by Professor Sushkin concerns the all-too-familiar house sparrow, which he finds from the structure of the palate and other characters to belong not with the true finches in the Fringillidæ, where it has almost always been placed, but in the Old World family Ploceidæ, which includes the weaver-birds, widow-birds, and waxbills. This would suggest a true relationship between the house sparrow and the social weaver or republican finch of southwestern Africa, famous for its enormous colonial nest, looking like a small haystack draped over some thorn tree in the dry, open plains. The latter bird, *Philetairus socius*, has been shifted back and forth between the Fringillidæ and Ploceidæ, but its anatomy has not yet been carefully investigated.

In the department of vertebrate paleontology Professor Sushkin's attention was devoted especially to the material from the Permian of Texas, and to the latest methods of cleaning and mounting fossil specimens in general. Besides having charge of the bird collections of the Russian Academy of Sciences, he is also curator of Permian fossils.

After leaving New York on April 25, Professor Sushkin attended the meeting of the National Academy of Sciences in Washington, where he read two papers on his paleontological work and on the past distribution of life in Asia. Further studies were pursued in the National Museum, followed by visits to the museums of Pittsburgh and Chicago, and a trip to other spots of special interest in the West. Professor Sushkin is one of the foremost authorities on the distribution of birds in Asia, and it is expected that his elaborate work on the avifauna of the Altai Mountains will be published by the Boston Society of Natural History. He has also promised us a paper on the birds of Central Asia for inclusion with the reports of the Third Asiatic Expedition.



BIRDS IN BOOKS



FAMILY MOTACILLIDÆ
THE PIED WAGTAIL
Motacilla leucophaea, Temminck
PLATE 34

The Pied Wagtail, although common and resident throughout the British Islands, is subject to a partial migration southwards in autumn. According to Lord Lilford "its range appears to be virtually limited to our islands and the extreme west of the Continent of Europe."

The nest composed of moss, grass-stalks and roots, and lined with hair, is placed in a cavity under some bank, or rock, in thatch, or often in thick ivy growing on a wall. It is usually begun in April, and contains from four to six eggs, in colour white, speckled with grey. The food of this bird consists chiefly of insects and it is a most expert fly-catcher. I have observed it at work, feeding its young in a nest placed close to my window, cleverly catching these insects, although its bill already held a plentiful supply. Sometimes only half a minute passed between the visits of the female to the nest, and she occasionally wetted the food in a drinking pan before taking it to her brood.

The Pied Wagtail is not with us fields and perhaps river-side meadows are also favourite haunts, where it keeps in close touch with grazing cattle or horses to secure the insects disturbed by their hoofs. In autumn many feed among sea-weed on the shore.

It is a strikingly beautiful bird, the various tones of white, black, and grey being strongly contrasted. In spring it has a pleasing though short song.

From Thorburn's *British Birds*
(Reduced).

Catalogue of Birds of the Americas. By Charles B. Cory, late Curator of Zoology, revised and continued by Charles E. Hellmayr, Associate Curator of Birds. Part III. Pterotochidæ; Conopophagidæ; Formicariidæ. Publication No. 223; Field Museum of Natural History. 8vo. 369 pages.

The late Charles B. Cory planned his *Catalogue of Birds of the Americas* with characteristic breadth of vision. Unfortunately he lived to see only two parts of it appear, but had he known that he must resign in favor of another, he would have been the first to approve of the selection of Dr. C. E. Hellmayr to complete the task which he had begun.

Called from his post in the Zoological Museum in Munich to become associate curator of birds in the Field Museum, Dr. Hellmayr at once took up Cory's work where he had left it, and the first result of his labors is seen in Part III of this important undertaking. It deals with the tropical families of Tapacolas (Pterotochidæ), gnat eaters (Conopophag-

idæ), and ant birds (Formicariidæ). This volume we are told in the introduction by W. H. Osgood, curator of zoology in the Field Museum, was left by Mr. Cory "in an advanced stage of preparation" but has been revised and augmented by the junior author.

The work is in the highest degree authoritative; indeed it is the first adequate treatment of the groups concerned which has ever appeared. In effect, Doctor Hellmayr for a quarter of a century has been preparing for the opportunity which the Field Museum has offered him in its invitation to continue Cory's work. More familiar than any other person with European bird collections, he has long devoted himself to the study of the birds of tropical America. Had he known of the task he was to be called on to perform, he could not have prepared himself for it more thoroughly. The science of ornithology, therefore, is to be congratulated on having the results of these years of study made accessible, and we look forward impatiently to the appearance of succeeding parts of this helpful publication.—F. M. C.

Zoologica, VI, No. 1, 1925, 1-193 pages; illustrated with line cuts and half-tones. "Studies of a Tropical Jungle." By William Beebe.

In a recent number of *Zoologica*, the scientific journal of the New York Zoological Society, Mr. Beebe devotes two hundred pages of text to a discussion of the fauna of one-quarter of a square mile of tropical jungle at Kartabo, British Guiana. The area is that surrounding the Tropical Research Station, between the Mazaruni and Cuyuni rivers. It has been subdivided into more than a thousand one-hundred foot squares, any one of which can be readily located through reference to a key chart.

The paper opens with an unequal but informing account of the geography, meteorology, geology, physiography, and flora of the region, and closes with a brief historical sketch. The remainder, 150 pages or thereabouts, is devoted to the animal life of which the birds, numbering 464 species, "in visual, color and vocal dominance . . . stand first, yielding only to fish and amphibians [among vertebrates] in point of number of individuals. . . . Insects are the only other organisms which stand comparison in point of general dominance." Mr. Beebe tells us that the birds make up 56 per cent. of all vertebrates at Kartabo, and that, furthermore, the variety of bird life in the quarter-mile square comprises 64 per cent. of the total avifauna of British Guiana.

Representatives of all of the twelve phyla of animal organisms, except echinoderms, occur in the small, segregated area. The abundance of life in the jungle and in the small open spaces or along the water courses is indicated by the author's "forty-five minute list." Within such a brief period, he tells us, no less than 256 species and 536 individual creatures came under his notice.

In a swift and necessarily superficial manner, Mr. Beebe catalogues the various classes, orders, and subgroups of the Kartabo microcosm, beginning with the Protozoa and proceeding dauntlessly to the highest of the vertebrates. The catalogue, in spite of its cursory nature, is very much of a *tour de force*, giving an impressive picture of the indescribable wealth and luxuriance of tropical life. Nor does the author fail to fill his terse paragraphs with ecological notes of great interest. His tabulations of stomach contents, and reference to the prey and the devourers of

many species, mark the beginning of exact work which can profitably be carried on indefinitely.

The account of the birds includes a "Christmas Census" of the Kartabo region in accordance with the popular custom which originated in the United States through the magazine *Bird-Lore*. One hundred and sixteen species were observed, of which all but twenty-one are permanent residents of the district. "A vivid idea of the relative abundance of species of birds in the tropics as compared with the temperate zones is shown by the avifauna of New York State and that of the quarter of a square mile of jungle about Kartabo. The former, in actual area, is 180,000 times as large as our tropical field of research." Excluding introduced, accidental, and exterminated species, however, the bird life of the two regions sums up as follows:

	New York	Kartabo
Total species	330	464
Migrants	262	21

Mr. Beebe's paper is an original and comprehensive study, which makes an excellent basis for the detailed monographs of the various groups of organisms promised by the author.—R.C.M.

A Natural History of the Ducks. By Dr. John C. Phillips. Longmans, Green & Co., Vol. I, 1923; Vol. II, 1924 (two more volumes to follow).

Zoologists of today are asking themselves how their successors of a few decades hence will find it possible to keep abreast of what has been published in their chosen fields. The literature of ornithology in particular widens and deepens unceasingly. It is especially fortunate that in addition to yearly indexes like the *Zoological Record* there appear from time to time general reviews of the faunas of particular regions, and of certain large groups of birds throughout the world.

Thus the naturalist seeking information on a given family of birds has often been able to refer to one of the classical "monographs" by various authors, treating for example of the pheasants, kingfishers, birds of prey, and many others. But as ornithological exploration and classification advances, the older monographs grow more or less incomplete, and new ones become a necessity. These standard monographs have varied in their mode of treatment. At first they laid particular stress on figuring as many species as pos-

sible in color, and added only a brief explanatory text—often all that was known. In more recent works there has been more and more to include in the letterpress.

Few families of birds exceed in their many-sided interest for mankind that of the ducks and geese. Doctor Phillips has wisely chosen to call his great work a "Natural History," so much is there to tell of the members of the Anatidæ. Though monographic in nature, these volumes not only present the best to be had in artistic portrayal of a majority of the species, but they contain a summary almost encyclopedic of all that is known concerning the distribution, behavior, food, and nesting of each species. The original sources are scrupulously stated, in case the reader wishes to investigate still further. The domestication and hybridization of many species is likewise touched upon, this being a field where Doctor Phillips has done original work.

The first volume treats of the subfamilies Plectropterinae, Dendrocygninae, and a section of the Anatinae—the true sheldrakes, and Egyptian and Orinoco "geese." Current usage is followed in part in grouping among the Plectropterinae such very different birds as the spur-wings, comb-ducks, Hartlaub's "teal," and "pygmy geese"; but the wood and mandarin ducks have been excluded. The tree-ducks or Dendrocygninae, on the other hand, are a more natural assembly.

Volume Two is devoted to the single genus *Anas*, here including typical pond-ducks which Sharpe's *Hand-List* divided in ten distinct genera. Doctor Phillips' opinion is founded upon an intimate acquaintance with the live birds, in captivity as well as in the wild state, their complex resemblances, and their well-known tendency to interbreed. The thoroughness of treatment of each species might be illustrated in the case of any of our American examples, the black duck for instance, to which are devoted a little more than ten quarto pages, a distributional map, and duotone plate. Besides a full description and a list of scientific and vernacular names, there are detailed statements of distribution and migration and elaborate notes on the food. The sportsman will even find an appraisal of the species as adapted to the human palate. The geographic races are discussed more briefly; and the treatment by species or binomial forms, rather than to give excessive importance to trinomials, has much to commend it in a book of this wide scope. In most

families of birds a list of subspecies goes out of date rather rapidly, whereas the species of ducks as here given will prove relatively stable.

Equally full accounts are given of many exotic ducks, just as far as present knowledge permits. The majority of plates are in color; and the distributional maps, though drawn perhaps a little larger than necessary, cover every species. The appearance of Volume Three during the present year is awaited with great interest. With the exception of two frontispieces by Frank W. Benson, showing the pintail and mallard in their haunts, the plates are by Louis Agassiz Fuertes and Allan Brooks, with one also by Henrik Grönvold, all bird artists *hors concours*. It is perhaps to be regretted that some of the plates in half-tone, like that of the black duck, could not also have been reproduced in full color. Duck-lovers for years to come will be deeply grateful to Doctor Phillips for this exhaustive biography.—J.P.C.

A Monograph of the Birds of Prey (Order Accipitres). By H. Kirke Swann. London, Weldon & Wesley, Ltd. Parts I-III, November 25, 1924, January 31, 1925, May 30, 1925. Pp. i-xi, 1-196, five unnumbered plates per part, some colored.

Mr. Swann has long been known as a student of the birds of prey, and his recently published synopsis is the first general review of the group in forty years. The present elaborate and handsome monograph may consequently be regarded as the final product of his studies. The first three parts, which have appeared with commendable promptness, give a very fair idea of the caliber of the work. Primarily a technical and systematic account, it has the usual full descriptions of characters and an elaborate synonymy, but the geographical distribution and ranges of many forms are regrettably general. The systematic classification of the Accipitres has long needed very careful study and revision, which is still awaiting the accumulation of adequate skeletal material in the hands of a competent anatomist. The classification adopted in the present work is a modification of the old one, based largely on external characters. The author is conservative in his treatment of the higher groups, dividing the order into three families: the vultures, the unique secretory bird of Africa, and the hawks and eagles proper. The last family is by all mean

the largest, and is further subdivided into eight subfamilies, the characters of which are often slight and tend to overlap. Mr. Swann is gratifyingly conservative in his conception of the genus, but is something of a "splitter" in recognizing slight variations of size or color as subspecies. In many cases, however, this serves a useful purpose and emphasizes the need of further specimens to obtain a correct idea of racial as distinguished from individual variation. Hawks have many complicated changes of plumage and color phases, and as they are large birds and it takes a long time to prepare specimens, collectors have never cared to devote much time to accumulating series. This has handicapped all students of the group, through no fault of their own.

While Mr. Swann does not in this work claim to advance our knowledge of the Accipitres to any material extent, he is to be congratulated on having compiled such information as is now available, and he is presenting it in what gives every indication of being one of the handsomest and most accurately printed monographs which have appeared in recent years.—L. G.

British Birds, written and illustrated by Archibald Thorburn with 192 plates in color. In four volumes. Vol. I. New edition. Longmans, Green and Company. London, New York, Toronto, 1925. 8vo. xii, 176 pages, 48 plates figuring 108 species.

While the biographer would find it difficult to produce a book on British birds containing much that was new, they will doubtless always afford fresh material for the artist. The text of the present work, for example, is essentially that of the same author's four-volume royal quarto of 1915-16. Indeed it is issued as a new edition of that sumptuous publication. The plates, however, are wholly new and this fact in connection with the book's much smaller size and lower cost makes it a quite different work.

As an artist Mr. Thorburn, we believe, is generally conceded first place among British bird painters, but as a painter of birds' portraits his position as a leader may perhaps be questioned. He possesses in an exceptional degree the gift that many bird painters lack of placing his bird in nature. In composition, tone, choice of accessories, and general treatment his pictures possess rare charm. When, however, it comes to details of anatomy, pose, and physiognomy, he is not always so success-

ful. We trust that the remaining three volumes will appear shortly, for the book will be a useful one. It should be in demand among American bird lovers who propose to visit great Britain or the continent. The publishers would, however, have more nearly supplied the wants of the traveling bird student if, instead of reducing the original quarto to an octavo, they had made it a duodecimo and in two volumes instead of four. It could have been done.—F.M.C.

Zoological Results of the Swedish Expedition to Central Africa, 1921, Birds. By N. Gyldenstolpe, Kungl. Svenska Vetenskapakademiens Handlingar, (3) I, No. 4, 1924, pp. 1-326.

Prince Wilhelm of Sweden, on his expedition to the Kivu district in quest of big game and gorillas, was accompanied by Count Nils Gyldenstolpe as zoölogist. The excellent reports on the birds and mammals of Siam previously prepared by Count Gyldenstolpe gave proof of the care and thoroughness of his work, and the present account of the birds he collected in Africa is a most detailed and useful commentary on the avifauna of the Kivu and adjacent regions.

Spending nine months in eastern equatorial Africa, the Swedish Expedition made a special investigation of the now-famous Birunga volcanoes and the eastern border of the Congo forest near the Semliki River and Irumu. The varied zoölogical collections brought back to the Royal Natural History Museum of Stockholm included nearly 1700 birds of about 400 different species. The new forms discovered by the Expedition and here listed include eight subspecies and one distinct species, the latter a small flycatcher, *Cryptotolpha wilhelmi*, from the alpine region of the Kivu volcanoes. It is allied to *C. alpina* of Mt. Ruwenzori, and Count Gyldenstolpe secured many other species on the higher slopes of the volcanoes which illustrate the relations between the mountain-dwelling birds of the two ranges. On Mt. Karisimbi, for example, he discovered the male of *Cryptospiza shelleyi*, a weaver-finch previously known from a single female specimen taken on Ruwenzori.

Such additional knowledge is often just as valuable as the finding of a new geographic race. Of several birds previously known only from single specimens brought home by the American Museum Congo Expedition, such as *Chætura melanopygia* (a large swift), *Batis ituriensis* (a flycatcher), and *Malimbus flavipes*

(a weaver) Count Gyldenstolpe obtained additional material that confirms the original descriptions. The difficulty of finding a new species of bird in the Congo at the present time is a reliable indication of how well the birds of the region are beginning to be known. Since the year 1890, when Emin Pasha and Doctor Stuhlmann inaugurated the zoological investigation of the Ruwenzori region, remarkable progress has been made both in the political administration and in the scientific exploration of the region.

Now that the avifauna is so well known as regards the species, it is time to undertake more detailed studies of the life histories, food, and determining factors of distribution. Much of this will be found in Count Gyldenstolpe's report. Its introduction is of special interest, and contains notes on the vegetation of the Birunga volcanoes, with special reference to the distribution of birds, and is illustrated with landscape photographs. Throughout the systematic part the author presents his notes as to the haunts and behavior of the birds, factors of great weight in their distribution. In many ways his treatment is a model. Colors of the soft parts, which disappear in dried skins, are carefully described, and the principal dimensions of every specimen are given. The fullness and accuracy of the bibliographic references are gratifying, and make this a reference book of the highest utility to fellow-workers on African birds. It enables one to get at the main facts of geographic variation in any given species with the least possible delay; and this is a valuable help at the present time, when the systematic worker loses more time over the minutiae of trinomial forms than with many a more important question of classification or relationship among birds. The well-chosen color plates and excellent map form a fitting close to such a useful and well-planned report. —J.P.C.

University of Iowa Studies, Fiji-New Zealand Expedition, 1924. By C. C. Nutting and Collaborators.

This profusely illustrated and rather unusual volume of 369 pages is the fourth narrative in book form relating to expeditions sent out in the interests of natural science from the State University of Iowa. The series originated in the author's mind after reading such older classic works as Darwin's *Voyage of the "Beagle."* Professor Nutting explains further

that in the recent past "much of interest has been lost to the general public by the failure of those in charge of scientific explorations . . . to recognize the claims of the general public to a more popular account of such work than is given in the series of technical reports customarily issued."

The field party was limited to six professional naturalists representing the departments of geology, botany, and zoology of the university. They left Iowa in May, 1922, and subsequently spent about one month at the Fiji Islands and five weeks in New Zealand. The nineteen chapters of the book cover not only the narrative of the journey by Professor Nutting, but also special accounts of the fauna of various restricted regions, as well as chapters relating to the history, customs, and ethnic characters of the Fijians and Maoris, by the same author. Dr. Dayton Stoner contributes chapters on ornithological and entomological experiences in Fiji and New Zealand, respectively, while similar accounts relating to the geological subjects are given by Dr. A. O. Thomas, and two chapters on botany by Dr. R. B. Wylie.

Doctor Stoner's ornithological notes are in the nature of general impressions rather than detailed studies. Much of the text is reprinted from articles which the author has already published elsewhere. His remarks on species introduced into Fiji, such as the minah, are interesting and pertinent. He greatly over-emphasizes the scarcity of marine birds in the Fiji region, however, and in attempting to be accurate beyond his actual data he mis-identifies the local tropic bird, for *Phaëthon æthereus* is a species which has never been recorded in that part of the Pacific.

Professor Nutting's sections of the book include an excellent naturalist's record of field work on Makuluva, an island a few miles from Suva, in which he not only describes the south Pacific reef fauna, but also makes illuminating comparisons based upon his former experiences with conditions in the West Indies and elsewhere. In other parts of the work he gives us good first-hand accounts of such historic creatures as *Periophthalmus*, the "tree-climbing fish," and of the primitive *Sphenodon* or tuatara. Four of the latter reptiles, the gift of the New Zealand Government, were brought back alive to the University of Iowa. Professor Nutting, moreover, has much of interest to say regarding the

excellent traits of physique and character which belong to the Fijian aborigines, and he describes with a sympathy, which his readers must also feel, their inevitable losing struggle for existence against the rapidly increasing Hindus who were first introduced into the islands as farm laborers. In discussing the inhabitants of the Fiji Islands, however, the author falls into the common error of confusing them with Polynesians. In spite of the undoubted racial mixture in the south Pacific, the Fijians must certainly be termed Melane- sians and should not be loosely associated with Tongans or Tahitians when characteristics of

the "South Sea Islanders" are under discussion.

In spite of the highly personal, not to say trivial, nature of much of Professor Nutting's narrative, most readers who are interested in the present status of south Pacific geography and civilization will find the work entertaining and valuable, while travelers will heartily agree with the author's caustic thrusts at certain aggravating phases of the United States passport and customs regulations and at the appalling bureaucracy of some of our own representatives in these services when compared with similar officers of other nationalities.—R.C.M.

The Ornithological Magazines

THE appended notes on the contents of the more recent numbers of the leading ornithological magazines are presented not as a critical review but as a means of conveying information regarding the character, function, and place of issue of these publications; in short, as an annotated directory of bird journals. It will be observed that all the magazines here noted are the organs of societies.

The Ibis: A Quarterly Journal of Ornithology.

Edited by William Lutley Sclater. Published by the British Ornithologists' Union. Wheldon and Wesley, Ltd., 2-4 Arthur Street, London. Twelfth Series, Vol. I; Nos. 1-3, 1925.

The Ibis, founded in 1859, is the meeting place of British ornithologists from every corner of the world. The first two issues for 1925, for example, contain articles on the birds of Arabia, Majorca, Sierra Leone, British Sudan, the Cameroon, Himalaya, Indo-China, Palestine, Macedonia, Spain, and British Guiana. Most of these articles are regional lists of the species observed, with notes on their numbers, distribution, and habits. There are also papers on avian anatomy, classification, and distribution, reviews, letters, and general notes and news.

The illustrations include maps, half-tones, and excellent colored plates.

Journal für Ornithologie, published quarterly by the German Ornithological Society, and edited by Dr. Erwin Stresemann, Berlin.

The *J. f. O.*, as it is familiarly called, was founded in 1853 by Dr. Jean Cabanis, and edited for many years by Professor Anton Reichenow. Doctor Stresemann is the third of its editors, all of whom have been curators

of birds in the Berlin University Museum.

Contributions to this journal come from all parts of the world, but more space is usually devoted to the birds of Europe and Africa than to those of other continents. The questions discussed are exceedingly varied in scope, and by no means mainly systematic. In the first two numbers for 1925 we find descriptions of new birds from Brazil, as well as accounts of the use of birds in the medical practice of the ancients, the interrelation of avifauna and vegetation in southern China, experiments on the sense of taste in birds, the structure of metallic feathers, a bibliography of ornithology in Saxony, and reviews of African glossy starlings and several birds of prey in Europe.

The interesting proceedings of the German Ornithological Society are also included, but reviews of ornithological literature are now printed in the *Ornithologische Monatsberichte*, also edited by Dr. Stresemann. The *Monatsberichte* thus serves as a supplement to *J. f. O.*, with shorter articles on technical subjects and many notes on the occurrence of birds in Europe.

The Auk: A Quarterly Journal of Ornithology.

Edited by Witmer Stone; Published by the American Ornithologists' Union. Lancaster, Pa. Vol. XLII, Nos. 1-3, 1925.

While the members of the British Ornithologists' Union are as widely distributed as

the British Empire itself, the members of the American Ornithologists' Union are for the greater part resident in North America. It follows, therefore, that the contents of *The Auk*, organ of the A. O. U., relate largely to American birds. There is thus a greater community of interests among contributors to *The Auk*, than among contributors to *The Ibis*, with a corresponding increase in the number of notes of more or less local importance covering a more restricted area and with a greater number of observers. *The Auk* has largely passed the faunal-list stage of bird study and its articles are now chiefly biographic or subjective in character.

There is an admirable department of "Recent Literature," and others for "Correspondence" and "Notes and News." The illustrations are half-tones from photographs. There are no colored plates.

The Emu: Quarterly Organ of the Royal Australasian Ornithologists' Union, 376 Flinders Street, Melbourne, Australia.

The Emu always brings with it a feeling of wide spaces and good fellowship. Bird study in Australia is conducted in the field rather than in the laboratory, and a volume of *The Emu* leads us over much little-known territory where we meet strange birds in strange places.

The next annual Congress of the American Ornithologists' Union will be held within the walls of the American Museum, and after adjournment there will be some one-day excursions to neighboring bird resorts. But an annual Congress of the Royal Australasian Ornithologists' Union is accompanied by a "camp-out" which evidently rises above the excursion stage and affords rare opportunities for coöperative observation.

The first two numbers of *The Emu* for 1925 (Vol. XXIV, Nos. 3 and 4) contain an annotated list of the birds observed in connection with the Union's Congress for 1924. It includes 182 species of which 42 were found nesting. This Congress was held in Roehampton, Queensland, whither most of the members traveled from Brisbane as guests of the mayor and were later addressed by the governor and variously entertained,—all circumstances quite as foreign to an A.O.U. Congress as a "camp-out!"

Aside from a detailed report of the Congress there are numbers of excellent papers in these two issues, of which the most notable is the

presidential address of Dr. J. A. Leach on "The Naming of Australian Birds."

The Condor: a Bi-monthly Magazine of Western Ornithology. Edited by Joseph Grinnell. Published by the Cooper Ornithological Club, Pasadena, Cal. Vol. XXVII, 1925; Nos. 1-3.

The Condor is to the Cooper Club what *The Auk* is to the A. O. U., but, covering a smaller area and reporting the proceedings of an organization which meets monthly instead of yearly, it has closer relations with its clientele.

Living in one of the most interesting ornithological regions in the world, the members of the Cooper Club have taken advantage of their opportunities, and the pages of *The Condor* bear witness to their industry and the keenness of their observations.

There are departments for bird banders, notes from field and study, reviews, and editorial comment. The illustrations are half-tones from photographs, which, like the magazine, are exceptionally well printed.

The Wilson Bulletin. A Quarterly Magazine Devoted to the Study of Birds in the Field. Edited by T. C. Stephens. Published by the Wilson Ornithological Club at Sioux City, Iowa, Vol. XXXVII, Nos. 1 and 2.

The Wilson Ornithological Club brings together the bird students of the Mississippi Valley, and in the publication of its official organ has the coöperation of state bird clubs in Nebraska, Iowa, Kentucky, and Tennessee. As its subtitle indicates, it is a magazine for the student of birds in nature, and its contents deal therefore with the living bird. Bird banding is a phase of bird study in which many of its members are interested.

After serving as editor for thirty-six years, Professor Lynds Jones was succeeded by the present editor in March of this year.

Bird-Lore. Official Organ of the Audubon Societies. Edited by Frank M. Chapman. D. Appleton & Co.

Four numbers of the twenty-seventh volume of this bimonthly have appeared during the year. The January-February issue is chiefly devoted to the results of the Christmas Bird Census which this magazine has conducted for a quarter of a century. Twenty-seven observers contributed to the census of 1900; more than 400 took part in that of 1924, a

measure of the growth of our interest in birds during the last twenty-five years.

Under "The Seasons," edited by John T. Nichols, each number of *Bird-Lore* contains reports from a corps of observers throughout the country on recent events in their part of the bird world, making a symposium of current interest and permanent reference value. There are scores of general articles on

birds in nature, minor notes, colored plates by Fuertes and Brooks, and many photographs.

As editor of the school department, Dr. Arthur A. Allen contributes to each number a fully illustrated article designed to be helpful to teachers, and in the Audubon department, Dr. T. Gilbert Pearson, president of the National Association of Audubon Societies, presents the news relative to bird conservation



UPLAND PLOVER

With wings aloft when alighting; showing the beautiful pattern of their under surface. Photographed by Dr. Frank N. Wilson, Belleville, Mich. From *Bird-Lore* for October

FROM OTHER MUSEUMS



ALEXANDER WETMORE

Assistant Secretary of the Smithsonian Institution, in charge of the United States National Museum

The appointment of Dr. Alexander Wetmore as assistant secretary of the Smithsonian Institution was a logical event in the history of a career which has been marked by advance as rapid as it is deserved.

Entering the service of the Biological Survey on part time in 1910, while still a student in the University of Kansas, Doctor Wetmore, on graduating in 1911, joined the Survey's staff.

During the succeeding thirteen years he was its representative on a number of important scientific missions of widely varying character. These have carried him to Porto Rico, southern South America, parts of the United States, Hawaii and other Pacific islands.

Between times Doctor Wetmore has found, or probably it would be more exact to say,

has made, opportunity to do a large amount of original research. A thorough workman, he has also the ability to produce without loss of time, and he already has to his credit a surprising number of authoritative publications.

Doctor Wetmore was elected a Fellow of the American Ornithologists' Union in 1919 and a vice-president in 1923. In November, 1924, he was appointed director of the National Zoological Park, succeeding the late N. Hollister, and was soon thereafter advanced to the post he now holds. It is to be hoped that his new duties will leave him time for further studies in a field which he has occupied with so much credit to himself and profit to the science of ornithology.

Introductory Note

IN ORDER to give some conception of current ornithological activities in the museums of this country which have devoted especial attention to birds, we have asked some of our colleagues to tell us of their work in field, study, and exhibition hall, and of their plans and policies.

This necessarily brief review far from completes the picture of what is being done to advance our knowledge of birds. To do this would require a description of the manifold functions of the Biological Survey, of the National Association of Audubon Societies with those of its state and local allies, of the work of many of the smaller museums, which often reach their public more effectively than the larger ones (witness the Museum of Birdcraft Sanctuary), and of the opportunities offered students by educational institutions, like Cornell University, which have regular courses in ornithology.

UNITED STATES NATIONAL MUSEUM

FOREMOST among the special projects in or connected with the Division of Birds is the work by Robert Ridgway, known as Bulletin 50, or "Birds of North and Middle America," of which eight volumes have been published to date. When the work was first projected as a definite task, in 1894, it was thought that eight volumes would suffice, but this limit was later extended to ten, with a possible supplementary volume. The eight volumes that have been published contain 6623 pages and 222 plates. Mr. Ridgway is now assembling data for the final volumes.

"Life Histories of North American Birds," by Arthur Cleveland Bent, bears the same relation to biographic, that Mr. Ridgway's volumes do to systematic ornithology. Of this work five parts have appeared, each as a separate Bulletin of the National Museum. Mr. Bent has prosecuted this work with characteristic energy, with the result that another volume covering herons and allied birds is about ready for the press, and notes have been assembled for succeeding parts.

Another project under way for many years is one that deals with the generic names of birds, showing their variations (emendations), giving their types, family relationships, and other information. The author, Dr. C. W. Richmond, has thus far issued three supplements to Waterhouse's *Index Generum Avium*, while a fourth is nearly ready for the press. He has also spent much time in preparing a card catalogue of specific names of birds, giving certain useful information about them (author, place of publication, date, type locality, and similar data), but it is not expected these data will be published, useful though they are to those who prosecute their studies in the office of the Division of Birds.

Dr. Alexander Wetmore, assistant secretary of the Smithsonian Institution, in charge of

the National Museum, has in progress a series of studies on the anatomy of birds, and has done considerable work on fossil birds, chiefly of North America. He is engaged at present with Miocene material belonging to the American Museum of Natural History, and Miocene and Eocene specimens from the Carnegie Museum, in addition to fossils and cave material that have come recently to the National Museum.

With Dr. Casey A. Wood, he has completed a paper on a collection of birds from the Fiji Islands, obtained by the last-named author. He has now in press a report on the collections made by him in Argentina and neighboring states, under the auspices of the Biological Survey, and has in contemplation a report on the material obtained by him under the same auspices on Laysan, Midway, Wake, and other islands in the Pacific, and a revised account of the birds of Porto Rico to appear in the series sponsored by the New York Academy of Sciences.

Mr. J. H. Riley has been occupied with the study of important collections received in recent years from China, in part through co-operation with the National Geographic Society and in part through the activities of the Rev. D. C. Graham. Mr. Riley has practically completed an account of a fine collection made in Yunnan by J. F. Rock, traveling for the National Geographic Society, and is at work also on the series brought to the Museum by F. R. Wulsin, secured in southern China, under the same auspices.

Dr. H. C. Oberholser, of the Biological Survey, has for years worked over the collections made by Doctor Abbott in the Malayan region and islands, and has reported upon several of the collections. He has given preliminary descriptions of many new species and forms from the same collections, and is still engaged in these studies.

Doctor C. W. Richmod and B. H. Swales, honorary assistant curator of the Division of Birds, have in preparation a bulletin listing the type specimens of birds in the United States National Museum, as well as one on the birds of Haiti and Santo Domingo, but work on these subjects has been delayed for various causes. It is hoped that a more decided advance on these projects may be made in the near future.

Among other activities of the Division of Birds may be mentioned assistance given to the American Ornithologists' Union in the preparation of its proposed new *Check-List of North American Birds*, and of the latest "Index" to *The Auk*, now in manuscript. The foreign references of the forthcoming "Index" to *The Auk* for the period from 1910 to 1920 are now being revised in the Division of Birds, and Doctor Wetmore has coöperated with Mr. W. DeW. Miller of the American Museum in revising the classification of birds for the new A. O. U. *Check-List*.

ACADEMY OF NATURAL SCIENCES, PHILADELPHIA

IN DEVELOPING the bird collection the attempt is being made to secure representatives of all the genera of the world and the more distinctive species in each, especially those which have served as the types of genera. The Academy's collection having always been a very representative one, this policy is simply carrying on that of the past.

At the same time efforts are being made to strengthen the representation of the birds of countries where the collection has been weak, and collectors are procuring material for us in parts of China, Siam, and in Bolivia. Wherever possible, too, juvenal plumages of foreign birds are being procured to aid in the study of plumage development and relationship.

While the collection of North American birds is reasonably complete, efforts are being made to obtain better specimens and fuller representations of the larger land and water birds. Through the liberality of certain members of the Academy, it has been possible to secure during the past winter a fine series of the ducks of the Atlantic Coast which have been specially prepared to ensure their preservation in the future.

The local collection has been made readily accessible to students, with the result that many private collections made in past years

by members of the Delaware Valley Ornithological Club have been presented and added to it. As individual collecting of local birds is now but seldom carried on, it seems desirable to gather together all such material that is in existence and place it where its preservation will be assured and where it will be accessible to all who are qualified to make use of it.

The D. V. O. C. holds its meetings at the Academy through the courtesy of the institution, and does much to stimulate ornithological interest, while the Pennsylvania Audubon Society and the Wissahickon Bird Club, interested more especially in the conservation of bird life, also make the Academy their headquarters.

Besides the extensive local collection of birds on permanent exhibition in the Museum, a seasonal collection of birds mounted in small boxes is exhibited and changed from time to time as the season advances, to show just what birds may be found in the vicinity of Philadelphia at any time.

MUSEUM OF COMPARATIVE ZOOLOGY

Thanks to Mr. John E. Thayer, the department of birds is now represented in the field by W. W. Brown in southern and southwestern Vera Cruz, where, among other interesting species, he has secured the rare wren *Hylorchilus*.

Harvard University is participating in the Mjoberg Expedition to the mountains of Central Borneo.

Recent expeditions include those of Dr. John C. Phillips to Uganda and the Eastern Congo; J. L. Peters to Martinique, St. Vincent, and St. Lucia; W. S. Brooks to Cape Colony, Natal, Transvaal, Rhodesia, and the Southwest Protectorate, and Outram Bangs to England, France, and Germany. In addition to the specimens resulting from these expeditions the department has received a collection of about 1000 birds from northern Argentina, including both the high Andean flamingos, the rare snipe, *Phegornis*, and finch, *Idiospar*, the Swann Collection of Accipitres, and representative series taken by G. H. H. Tate in northeastern Venezuela and by H. Friedman in north and south Central Africa.

Mr. J. E. Thayer has presented the Museum with numerous birds from northern Mexico, and Dr. Thomas Barbour, who is especially interested in our exchanges, has filled important gaps in the collection from

time to time. In the laboratory, Peters' work on a card catalogue of the birds in the Museum is progressing satisfactorily. It contains all the forms recognized up to 1925 and indicates those represented in the Museum. Using Sharpe's *Handlist* as a basis, it appears that of the 2647 genera of recent birds recognized by him, but 182 are lacking in the collection. Of the 18,938 species recognized by the same authority the Museum has about 10,000. The collection contains about 150,000 skins and probably more than 1000 types.

The third volume of Doctor Phillips' monograph of the ducks of the world (see review, p. 509) has just appeared and proof-reading is well advanced on the fourth. Doctor Phillips is now engaged on a new work on extinct and disappearing birds.

Mr. T. E. Penard and Outram Bangs have nearly completed their life of Lafresnaye and account of his collection as well as of the Lesson, Boissoneau, Guerin, and other types contained therein.

A change in the arrangement of the teaching laboratories will greatly increase the amount of space available for the bird department. Of special importance in this connection is a course in ornithology by Dr. G. M. Allen, the first ever given at Harvard. For this course, which was most successful and popular, full credit is allowed for the degrees of A.B. or S.B.

CARNEGIE MUSEUM

With the receipt of 4522 birds from the Rio Solimões, Brazil, the Carnegie Museum has the largest and most complete collection of Amazonian birds in existence. The new forms in this addition to the Carnegie collection are in process of being described; the collection as a whole is being worked up in connection with the general collection.

During the year critical determinations of the specimens representing six families have been completed. A paper on the tropical American species of the goldfinches of the genus *Spinus* has been completed.

The compilation of data for a proposed work on the birds of Western Pennsylvania has been prosecuted steadily by Miss Ruth Trimble, whose services have been available through the generosity of the local Audubon Society.

The most notable addition to the exhibitions is a group showing the blue goose at James Bay, the gift of John B. Semple.

THE CLEVELAND MUSEUM OF NATURAL HISTORY

THE South Atlantic Expedition of the Cleveland Museum of Natural History was undertaken in coöperation with the American Museum of Natural History. Its purpose is to study the oceanic islands of the Atlantic as the Whitney South Sea Expedition is studying those of the Pacific. The expedition sailed from New London in November, 1923, in the three-masted schooner "Blossom," 109 feet over all, under the leadership of George Finlay Simmons.

The first work of the expedition was an extensive study of the bird life of the Cape Verde Islands off the west coast of Africa. Practically all of these islands were thoroughly studied, and although the common European migrants were neglected in favor of local species, the collection includes more different forms of birds than were previously known from the group.

From the Cape Verde Islands the "Blossom" sailed to the African mainland at Dakar, Senegal. In but few places is there a better opportunity of studying the life of the mainland in comparison with that of an adjacent oceanic island group than in Senegal. Here the "Blossom" obtained collections that make an excellent beginning of the Cleveland Museum's African fauna, and afford a fine foundation for later study of the relationships of the life of the mainland to that of the Cape Verde Islands.

Since the "Blossom" left Dakar, she has been working south of the equator, and only the collections and reports forwarded from Rio Janeiro are available at this time. The most interesting of these pertain to the "Blossom's" visit to the Martin Vas Rocks and the volcanic island of Trinidad, seven hundred miles east of Rio Janeiro. The Martin Vas Rocks had probably never been landed upon before, yet the Expedition collected two species of spider, an interesting problem in geographic distribution. Another puzzle in distribution is the presence of earthworms on these islands. Important bird collections were made on Trinidad and specimens were secured there of the descendants of the goats landed by Captain Edmund Halley more than two hundred years ago.

It is expected that the "Blossom" will report soon at the Island of Ascension, which is a cable station, and will reach a home port in the autumn of 1925.

FIELD MUSEUM OF NATURAL HISTORY

FOLLOWING the completion of the third part of the "Catalogue of Birds of the Americas" (see review, p. 508) Dr. C. E. Hellmayr, associate curator of birds, at once began work on Part IV and in this connection has spent the summer studying in European museums.

Aside from Hellmayr's work, the most important matters in the Division of Birds are the splendid growth of our ornithological library and the progress of Mr. H. B. Conover's collection. Under the patronage of Mr. E. E. Ayer, the first president of the Museum and still an active trustee, a very large number of scarce and desirable ornithological books have been purchased during the past two years. J. T. Zimmer has made a very fine bibliographic catalogue of the library which will be published in the near future.

Mr. H. B. Conover's collection of the game birds of the world, which is deposited in a special room in the Museum, continues to grow. Mr. Conover employs collectors throughout the world, and at the present rate of progress should within a few years have the best collection of the families included in this country.

The oölogical collection has been advanced to the first rank through the receipt of the collection of Mr. R. M. Barnes, of Lacon, Illinois.

Plans for field work, in which special attention will be paid to birds, include an expedition to Brazil. It is hoped that George Cherrie's presence on the Roosevelt Expedition to Central Asia will result in a collection representing the bird life of the region visited.

COLORADO MUSEUM OF NATURAL HISTORY

THIS Museum is becoming widely known for its growing series of bird groups, planned and prepared under the direction of Director J. D. Figgins, who played so important a part in the production of the bird groups in the American Museum.

The earlier groups were made with the use of photographic transparencies as background, but with the completion of the Joseph M. Standley Wing to the Museum building, more elaborate habitat groups of birds were undertaken, these being largely confined to North American species not found in Colorado. Chief among these groups are the summer

birds of southwestern Louisiana, the water fowl wintering on the coast of the same region, the Bahama Island birds, a large group illustrative of the breeding birds of the Bear River Marshes, Utah, and numerous others of rare or extinct species. For the most part, however, this series of groups consists of Far North varieties, the large birds of the Arctic coast region of Alaska being especially well represented.

The Colorado Museum has used from three to thirty-eight species of birds in some of its habitat groups, and with the installation of like exhibits in the W. H. James Memorial Wing, to be devoted exclusively to South American subjects, the number will be greatly increased.

A party from the Colorado Museum is now at work in Argentina, Paraguay, and southern Brazil, collecting specimens and materials for the construction of habitat groups, some of which will be in excess of one hundred feet in length. An example of this plan of installation will be the birds of the upper Paraguay River. Accounts of naturalists who have visited that region, notably that of Colonel Theodore Roosevelt (in *Through the Brazilian Wilderness*) describe an enormous number and variety of species found in small areas. Any attempt adequately to illustrate scenes of that character necessitates a radical departure from hitherto recognized standards of group construction, and instead of utilizing several exhibits representing localized conditions of bird life, the entire length of the halls of the James Memorial Wing will be employed, in which a cross section of the greatest abundance of bird life can be shown. Obviously, then, the future development of habitat groups is limited only to the space available in the halls of a museum building.

CALIFORNIA ACADEMY OF SCIENCES

THE Academy is especially interested in the distribution of bird life in California and on the islands off the coast.

The Mexican government has not only greatly assisted our expeditions to certain of the islands off Lower California, but has even gone so far as to invite us to send representatives upon some of its own voyages of investigation. This courtesy has been reciprocated by the Academy, and Mexico has invariably been in turn invited to send representatives upon our own voyages to its territory. In this way a most friendlyfe!

has been established, to the benefit of all concerned.

The most recent expedition of this sort has been one to the Revillagigedo and Tres Marias groups, which the Academy was enabled to undertake through the courtesy of Secretary of the Navy Wilbur, who placed at its disposal the mine sweeper "Ortalan" from mid-April until mid-June.

The bird department has been represented upon all of these expeditions, when specimens and data have been obtained which are to be worked over and incorporated into a proper report. Further work in this line is being planned for the near future and there is good reason to expect gratifying results.

MUSEUM OF VERTEBRATE ZOOLOGY, UNIVERSITY OF CALIFORNIA

THE Museum of Vertebrate Zoology was founded in 1908 by Miss Annie M. Alexander, and continuously from that time it has received from her a large part of its support. In its inception this museum was devoted primarily to the study of the animal life of western North America, especially that of California, and its activities have remained pretty closely within these limits.

Dr. Harold C. Bryant, economic ornithologist in the Museum, editor of *California Fish and Game*, and in charge of education, publicity, and research for the California State Fish and Game Commission, is mainly concerned in the educational aspects of ornithology. He conducts nature classes in the Extension courses offered by the University of California throughout the academic year. Nature guide service, begun in a modest way in Yosemite Valley several years ago in cooperation with the National Park Service, has grown to such proportions as to engross his entire time during the summer months, and to require the employment of several assistants during the present (1925) season. In this connection there has been developed a school

for the training of nature guides which is receiving marked support.

Mr. J. Eugene Law, curator in osteology, has devoted much time to the care and development of the osteological collections of the Museum. The series of bird species thus represented have been built up largely with regard to the needs of Dr. Loye Miller in the study of the fossil bird remains in the Rancho-la-Brea deposits and elsewhere in California.

Miss Margaret W. Wythe, assistant curator of birds, has been occupied, in collaboration with Doctor Grinnell, on an account of the birds of the San Francisco Bay region.

Dr. Joseph Grinnell, director of the Museum, is also professor in the department of zoology of the University, and in this capacity devotes considerable time during two courses in vertebrate zoology (general and economic) to class instruction in ornithology. Work in progress includes a coöperative study with Miss Wythe on the birds of the San Francisco Bay region, as already mentioned, and, during the past year, with the late Richard Hunt on the birds of Morro Bay, California. A rather extensive program for the study of the natural history of a cross section of the California Sierras in the Mount Lassen region is now being carried out by Doctor Grinnell and Mr. Dixon.

Miss Annie M. Alexander and Miss Louise Kellogg, though latterly more especially interested in palaeontological collecting, gather in a few birds as occasion permits. Last year their efforts resulted in a small collection of birds from Egypt, and in other years series from the Hawaiian Islands and from various localities in the deserts of the Southwest.

While the bird collection of the Museum pertains mostly to North America, and especially to the western parts thereof, small collections of exotic species have been acquired, for the most part, as gifts from various individuals.



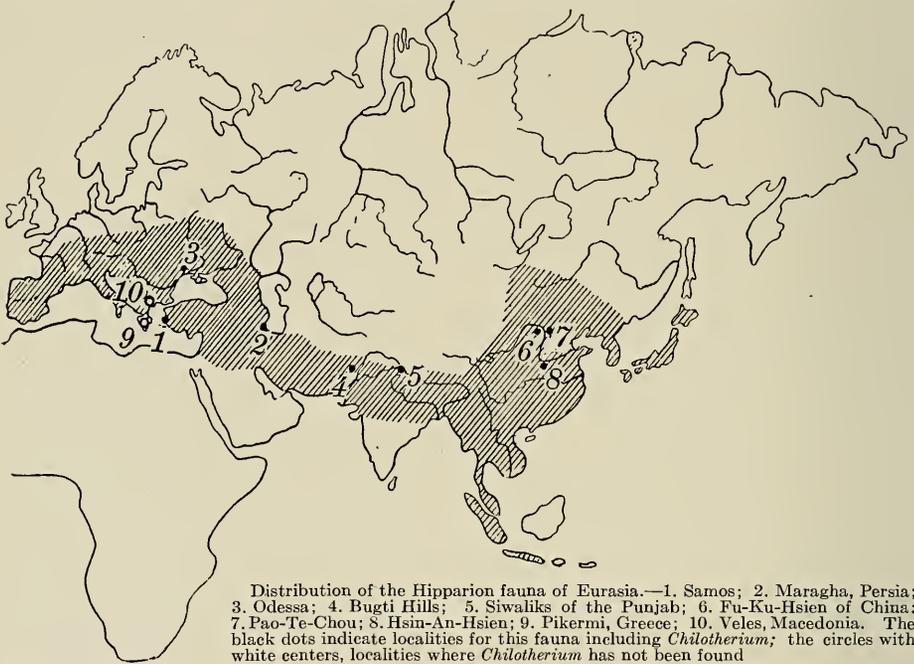
NOTES

EXTINCT ANIMALS

EXTINCT RHINOCEROSSES OF NORTH CHINA.

—Dr. Torsten Ringström contributes to *Palæontologia Sinica*, published under the direction of V. K. Ting and W. H. Wong, of the Geological Survey of China, an invaluable memoir entitled "Nashörner der Hipparion-Fauna Nord-Chinas," in which appears a

American branch was given off, terminating in the American species, of which the most characteristic was *Teleoceras fossiger*, which swarmed in great numbers in the rivers and swamps of our western Pliocene deposits. This animal was protected by a sharp horn at the very tip of the nasals, to which the name *Teleoceras* refers. The Asiatic form *Chilo-*



geographic distribution map which is reproduced herewith. In this widespread life zone, indicated by shaded lines, a very similar fauna was distributed throughout Pliocene time, beginning with the lower Pliocene of Pikermi and of Samos and closing with the upper Pliocene, in which *Hipparion* entirely disappears not only in Asia but in North America. Extending from this broad and at the time fertile and hospitable life zone, were species of the short-limbed, low-bodied genus of rhinoceroses to which the author gives the name *Chilotherium*. This genus represents the Asiatic branch of the subfamily of the rhinoceroses known as *Teleocerinae*, which is represented in the corresponding period in North America by the genus *Teleoceras* of Hatcher. The author shows (p. 68) that from an unknown source in upper Oligocene time an

therium, on the other hand, entirely lacks the horn in both sexes. The nasals are horizontal; the inferior incisors are correspondingly enlarged for purposes of attack. The geographic distribution is from upper Miocene to lower Pliocene time in Eurasia. Of equally great interest in this valuable memoir is the recognition by the author of the ancestor of the giant single-horned Pleistocene rhinoceros described by Brandt a half century ago as *Elasmotherium*. The ancestry of this animal has long been in doubt; the author now discovers its ancestry in the genus *Sinotherium*, and places it in a separate family *Elasmotheriidae* (pp. 143-45). *Sinotherium* is distinguished from *Elasmotherium* by the relative simplicity of its grinding teeth and by the presence of one more premolar tooth. The upper jaw is greatly compressed. For the

same animal Killgus (p. 123) gives the name *Parelasmotherium*, and the bones of this animal were referred by Schlosser, 1903, to the genus *Hippopotamus*.

These two discoveries greatly enrich our knowledge of the ancestry and descent of the rhinoceroses in the Old World. Doctor Ringström accepts the phylogeny and classification of the rhinoceroses substantially as described by Professor Osborn in a recent number of *NATURAL HISTORY*.

Another important contribution to this series of memoirs on the Hipparion fauna of China is by Doctor Zdansky and deals with the Carnivora. It will be reviewed in a later issue of *NATURAL HISTORY*.—H. F. O.

HISTORY OF THE EARTH

"THE ENDLESS CAVERNS."—The forty-eight-page booklet on "The Endless Caverns of the Shenandoah Valley," by Associate Curator Reeds of the department of geology, should be of interest to every reader of *NATURAL HISTORY*. The booklet, which was published by the Evans-Brown Co., Inc., 150 Lafayette Street, New York, appeared in July after Doctor Reeds had visited these beautiful caverns in January and May of this year. Not only is the wonderful work of water above and below ground discussed, but special consideration is given to how caverns are excavated, what processes are at work, the circulation of air in caves, how secondary growths are formed in caverns, and what becomes of the water of caves and underground streams. The age of these spectacular caverns is considered in relation to four cycles of erosion which are well exhibited in the surface features of the region. The booklet is fully illustrated with photographs that have not been excelled in any other publication.

FISHES

THERE is no more fascinating department of study in the science of ichthyology than that which relates to the various extraordinary means adopted by fishes for the protection and hatching of their eggs and for the care of the young until they can fend for themselves. Among some sharks and rays and also among some few bony fishes, viviparity is practiced—i.e., the young are born alive. Other bony fishes like perch and bullheads make nests in the sand wherein the eggs are laid and guarded. Other fishes make birdlike nests of

sticks and weeds, or even of foam. Still other fishes take into their mouths the newly laid eggs and there incubate them, not only exercising parental care until the eggs are hatched but until the young are developed sufficiently to look out for themselves.

Still another class of ocean fishes lay their eggs in a gelatinous raft which floats about at the surface of the water until the eggs, under the warmth of the sun, hatch, and the fishlets break out of the band of jelly and begin a free life. It has long been known that the angler, "all-mouth," or goosefish of our northern waters, lays such an egg raft. Less well known to those who do not have at hand a knowledge of the literature of reproduction of fishes, is the fact that the Sargassum fish, which lives among the seaweed of that name, as it crawls among the weed extrudes a gelatinous raft of eggs, and this, intertwined in the weed, forms the so-called "nest" of this fish.

But now there comes the amazing news from the researches of Mr. C. Tate Regan, the distinguished ichthyologist of the British Museum, that among certain deep-sea angler fishes taken in the waters of the northern Atlantic and in the Gulf of Panama, the females are large and well developed, while the males are small, insignificant, and permanently attached to the females as parasites. In one case a female measured 1030 mm. in length, and the parasitic males 80 and 85 mm.; in another case the female was 1000 mm. in total length and the attached male 105 mm. over all.

These dwarf males are born as independent, free-swimming little fishes, but they later become permanently attached to the female. The jaws and lips of the male grasp a papilla of the skin of the female and in some unknown way become fused to the skin, forming a continuous tissue. This tissue is fibrous and highly vascular, and the blood vessels lead from one fish into the other—as Regan puts it: "It is impossible to say where one fish begins and the other ends." That is to say, there is in this case an absolute case of parasitism of the male fish on the female, in that all his food is carried through the blood vessels which are continuous from the female to him. This parasitism effectively provides a male at hand to fertilize the eggs when these are extruded by the female, and inevitably and effectively insures reproduction.—E. W. G.

NEW MEMBERS

SINCE the last issue of NATURAL HISTORY, the following persons have been elected members of the American Museum, making the total membership 8300:

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MAMMAL NUMBER NOVEMBER-DECEMBER

The November-December issues of *Natural History* will be a "Mammal Number" and will be edited by Mr. H. E. Anthony, in charge of the department of mammals. This number will show the great diversity of interests which may attract the attention of one studying mammals.

Professor Henry Fairfield Osborn will contribute the leading article, on a subject of fascinating interest, "Mammals and Birds of the California Tar Pools." These pools of viscous tar trapped literally thousands of saber-toothed tigers, enormous lions, wolves, condors, and other creatures of a bygone era. Dr. J. Howard McGregor, research associate in human anatomy, will present some hitherto unpublished data on the greatest of the mammals, man himself. Doctor McGregor writes on the primitive man, *Pithecanthropus* of Java.

The editor has selected from the letters and diary of Martin Johnson a few of the more exciting episodes which make up the day's work of the Martin Johnson African Expedition. Accompanying these will be a pictorial section in duotone, showing photographs recently received from the field. Mr. Barnum Brown, associate curator of fossil reptiles, will tell of his experiences in an unfamiliar big-game country, Abyssinia, the one-time home of the Queen of Sheba.

Ernest Thompson Seton will contribute excerpts from his forthcoming second volume of *Lives*. This de luxe edition of animal biographies is the most complete and ambitious account of North American mammals ever undertaken. Volume one, just recently published, will be reviewed by the editor.

Mr. H. C. Raven, assistant curator of comparative and human anatomy, will review some recent work by Australian mammalogists, who have made some very important contributions to science. Mr. Ira A. Williams of Oregon will contribute an account of unusually fine beaver-dam construction, with excellent photographs. The editor, who has had considerable experience with bats, both in the field and in the laboratory, will bring together for this number some interesting facts concerning these small mammals. Finally, there will be included the latest reports from expeditions in the field, plans for important research work, and discussion of some of the problems connected with the study of mammals.

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NATURAL HISTORY

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H. E. ANTHONY, EDITOR

NOVEMBER—DECEMBER

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NATURAL HISTORY

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Mammals and Birds of the California Tar Pools

BY HENRY FAIRFIELD OSBORN

Honorary Curator of Vertebrate Paleontology, American Museum

THE story of the California tar pools of Los Angeles and McKittrick is a romance of Nature and Civilization, of the prehistory of California, and of its present economic resources. The now famous formation of the Rancho-la-Brea, referred to by early historians of southern California, was formerly the property of Major Henry Hancock, and for a period was worked extensively for asphaltum and fuel. The bones thus uncovered were recognized as prehistoric, but attracted little notice until 1906, when Dr. John C. Merriam realized their great importance and began excavation for the University of California. His scientific studies and those of his colleagues and students on the fossil birds and mammals extended into a vast literature. In 1913 the whole tract of thirty-two acres, including all the fossil-bearing asphalt pits at Rancho-la-Brea, was granted to Los Angeles County by George Allan Hancock as a memorial to his parents, Major Henry Hancock and Mrs. Ida Hancock. The present article brings back to life these birds and mammals as revealed by twenty years of excavation and research.

NATURE does nothing by halves in the great State of California, sculpturing the longest and greatest coast line, rearing the loftiest mountain peak in the Union, carving the grandest glacial gorges, preserving the tallest of the ancient conifers of the world, nourishing the most varied glacial flora of the parks of the High Sierras, of the humid coasts, of the arid and torrid deserts, and harboring a still active volcano—thus Nature builds the golden state out of her superlatives!

While quick to display her present natural grandeur, California has been slow to reveal her prehistoric glory. The 'Ancient Territory of Nebraska' (including the present states of Nebraska and the Dakotas) and the states of Wyoming and Montana, as well as of New Mexico and Arizona, have hitherto surpassed in prehistory our great Pacific Coast state. This is because California was still in the making of her mountains and her coast lines during the Age of Reptiles and the Age of Mammals. Her sparse records of the Age of Mammals have only in recent years been

unearthed by John C. Merriam and his students. As if to compensate us for this long prehistoric silence in the Tertiary or Age of Mammals, California suddenly reveals with unprecedented fullness and completeness her life during the Quaternary or Age of Man. Her bird life is recorded with unparalleled fullness in the tar pools of Los Angeles and of McKittrick, and the rarest of all fossil life is bird life, owing to the fragile nature of the bird skeleton. In the same tar pools the mammal life of early Quaternary or Pleistocene time was suddenly revealed as nowhere else in the world with such redundant fullness and completeness.

The long-famous Pliocene deposits of the Pikermi of Greece and of the Island of Samos, even the wonderful Lower Miocene assemblage of the Agate Spring quarry of Nebraska, fade in comparison with the fossil hosts of the tar pools, which include numerous representatives of the *entire large bird and mammal fauna* of the southern California region at the time the pools were capturing their prey.

The following is a partial and in-

¹The illustrations of the Rancho-la-Brea murals are from photographs copyrighted by the American Museum.

complete summary of the numbers of mammal remains in the Rancho-la-Brea pools excavated up to the year 1920:

quently, we are led to a death-cycle theory of the foot-entangling tar pools somewhat as follows: all the quadrupeds, through instinct or intelli-



Fig. 2.—The old Rancho-la-Brea (Ranch of the Tar Pools), property of Major Henry Hancock, surrounded by trees and clumps of cactus, the 'Brown pool' and pits (9, 10, 11, 12) in the foreground, oil-pumping wells above the oil-bearing strata in the middle distance, and the Coast Range beyond. In this large pool was secured, shortly after the discovery, the first Los Angeles High School collection, also skeletons of the sloth (*Mylodon*), and a complete mastodon skeleton.

This and succeeding photographs by courtesy of the Museum of History, Science and Art, Los Angeles

- IMPERIAL MAMMOTHS (*Archidiskodon imperator*)—parts of 17 or more individuals.
 SMALLER SHASTA SLOTHS (*Nothrotherium shastense*)—13 or more.
 ANCIENT BISONS (*Bison antiquus*)—70 or more.
 GIANT GROUND-SLOTHS (*Mylodon harlani*)—60 or more.
 WESTERN FOSSIL CAMELS (*Camelops hesternus*)—60 or more.
 ARCH-FRONTED HORSES (*Equus occidentalis*)—17 or more.
 CALIFORNIA SABRE-TOOTH TIGERS (*Smilodon californicus*)—2000 or more.
 DIRE OR "GRIM" WOLVES (*Enocyon canis dirus*)—3000 or more.

The carnivores, such as the dogs and the sabre-tooths, predominate over the herbivores, such as the sloths, camels, horses, bisons, mastodons, and mammoths: similarly, in the air the carnivorous birds predominate over the aquatic and shore birds. Conse-

quently, avoided the dangerous tar pools, except perhaps in seasons of drought, when, driven by extreme thirst, they lost their caution and ventured on the treacherous tar surfaces, which the thin sheets of water barely covered.

A parallel today to this lack of caution is the reckless approach of African quadrupeds to water pools in periods of severe drought, or the eating by hungry quadrupeds of poisonous plants which are instinctively avoided in times of food-plenty. In a similar manner, driven by hunger, carnivorous wolves and sabre-tooths lost their instinctive cautiousness when attracted by the freshly entrapped carcasses of the larger or smaller quadrupeds. Just as today hyenas and vultures gather in numbers around the decaying carcass of an African

zebra after the lion, the king of beasts, has taken his fill, so it is not improbable that wolves and sabre-tooths came in numbers or packs, while the giant

tions, depict all the principal elements of the fauna. Whereas the entire Hall of the Age of Man epitomizes 125 years of most difficult and varied research,

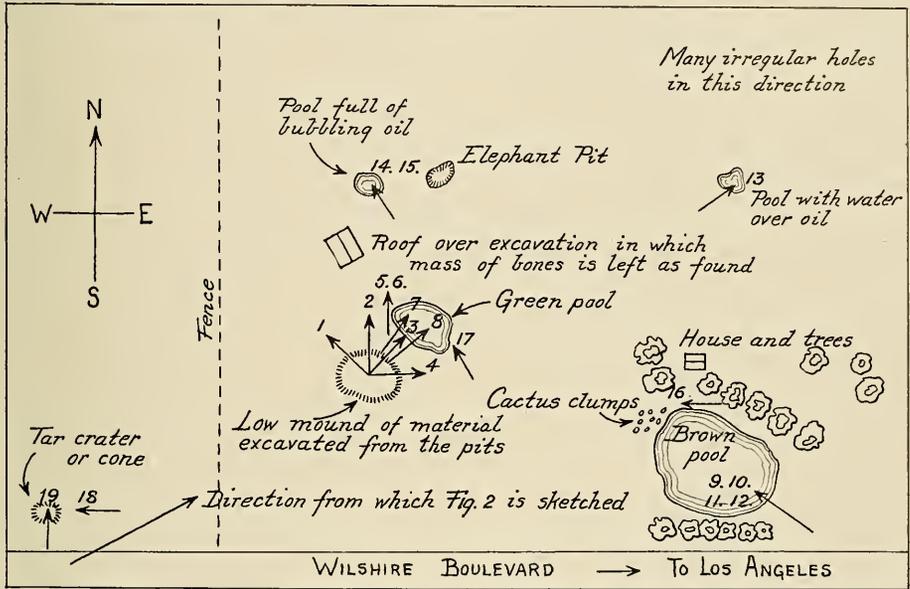


Fig. 3.—Key to the frontispiece and Fig. 8, showing the location of the Rancho-la-Brea (16), of the 'Brown pool' (9-12), of the 'Green pool' with pits (1-8, 17), and of the elephant pit (14, 15). The oblique arrow in lower left-hand corner indicates the direction from which the great mural reproduced in the frontispiece and in the corresponding Fig. 8 was drawn

lions (*Felis atrox bebbi*) and the short-faced bears (*Arctotherium californicum*) came singly and were rarely attracted to the tar pools.

It is to all these different phases and episodes of the Lower Pleistocene life of southern California that the present article is devoted.

LANDSCAPE STUDIES IN THE MAKING OF THE GREAT MURALS

For all these reasons the place of honor on the southeast walls of the Hall of the Age of Man is given to the mammalian life of southern California during the early periods of the Ice Age; the four mural panels, two of larger, two of smaller size, as reproduced in the accompanying illustra-

the murals and exhibits of its southeast walls display the knowledge we have gained in the relatively brief period of 19 years since Dr. John C. Merriam in 1906 recognized that the tar pools of the now world-famous Rancho-la-Brea were crowded with a vast number of the bones of a long extinct fauna. In describing this wonderful region let us reverse the order of thought usually employed by palæontologists and begin with the present condition of the tar pools—the machinery of the great wells supplying oil to the industries and navigation of the world—wend our way slowly back into the past, and thus convey to the reader some faint conception of the stupendous changes which have taken place and

of the long and tedious processes of exploration, research, and reasoning which have brought this marvelous ancient world right out of the grimy material surroundings of a modern oil field.

In the inspiring companionship of California's adopted son, John Muir, of Stephen Tyng Mather, leader in our national park and forest conservation movement, and of John C. Merriam, discoverer of the fauna of the tar pools, the present author has visited every part of the great State and with Joseph D. Grant and other California idealists is battling to save the redwoods from destruction. For the purposes of the mural restoration of the great landscape during the arid summer season, the author took three journeys to this region, guided by Doctor Merriam and the late Director Frank S. Daggett, of the Los Angeles Museum, and accompanied once by the enthusiastic photographer, Russell T. Kirby, to whom the mountain profiles of the murals are due. Referring to our Figures 8 and 8a and to the diagram, Mr. Kirby wrote February 25, 1920:

I got up my courage finally to go over to the Huntington Hotel and see Professor Osborn. His idea is to make a picture in the direction of the big arrow on the other side, showing a group of sloths struggling in a pit with the sabre-tooth tiger prowling around. Mountains in the background drawn so accurately as to be recognizable. He thinks the pit had rather gently sloping banks, that there were numerous trees about (the remains of a certain McNab's cypress have been found packed down among the bones), and that the animals came there to drink the water retained on the oily surface and took great risks to obtain it because of severe drought.

The controlling idea in the composition is to place the tar pools in the foreground surrounded by one or more

groups of animals, with the Coast Range in the background. This part of the Coast Range is now famous, since from its center rises Mt. Wilson, on the summit of which is the observatory designed by George Ellery Hale and erected with the ample funds of the Carnegie Institution. The great telescopes of this observatory are capable of locating and measuring by the Michelson method such gigantic stars as Betelgeuse.

During the early Ice Age, when the great animals frequented the drinking pools spread over the treacherous tar beneath, these mountains with the same very simple contours were present. The snow, however, descended much lower on their sides, and the artist must therefore present the Range with the higher summits covered with snow and snowcaps reaching much lower down the mountain-sides than they do now even during the winter season. The precise location of the pits where the different kinds of animals were found was surveyed and plotted with very great accuracy under the direction of Doctor Merriam and Director Daggett. Every single bone of the thousands taken out was definitely located, so that the association of parts with individual skeletons, as in the case of the imperial mammoth and certain of the ground-sloths, is definitely recorded.

ANIMAL STUDIES FOR THE MURAL COMPOSITION

The animal studies for the mural composition were guided by the researches on the mammals of John C. Merriam, followed by those of William D. Matthew and Chester Stock, by the studies of Osborn on the proboscideans and by the researches on the birds of Loye Miller, aided by L. E. Wyman.

The recent summary of the mammal fauna by Chester Stock in his great memoir of 1925 includes twenty-nine species of larger mammals—carnivores, edentates, artiodactyls, perissodactyls and proboscideans—not in-

cluding the insectivores, bats, and numerous and varied rodents.

The preponderance of extinct genera and species indicates that the tar pool traps were most effective during one or more centuries of *arid early*

MAMMALS

CARNIVORA

- Arctotherium californicum* Merriam, extinct California short-faced bear; also of South American Andean region
- Ursus* sp., true bear; about size of the living grizzly (*Ursus horribilis*).
- Canis* (*Ænocyon*) *dirus* (Leidy), the great extinct dire wolf; also found fossil in Indiana.
- Canis* (*Ænocyon*) *milleri* (Merriam), a variety of the extinct dire wolf.
- Canis occidentalis furlongi* Merriam, related to the western wolf, *Canis occidentalis*.
- Canis ochropus orcutti* Merriam, close to the living coyote of California, *Canis ochropus*.
- Canis andersoni* Merriam, extinct short-headed coyote-like wolf.
- Urocyon californicus* Mearns, the living species of gray fox of southern California.
- Taxidea*, the badger; possibly a new species; also of western America.
- Spilogale*, a species of spotted skunk.
- Mephitis occidentalis*, the living western skunk; possibly a new species.
- Mustela*, a species of the living marten.
- Smilodon californicus* Bovard, extinct California sabre-tooth tiger.
- Felis atrox bebbi* Merriam, extinct giant lion or wild cat of La-Brea; also fossil in southern United States.
- Felis daggetti* Merriam, Daggett's puma or mountain lion, extinct
- Lynx, near *rufus californicus* Mearns, Fisher's lynx or caracal.
- Felis lynx*, the lynx.

EDENTATA. Edentates, Ground-sloths. All extinct.

- Mylodon harlani* Owen, Harlan's giant ground-sloth; also of South America.
- Mylodon harlani tenuiceps* Stock, small-headed species of the above.
- Megalonyx jeffersonii californicus* Stock, large-clawed sloth of California; also fossil in eastern United States.
- Nothotherium shastense* Sinclair, Shasta smaller ground-sloth; also of Brazil and the Argentine.

ARTIODACTYLA. Camels, antelope, deer, bison, peccaries.

- Camelops hesternus* (Leidy), fossil western camel; also of northern California.
- Capromeryx minor* Taylor, small fork-horned antelope; also of western Nebraska.
- Odocoileus* sp., species related to our Virginia deer; also of temperate North America.
- Bison antiquus* Leidy, Leidy's ancient bison, narrow-fronted; also of eastern United States.
- Platygonus*, extinct crest-toothed American peccary.

PERISSODACTYLA. Horses, tapirs.

- Equus occidentalis* Leidy, extinct arch-fronted horse of California; also of northern California.
- Tapirus* sp., a species of tapir; also of Central and South America.

PROBOSCIDEA. Elephants, mastodons.

- Mastodon americanus*, true American mastodon; also of central United States and Eurasia.
- Archidiskodon imperator*, imperial southern mammoth; also of central United States and Mexico.

RODENTIA. Hares, rabbits and many smaller rodents.

INSECTIVORA. Moles and shrews.

CHIROPTERA. Bats.

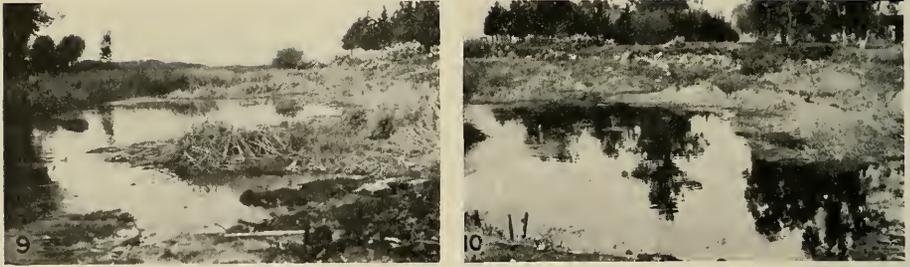


Fig. 4.—Two views of the 'Brown pool' adjoining the Rancho-la-Brea, showing the present appearance and location of pits 9 and 10, in which the early excavations of the Los Angeles High School yielded skeletons of the giant ground-sloth (*Mylodon harlani*) and American mastodon (*Mastodon americanus*)

Quaternary age; they then ceased to capture prey during a very long middle and upper Quaternary period of *moister* climate. In the mammal list there are many long-extinct genera: *Arctotherium*, *Enocyon*, *Smilodon*, *Mylodon*, *Megalonyx*, *Nothrotherium*, *Camelops*, *Capromeryx*, *Platygonus*, *Mastodon*, and *Archidiskodon*. The greater number of species is extinct, namely, out of the total of twenty-nine species of mammals listed, twenty-one are extinct, only eight being so closely similar to living types as not to be separable specifically. These eight species are relatively small and inconspicuous mammals. All the larger kinds of predominant mammals which surrounded the tar pools are extinct. Another reason for recording these assemblages as of *early* Pleistocene age is the presence of the imperial southern mammoth (*Archidiskodon*

imperator), an elephant belonging only to early Pleistocene time.

The same impression of great antiquity is given in the survey of bird life of the Rancho-la-Brea. Let us, however, first survey the mammal life more closely.

THE CARNIVOROUS MAMMALS

The *Canis* (*Enocyon*) *dirus* was the dominant type of wolf in this region and in the central and eastern states; the type of this genus and species is from Evansville, Indiana. It includes the largest known individuals of the wolf group in America, the skull being especially large in proportion to the relatively light limbs, which show that it was a poor traveler. The great number of individuals in the Rancho-la-Brea pools suggests that this animal hunted in packs, attacking isolated quadrupeds and sloths. The hardly



Fig. 5.—Right: the mound (2) in front of the 'Green pool'; in the distance the elephant (*Archidiskodon imperator*) pit (arrow). Left: fresh tar crater or cone (19) near the elevated point from which frontispiece was painted



Fig. 6.—Left: near the elephant (*Archidiskodon imperator*) pit below flow of bubbling oil (14). Center: McNab's Cypress (*Cupressus macnabiana*) excavated from the pit near by. Right: hardened surface of the 'Green pool' (17)

less numerous sabre-tooth (*Smilodon californicus*), of which more than two thousand individuals have been found, is about the size of the sabre-tooth of Florida (*Smilodon floridanus*); it is decidedly smaller and shorter-faced than the great extinct sabre-tooth (*Smilodon neogæus*) of the Pampean formation of Argentina and differs widely from the true lion and tiger in its short tail, its short, massive limbs, its abbreviated face. As pointed out by Matthew, the distinctive character of all the sabre-tooths is their ability to throw the jaw back upon the neck, as seen in the Frontispiece and Figure 8, thus completely exposing the dagger-like tusks.

The California short-faced bear (*Arctotherium californicum*) was an intelligent animal rarely captured in the tar pools; it is represented merely by a giant inferior canine tusk and giant foot-bones, which enable Merriam to compare this animal with the short-faced cave bear (*Arctotherium simum*) of northern California; it equalled or exceeded in size the gigantic living bears of Alaska. Relatively numerous is the giant cat of La-Brea (*Felis atrox bebbi*), of which fourteen skulls

have been found. First discovered in Mississippi (*Felis atrox* Leidy), this is a true feline, with the majestic proportions of the lion, including long limbs, but far exceeding either the African or the Asiatic lion in size, the largest individuals nearly equalling the Kadiak bear (*Ursus merriami*); its nearer zoölogical affinities are rather with the American felines than with the true lions or tigers of the Old World. Among the other felines are Daggett's puma or mountain lion (*Felis daggetti*), a lynx near the existing California species, and representatives of the dog family besides the dire wolf (*Enocyon dirus*)—a western fossil wolf



Fig. 7.—Jack rabbit (*Lepus californicus*) trapped on surface of the tar pool exactly as its ancestors were trapped in Lower Pleistocene times



FIG. 8.—THE TAR POOL DEATH CYCLE, FIRST PHASE. Location and restoration of the chief tar pools of the Rancho-la-Brea, according to the knowledge afforded by Figs. 2-7. Reproduced from the Rancho-la-Brea mural drawn by Charles R. Knight under the direction of Henry Fairfield Osborn.

This photograph and the Frontispiece do but scant justice in color to the original 9×25 foot mural on the southeast wall of the Hall of the Age of Man. The mural, completed in 1921, was three years in preparation. After repeated visits to the scene, the writer finally selected the exact point from which the painting should be composed.

The painting depicts the moment when one ground-sloth (*Mylodon*) has been entrapped and his two companions are standing guard to ward off the threatened attack of the sabre-tooth tiger (*Smilodon*).

The great condor (*Teratornis*) is drawn to scale from the description of Loye Miller; the sabre-tooth (left), chiefly from the anatomical studies of J. C. Merriam and W. D. Matthew; the great ground-sloth (right), chiefly from the studies of J. C. Merriam and Chester Stock; the imperial mammoth (center in the distance), from the studies of H. F. Osborn. The cypress trees were drawn from McNab's Cypress (*Cupressus macnabiana*) found in one of the pits. The mountain profile was drawn from studies and photographs secured by Russell T. Kirby

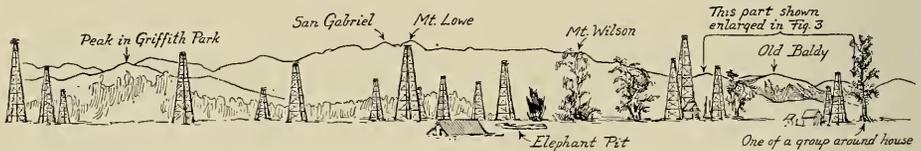


FIG. 8a.—Key to the Coast Range and chief mountain peaks shown in the above restoration. Mt. Wilson is famous all over the world as the site of the great Carnegie Observatory. 'Old Baldy' is represented as lightly covered with snow in Pleistocene times

(*Canis occidentalis furlongi*), and two species related one to the living coyotes and the other to the living gray fox.

THE EDENTATES AND SLOTHS, HORSES AND TAPIRS

Unlike the Carnivora, which are all of North American or north Asiatic parentage, the sloths are of South American origin, nearer or more remote, including the three principal types, Harlan's giant ground-sloth (*Mylodon harlani*), the giant large-clawed sloth (*Megalonyx jeffersonii californicus*), and the Shasta smaller ground-sloth (*Nothrotherium shastense*)—all slow-moving quadrupeds, defenseless in tooth structure but with large and

formidable fighting claws on the forefeet and more or less impenetrable coarse hair and hide reinforced with dermal ossicles. The wide distribution of these animals all over the southern and middle United States region tends to prove that the powerful adults could defy the larger carnivores, except when weakened by old age or when entrapped in the tar pools.

The mural (Frontispiece and Fig. 8) represents two of these sloths standing by a doomed comrade and defying an approaching sabre-tooth. According to Chester Stock in his monograph of 1925, "The Pleistocene *Megalonychinae* and *Myodontidæ* of Rancho-la-Brea," Harlan's *Mylodon* ranged

fearlessly through open or partly forested country and in South America inhabited the great stretches of the Pampas, always in the threatening companionship of sabre-tooth tigers and in the friendly company of various species of wild horses. The large-clawed *Megalonyx* enjoyed as wide a range in North America as *Mylodon* but

in northern California, differs from the modern horse (*E. caballus*) in its shorter and wider nostril region, more convex forehead or arch-fronted face, more massive lower jaw, and in the simplicity of the enamel pattern of its grinding teeth; it was a California or Pacific Coast outlier of the great herds of horses, small and large, swift and

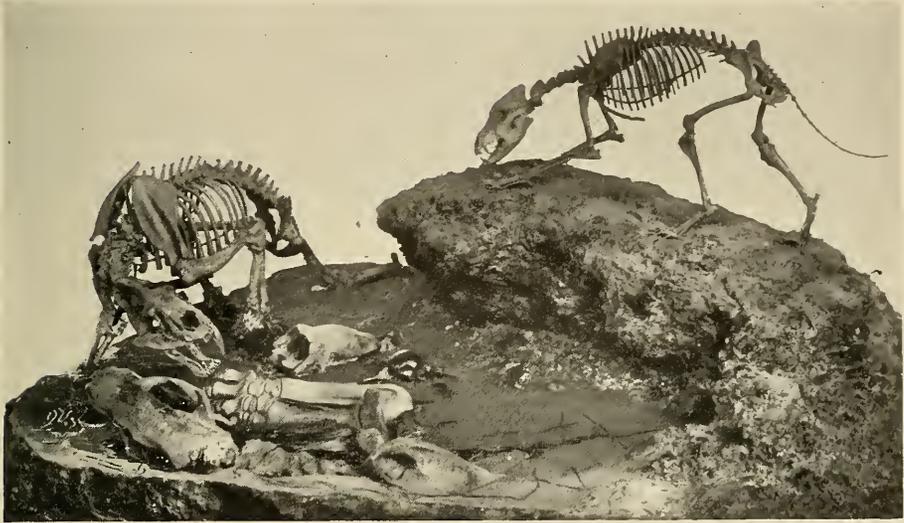


Fig. 9.—THE TAR POOL DEATH CYCLE, FINAL PHASE. Reproduced from the American Museum Asphalt Group completed in 1913 under the direction of J. C. Merriam and W. D. Matthew. This group represents the final phase in the death cycle, following that of the mural shown in the frontispiece and Fig. 8. The unfortunate ground-sloth (*Mylodon*) has sunk deeply into the treacherous tar; the sabre-tooth (*Smilodon*) is also hopelessly entangled, but his growl wards off the dire wolf (*Enocyon canis*). In such death cycles as these were captured more than 60 ground sloths, 2000 sabre-tooths, and 3000 wolves

has not been certainly identified in South America. The smaller large-clawed sloth *Nothrotherium*, a long-limbed form, ranged from Brazil northward into Texas and California, occurring in cave deposits and first discovered in a cave near Mt. Shasta, to which it owes its specific name *shastense*; it is of true South American parentage of remote Miocene time.

Eleven excellent skulls of the western fossil horse (*Equus occidentalis* Leidy) prove that this intelligent animal was occasionally entrapped; this western arch-fronted species, first discovered

slow-footed, which ranged all over the United States until the last period of glaciation. The tapir, a distinctive forest-living animal, is of very rare occurrence in the Rancho-la-Brea pools.

THE MASTODONS AND ELEPHANTS

These highly intelligent proboscideans are rare in occurrence, although the true American mastodon (*Mastodon americanus*) was among the earliest discoveries in the large pool first explored. The finding of the mastodon is especially interesting, because this animal, which as early as



LION



SLOTH (FRONT AND SIDE VIEWS)



ANTELOPE



GIANT SLOTH (FRONT AND SIDE VIEWS)



BISON



SABRE-TOOTH TIGER



WOLF



CAMEL



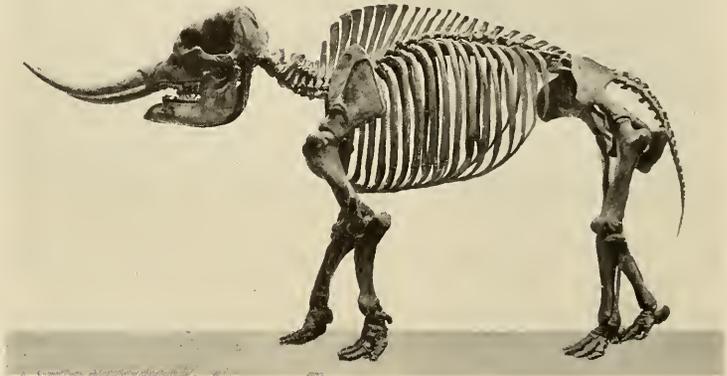
HORSE

Fig. 10.—Skeletons from the Rancho-la-Brea as mounted in the Museum of History, Science, and Art, Los Angeles, all reproduced in same scale. ($\frac{1}{2}$ natural size)

Miocene time entered North America from Asia and more remotely from northern Africa, throughout its entire range over the northern hemisphere is strictly a forest-frequenting proboscidean, as great a forest-lover as is the tapir. It is represented in the Los Angeles Museum by the skeleton of a small individual, certainly a female.

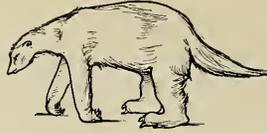
Most notable as regards its wide migration from southern Asia and most distinctive as indicating early Pleistocene age is the presence in this fauna of the imperial mammoth (*Archidiskodon imperator*), one completely assembled skeleton of which includes a perfect skull, unmistakably of the true sharply-crested shape distinctive

Fig. 10a.—Skeleton of American mastodon (right) and imperial mammoth (below) from the Rancho-la-Brea, as mounted in the Museum of History, Science, and Art, Los Angeles. ($\frac{1}{50}$ natural size)





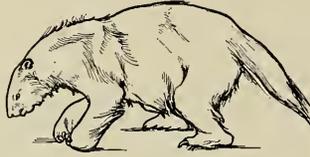
LION



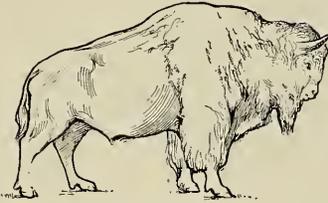
SLOTH (FRONT AND SIDE VIEWS)



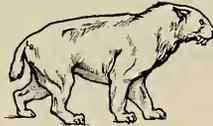
ANTELOPE



GIANT SLOTH (FRONT AND SIDE VIEWS)



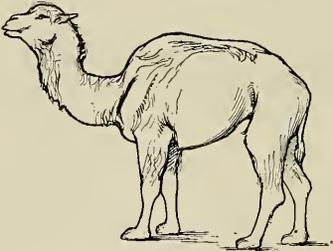
BISON



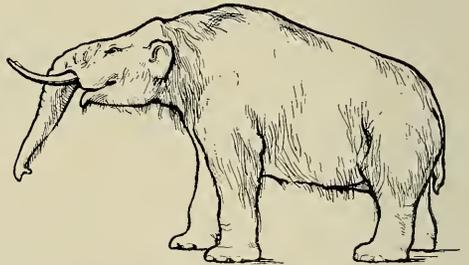
SABRE-TOOTH TIGER



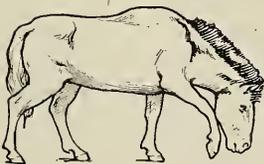
WOLF



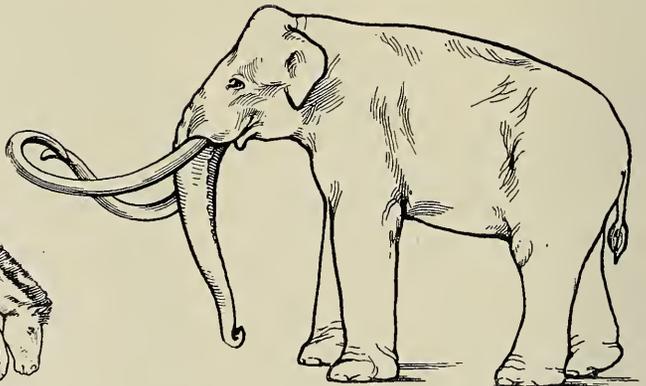
CAMEL



AMERICAN MASTODON



HORSE



IMPERIAL MAMMOTH

Fig. 11.—Outline restorations of the chief mammals of the Rancho-la-Brea, corresponding with the mounted skeletons pictured on pp. 536, 537. (3/4 natural size). Drawn by L. M. Sterling



Fig. 12.—PACK OF DIRE WOLVES AND HERD OF WESTERN HORSES. Reproduced from the Rancho-la-Brea murals drawn by Charles R. Knight under the direction of Henry Fairfield Osborn. The scene represents a pack of seven dire wolves (*Aenocyon canis dirus*) in the foreground and middle distance, with the Coast Range and snow-capped 'Old Baldy' to the left seen through the branches of McNab's Cypress; to the right is part of a herd of fossil western horses (*Equus occidentalis*); in the foreground is the skull of a bison (*Bison antiquus*). The profile of the horse is incorrectly drawn; it should be more rounded or convex as in the existing Nordic horse (*Equus caballus nordicus*).] These intermediate scenes form a continuation of the great Rancho-la-Brea murals, which altogether fill a linear space of 50×9 feet, on the southeast wall of the Hall of the Age of Man of the American Museum. An adaptation of this series to the same scale is placed on the end wall of the Museum of History, Science, and Art of Los Angeles

of all the mammoths and totally different from the round-crested skull of the genus and species *Parelephas jeffersonii*, a genus and species characteristic of the more recent period of the Pleistocene. No trace of this more recent genus and species is found in the Rancho-la-Brea, another proof of the early Pleistocene age of this deposit.

The late Director Daggett observed the remarkable fact that practically all the elephant remains in the asphalt beds were taken from a single deposit, (14,15) known as 'the elephant pit'; here in a cone-shaped area fifteen by twenty-five feet in diameter at the surface, with an extreme depth of nearly thirty-five feet, were found limb bones of no less than seventeen elephants (*A. imperator*), together with

a number of bones of the mastodon (*M. americanus*) and a great quantity of bones of the ancient bison (*B. antiquus*), of the giant ground-sloth (*Myiodon*), of the western camel (*Camelops hesternus*), of the western horse (*Equus occidentalis*), as well as of Carnivora—the giant lion, the sabre-tooth, the dire wolf, and the giant bear (*Arctotherium*). The elephants must have been trapped singly or in small groups, as the 'elephant pit' was too small to hold the huge bodies of seventeen elephants all at one time.

THE CAMELS, BISON, ANTELOPE, DEER, AND PECCARIES

Remains of the western camel (*Camelops hesternus*), estimated at sixty to seventy, are about as numerous as



Fig. 13. LA-BREA LION AND HERD OF THE CAMEL-LLAMA. Reproduced from the Rancho-la-Brea murals drawn by Charles R. Knight under the direction of Henry Fairfield Osborn. This scene depicts the giant cat (*Felis atrox bebbi*) stalking a herd of camels (*Camelops hesternus*) unsuspectingly approaching a water pool. In the distance is a herd of fossil western horses (*Equus occidentalis*).

These camels are restored after the written studies of Dr. John C. Merriam, in whose opinion they are more nearly related to the llamas (*Auchenia*) of South America than to the existing camels of the Old World. The giant cat as restored by Mr. Knight is purposely spotted so as not to imitate too closely the true lion (*Felis leo*) of southern Asia and of Africa.

are those of the ancient bison (*Bison antiquus*); the remains of these two less intelligent animals are three times as numerous as those of the more intelligent species of horse, of which there are only about seventeen individuals. These three large quadrupeds—the camel, bison, and horse—are equally distinctive of the plains, savannahs, partly forested, and seasonally dry regions, but they were not equally apt to be deceived by the thin sheets of water covering the tar pools, because of their varying intelligence.

The Rancho-la-Brea yielded many fine skulls and materials for two mounted skeletons of *Camelops hesternus*, an animal approximating the Bactrian camel (*Camelus bactrianus*) but, according to J. C. Merriam, much nearer in relationship to

the South American *Auchenia* (llama, vicuña). Matthew, however, regards *Camelops hesternus* as distinct from the existing llama and the true camel of Asia. This species of tylopod, also known in Kansas (*Camelops kansanus*), is a gigantic quadruped, towering in size over its Rancho-la-Brea companion. This companion, the ancient bison (*B. antiquus*), was first discovered in the Big Bone Lick beds of Kentucky. It is represented in the Los Angeles Museum by two skeletons and a large series of skulls; the horn cores, longer and relatively more slender, are set at right angles to the face, whereas in other species of bison the horns are more or less obtuse. Other and much rarer Herbivora are representatives of the existing pronghorn family of American antelope

known as *Capromeryx minor*, a genus also represented by a species (*C. furcifer*) of Hay Springs Lower Pleistocene beds of western Nebraska. The true pronghorn antelope (*Antilocapra*)

sensation of this part of the avifauna, which has been analyzed by Merriam, Miller, and Wyman as belonging to thirty-two species and twenty-three genera:

BIRDS OF PREY

Catharista occidentalis, nearly related to living black vulture.
Cathartes aura, turkey vulture.
Cathartornis gracilis, extinct vulture of New World type.
Gymnogyps californicus, California vulture.
Sarcorhamphus clarki, extinct condor.
Teratornis merriami, extinct condor with very large bill.
Neophrontops americanus, extinct vulture of Old World type, resembling 'Pharaoh's chicken.'
Neogyps errans, apparently an extinct vulture of Old World type.
Elanus leucurus, white-tailed kite.
Circus hudsonius, marsh hawk.
 Indeterminate species of *Circus*.
Buteo borealis, red-tailed hawk.
 Indeterminate species of *Buteo*.
Archibuteo ferrugineus, ferruginous rough-legged hawk.
Aquila chrysaëtos, golden eagle.

Halixetus leucocephalus, bald eagle
Geranoaëtus grinnelli, extinct buzzard-like eagle.
Geranoaëtus fragilis, extinct buzzard-like eagle.
Morphnus woodwardi, extinct harpy-like eagle.
Morphnus daggetti, extinct eagle, recalling secretary bird because of its long legs.
Falco peregrinus, peregrine falcon or duck hawk.
Falco mexicanus, prairie falcon.
 Indeterminate species of *Falco*.
Falco sparverius, sparrow hawk.
Polyborus cheriway, Audubon's caracara
 Small indeterminate species of *Polyborus*.
Tyto pratincola, barn owl.
Asio wilsonianus, long-eared owl.
Asio flammeus, short-eared owl.
Otus asio, screech owl.
Bubo virginianus, great horned owl.
Speotyto cunicularia, burrowing owl.

is not present. Equally rare are traces of the existing true Virginia or white-tailed deer (*Odocoileus*), a forest-living animal. Rare, too, is the crest-toothed peccary (*Platygonus compressus*), a species larger than the existing peccaries, with sharply cross-crested grinding teeth, and limbs and feet more progressive in their adaptive running habit than in the existing peccary (*Dicotyles*).

BIRDS OF THE RANCHO-LA-BREA AND MCKITTRICK TAR POOLS

The helpless mammals, foot-entangled in the tar pools, attracted and thereby lured to the same fate numerous species of birds of prey of the early Pleistocene period, and thus provide us with a fairly complete repre-

In the Rancho-la-Brea the extinct condors (*Teratornis* and *Sarcorhamphus*) dominate the other flesh-eating birds in size. There were six smaller species of vultures, three of which are now extinct, namely, the *Cathartornis* of New World type, and the *Neophrontops* and *Neogyps*, believed to be of Old World type. The kites, hawks, golden and bald eagles, falcons, sparrow hawks, and caracaras were chiefly of recent species, but there were three extinct eagles, two of buzzard-like type and a long-legged harpy eagle (*Morphnus daggetti*), recalling superficially the secretary bird of Africa. There were six species of owls, all of recent type. Most remarkable among the game birds (Gallinæ) was a large form (*Parapavo californicus*) inter-

mediate in character between the peacock (*Pavo*) and the ocellated turkey (*Agriocharis*). The game birds are also represented by the California quail and an indeterminate pheasant.

The total list of non-raptorial birds such as ducks and geese, herons and storks, cranes and rails, as determined by Loye Miller, is so remarkable that it deserves entering in full:

NON-RAPTORIAL BIRDS

PYGOPODES: DIVERS

Podilymbus podiceps, pied-billed grebe.

ANSERES: DUCKS AND GEESE

Anas platyrhynchos, mallard.

Chaulelasmus streperus, gadwall.

Mareca americana, American widgeon.

Nettion carolinense, green-winged teal.

Querquedula cyanoptera, cinnamon teal.

Spatula clypeata, shoveller.

Dafila acuta?, pintail.

Marila americana, redhead.

Chen hyperboreus, snow goose, a small form.

Anser albifrons?, white-fronted goose.

Branta canadensis, Canada goose.

Branta dickeyi, a gigantic goose, as large as a swan.

HERODIONES: STORKS AND HERONS

Mycteria americana, wood ibis.

Ciconia maltha, an extinct stork.

Jabiru mycteria, jabiru.

Ardea herodias, great blue heron.

Indeterminate heron, smaller than a night heron.

PALUDICOLÆ: CRANES AND RAILS

Grus canadensis, brown crane.

Rallus virginianus, Virginia rail.

LIMICOLÆ: SHORE BIRDS

Recurvirostra americana, American avocet.

the giant cat, the horse, the bison, the sloth, and the camel; and the great sabre-tooth of Rancho-la-Brea is entirely wanting. With this relative scarcity of mammals in McKittrick there is a notable scarcity of the large scavenging birds. The giant condor *Teratornis* is rare and none of the other great condors of the Rancho-la-Brea is present, although the golden

Macrorhamphus griseus, dowitcher.

Totanus melanoleucus, greater yellowlegs.

Pelidna alpina, red-backed sandpiper.

Oxyechus vociferus, kildeer.

GALLINÆ: GAME BIRDS

Lophortyx californica, California quail.

Indeterminate pheasant.

Parapavo californicus, a large bird intermediate between peacock (*Pavo*) and ocellated turkey (*Agriocharis*).

Meleagris?, turkey.

COLUMBÆ: PIGEONS AND DOVES

Zenaidura macroura, mourning dove.

COCCYGES: CUCKOOS

Geococcyx californianus?, road-runner.

Neomorpha?, probably a ground-cuckoo

PICI: WOODPECKERS

Colaptes cafer, flicker.

PASSERES: PERCHING BIRDS

Corvus brachyrhynchos, American crow.

Indeterminate species of *Corvus*.

Corvus corax, raven.

Sturnella neglecta, western meadowlark.

Pipilo, indeterminate species of towhee.

Petrochelidon lunifrons, cliff swallow.

Lanius ludovicianus, loggerhead shrike.

Several other indeterminate passerine birds.

The birds from the McKittrick asphalt—a region in Kern County, California, about 120 miles northwest of the La-Brea—as summarized by Loye Miller¹ are regarded as of somewhat more recent geologic age. In these pools were captured relatively few mammals, such as the dire wolf,

eagle *Aquila chrysaetos* is extremely abundant. In short, the raptorial list from McKittrick is a small one; the great mass of the McKittrick collections is composed of ducks, herons, cranes, storks, and shore birds, a fossil avifauna showing the greatest resemblance to that of Fossil Lake, Oregon, as described by Shufeldt. The distinctive fresh-water fauna suggests to the

¹Loye Miller: "Avifauna of the McKittrick Pleistocene." Univ. of Cal. Publ. Bull. Dept. Geol. Sci., Vol. 15, No. 9, pp. 307-326.

imagination a landscape made up of shallow, open, muddy-margined ponds interspersed with grasses or sedge—the ponds too shallow for gulls, pelicans, and other fish-eating birds, the mud and grass attracting shore birds, cranes, herons, ducks, and storks. The large peacock-turkey (*Parapavo*) so conspicuous at Rancho-la-Brea is entirely lacking. The census of groups for the McKittrick tar pools is substantially as follows:

Anserines: ducks and geese.....	33%
Limicolines: sandpipers, plovers.....	20%
Herons, storks, cranes.....	14%
<hr/>	
Total water birds.....	67%

This Rancho-la-Brea and McKittrick fauna has been reviewed by James P. Chapin with reference to the interesting problem of geographic origin and migration, a problem largely solved in the case of the American fossil mammals but still awaiting solution in the case of the rapidly migrating and less-known birds. Certain of the birds may well have accompanied the mammals in their great journeys toward the Rancho-la-Brea region from southern and northern Asia and from South America.

Certainly of south Asiatic origin is the giant mammoth (*Archidiskodon imperator*); it may possibly have been accompanied by the forerunners of the wood ibis (*Mycteria americana*), by the fossil peacock-turkey (*Parapavo californicus*) and the forebears of true turkeys (*Meleagris*), by the Old World vultures (*Neophrontops* and *Neogyps*), and by the ground cuckoos (*Neomorphus*), a genus closely allied to *Carpococcyx* of southern Asia. Of north Asiatic or Holarctic and of North American origin may have been all the ducks and geese, herons and storks, cranes and rails, cuckoos,

woodpeckers, and perching birds.

Probably of tropical American origin or affinity are seventeen species, including the New World vultures and giant condors (*Teratornis*)—in short, the majority of the vultures characteristic of South America are richly represented in the avifauna of Rancho-la-Brea. Chapin remarks that the American vultures, for example, must be of tropical American origin, for although in the early Pleistocene they

Golden eagles.....	28%
Other land birds, including additional raptorial species.....	5%
<hr/>	
Total land birds.....	33%

evidently were well represented in California yet they had not crossed to Asia. The birds that can be proved of North American origin are few and those of possible South Asiatic origin still less numerous. There are also in the McKittrick and Rancho-la-Brea representatives of some groups of birds now so widely spread over the whole globe that their origin can scarcely be guessed. This fifth group is fairly cosmopolitan in nature; in it are a species of stork (*Ciconia*), rail (*Rallus*), avocet (*Recurvirostra*), white-tailed kite (*Elanus*), marsh hawk (*Circus*), peregrine and sparrow hawk (*Falco*), barn owl (*Tyto*), short-eared owl (*Asio*), screech owl (*Otus*), horned owl (*Bubo*), and cliff-swallow (*Petrochelidon*).

To summarize this story of the tar pools of early Quaternary time, we have every reason to believe that it is a nearly complete chapter in the pre-history of the Southwest. It reveals practically the entire large mammal and bird life of the period, and it is this fullness of life which renders the discovery unique in the history of palæontology.



Fig. 1.—Site of discovery of *Pithecanthropus* on the left bank of the Solo River, at Trinil, Java, indicated by a black cross. From the Report of the Selenka Trinil Expedition

Recent Studies on the Skull and Brain of *Pithecanthropus*

BY J. H. MCGREGOR

Research Associate in Human Anatomy

THE "Ape-man of Java," *Pithecanthropus erectus*, has occupied a preëminent position in the literature of human palæontology for more than thirty years; and the main facts regarding it and the history of its discovery at Trinil, Java, in 1891-92 by Dr. Eugene Dubois, as presented in dozens of books, technical and popular, have become almost common knowledge among scientifically informed persons. Doctor Dubois, who at the time of his famous discovery was a surgeon in the Dutch Colonial Military service, and is now professor of geology in the University of Amsterdam, published an illustrated quarto memoir in 1894, describing the calvarium, or top of the skull, the left femur, and two molar teeth. In September, 1895, he exhibited the remains at the International Zoölogical Congress at Leyden, where they were examined by numerous anatomists and

palæontologists. The differences of opinion among these experts as to whether the fossils were human or simian, or an intermediate form, are notorious. Some held that they were the remains of an ape, more manlike than any hitherto discovered, others considered them human but extremely primitive, some regarded them as human, but merely pathological anomalies. However, the weight of opinion favored the view ably defended by Doctor Dubois, that the bones were those of a creature intermediate between the anthropoid apes and man—a real "missing link."

At the time of the Leyden meeting the cranial cavity was still filled with a very hard matrix. Later Doctor Dubois removed the greater part of this and made an endocranial cast, which he exhibited and discussed at the Fourth International Congress of Zoölogy, at Cambridge, England, in

1898. Measurements of the skull cavity at that time led him to calculate the encephalic volume at 855 cubic centimeters (an estimate which he has since increased, as discussed below), a very fair intermediate between the brain volume of the gorilla and man. In general, it may be said that the evidence adduced from these early studies seemed to confirm the "missing link" idea, though, as Doctor Dubois emphasized, this conception does not imply that Ape, *Pithecanthropus* and *Homo* form a linear series; the "link" may just as well be merely the middle one of three divergent branches.

While I have no intention of reviewing here the descriptive or critical literature of *Pithecanthropus*,—much of which is readily available, it may be as well to mention a few items of popular interest. When Doctor Dubois started from Holland for Java, he avowed his intention to find "the missing link." Naturally when he announced the fulfillment of the promise, surprise bordered upon incredulity—at first. The generic name *Pithecanthropus* (ape-man) had been proposed many years before by Ernst Hæckel for a hypothetical annectent creature, midway from ape to man, and was aptly applied by Doctor Dubois to the fossil which seemed to embody its realization; the specific name, *erectus*, refers to the upright posture and bipedal gait, which were to be inferred with certainty from the manlike femur. Doubts have often been expressed regarding the association of the skullcap and the femur, which were found some fifteen meters apart, some critics maintaining that the femur was truly human, the skull that of an enormous ape, probably a giant gibbon. It is quite true that the calvarium exhibits some striking points

of likenesses in form to the skull of a gibbon, likenesses which have been fully indicated in great detail by Professor Dubois, but in his Cambridge paper in 1898, and also in his recent work published in 1924, he demonstrates the extreme improbability of the giant gibbon theory.

Until quite recently no additional data were available later than Doctor Dubois' contribution in 1898. In general, his early view of the midway status of *Pithecanthropus* was widely accepted. The giant gibbon theory had a few defenders, the most notable being Professor M. Boule, of Paris, and a number of the ablest authorities were disposed to place *Pithecanthropus* definitely in the human family. Sir Arthur Keith in 1911 expressed the opinion that the form might aptly be named *Homo javanensis*, though he does not mention this in his later writings, and Professor Osborn (1915) refers to it as "Trinil man." Duckworth suggested that the Heidelberg jaw, clearly human, and the Trinil calvarium might be complementary parts of two essentially similar types. Professor G. Elliot Smith, who carefully examined the endocranial cast at Cambridge in 1898, read a paper before the Royal Society in 1914, in which he maintained that, judged by its brain, *Pithecanthropus* must be considered a member of the human family, possessing the rudiments of language but probably not ancestral to any existing race.

In the summer of 1923 Professor Dubois invited President Osborn, of the American Museum of Natural History, to Holland to study the original fossils. Professor Osborn found it impossible at the time to accept the invitation, and kindly suggested that I go in his place (a suggestion for which I am deeply indebted to

him) as I had devoted considerable study to the literature of *Pithecanthropus*. This arrangement met with gracious assent from Professor Dubois, and I accordingly went to Holland, where every facility was given to me for the study of these world-famous fossils, which are housed in the attractive Teyler Museum in Haarlem. A large series of stereophotographs was made of all the remains, which, in addition to the well-known calvarium, femur, and two upper molars, include a first left lower premolar, found later at Trinil and probably from the same individual, and a fragment of a lower jaw, found some twenty-four miles from Trinil, very probably from a second individual of the same species. There is also a very perfect endocranial cast, a most important document, which tells even more about the creature than does the outside of the skull.

The study of these specimens yields abundant new data, the more significant features of which I shall try to indicate briefly. Since my study of the material in 1923, Professor Dubois has published a contribution of great value, "On the Principal Characters of the Cranium and the Brain, the Mandible and the Teeth of *Pithecanthropus Erectus*," together with a second paper containing eleven splendid plates illustrating all these parts in heliotype.¹ Professor Dubois has studied these fossils so thoroughly and critically, and from so many aspects, that it is practically impossible to touch any question relating to *Pithecanthropus*, the pros and cons of which he has not exhaustively considered. In the following pages I shall draw freely from his new work, as well as his earlier

memoir, and also from my own notes and photographs. As I believe Professor Dubois is about to publish a new study of the femur, the treatment of that bone will be omitted here, and I shall limit my discussion to the skull, including the encephalon, the jaws, and the teeth.

Taking first the calvarium or skull-cap: the external size and form of this fragment have long been familiar through the commercial casts to be seen in many museums, with the greatly depressed crown, the excessively low and narrow forehead, the prominent supraorbital torus and the slope of the nuchal surface of the occipital region, where the great neck muscles are inserted. All these suggest the anthropoid ape, and especially the gibbon. The narrowness of the forehead just posterior to the orbital region, and the marked width of the postero-lateral region, a condition known as trigonocephaly, may be due, in Professor Dubois' opinion, to premature closure of the frontal suture. The median ridge on the forehead strongly suggests this condition, though it should be made plain that there is no considerable deformity of the cranium, nothing really pathological, and nothing to lend the slightest support to the absurd suggestion, made many years ago, that it might be the skull of an idiot. It may be remarked in passing that a very similar condition of the frontal bone is apparent in the recently discovered Rhodesian skull. Useful as is the cast of the skullcap, many important features are discernible only in the actual fossil, and study of casts has led to some erroneous conclusions by various authors. In several regions, as may be seen in the original skull, the outer surface of the bone has been eroded, in some places quite deeply,

¹Koninklijke Akademie van Wetenschappen te Amsterdam, Proceedings, Vol. XXVII, Nos. 3, 4, 5 and 6.

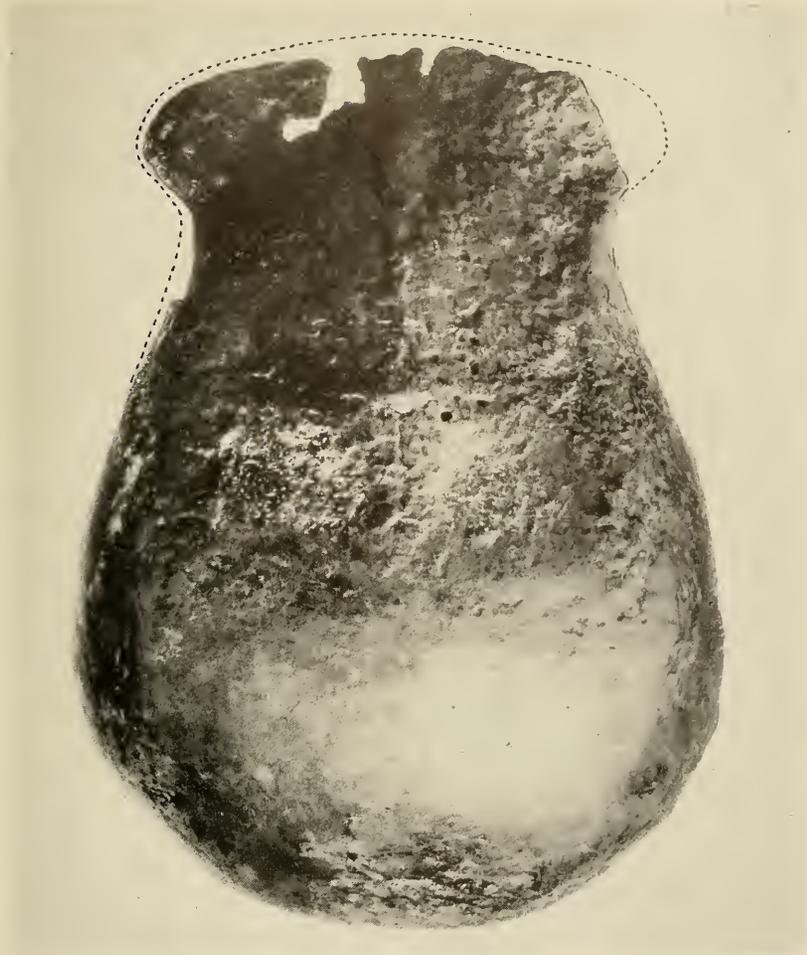


Fig. 2.—The calvarium of *Pithecanthropus*, seen from above. The narrow postorbital region and wide posterior parietal region are clearly shown. The bregma or meeting point of coronal and sagittal sutures also shows distinctly. The roughness of much of the surface is due to erosion. This photograph is reproduced (reduced) from Professor Dubois, with his kind permission. The dotted line has been added by Professor McGregor to indicate approximately the outline of the anterior parts of the skull before erosion. Two-thirds natural size

by sulphuric acid, formed, as Professor Dubois has explained, by decomposition of pyrite in the volcanic tufa in which the skull was embedded. In the anterior parietal region on each side of the sagittal suture, the apparent slight concavity is thus partly the result of loss of the outer lamina of bone. The anterior border of the great supra-

orbital torus, and, to a less extent, the region of the inion at the back of the skull, have also suffered similar loss, diminishing the length of the cranium to the extent of 3.5 millimeters or more, indicating that the maximum length of the cranium before injury was about 184 millimeters, instead of 180.5 which it now measures. The deep pit

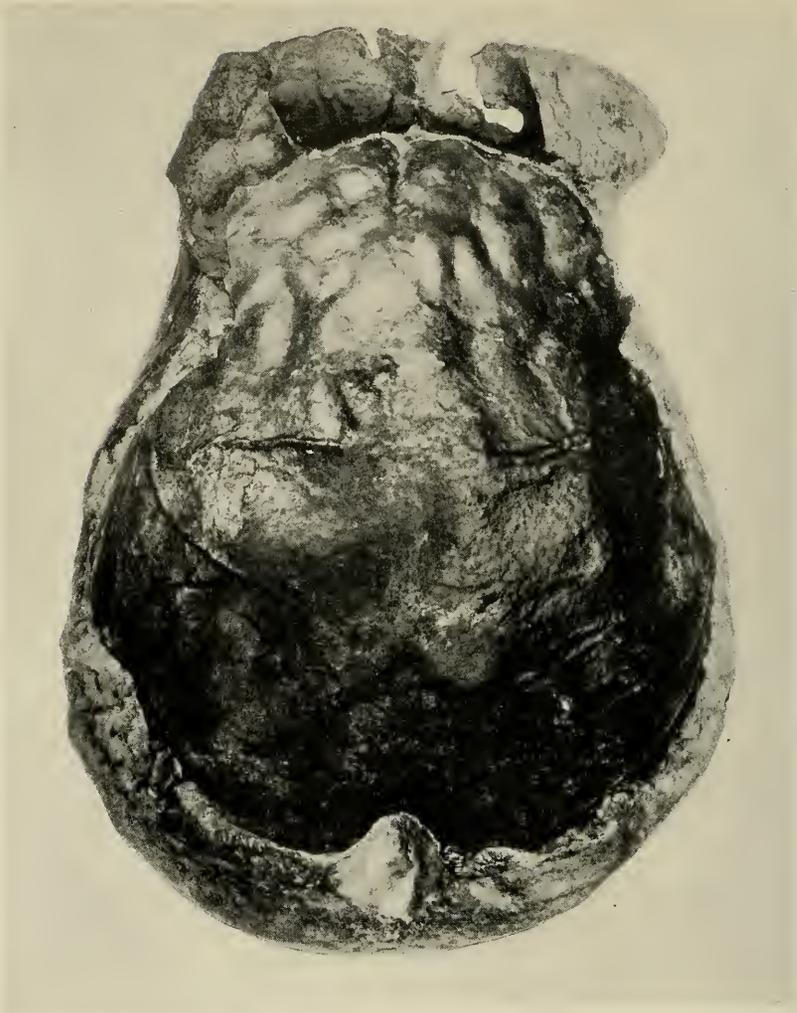


Fig. 3.—The calvarium of *Pithecanthropus* seen from below. The capacious frontal sinuses are clearly shown. The thinness of the margin of fracture in the occipital region is due to erosion of the outer lamina of bone. A small amount of matrix was still in the posterior part of the brain cavity when this photograph was made. Two-thirds natural size. From Dubois, by permission

in the nuchal surface of the occipital, which has always been a feature of interest, is also in part due to external erosion. At the broken edge in the occipital region only the inner table of the bone is left, forming a thin blade-like border and indicating that, in the uninjured state, the occipital slope was still more nearly vertical

and more apelike than would be supposed from the cast. In the figures showing the norma verticalis and norma lateralis, the dotted line indicates approximately the natural outline before erosion. The maximum width of the skull is 131 millimeters, which, allowing for surface erosion, gives a cranial index of 71.5, thus placing

Pithecanthropus well within the dolichocephalic, or long-headed, category. This long-headedness, however, is largely due to the projection of the supraorbital torus, containing the greatly inflated frontal sinus, well shown in the illustrations, and hence the cranial index in this case has little significance in comparisons with simian and human skulls. The index would be very different in a young *Pithecanthropus*, before the frontal sinus had attained its development.

There has been much confusion in the past regarding the position of the bregma (the point of union of sagittal and coronal sutures) in *Pithecanthropus*, but in the actual fossil it is clearly observable and coincides with the slightly elevated boss on the top of the skull, shown in the figures. It is rather far posterior so that the frontal bone presents a longer arc in the median plane than the parietal (according to Professor Dubois' identification of the lambda), unlike the condition in *Homo*, where the increased size of the brain necessitates an expansion of the parietal arc.

A notable feature of the external surface of the cranium is the slight development (though perhaps partly obscured by erosion) and the wide separation (about 85 millimeters) of the temporal lines on the sides of the skull, which mark the limit of attachment of the temporal muscles of the mandible. This indicates that the jaws were relatively small, as compared with those of the great apes, an inference fully corroborated by the condition of the mandibular fragment attributed to *Pithecanthropus*, described farther on. The weak development of these temporal lines, and the general absence of crests for muscular attachment, has led some palaeontologists to

regard the specimen as a female, but in the absence of material for comparison the sex must remain in doubt. It is certain, however, that the skull is that of an adult, as fully attested by the condition of the sutures, and the great expansion of the frontal sinuses.

Considering the external form of the skull, Professor Dubois is inclined to regard it, "On the whole not human; nor is it a transition of any type of manlike apes to the human type. The agreement with the anthropoid cranial type, particularly that of the small gibbon species of the genus *Hylobates* may, on the other hand, be called perfect, taking into consideration the inevitable deviation in the proportions in consequence of the ratio of the volume of the brain and the eye varying with the increasing bulk and cephalization." The deviation from the human condition is especially marked in the posterior region, where the strongly developed occipital torus, and the more nearly vertical slope of the nuchal plane indicate "that the head was not equipoised on the spinal column as in modern man, but was carried by strong nuchal muscles and ligaments, as in the apes. It is not to be seen by the structure of the skull that *Pithecanthropus* deserves the name of *erectus* assigned to it on account of the features of the femur." Professor Dubois makes it clear, however, that he does not consider it the skull of an anthropoid ape, and that the resemblance to the gibbon is not sufficient to warrant its classification among the Hylobatidae, the gibbon family.

Of greater importance than the outer surface of the cranium, as yielding criteria of relationships, is the inner surface. Fortunately in the present case this is practically perfect. When Doctor Dubois exhibited an

endocranial cast at the International Zoölogical Congress in Cambridge in 1898, a small portion of the matrix was still in place so that the cast was incomplete. Later he skilfully removed this remnant of rock to the last particle, using a dental drill and

fissure, and just anterior to this a small portion of the lateral part of the frontal floor is preserved, showing that the lower frontal region was decidedly more manlike than apelike. The impressions of frontal convolutions on the skull are exceptionally clear for a

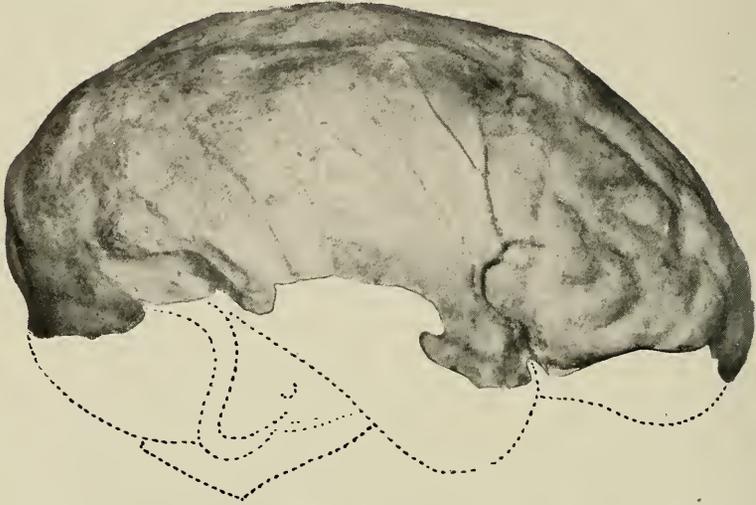


Fig. 4.—The endocranial cast of *Pithecanthropus* seen from the right side. The convolutions of the frontal lobe, which present an essentially human pattern, are well shown. This photograph is taken from Professor Dubois' recent contribution, and reproduced with his kind permission. The dotted outline of the missing portion has been added by Professor McGregor as an aid to the general reader. Two-thirds natural size

devoting many days of most painstaking care to the work. The result amply justifies the arduous labor. The erosion which is so pronounced on the outer surface of the skull is here entirely absent, and the surface details of the cast are virtually as perfect as if it had been made from a fresh skull. It is particularly fortunate that the line of fracture is sufficiently low to preserve many features of the greatest importance. On the right side enough of the skull wall remains in the region of the pterion to show a crest indicating a marked separation of frontal and temporal lobes of the brain, as in man, at the anterior end of the Sylvian

primate—possibly indicating that this part of the brain was somewhat constricted by abnormally early union of the frontal bones, a condition also indicated on the outside of the skull as described above. An especially important feature seen in the cast is the marked development of the lower frontal convolution, the region in man of motor control of the speech organs, the so-called Broca's convolution. Opinion differs as to the value of such evidence as criterion of specific function, but this region of the brain of *Pithecanthropus* resembles so closely the corresponding part of the brain of *Homo* that one can scarcely escape

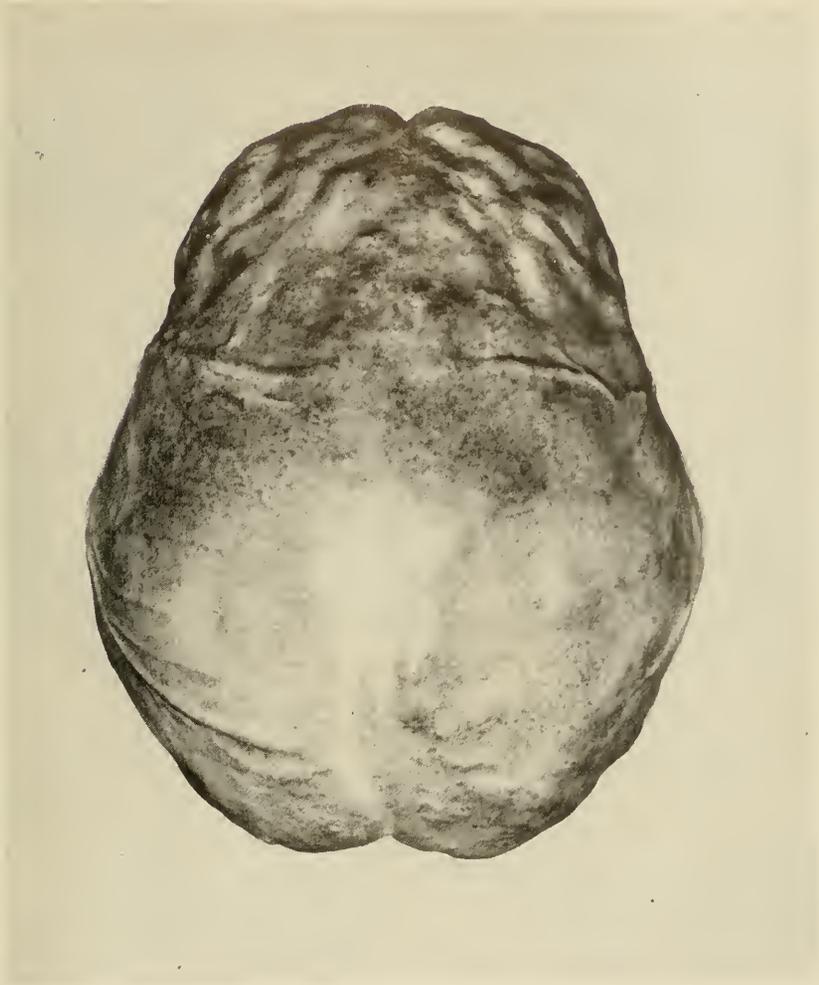


Fig. 5.—The endocranial cast of *Pithecanthropus*, seen from above. This photograph shows the remarkably clear impressions of the frontal convolutions, and the general human form of the brain as seen in the norma verticalis. Two-thirds natural size. From Dubois (1924) by permission

the conclusion that the creature must have possessed some rudiments of speech. But speech requires more than mere control of the motor mechanism; there must also be appreciation and discernment of vocal symbols. Now, it happens that one of the most notable features of the cast in question is the great expansion of that portion of the temporal lobe (the middle temporal convolution)

concerned in man with this function, the so-called auditory speech center. The development of this area is clearly seen in the photograph of the endocranial cast viewed from above. Professor G. Elliot Smith, the eminent neuro-anatomist of London, in calling attention to this very point in the endocranial cast, says: "This can have only one meaning, the fact that in the earliest known member of the

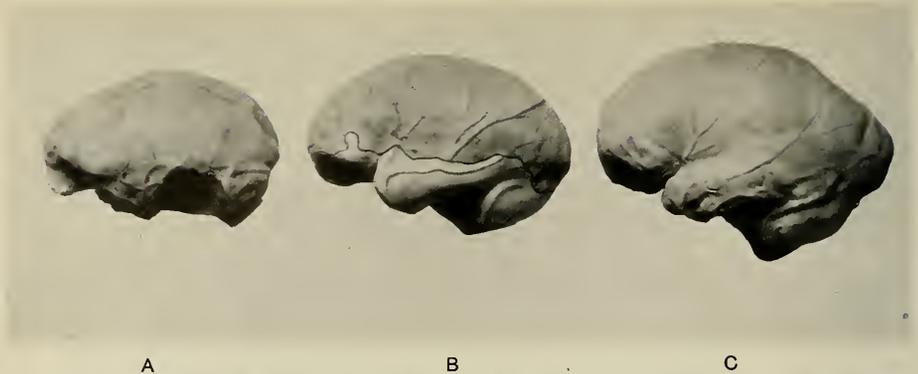


Fig. 6.—Endocranial casts of a large male gorilla (A), *Pithecanthropus* restored (B), and Rhodesian man (C). The three casts were photographed together to show the relative sizes. The volumes of the three are A, 580 c.c.; B, 940 c.c.; and C, 1300 c.c. The reader can readily compare *Pithecanthropus* with the ape and man. The lower part of the *Pithecanthropus* cast is restored

Human Family there was a sudden expansion of the acoustic territory for the appreciation of some sort of speech." In the opinion of Professor Dubois the great breadth of the temporal region is due rather to the constriction of the frontal area above mentioned, than to spontaneous expansion of the former. However, the concomitant hominoid development of these two regions concerned with motor and auditory phases of articulate speech certainly appears to be significant.

Seen from above, the form of the brain appears rather human than ape-like, but in side view the extremely low crown differentiates it from even the lowest types of man. Professor Elliot Smith emphasizes the fact that the regions in which *Pithecanthropus* exhibits the most striking deficiency are precisely those regions which attain their full elaboration latest in the cerebral development of the human child, namely, the prefrontal and parietal areas. The inferior temporal



Fig. 7.—Endocranial casts of a large male gorilla (A), *Pithecanthropus* (restored) (B), and the Gibraltar example (restored) of the Neanderthal race (C). The volumes of the three are A. 580 c.c., B. 940 c.c., and C. 1280 c.c.; thus the gorilla's brain has three-fifths the volume of that of *Pithecanthropus*, and the latter almost exactly three-fourths that of the Gibraltar brain

area is a third region similarly belated in human ontogeny, but as this is lacking in the cast, the slight development of this area in *Pithecanthropus* is chiefly inferential, though there is some actual evidence, on the right side of the cast, that such deficiency was present. Professor Smith's studies

Pithecanthropus, and Rhodesian man are photographed together, illustrates this feature clearly. Comparing figure 7 it will be seen that in this feature the Gibraltar brain (Neanderthal race) appears to be more primitive and more like *Pithecanthropus* than the brain of Rhodesian man.

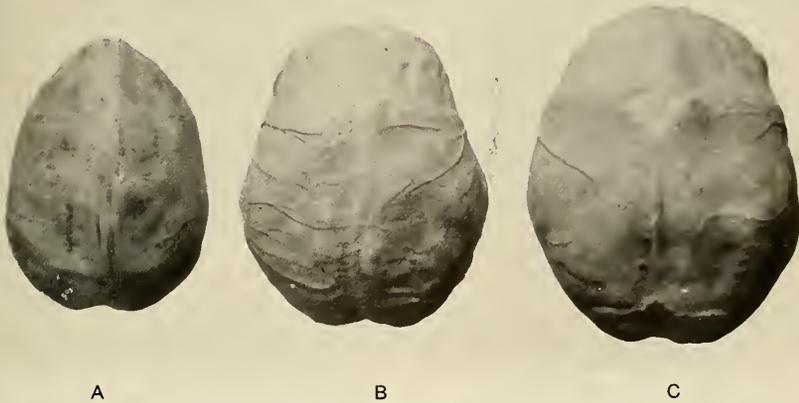


Fig. 8.—Endocranial casts of a large male gorilla (A), *Pithecanthropus* (B), and Rhodesian man (C), photographed together to show relative size and form. The volumes are A. 580 c.c., B. 940 c.c., and C. 1300 c.c. *Pithecanthropus* resembles the human far more than the ape in the form of the frontal lobes of the brain

of the endocranial casts of *Eoanthropus*, Rhodesian man, and various specimens of Neanderthal man, also demonstrate the deficiency of these regions, although in much less degree than in *Pithecanthropus*. As might be expected, the sulcus lunatus or "Affenspalte" which is present in all the apes, and frequently in primitive and underdeveloped human brains, is well marked in *Pithecanthropus*. Fortunately, the cast shows a portion of the cerebellar surface and, especially on the right side, the transverse sinus. We have thus a clear picture of the occipital region of the encephalon, which approximates the anthropoid ape in the very slight overhang of the occipital lobe of the cerebrum. Figure 6 in which endocranial casts of gorilla,

A question of great interest, in connection with the possible human relationship of *Pithecanthropus*, is the size of the brain. Professor Dubois, from his recent studies, has increased his former estimate of 855 cubic centimeters to 900. His calculations were made by measuring the capacity of the calvarium to a certain line with water, then calculating the volume of the remaining portion by careful morphological comparison with corresponding parts of "skulls of apes which resemble *Pithecanthropus* as much as possible." *Hyllobates agilis* appears to be the form chiefly used in the comparison, with due allowance for the relatively greater encroachment of the orbits upon the frontal lobes and other morphological differ-

ences. It appears to me that there is a more reliable method of calculation, that is to complete the endocranial cast by modeling the missing portions by careful comparison with endocranial casts of apes and men. I have at-

construct approximately the size and form of the brain of *Pithecanthropus* by lining a piece-mold of the skull with clay of the estimated thickness of the cranial wall, then making a cast of the interior and modeling the missing

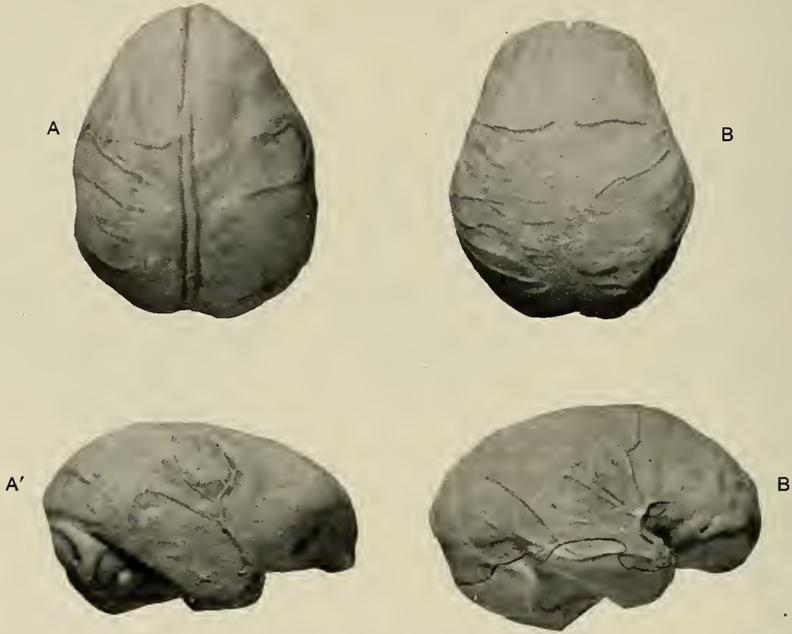


Fig. 9.—Endocranial casts of *Hylobates*, a gibbon (A and A') and *Pithecanthropus* (B and B'), top and side views. To facilitate comparison the photographs of both are here reproduced about the same size, though the brain of *Pithecanthropus* is many times larger than the other. In the top views the frontal region of the gibbon is seen to be relatively far smaller. It lacks also the localized expansion of the temporal region,—the area concerned in man with appreciation of speech symbols or words,—which is conspicuously developed in *Pithecanthropus*. In side view *Pithecanthropus* is far more manlike, though the occipital region shows strong resemblance to the apes

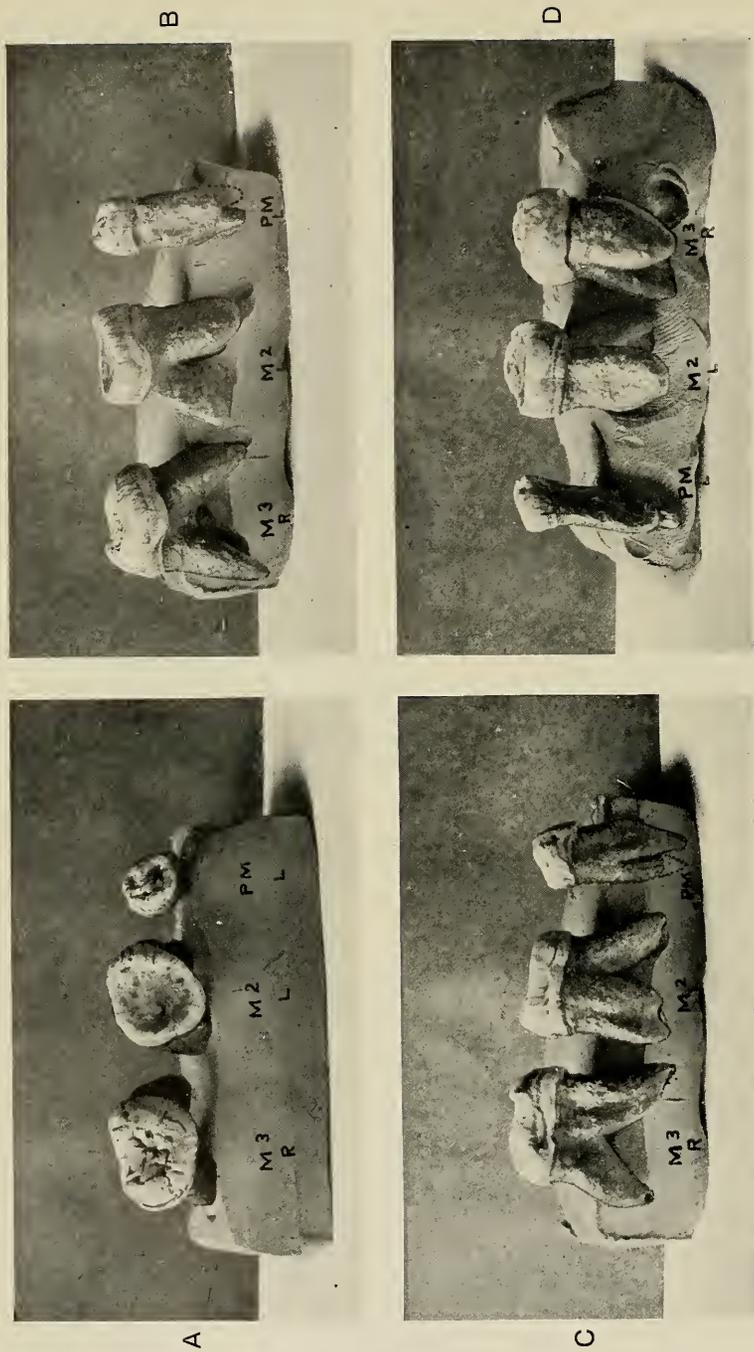
tempted this, and the result is the only portion of the present paper for which originality can be claimed. Endocranial casts of *Hylobates*, orang, chimpanzee, gorilla, Rhodesian man, and the Neanderthal specimens from Gibraltar, Chappelle-aux-Saints and La Quina, together with modern human types, were used in the comparison. Some years ago I attempted to re-

parts. In London, in 1921, before Professor Dubois' endocranial cast was available, I made a second attempt, having at that time the invaluable aid and advice of Professor Elliot Smith. The result was a fair approximation to the actual condition later revealed in the cast. The benefit of Professor Smith's counsel in that tentative restoration is now embodied

in the restored part of the present model, but I wish to make it clear that as at the present writing he has not seen the new restoration he is in no sense responsible for any defects it may possess. The present non-technical article is not the place for a discussion of the reasons for the morphological details of the restoration which I hope to publish elsewhere in the near future. It may be stated, however, that the parts preserved give ample warrant, in the light of comparison, for every important feature of the restored portions. On the whole, as is obvious from the photographs, the hominoid features outweigh the pithecoïd very decidedly. The frontal region, deficient as it is in the prefrontal area, is far more manlike than apelike both in general form and in the pattern of the convolutions. The deep incisure separating frontal and temporal lobe is also a human character. The probable size of the petrous space between temporal lobe and cerebellum was carefully considered in relation to these parts of the brain, and also to the underlying bone. The form of the cerebellum and its forward extent in lateral view, and the anterior position of the downward turn of the transverse sinus, are all human features, in contrast to the nearly vertical apelike slope of the occipital surface. It should be made clear that the restored part, like the actual cast, does not represent the brain surface, but the inside surface of the skull, or the outside of the entire encephalon, including the meninges, blood-sinuses, etc. The probable position of important foramina—optic foramen, superior orbital fissure, the foramina rotundum, ovale, and spinosum, the carotoid arteries and transverse sinuses, have all been calculated as carefully as

possible, partly to make sure that all portions of the restoration would be mutually consistent throughout, thus insuring greater accuracy, and also to serve as a basis for a restoration of the entire cranium which is now under way, involving cranio-cerebral topographical correlations.

Now as to the endocranial capacity of *Pithecanthropus*, as arrived at by this laborious method. By water displacement the volume of the cast as restored is found to be 940 cubic centimeters. Of course there is some possible error. It may be that the cerebellum should be a shade smaller; perhaps the temporal lobe ought to be a trifle more voluminous, but it seems unlikely that the deviation can be more than 15 to 20 cubic centimeters in either direction, and I believe 940 cubic centimeters to be a close approximation to the truth. This falls just within the normal minimum of modern man. Sir W. Turner found a female Australian skull of 930 cubic centimeters capacity, and a number of others under 1000 have been measured, while the largest gorilla barely exceeds 600. The very large gorilla cast here represented measures 580 c.c., almost exactly three-fifths the volume of *Pithecanthropus*. The Gibraltar cast (a female Neanderthal) as restored measures 1280. The Rhodesian man, as restored by Mr. F. O. Barlow of the British Museum, 1300 cubic centimeters. These are the two human endocranial casts here figured. Thus *Pithecanthropus*, with nearly three-fourths the encephalic volume of these ancient and primitive humans, and equalling some of the more lowly modern types, seems, as regards brain size, as well as brain form, to belong within the human family. In form of brain it is distinctly closer to the low-



THE THREE TEETH OF *PITHECANTHROPUS*, FOUND AT TRINIL

Fig. 10.—P M is the anterior left lower premolar. The tip of the inner (lingual) branch of the divided root is broken off. Its probable form is indicated by a dotted outline in B and C. M 2 is the left second upper molar, the crown of which is worn to a smooth, slightly concave surface. The facet of contact with the third molar is shown in B, the contact facet with the first molar in C. M 3 is the right third upper molar, or wisdom tooth. A.—Crown view. B.—Posterior (distal) view. C.—Anterior (mesial) view. D.—Inner (lingual) view. About natural size. Photographed from the original by J. H. McGregor

crowned Neanderthal and Rhodesian than to any normal modern type. In view of the fact that the external skull form so strongly suggests the gibbon, I have thought it might be of interest to present photographs showing an endocranial cast of *Hylobates* side by side with that of *Pithecanthropus*, both reproduced about the same size to facilitate comparison. As seen from above, and also from the side, the differences, even ignoring the restored part of *Pithecanthropus*, are more striking than would be supposed from a similar comparison of the external skull form, and the deviations of *Pithecanthropus* from *Hylobates* are all in the direction of man. On the whole, it may be stated that the brain of *Pithecanthropus*, in size and in form, is distinctly closer to that of man than to that of any ape. The general brain form is, perhaps, rather more like *Hylobates* than gorilla, but judging from the hominoid convolution pattern, as indicated in the frontal region, the cerebral surface was certainly closer to gorilla than to gibbon, since the gorilla in this respect is by far the more manlike of the two apes.

Professor Dubois' original memoir in 1894 contained a description of two upper molar teeth, a left second and right third, the former considerably worn. They are characterized by widely divergent roots and extremely large crowns, especially wide in transverse (bucco-lingual) diameter. The third molar, or wisdom tooth, shows a reduction of the cusps and a peculiar contraction and wrinkling of the crown, the wrinkles suggesting the teeth of the orang and resembling the condition observed in various Neanderthal and Australian teeth. Able palæontologists have disagreed as to whether the teeth were predominantly human, or

apelike. As recently as 1923 Mr. Gerrit S. Miller, Jr., of the U. S. National Museum, studying casts of teeth without considering their possible relation to the skull, believed them to be the teeth of "A now extinct Javan great ape, resembling the orang of Sumatra and Borneo." But Sir Arthur Keith, Gregory, Hellman, and others find important similarity to human molars. Doubt has been expressed as to the association of the teeth with the skull, but as the calvarium was found not more than a meter distant from the third molar, and in the same level, there can be practically no question as to their being parts of the same individual. I feel quite certain, also, from study of the original teeth, that the two molars belong to the same creature.

After Doctor Dubois' return from Java, a third tooth was found in the Trinil excavation, a left anterior lower premolar. This is a particularly important tooth, as it yields indubitable evidence regarding the upper canine. The tooth is small, and quite human, and had it been found alone there would have been no question as to its humanness. The root is forked at the tip, or rather there are two roots united except at the extremity, a primitive condition occasionally seen in the corresponding tooth of man, and an important human character is that the two branches of the root, buccal and lingual, are opposite, not obliquely placed as in the corresponding tooth of the apes. Facets of wear show the occlusion of this tooth with the upper canine and first premolar, and a contact area on its mesial border indicates its close proximity to the lower canine. This tooth clears up one highly important point hitherto doubtful. It

proves that the upper canine, which is always slightly larger than the lower, was small and hominoid. In all the anthropoid apes the first lower premolar is elongated and enlarged in adaptation to a shearing occlusion

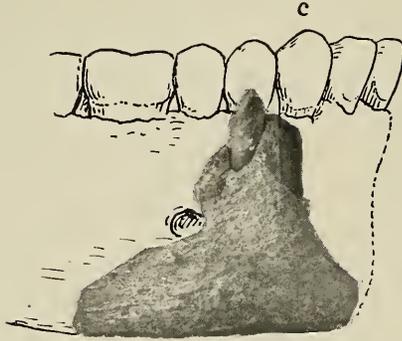


Fig. 11.—Photograph of the mandibular fragment from Kedung Brubus, with pen and ink restoration of the chin region and anterior teeth. The fully preserved root is that of the anterior premolar. The canine is marked C. The restoration extends only to the symphysial line which is dotted. The small size of the anterior teeth and the nearly vertical chin are clearly shown. Three-quarters front view. Natural size

with the tusklike upper canine, consequently *Pithecanthropus*, with small premolars and canines, must have been manlike in possessing a short dental arch. Of course the question may be raised whether the premolar belongs to the same individual, or even the same species, as the molars. As to this it may be stated that the condition of fossilization, the color and texture of crown and roots, etc., which are apparent in the original teeth, together with the absence of any remains of other large primates, render it highly probable that the three teeth are all members of the same denture.

The view that *Pithecanthropus* possessed a manlike dental arch receives strong confirmation from another

source. This is a most important piece of evidence—a fragment of a lower jaw. It was found by Doctor Dubois in 1890, nearly a year earlier than his discovery of the Trinil wisdom tooth. The site of discovery of the jaw was at Kedung Brubus, about twenty-four miles east-southeast of Trinil, and in the same geological level which yielded the Trinil fossils. The mandibular fragment was briefly described by Doctor Dubois in 1891 as a human fossil “of another and probably lower type” than the known European Pleistocene races (Neanderthal *et al.*) Later study and comparison with *Pithecanthropus*, especially with the lower premolar, have convinced Professor Dubois that the jaw fragment is really from another example of the same genus. The part preserved, which is from the right side of the chin region, contains the entire root of the first premolar tooth, part of the canine alveolus and the extremity of the root of that tooth; also the alveolus of the second premolar and the anterior border of the mental foramen, sufficient to convey a fairly authentic picture of the form of the chin region. It proves, for one thing, that the chin was practically vertical, but lacking any pronounced mental eminence,—in short, somewhat like the Neanderthal chin, and quite different from that of any ape; though, as Professor Dubois observes, it is approximated somewhat by the chin region of *Hylobates*. A unique feature is the great extent of the digastric fossa, which is bounded externally by a rather sharp inferior margin. It is difficult to imagine the functional significance of this peculiar condition. The body of the mandible is shallow—only 30 millimeters in height in front of the first premolar. The root of the first

premolar is quite flat, measured mesio-distally, and the root canal can be seen to divide into buccal and lingual branches, corresponding exactly to the bifurcation of the root in the first premolar from Trinil. The canine alveolus containing the extremity of the root demonstrates the small size of that tooth, thus completely confirming the inference drawn from the Trinil premolar that the canines must be small and manlike. Before the publication of the data, photographs, casts, etc., regarding the Trinil premolar and the mandible fragment from Kedung Brubus, it was naturally supposed that the anterior portion of the dental arch and the chin region would show a development essentially intermediate between the anthropoid apes and man (with perhaps a closer approximation to the human), in correlation with the assumption that the cranium represented a transitional form, or at least an exceedingly apelike type of man. Study of the endocranial cast, however, has necessitated a revision of this view, since the diagnostic features of cranium and brain indicate that *Pithecanthropus* is a humble member of the human family. The hominoid characters of the jaws, chin, and teeth, are quite compatible with this latter conception, though the small size of the anterior teeth as compared with the molars may seem to indicate some morphological disharmony. However, since the Piltdown discovery, we have come to realize that nature may sometimes ignore our preconceived notions of harmonious correlation.

In 1914 I essayed a restoration of the

skull of *Pithecanthropus*, having only the commercial cast of the exterior of the calvarium and the writings of Professor Dubois and others to guide the work. A little later a flesh restoration was modeled on the reconstructed skull. The new evidence regarding the teeth and chin convinces me that these restorations were somewhat too prognathous, therefore, in the light of new knowledge, a revised restoration of the skull, which will be more authoritative, has been commenced. I hope before long to publish elsewhere a more technical treatment of the skull and brain of this most important fossil which, even though it now seems to be a member of the human family, is still the most apelike type of man, and more than any other known form merits the appellation of "missing link." But this does not necessarily imply that *Pithecanthropus* is a direct ancestor of any true *Homo*, fossil or living. It may represent a side twig of the hominoid branch, a great uncle rather than a grand father of man. Despite certain simian features the evidence, on the whole leads as Professor Dubois states "to the conclusion that *Pithecanthropus* should be considered as a member, but a distinct genus, of the family of the Hominidæ."

In conclusion, it is a pleasure to acknowledge my indebtedness to Professor Dubois, who not only kindly afforded me every facility for the study of the material and for making numerous stereophotographs, but devoted two entire days to aiding me in the work, and who finally has granted permission to copy figures from his valuable memoir published in 1924.



Daubenton's Bat

DAUBENTONS' BAT: A EUROPEAN SPECIES

Thorburn, the great British artist-naturalist, has given some excellent illustrations of bats in his work on *British Mammals*. Through the courtesy of Longmans, Green and Company, NATURAL HISTORY is able to show an example of Mr Thorburn's skill in depicting the bat in flight. See text for description of the flight mechanism of bats

The Bat¹

A MUCH MALIGNED AND LITTLE UNDERSTOOD MAMMAL

By H. E. ANTHONY

Associate Curator of Mammals of the Western Hemisphere

TO the mind of the average person the bat is a creature of disagreeable attributes, striving to entangle itself in women's hair, carrying unwelcome insect life, and possessing features of both mammal and bird, so that one is bewildered what to call the creature. There is so little truth in what currently passes as fact with regard to bats, these animals are so interesting upon acquaintance, and they have so few bad qualities to discourage a closer acquaintance, that it seems timely to set forth some of the authentic data. Inquiries received at the Museum show that there is a fairly widespread interest in bats, and that people would like to know more about them.

From time immemorial the bat has been placed in the category of evil creatures, along with the owl, the black cat, and others. Because of its nocturnal habit the bat naturally would be associated in primitive and ignorant minds with the dread of darkness. Folklore and legend show us that this has been the case. It has been said that the bat-motif is well demonstrated in the crude pottery of the Arawaks, who lived in the West Indies in pre-Columbian times. It is doubtless to be found in the figured designs of many prehistoric and early peoples.

When witchcraft was in vogue the bat enjoyed an unsought notoriety. Not only was it reputed to be a creature of the devil, but certain parts of its anatomy served for charms and poisons.

For example, witches used, among other things,

Eye of newt, and toe of frog,
Wool of bat, and tongue of dog,

to fill their cauldron on the heath and work the ruin of Macbeth. Possibly the following negro incantation is an indirect version of that in *Macbeth*:

Pizen insides in de pot
Wid de sarpints steamin' hot.
Add de hin' laigs uv a toad
Hoppin' on a ha'nted road.
Wuhms an' bats an' lizuhds stir
An' a piece uv 'possum fur.
Little bit of el'phunt's nose
An' a witch's middle toes.
Bubble, bubble, trouble brof.
Skeer de ebil speerits off.

An old Natural History of 1744 states that the tongue and the heart of a bat are said to be poisonous. Many statements and beliefs of this sort, which seem amusing to us today, can be traced in the early writings.

In the Bible the bat is made the associate of the mole, presumably because both are dwellers in darkness and of devious and little understood habits:

In that day a man shall cast his idols of silver, and his idols of gold, which they made each one for himself to worship, to the moles and to the bats. Isaiah ii, 20.

In Leviticus and in Deuteronomy, the bat is listed among the forbidden animals:

And the stork, and the heron after her kind, and the lapwing, and the bat.

Note that the bat is here associated with the birds!

¹Photographs by the author

And so on down the ages the bat has been under a handicap, treated by man about as Æsop tells us the bat was treated by the other animals, neither as a bird nor a mammal, but a creature by itself, avoiding observation by day and coming forth only in the darkness.

As a matter of fact, the bat is a perfectly typical mammal, bearing its young alive and nursing them at the breast, the same as a mouse. The general resemblance of small bats to mice has found expression in the word for bat in the various languages, such as the French *Chauve-souris*, the Spanish *Murcielago*, and the German *Fledermaus*. In the British West Indies the negroes call it "rat-bat,"

because they use the word bat for butterflies.

Bats are seemingly vicious little creatures and a captive invariably bites when caught. The small species can do little harm to the hand, scarcely puncturing the skin, but the larger species very soon impart a respect for their prowess. I rather suspect that the bat disposition is more easily irritated than that of most mammals, but since our observations of bats are made under circumstances which must be necessarily very disturbing to them, the creatures can scarcely be expected to display a calm, unruffled temperament.

Bats are among the most ancient of mammals. To judge from the great number of existing species and subspecies, belonging to many families, the bats as an order must have originated at a very remote period. We

know that bats, apparently as well developed as we see them today, were living in the Paleocene, since fossil records have been discovered in that horizon in America. In Europe, fossils of bats have been found in the Eocene. We are certain, then, that the first flying ancestors of the bats must have lived long, long before these specialized and highly developed forms found in the Eocene, and the creatures we know as bats must have



One of the common bats of Jamaica, *Chilonycteris parnellii*. Bats habitually hang head downward when at rest, and the sharp claws on the hind feet are admirably adapted for clinging

been capable of flight for millions upon millions of years.

No other order of mammals shows such great diversity of structure or so many highly specialized features. The modern classification, based upon these differences in structure, recognizes no less than 263 species and subspecies (taken from Miller's *List of North American Recent Mammals*) in North and Central America. This number is probably only a little more than one-tenth of the total number of varieties found in the world. Doubtless the complete list of bats exceeds 2,000 different forms.

Bats differ from all other mammals in their ability to maintain sustained flight. Other mammals, such as the flying squirrel, have the power to glide, but bats alone are able to propel themselves through the air. To accomplish this the bodily structure of the bat has undergone profound modifications. The forelimb has lost its primitive, primary function of quadrupedal locomotion and has become a framework and a support for a flying membrane. The digits have lengthened enormously, the thumb is short, but the four fingers are so long that they constitute in the combined length of metacarpals and phalanges the longest bony structure in the entire skeleton. The third finger is the longest and about equals in length the total length of head and body. Only the thumb has a claw (in our New World bats), the four fingers are clawless, and their long, slender bones are employed to spread and hold in position the tough membrane of the wing.

The wing stretches back from the shoulder, elbow, and forearm to the hind leg, and in many species the membrane continues across from leg to leg and includes the tail. The membrane which is supported by the two legs, is called the interfemoral membrane and is of great importance in controlling the direction of flight, acting more or less as a rudder and not being a part of the propelling mechanism.

No warm-blooded animal has so completely mastered the mysteries of flight as the bat. We have yet much to learn of the distances bats can fly; it is improbable that any bat can fly as far or as fast as a plover, a falcon, or a swift, for example, but for aerial gymnastics and perfectly controlled flight there is no bird to match the insect-catching bats. These bats can

check their flight instantly, change direction in any plane, and have a certainty of movement that shows perfect mastery. Birds which catch insects while in full flight, the swifts, swallows, and nighthawks, for instance, have a very large gape to the mouth and can scoop up their prey. Bats, on the contrary, do not have such an excessive gape, and the mouth opening is only slightly larger in proportion to the body than it is in comparable terrestrial mammals. In order to capture a rapidly moving insect the bat therefore must be certain of its aim, for its jaws are no dragnet. The flight of the bat reflects this precision of aim in its sharp angles and abrupt zigzags, quite unlike the more rounded, evenly flowing passage of a swallow.

The flight mechanism of the bird is composed of a series of vanes,—the feathers,—and there is always an opportunity for the escape of air between adjacent feathers. This quantity of air varies with different types of bird wings, but there is no bird wing which is air-tight throughout its entire feather expanse. The flight mechanism of the bat is essentially an air-tight membrane thrown into changing curves and shifting planes by the muscles, and the pattern of the curves and the position of the planes are controlled by the elongated fingers and the hind legs. The primaries of the bird are held and directed at their forward ends only; the shape of the feather is fixed, except as it bends to air pressure. The bat membrane is secured, not only along its forward margin but at either side and to the rear as well. This explains, to some extent, the mechanics of the extremely erratic flight of the bat; the cause for the irregular course this mammal traces against the twi-

light sky is explained by the fact that the bat takes its prey where it finds it and goes to that spot in a straight line.

The science of aëronautics has sought deep into the mysteries of bird-flight in the search for data to build aëroplanes. A much closer analogy may be drawn between the bat and the aëroplane, but unfortunately the very intimate details of bat-flight are yet to be discovered. It is known from the structure of bats that there are many variations in the fundamental elements of the flight mechanism. For example, the shoulder girdle, which takes up the thrust of the humerus and consequently is the principal joint in the wing, articulates with the upper bone of the wing in several different fashions depending on the species. These differences in articulation, these variations in the joint, must certainly be reflected in varying freedom of wing movement. In other words, some bats may be able to give a powerful wing beat through a very wide arc, while others can thrust through only a limited arc. All of the bats of the northern United States, the Vespertilionidæ, a very highly developed group, fly with a motion perhaps best described as fluttering, and possess large, broad wing membranes and ample, interfemoral membranes. In the tropical regions we find another highly specialized group of bats, the Molossidæ, or free-tailed bats, possessing very narrow wing membranes and a narrower interfemoral membrane. The free-tailed bats ride through the air with a rapid wing beat, at a distance much resembling their feathered cousins, the swifts.

Bats have developed to fill each possible economic niche available to a flying mammal. The greater number of species are insect-eating and find an

abundance of food in their own medium, the air. Many others feed solely on fruit and must visit trees. The large fruit bats or flying foxes of the Old World belong in this category, which also includes many of the smaller New World bats as well, members of a distinct suborder, however. The American fruit-eating bats devour a great variety of the softer, pulpy fruits, from bananas to ripe coffee berries. Often they feed on the fruit where they find it; sometimes they pick it in passing and carry it away to eat in caves or other favored spots

Bats of more predatory types have been evolved and may be considered truly carnivorous. A genus of bats in America is known to be fish-eating, and there is a similar group with like appetites in the Old World. Indeed, the Asiatic *Megaderma lyra* is known to feed on fish, frogs, and bats smaller than itself. It has been observed on the wing, carrying another bat, sucking its blood as it flew, and later devouring the body, crunching the bones in true carnivorous fashion.

The most highly specialized of all the bats, from the point of view of food, is the true vampire bat, of the family Desmodontidæ, found only in America. The vampire feeds on fluid blood and it is difficult to understand how it could survive on any other food. Its teeth are reduced in number, the fewest in all the bats, and are adapted for puncturing the skin; they would be ill-suited for anything else. The intestines are short and the entire alimentary tract is modified for a highly concentrated, fluid food such as blood. Vampires have been long and unfavorably known. The early Spanish explorers were bitten by them, and so intense was the reaction among the pioneers in the New World that

they suspected most of the tropical bats, whether they were blood-suckers or not. Any bat with an ugly face, and this is an all-embracing term, was dubbed a vampire, and we find that even today the name is loosely used to include bats of irreproachable habits. While we know some of the outstanding features in the life-history of the vampire, we are yet woefully ignorant of the complete story. We know that this bat preys upon almost any blooded creature available, from birds to man; that its bites may be fatal to its prey when the animal is small and weakened by too heavy draining of blood; and that its manner of attack is so subtle that a man does not realize he is bitten, as a rule, until he awakens in the morning.

The following is an extract from *Ulloa's Voyage, 1772*:

Bats are very common all over the country; but Carthagenia is infested with such multitudes of them, that after sun-set, when they begin to fly, they may, without any hyperbole, be said to cover the streets like clouds. They are the most dextrous bleeders both of men and cattle; for the inhabitants being obliged, by the excessive heats, to leave open the doors and windows of the chambers where they sleep, the bats get in, and if they happen to find the foot of any one bare, they insinuate their tooth into a vein, with all the art of the most expert surgeon, sucking the blood till they are satiated, and withdraw their tooth; after which the blood flows out at the orifice. I have been assured, by persons of the strictest veracity, that such an accident has happened to them; and that, had they not providentially awaked soon, their sleep would have been their passage into eternity; they having lost so large a quantity of blood, as hardly to be able to bind up the orifice. The reason why the puncture is not felt is (besides the great precaution with which it is made) attributed to the gentle and refreshing agitation of the air by the bat's wings, hindering the person from feeling this slight puncture by throwing him into a deeper sleep.

Aside from the fact that the true

vampire bites both man and cattle, most of the above is overdrawn and inexact, but it serves as a typical statement of the times.

So much yet remains to be discovered in the life-histories of the various bats that no other field in mammalogy offers prospects of equal attraction to the observer. There are no less than fifty separate, distinct dental-formulæ among the bats; that is to say, there are that many different ways in which the teeth of bats are arranged, varying from a total of twenty teeth up to a total of thirty-eight teeth. There must be differences in habit and behavior, more or less marked, correlated with these differences in tooth arrangement, but of most of these we are ignorant.

Bats hibernate or migrate when they live in regions where severe winters cut off the food supply. In the northern United States, in winter, one may occasionally find the big brown bat, *Eptesicus fuscus*, hiding dormant in some dark, sheltered nook. Or in the fall, red bats, *Nycteris borealis*, may be seen flying southward in the daytime, and are frequently mistaken for birds.

Most species of bats have but a single young one at a birth, but a few species, such as the red bat, have from two to four. The young are carried about by the mother until they are almost full grown; and it speaks well for the bat's powers of flight that the female can, in the case of the red bat, carry much more than her own weight in youngsters and still hawk successfully for insects.

Contrary to some of the common beliefs, bats have good eyes, good in the sense that they are perfectly developed, although often proportionally rather small. The expression

"blind as a bat" has little foundation in fact, although many of our commoner species of bats behave in a bewildered fashion if brought into bright daylight, and may thus give the impression of faulty sight. But it is quite likely that bats depend very little upon the visual sense, either for securing prey or for finding their way about.

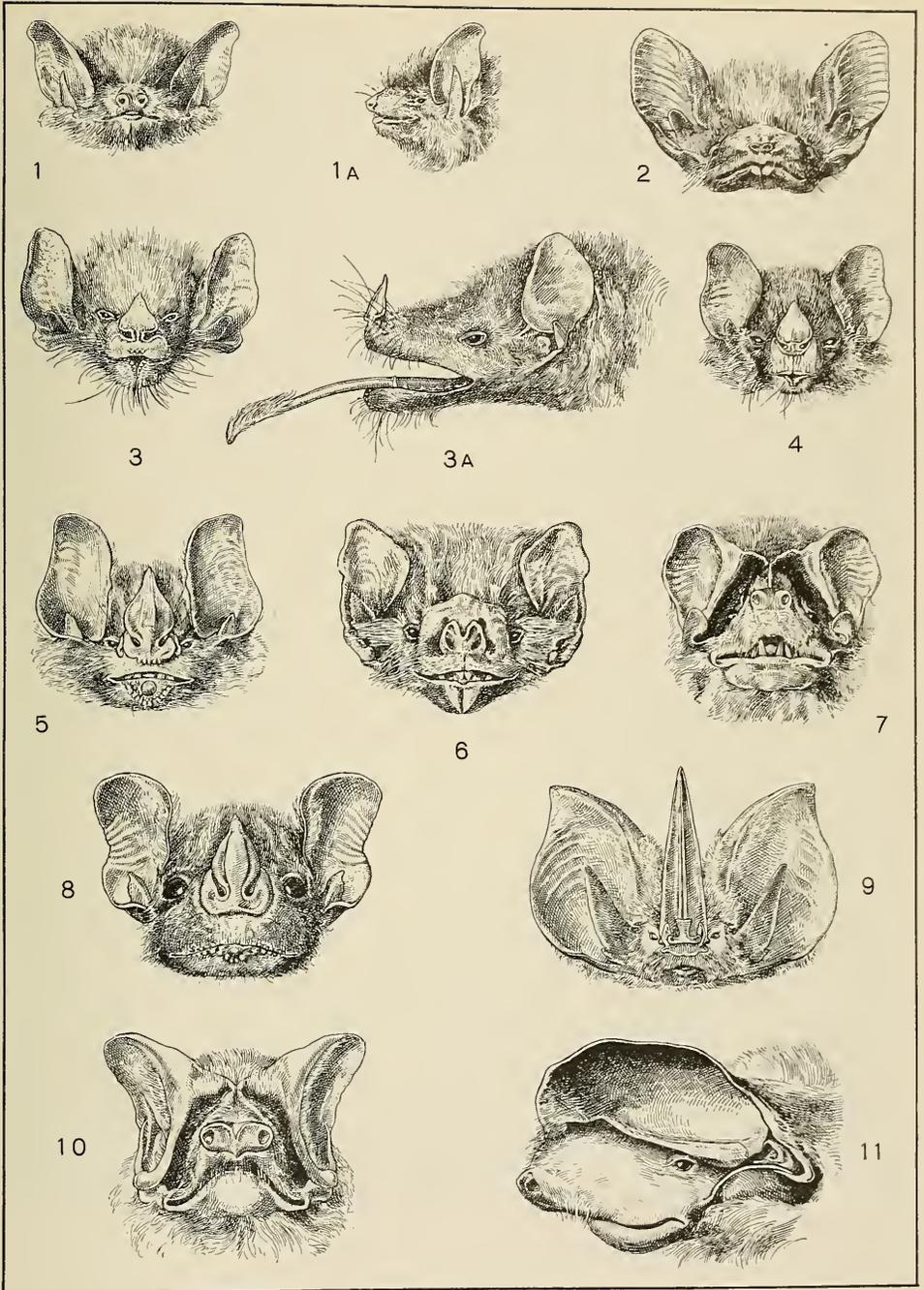
Bats frequent caverns the deepest recesses of which are never visited by a single ray of the weakest light, and hang, night after night, on the same small cornice or ledge with all the assurance of birds going to roost in the daylight. On dark nights the small eyes of the insectivorous bats can be of little value in finding the smallest of their prey. About the close of the eighteenth century, the Italian naturalist and experimenter, Spallanzani, performed his classical experiments with bats and discovered that the power of controlled and directed flight was independent of eyesight. Spallanzani closed the eyes of bats with varnish and liberated the creatures in rooms crossed and recrossed with fine, silk threads. The blinded bats flew freely back and forth between the threads, avoiding contact with the obstructions, and absolutely certain of direction. Later workers have reflected somewhat upon the comprehensive claims of Spallanzani, but confirm his statement in principle. The bats can find their way about, when blinded, because of the great development of a tactile sense or perhaps more than tactile, a pressure or vibration sense responsive beyond anything known in other mammals. These flying creatures may also possess a sixth sense, that of direction.

The peculiar outgrowths upon the nose, face, and ears of bats indicate to

us the presence of special sensory apparatus. A clear understanding of the functions of all of these structures waits upon future study, but it is not improbable that the nerve endings here, and perhaps some in the volar membranes as well, record the faintest differences in air pressure and air vibration, so that the bat is aware of physical obstacles before it reaches them. Hahn, whose experiments with bats are the basis of a most interesting report, states that the inner ear is the seat of these special sense organs of perception. The well-developed ears hint that they are an important source of information when insect prey is sought. The flight of insects must be audible to bats at a considerable distance. The bat's ear is tuned to the higher sound frequencies, such as those of a tiny insect's wing, and bat voices are correspondingly high-pitched, so high, in fact, that some people cannot hear them.

As has already been stated bats have been flying mammals for so long a time that their forelimb has lost its early function as a leg, and the hind leg bends in a reversed direction. In general, bats walk very poorly on the ground, supporting themselves on the wrists and the hind feet, but there are a few species which scamper about almost as readily as mice in spite of this handicap. These are the free-tailed bats, and doubtless the restricted flying membranes of these bats permit more freedom of motion of the limbs. Strange as it may seem, bats are capable swimmers and make good progress in calm water.

These winged mammals, like many other mammals, may be hosts for numerous parasites. The parasites may resemble forms which are troublesome to humans, but the bat does not



FACES OF NEW-WORLD BATS

1-1A, *Myotis*. 2, *Peropteryx*. 3-3A, *Anoura*. 4, *Glossophaga*. 5, *Heniderma*. 6, *Desmodus*, the vampire. 7, *Molossus*. 8, *Artibeus*. 9, *Lonchorhina*. 10, *Tadarida*. 11, *Eumops*



BATS HANGING FROM THE CEILING OF A CAVE IN PANAMA

This flash-light photograph was taken with the camera pointing directly upward at the cave ceiling, where hundreds of bats were clustered. A few bats were flying across the field of the lens and caused the indistinct blurs, most conspicuous at the top of the picture. An instant after the flash-light was fired the air teemed with bats

carry any insect pest which would leave the bat in preference for man. The parasites on the bat are all, for the most part, peculiar species found only on bats, and never troublesome in human habitations.

Bats have but few dangerous enemies and so their numbers are limited only by the food supply. Owls catch them, and in Cuba, it is said, the boa lies in wait at the mouth of caves and catches them occasionally. In Africa there is a bat-eating hawk, but this is a rare species. Cats may catch a bat now and then. In the north bats are never very abundant, probably living conditions are not very favorable; but in tropical America they are more numerous in species and in individuals than any other mammal. Unless one has had unusual opportunities for observation, he can scarcely imagine the spectacle of a well-tenanted bat cave in the West Indies or on the tropical mainland.

In Jamaica, for example, there are limestone caves of vast extent, some of them half a mile long, others three, four, or five miles long. These caves are the homes of great assemblages of bats. When a man visits the caves with a light, entering cautiously, only a few disturbed creatures will be seen flying about. It may be possible to note dark masses of drowsy bats clinging to the ceilings or packed into crevices and crannies. And if specimens were taken from each mass of individuals it would be discovered that each group contained only members of a single species, and these would be all of one sex. But let a shot be fired in the cave, and all is changed before the short-lived echoes cease. Confusion follows hard on pandemonium, and a tempest of wildly whirling forms bursts into the cave. Bats by the thousands pitch down from overhead

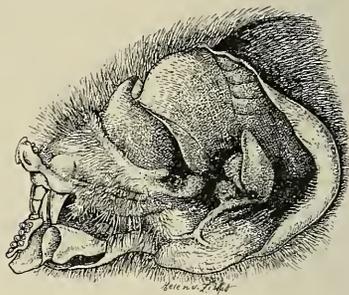
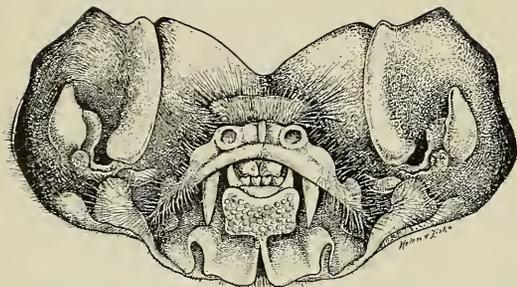
and the noise of terrified wings sounds like a gusty wind or a tropical rain storm approaching through the tree tops. High-pitched, strident squeaks voice the alarm, and the bewildered bats dash everywhere. It is seldom that the native, who has served as a guide to the cave and perhaps entered out of curiosity, will stand his ground when enveloped in a cloud of tens of thousands of these leathery wings which billows around his head. The old, superstitious fear proves too great, and he will seek the exit in a panic second only to that of the bats.

I have stood at dusk in one of the old, rambling buildings of Spanish architecture in the West Indies and watched the bats pour forth. The building was not being used, and here, there, and everywhere dilapidation had opened up ample crevices for bat habitation. Back of the loosened boards, behind the shutters, under the eaves, there was a boiling and seething of hidden life. The scuffling of tiny feet over the wood, the fine, wiry squeaking of impatient voices as those behind crowded the foremost, and the sense of bustling energy being set free showed that, for the bats, the day was just beginning. Out of the various nooks the bats were trickling in thin streams which flowed through the rooms to mingle in the center court or patio. Here the converging lines began to circle about in a counter-clockwise direction, mounting higher and higher on each revolution. The arrivals increased in number rapidly until the court took on the appearance of a great whirlpool of bats, a maelstrom of swiftly circling forms which flowed upward and spilled over the top of the building as the creatures set off on their hunting.

It is not easy to estimate the number

of individuals in one of the large caves, but it is certain that the census runs beyond the thousands, quite surely that it is well into the tens of thousands, and perhaps it would be little exaggeration to place it into the hundreds of thousands. It may require an hour or more for the cave to empty itself at dusk in a continuous stream of hurrying forms. In some of these

impossible in our present state of knowledge to say. Bats destroy myriads of insects, many of which are injurious to man's health and interests. In San Antonio, Texas, municipal bat-roosts have been erected to encourage bats to take up residence there to aid in freeing the city of mosquitoes and other insect pests. But competent observers have stated that



These two views, full-face and profile, show the physiognomy of the leaf-chinned bat, *Mormoops blainwillii*, a West Indian species. This bat is one of the most complexly ornamented forms known

caverns, where generations upon generations of owls have had their abode and levied tribute upon the bats, the bones of the victims lie piled on the floor, mingled with the remains of birds, reptiles, and rodents. These bone deposits may be measured in tons, and bear mute testimony to the long occupation of the cave, the great number of bats frequenting it, and the persistent toll taken by the owls.

As another index to the great bat population in favored caves, mention might be made of the great guano deposits formed by bat droppings. Vernon Bailey, in the *National Geographic Magazine* for September, 1925, estimates that 100,000 tons of bat guano have been removed from the Carlsbad Caverns of New Mexico since man has worked the deposits.

Bats have considerable economic importance, just how considerable it is

such a bat population has little real control over the mosquitoes. Bat guano has a high value as a fertilizer. The fruit-eating bats transport seeds and serve as a factor in the distribution of plant life. In some parts of the Old World the larger bats are an important article of diet on the native menu.

Finally, there is very little that can be said against bats, especially our North American species. The blood-sucking vampire never reaches the United States, and none of our species are injurious to crops. Bats do not wilfully entangle themselves in the hair of women; they do not carry insect life which lives on man; their diabolical physiognomies are their own concern and no proof of relationship to the evil one; and while they choose the dark hours for their activities, it is not because they have anything that they would hide from us.

Extracts from the Diary of Martin Johnson

THE Johnsons have been established at Lake Paradise about eighteen months, carrying on their work of making life histories of African wild life along the lines described in *NATURAL HISTORY* for May-June, 1924. The following extracts from Johnson's diary will give some idea of the thrills and heartaches that are sure to fall to their lot in this fascinating undertaking. We shall get infinitely more of it all from the story of "The African Elephant"—a film that is now completed and will soon reach New York. Johnson is enthusiastic over it, which means that it is the best he has done. Better than Johnson's best means pretty close to the ideal.

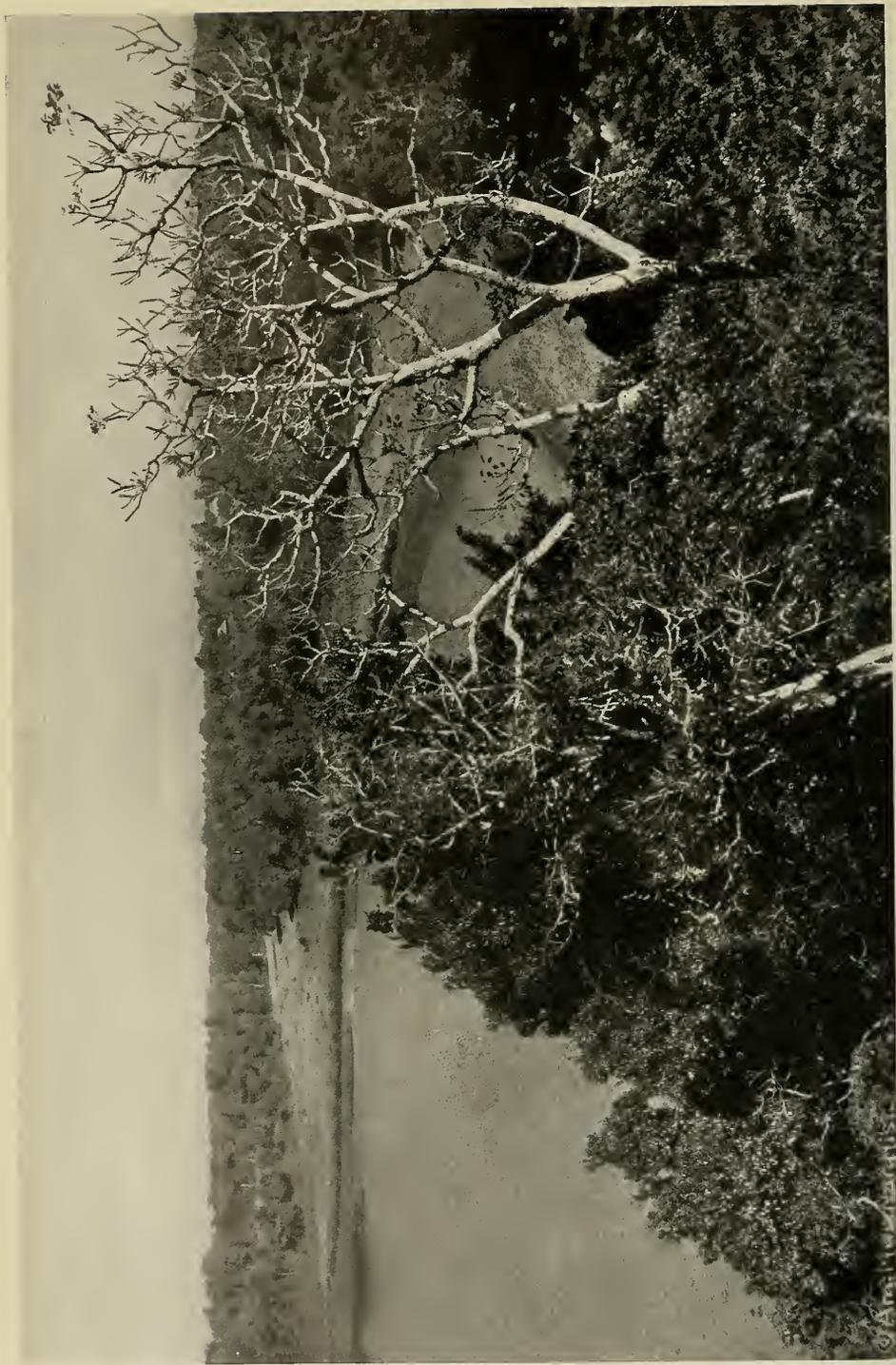
—CARL E. AKELEY.

“OSA and I are all keyed up and excited over our wonderful elephant films. It may seem queer that we started right out after elephants instead of the picture 'Songa the Tale Bearer.' But you see the elephants kept bothering me all the time. They seemed to beg to be photographed. As elephants interest us more than any other animal in the world, we could not help going right after them, and it would have meant traveling long distances to get the tribes necessary for 'Songa the Tale Bearer.'

“As a matter of fact, 'Songa' has been in the back of my head all the time. I continually photograph natives whenever I find them, but I have not succeeded in getting the proper sequence to make up the completed feature. While I now have an elephant film that I would give anything to see the first night it is shown to the public—but of course I would be off here making other films. I would like to see the audience, for I want to watch their expressions when they see elephants so big that they will seem to walk right out of the screen, although I wonder if they will ever appreciate how almost every scene is playing with death. So far I have not made a single scene from a blind, but have been right in the open with the elephants, Osa standing to one side with the still camera, Saunderson,

Boculy, and Bukari with their guns sighted on the elephants every second. Then when they 'get' us they start forward, but we make such a racket by yelling that almost always they run away. On our last trip, only a few days ago, nine elephants came for us three times, then turned back. On the last charge they kept coming and we had to knock down the leader four times before she would stop. Then she and the others ran away. I did not get the actual knocking down as my film ran out and I was loading, but I got the first two charges as they came within twenty yards of us each time before they turned, and now that I have developed it, I think it will prove the greatest wild animal film ever made by any one—just 200 feet, but the most valuable 200 feet I have ever made.

“And I wonder what the audience will do when a big bull lashes his trunk and comes for us seven times, backs off and comes again, then loses his nerve and runs away, each time coming so close that the aperture will show only his head. And I wonder what they will do when they see a baby elephant, a few days old, getting its dinner from its mother; a baby elephant that falls in a hole and scrambles out; another baby that runs in and out between its mother's legs as she walks along; and a mammoth mother rhino that, with her baby, comes within forty feet of



LAKE PARADISE

Surrounding Lake Paradise in every direction for hundreds of miles there is nothing but desert. A couple of our houses can be seen across the corner of the lake

us and stands undecided whether to charge or go—and goes.

“We have demonstrated how to save the lives of elephants and rhino when they are deciding to charge. We yell and make all the noise possible and with the one exception they have lost their nerve and run.

“As soon as I have finished developing in a few days, I will start assembling and getting the film ready for the market. Boculy has wandered off into the forest and I am expecting to have him back any day. Then, as I know he will do, he will come back excited, telling of elephants in a good photographic place and doing something wonderful. Then off I must go, for what can I do? Its the most wonderful and exciting thing in the world to photograph elephants. Of course, when I have this elephant film finished, I will go after lions and rhino and buffalo and the plains game, but I will always be making elephant films. I now have the satisfaction of knowing that I have a film that will be wonderful from the museum standpoint, for it shows almost everything elephants do, and I have them in every age, from a few days old to so old that they can scarcely carry their tusks.”

* * *

“We sent the boys and the camels on ahead while Osa, Saunderson, and I climbed a hill to get a good look at the country. As we came down the cook came running up, all out of breath, saying that he had gone off by himself and had run into an elephant. So we hurried after him. I nearly forgot about Saunderson. He had gone down the other side of the hill and we could not find him, so Osa and I and the camera boys, who always stay with us (never mind where the rest of the safari goes), found the elephant in a

little donga, feeding. We made a detour to get the wind right and when we came up to where he had been a few minutes before, he had disappeared. In fifteen minutes we found him again, but he seemed to vanish before we could get up to him. This happened three times and we had begun to think he was a spook. Osa named him ‘Houdini’ because he was so clever at disappearing. But we finally came up to him and made some fine pictures as he was feeding. Now we were doing a foolish thing. Saunderson was not with us and Boculy had wandered off ahead of the safari. This left only Bukari to guard us while we made pictures.

“‘Houdini’ then left his feeding and came toward us, but turned about when twenty feet away, went to a fair-sized tree and tried to pull it down with his trunk, but the tree bent and would not break. So he used his brains and pulled it down as far as he could with his trunk, then placed his tusks over the tree and held it while he reached up and got a better hold higher up with his trunk. He then pulled as far as he could, placed his tusks on it again, and so got another hold higher up. This time the tree snapped and he pulled it down to the ground with his trunk. He spent about thirty minutes feeding from it, selecting the tender young buds at the ends of the limbs.

When he had eaten all he wanted he walked around the tree and came directly toward us. I now had all the movies I wanted and told Osa to take her gun while I used the Graflex, and with my gun bearer standing right beside me I got several fine stills.

“‘Houdini’ came to within less than fifteen yards and saw us. He was moving slowly but when he saw us he

stopped so short that he swayed. His ears went out and he put his trunk out to try to get our wind. Then he slowly backed, turned and walked deliberately away. . . He was not angry and he was not afraid. Living on the game reserve all his life he had probably never been shot at and was not timid. Up to the time he saw us he gave the impression of being half asleep, although his eyes were wide open. In feeding he felt with his trunk, as though he was not seeing what he was doing. But when he saw us, he quickly became wide awake.

"We were in an absolutely open place without a tree. Had he taken a notion to come he would have been very dangerous. But we did not think of this until afterwards.

"We then packed up and continued towards Tembu Pass, where we were to camp. Just before we got there we saw Suko, Mrs. Johnson's boy, come running to us. He said elephants were right near the pass. . . I hurried to climb a rock and saw a big bull and a small bull walking along slowly in the open. I told my boys to follow and we scrambled along the rocky ridge at the top of the Pass until we came to a sloping rock leading down to the ground. Here I set up my cameras and in a few minutes the elephants were about twenty-five yards below me, drinking at a mud pool that was under a ledge, so I could not photograph them. But soon they came out and stood still in an open bit where the light was fine. I ground off a couple of hundred feet, and while I was reloading they saw us. I can't figure out, even now, what made the big bull so angry, but he was furious. Just as I got my "Akeley" loaded he came for the rock full speed. He tried to climb it but could not. He went

back about ten yards and stood blowing air out of his trunk. He swayed from side to side. He pawed up the earth and lashed the air with his trunk. Then he came for the rock again but could not get up. All the time I was getting 'movies' and Osa was getting 'stills.' Osa, seeing that he could not get up the rock, ran down closer. The elephant then turned and ran away into the bush, with the other one following. But the big fellow stopped several times and looked back. I have a hunch that he would not have been so furious if we had been down on the level ground with him, for it must have been that he could not make us out on the rock.

"Great rejoicing at camp last night. All night long elephants could be heard trumpeting in the valleys nearby."

* * *

"In the evening after dinner Osa, with Bukari, climbed a ten-foot rock after agreeing on signals. . . she was to give one whistle, repeated at intervals, if a rhino was coming in front of us, two, if one came to the left, three at the right, and four whistles if one came up behind us. Saunderson and I lay down in the sand about twelve feet from the flash-light lamps, without anything around us for protection. Mosquitoes were bad, but with Osa watching over the country with glasses we did not need to be very quiet, so we had a good time scratching. About ten o'clock Osa gave one whistle; I raised up and with my glasses saw a rhino coming right down our path toward us. We lay as quietly as possible but the rhino got our scent just a few feet short of the place I wanted him; he gave a start and began to run, but I took a chance and closed the electrical contact that made

the flash. I forgot to close my eyes as the flash went off, so I was blinded for about three minutes. Saunderson knew I was blinded so he gave me reports; he had remembered to close his eyes. He told me the rhino had run away, he had stopped, he was coming back, he was going away again, etc. When I could see once more, I reloaded the flash lamps, put in new plates, and we lay down again. The rhino by this time had started down the trail again, but he was suspicious this time, stopped when thirty feet too far away, pawed up the ground and snorted. . . Do you know it is not a pleasant sound to have a big rhino snorting at you while you are lying in the sand not over forty-five feet away? As the ground had a slight rise at this point, it seemed that the rhino was towering directly above us. We had our guns at hand and I had the flash push-button ready. I resolved to get a flash if he charged, shooting after the flash if it was necessary. But he turned and walked away a few yards and stood snorting there, then went away a little farther. He tried to go around us to get to the water, but we could not stand for that since he would get our wind very strong and be sure to come for us, so we stood up and threw stones at him. He ran about a hundred yards and stood there for half an hour, until we saw two more rhinos coming toward us . . . a mother and half-grown 'toto.' They would have come right down our trail, but the first rhino challenged them and they turned off the trail and went for him. He stood his ground and the two stopped about fifteen feet from him, all three with their tails in the air, snorting and pawing the sand. They circled about each other. For thirty minutes they kept this up;

but as they gradually came closer together they stopped being so angry and finally seemed to rub noses. I am sure the first rhino told the other two about the queer thing down the trail, for all three made a wide detour and we let them go on to water. They finished drinking, detoured again, and started away as two more came along. The usual snorting and pawing started all over once more, until they had satisfied each other that all was right. Then the two new ones left our trail and Blane! if they didn't go clear around to water, like the first three who by this time had gone away.

"This went on until about midnight; Osa was kept busy whistling until she stopped in despair; there were so many rhino about us and others coming and going that she could not keep track of them. She had no need to, for Saunderson and I were busy watching that none came too close. About one o'clock a mother and toto had been to drink and came up behind us. We threw stones at them and they ran back, but shortly came on again, and we had to throw more stones.

"At one time we counted ten rhino in plain sight, with others that we could hear at water and off among the rocks.

"At two o'clock a giraffe came within fifty feet of the cameras but its long neck allowed it to see us too plainly and it went away. A bunch of bush pigs came along single file, but they, too, saw the cameras. Some zebra came close, then went around. It was so light, the moon was nearly full, that the cameras showed up too plainly. Right here I decided the best time to make flash lights would be during the dark of the moon when the stars would give us enough light, reflecting on the

sand, to see the game, but the animals would not be so likely to see our apparatus."

* * *

"Broke camp and we were on our way at daylight yesterday, a most beautiful safari along a dry river bed between two mountains. Game tracks and spoor everywhere but over a week old. When we stopped at noon we came upon a Samburu tribe moving into new country. They had some fifty camels and a hundred goats. About fifty people in the bunch; they were a wild looking lot and the women cried when I took their pictures. They did not dare run away because they had to hold the camels, but they were so frightened that we tried to ease their minds by giving the women each a handful of sugar. We left them to go their way and we went ours. The Samburu said they had seen no elephants for days. Poor Boculy was very downcast. About four o'clock we had to go through a narrow pass, not over fifty feet wide, between a large rocky hill and a larger mountain. On the other side I told the safari to stop in the shade of the rocks while the cameras cooled off, the carrying cases were almost too hot to touch. I then walked around the rock to see what I could see, and saw it. I ran face to face with a big bull elephant. He was walking slowly along, coming in my direction. I was less than twenty yards away but as I was hugging the rock the elephant did not see me. I slid into a crack between two rocks and he stopped to feed from a small tree. I gently slipped out and went around another rock, and hurried for my cameras. I got them back and set them up on a rock about five feet high at a place where the elephant was likely to come, and he did, just as I

was ready for him. I made about two hundred feet of fine film; perfect light and a beautiful setting. Osa made four good stills, then he saw us and ran off into the bush. I packed up and went back to where the safari was waiting, very well pleased. I asked for Boculy but no one knew where he was. We were just starting out again when he came up, very down-hearted, and took his place at the head of the safari. I was full of pep after getting the picture and I started to ask him questions about the elephant. Then he pricked up his ears and wanted to know what elephant. He had gone to another hill to look over the country and had not known about my good luck. I told him about it and in a few minutes he was all grins. About that time, another big bull elephant walked across the road in front of us, but so close that he saw us and went on into the bush, with his tail in the air. I managed to get a good picture of him as he came out in an open place and made for the hills."

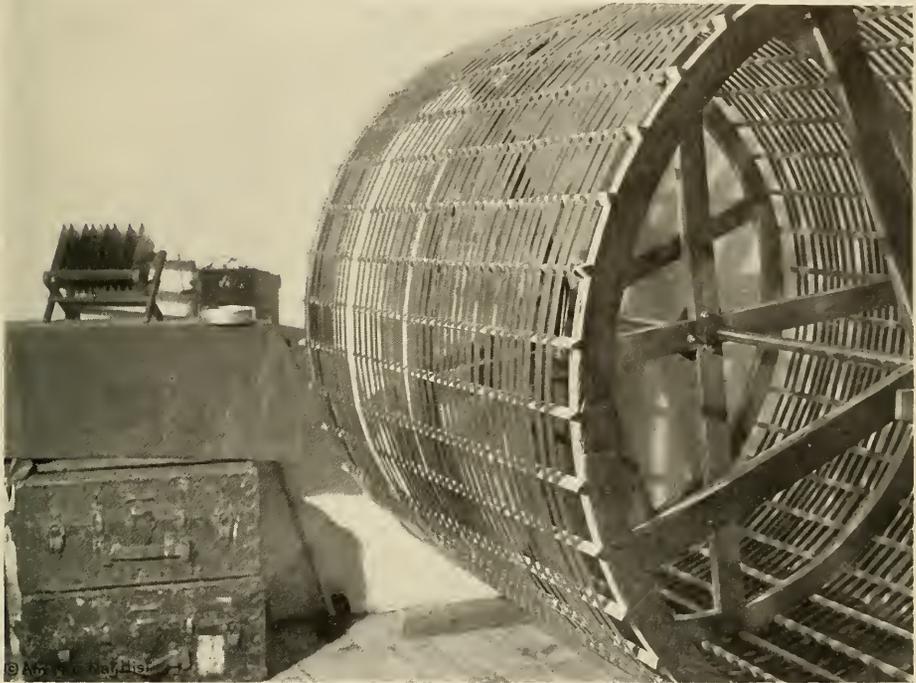
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"Boculy was on top of a nasty rock about two hundred feet high. He motioned for us to come up, which we did. Once on top I saw the elephant about half a mile away and I was mad because it was dangerous to take all my delicate cameras and apparatus over the rocks, and unnecessary. I am afraid I scolded Boculy more than he deserved, but he never said a word, although I could see from his face that he was furious. We climbed down and went after the elephant and I set up in a fine, open space. The elephant was feeding from a big tree and I started making films. I forgot to say that Osa was exhausted and we had left her with a pair of binoculars

on the top of the rock were Boculy had us climb up.

"In a few minutes the elephant started coming in our direction but saw us when within thirty yards. He returned to the tree and stood there a few minutes and then came toward us

for us once more. He had his head up in the peculiar way elephants have when they are angry. He did this four times. All this while I was getting priceless film. The fourth time we 'got his goat' and he ran away, but he stopped several times and faced us



Drying drum and a few of my film trunks built on the fireless cooker idea

again, this time very curiously, in little goose steps. When within fifteen yards he started circling about us, and then with his tail in the air he went across a small donga. We followed. He stopped in the bushes and then came out toward us again. He lashed his tail and his trunk and then stamped the ground. He seemed to make up his mind to charge and he would come several feet, stop and come on again. When fourteen yards from us (we measured afterwards) he turned and ran back, then whirled and came

before he finally was lost in the bushes. I did not get a single still picture but I am sure I got the most exciting elephant film ever made.

"When we got back we found that Osa had been crying. Through the glasses she had seen another elephant throwing water over itself from a water hole. He then came in the direction where we were making pictures. He saw us photographing the other elephant and he seemed about ready to charge. In fact, he went into the bushes near us and Osa was afraid he

would get us before we saw him. As a matter of fact, we had been so busy with the one that we had not seen the other.”

* * *

“. . . But the mules carrying water were lost and I sent Saunderson back on a mule to find them. I then climbed a tree to look over the country. I saw one elephant a mile away but it was too late to go after him. About six o'clock a big rhino came running full speed under my tree and continued on into the forest. Twenty minutes afterward Saunderson came limping in afoot. He had run into the rhino; his mule threw him into a dead tree. The mule made off back to the lake and the rhino was the one I had seen running. Saunderson is all skinned up and his clothing torn.

“This morning we took cameras and boys and started to a water hole an hour away; nothing there but lots of elephants using it. We went on for half an hour and found two elephants asleep in a small donga. Made some fine pictures of them but we got too close and frightened them. They ran up the side of the steep donga and I got a fine film of them scrambling out. We followed them and I caught them as they slowly moved down another small donga. Then they “got” us again and ran back to the bigger donga. Just then, as I was photographing the elephants, ten fine greater kudu came walking along on the other side of the donga. They were just in time, as I was all set up and I got a fine picture. They saw us after fifteen minutes and all crowded upon a small ant hill and I got a fine group, all looking at us. They were very tame and I made a better kudu picture than I ever hoped to get.

“We started back to camp and I

made another picture of a female elephant coming up the donga toward us. She was very good in stopping at little trees and feeding. Just before we reached camp another big bull elephant came out of the forest and stood about three hundred yards from camp, throwing earth over himself. Got another good picture. Here in one day I made over a thousand feet of fine film that more than makes up for the days when we got nothing.”

* * *

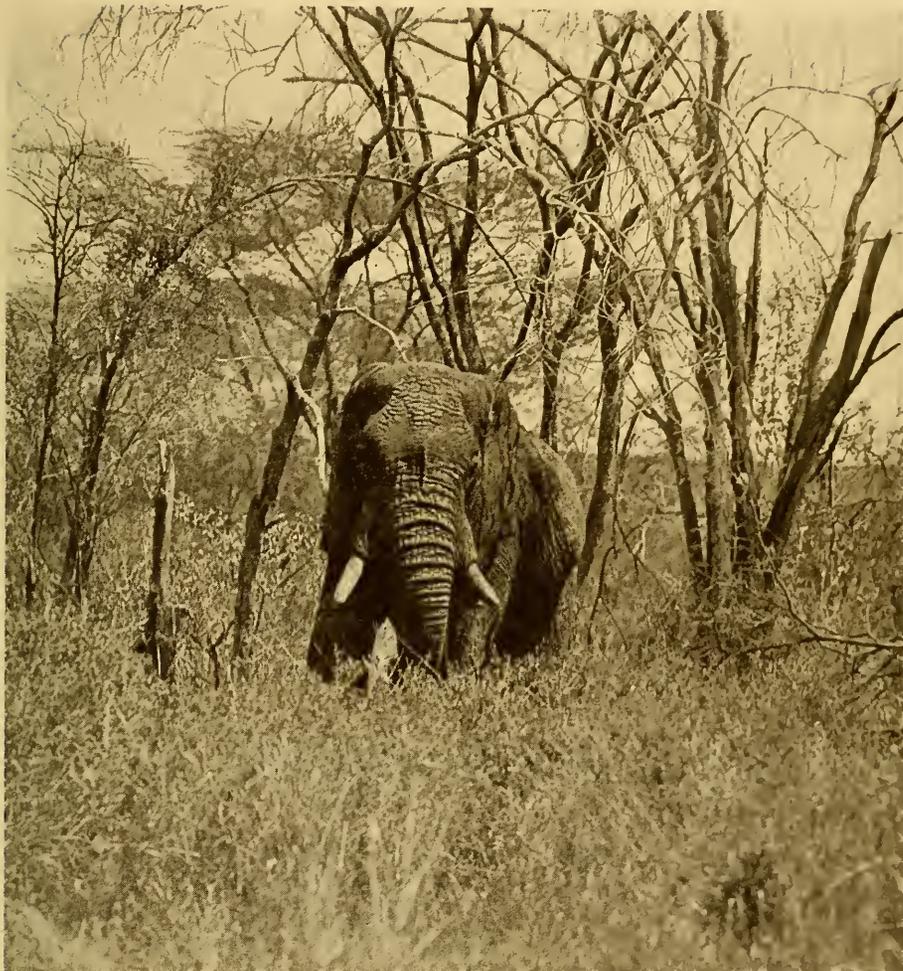
It might be interesting to know just what boys accompany me each day for camera work.—2 camera bearers; 1 tripod bearer (he carries 2 tripods); 1 boy who carries the lens case with different lenses in it; 1 boy carrying the Press Graflex with the tripod for it; 1 boy carrying a case of loaded film magazines; 1 boy carrying two cases of loaded plate holders; 1 boy carrying 4×5 Graflex with tripod; 1 boy carrying a case of odds and ends (ray filters, tools, oil, small medicine case, extra spools, etc.—sort of an emergency case) 1 boy carrying lunch; my gun bearer, Osa's gun bearer; Boculy and Bukari; making 14 blacks in all.

Everyone knows their duty. They all withdraw to a shady spot behind me while I am making pictures, but each one on the alert should I wish any case. Each case is numbered, and I call for them by number. You see I try to be alone so as not to frighten the game, as they might see movement if so many boys were about me. Osa never comes up with the still camera unless I call her, although she always sets it up the first thing and is ready. Saunderson and the gun bearers crawl along the ground to get beside me in case of danger. I try to stand as still as I can, as animals who can't see well can sometimes make out movement.

Scenes About Lake Paradise

REPRODUCTIONS FROM PHOTOGRAPHS TAKEN BY THE
MARTIN JOHNSON AFRICAN EXPEDITION¹

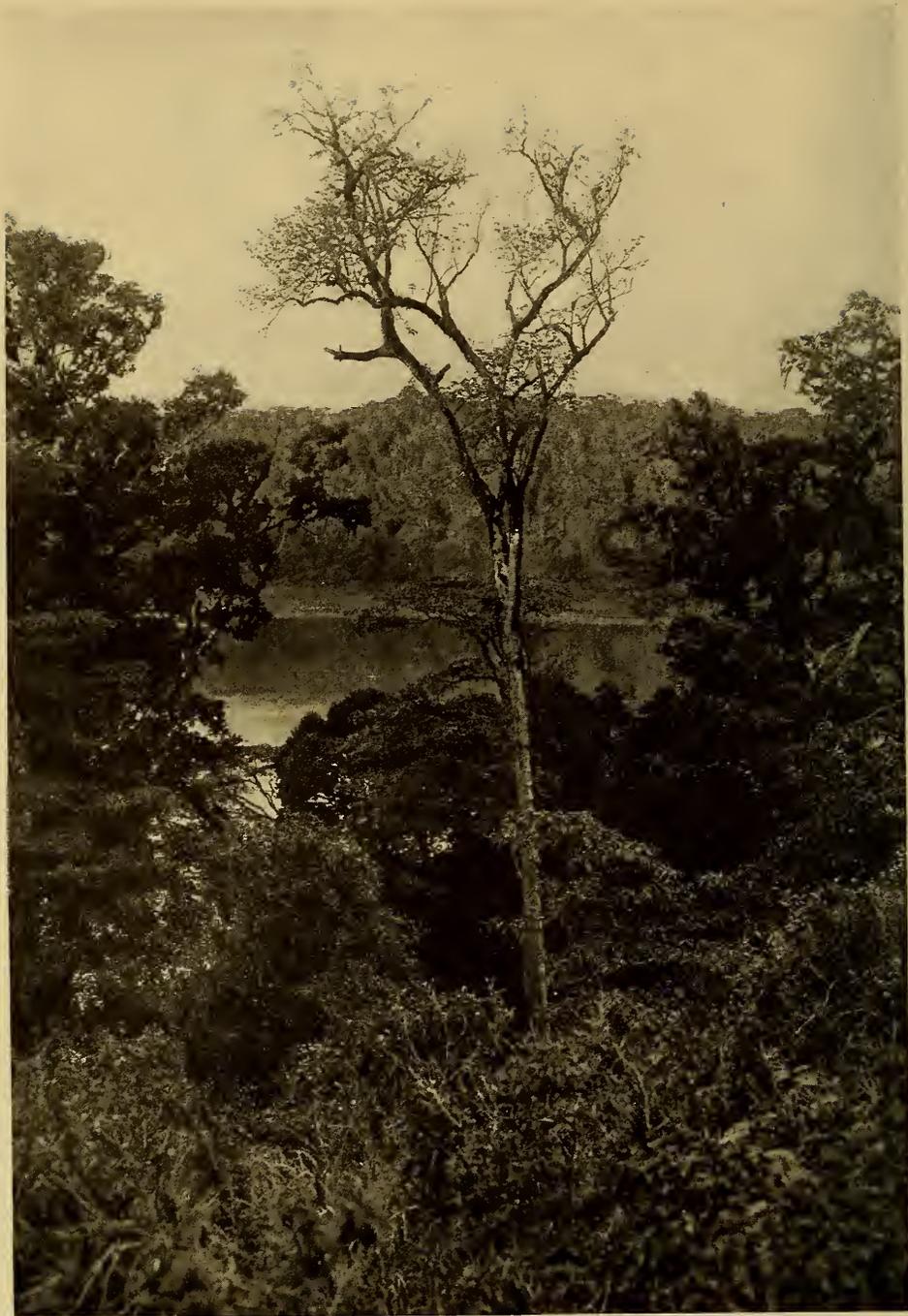
Photographs copyrighted by The American Museum of Natural History



AN AFRICAN ELEPHANT ALL-UNSUSPICIOUS OF MAN

This is the elephant referred to in the "Extracts from the Diary of Martin Johnson," as "Houdini," because of its ability to disappear unexpectedly. The photograph was taken just prior to that which appears as the cover illustration of this magazine. Above we have "Houdini" with ears laid back, seemingly unaware of an audience. The cover illustration shows the great difference in Houdini's appearance when he discovers the photographer. The elephant then throws forward vast, sail-like ears

¹Most of these photographs are being published for the first time, and have been selected by the Editor from a number forwarded from the field.

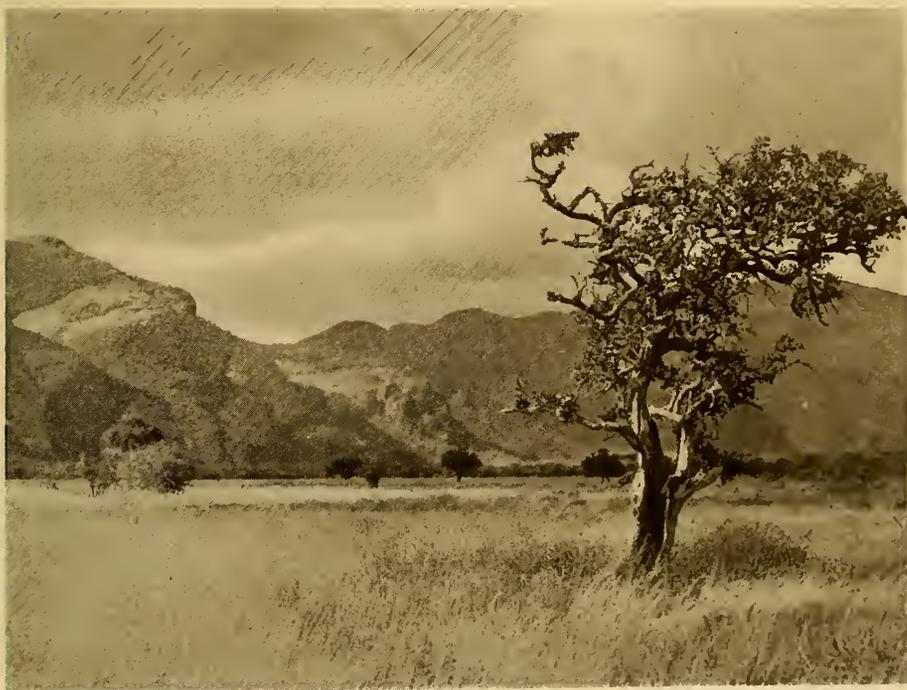


LAKE PARADISE AS SEEN FROM THE LABORATORY OF MARTIN JOHNSON

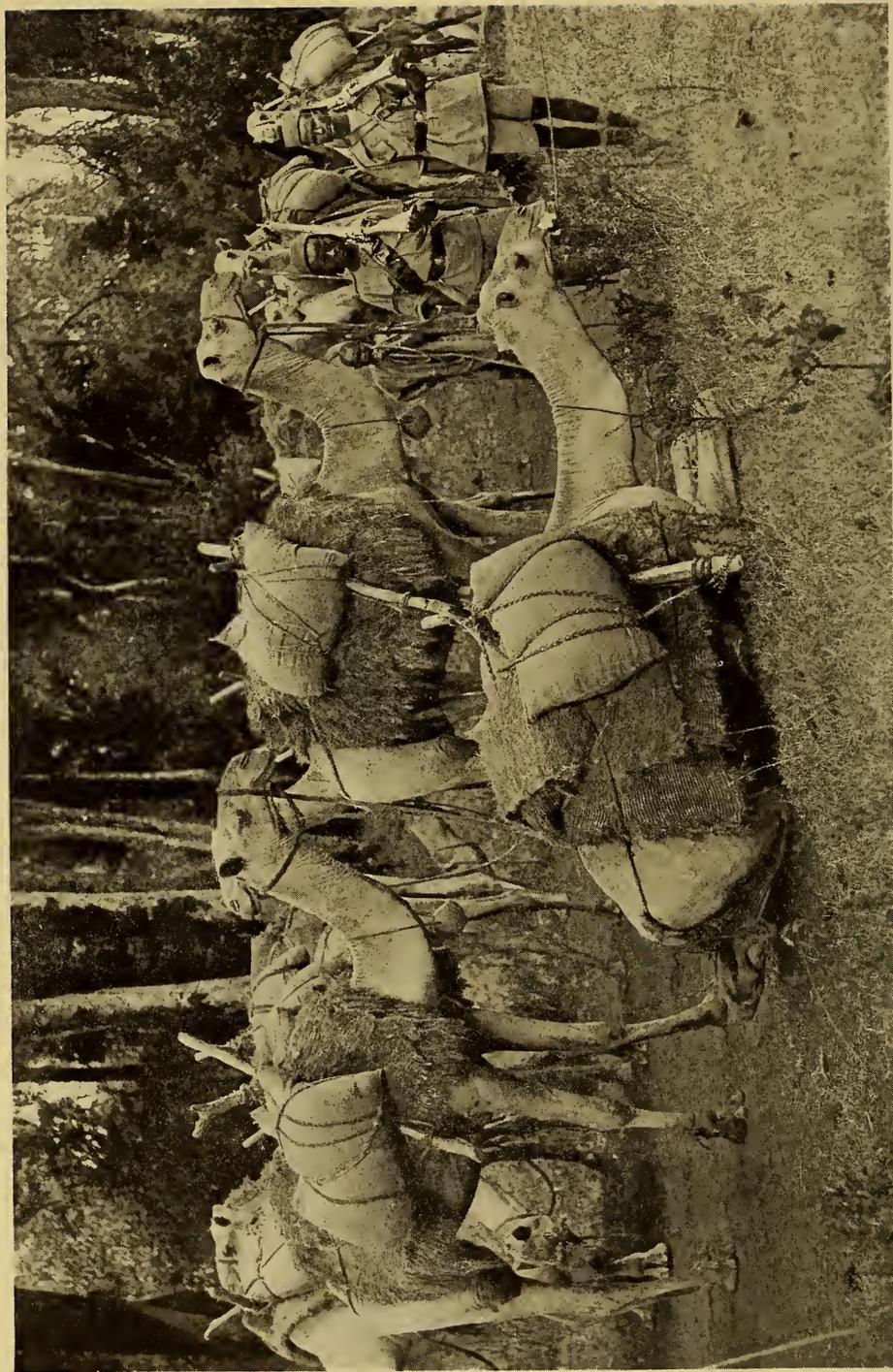
This lake seems appropriately named, and not only is attractive to man but to hosts of wild animals as well. Life of some description is almost constantly in view along its shores



Ndoto mountain scenery has much about it reminiscent of our own western mountains. The resemblance, however, is only superficial and related to the physical features of the landscape; the flora and fauna are distinctly different



The Ngron plains, flanked by the Ndoto mountains, lie in the Northern Game Reserve. The long grass, with scrub and small trees or thickets here and there, furnishes food for many grazing mammals



A CAMEL CARAVAN HALTED ON THE TRAIL

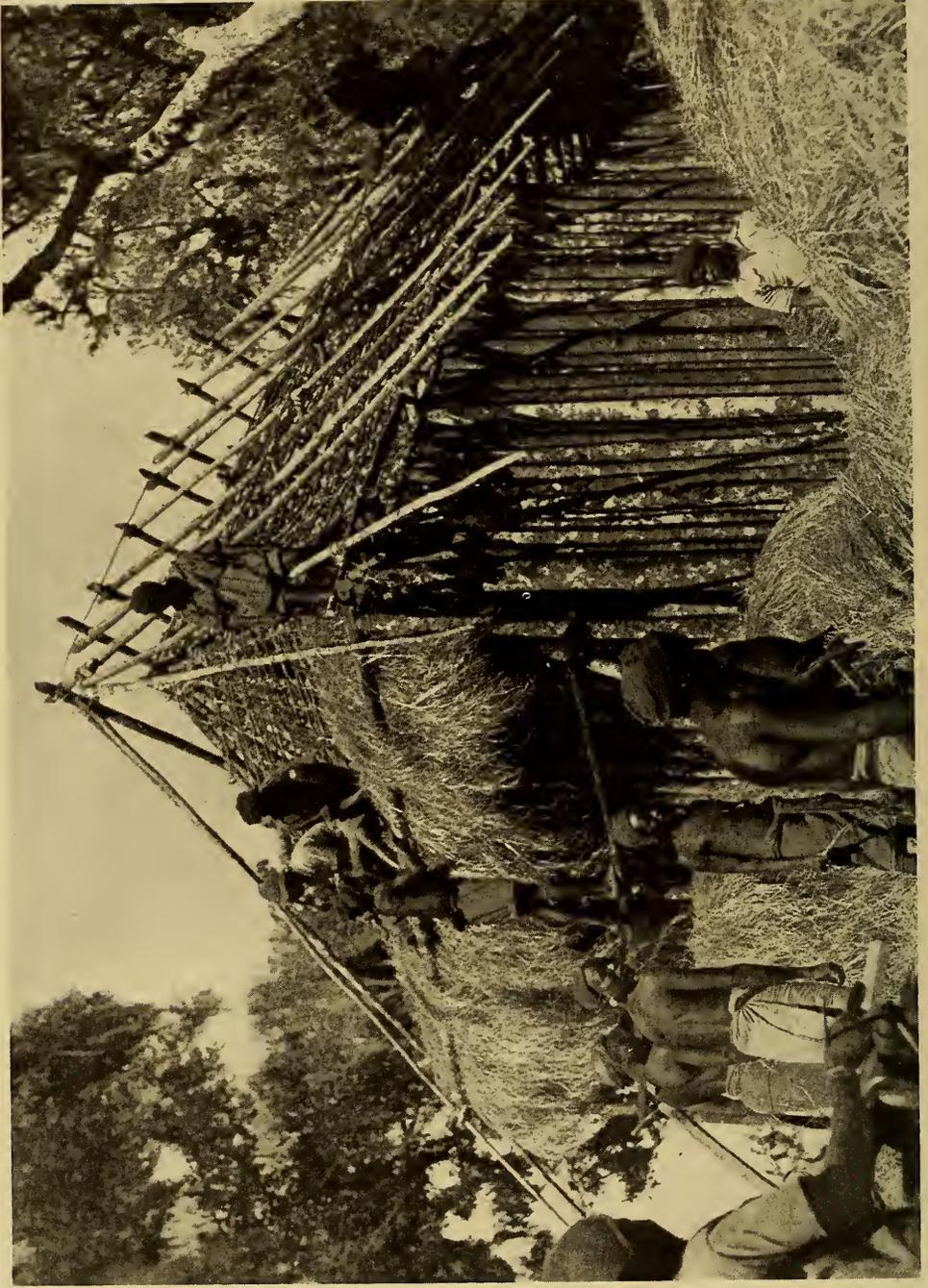
"A few of the camels bringing our posho from Abyssinia. The two askaris escorted them from Marsabit."—DIARY OF MARTIN JOHNSON



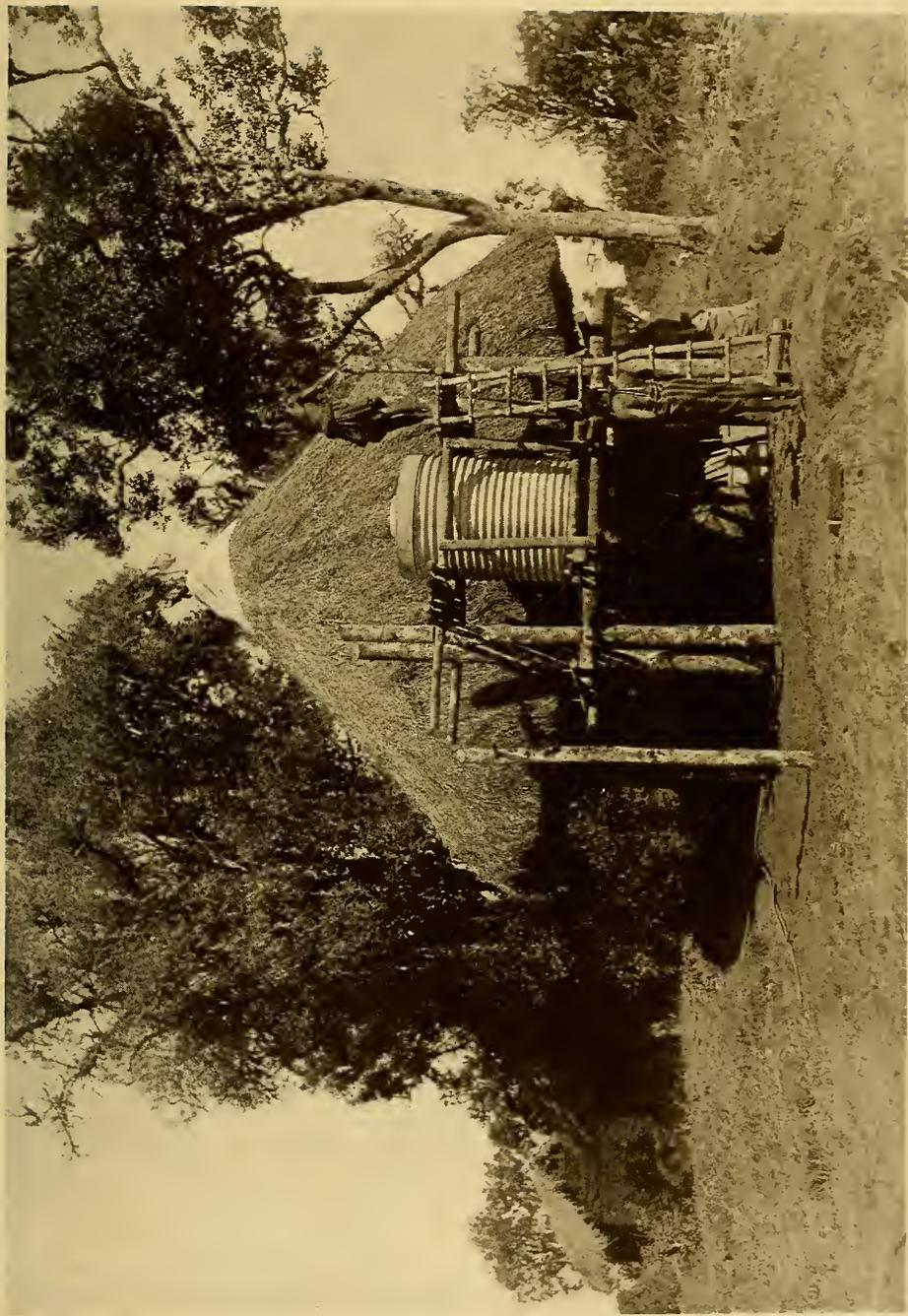
"Fundu Kubwa" is the carpenter who cannot saw straight nor hit a nail on the head, but would be absolutely lost without the level, although with it he is unable to get anything straight



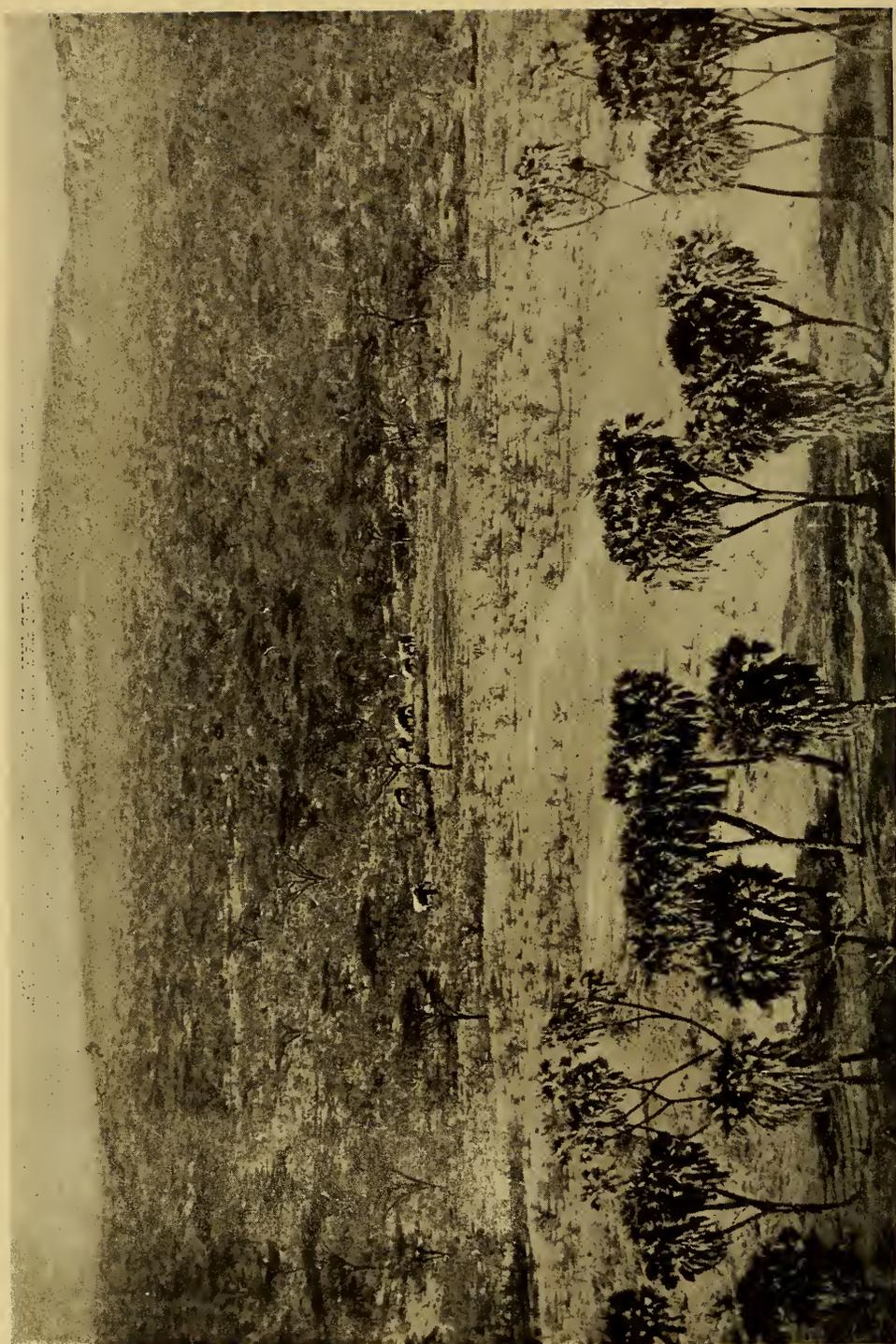
"Takatta" is one of the Wakamba porters. Natives of many tribes pass to and fro from Lake Paradise, or are employed as workers at the station. Note Takatta's filed teeth



THE SECOND OR DOUBLE ROOF BEING ERECTED ON THE LABORATORY AT LAKE PARADISE



THE REAR OF MARTIN JOHNSON'S LABORATORY. THE LARGE TANK IS USED TO STORE WATER FOR WASHING THE PHOTOGRAPHIC PLATES, AND DISCHARGES INTO THE DARK-ROOM



ELEPHANTS PASSING THROUGH SCRUB FOREST "ON SAFARI." A BABY ELEPHANT OR "TOTO" MAY BE NOTED UNDER ITS MOTHER'S TRUNK, ABOUT THE CENTER OF THE HERD



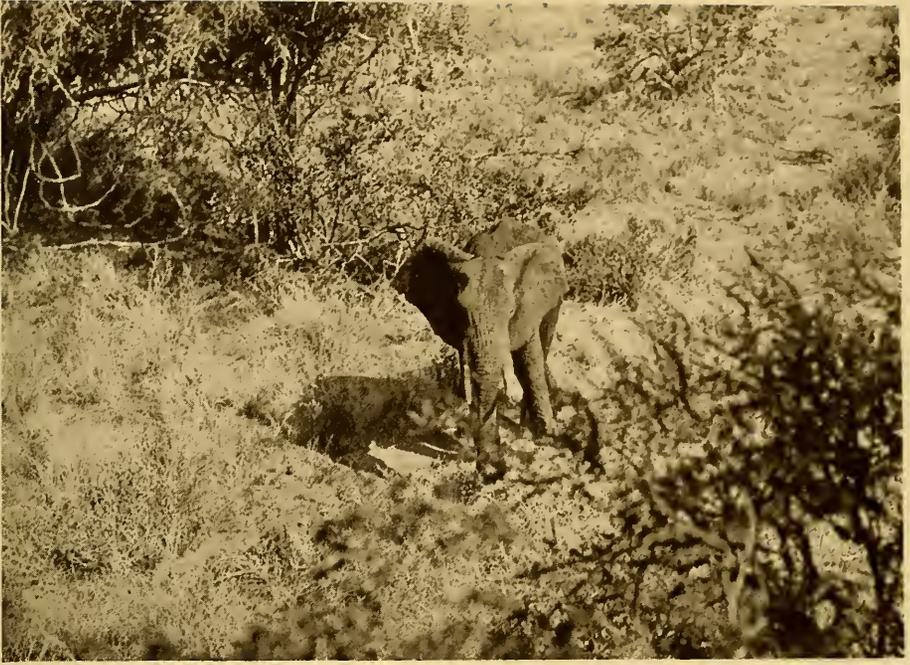
A LONE, BULL ELEPHANT, LONG-LEGGED AND LOOMING UP INTO THE SKY LINE, IS SILHOUETTED AGAINST THE WHITE CLOUDS



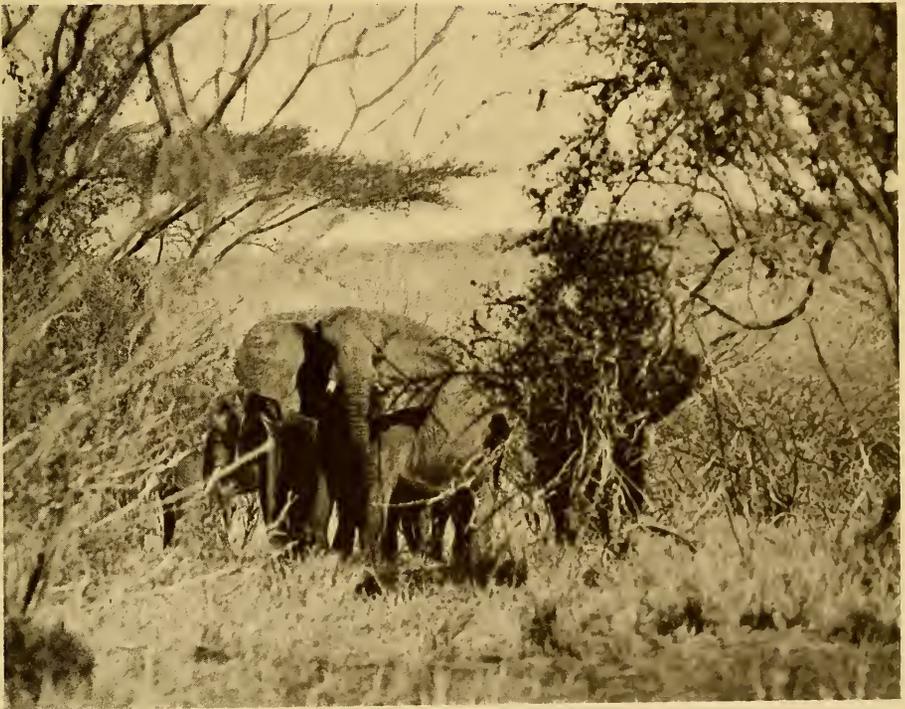
This elephant charged and charged again up to the rock upon which the Johnson party stood



Unlike the angry elephant above, when this one became suspicious he behaved true to expectation, and ran away



A young bull elephant moving toward the camera, apparently unsuspecting, since he soon began to feed near the Johnson party



Although there are nine elephants in this group, only a few may be seen. Just after the picture was taken the elephants charged



THIS FINE TUSKER OF THE NORTHERN GAME RESERVE POSED SO OBLIGINGLY THAT MARTIN JOHNSON SECURED A NUMBER OF SPLENDID EXPOSURES



NOT AWARE THAT HE IS BEING PHOTOGRAPHED, THIS BIG BULL IS CALMLY BREAKING DOWN A SMALL TREE AND FEEDING ON THE FOLIAGE



ON THE NORTHERN GAME RESERVE

The securing of such pictures as this—fine, clear exposures of the animal in an undisturbed habitat—marks the highest development of the photographer's art. It is extremely important that series of photographs of the all too rapidly vanishing large mammals be secured while it is yet possible. Martin Johnson has the hearty support of all conservationists, and nature lovers are in full sympathy with his work. His trophies can be admired by everyone; they will endure for all time and they are obtained at no cost to the animal



BULL ELEPHANT COMING OUT OF THE BRUSH

The calm demeanor of this elephant shows that he is probably completely unaware of the presence of the photographer. As the reader will gather from "The Diary of Martin Johnson," in this magazine, the camera is set up wherever chance dictates, and the facilities for concealing man or machine may be poor or even non-existent. By anticipating the movements of the animal it may be possible to "set up" in a position to take the best photographic advantage of the light and the background; patience, the courage to remain motionless in the face of closely approaching danger, and the presence of mind to make the most of each opportunity, will do the rest



A SUSPICIOUS RHINO ABOUT TO CHARGE

The rhinoceros is an uncertain beast at best. The photographer can trust this animal only to a very limited degree under the most favorable circumstances, and when this big brute is met with in undergrowth, he becomes more dangerous than ever. After this photograph had been taken by Martin Johnson, the rhino came several steps closer, and had to be stopped. Johnson's companion, Saunderson, shot the rhino at the base of the horn. The shock was too much for the animal; it whirled and ran away. A shot on the horn does not seriously wound the rhino, but it is a powerful distractor of attention

"Lives of Game Animals"¹

A REVIEW OF VOLUME I

By H. E. ANTHONY

Associate Curator of Mammals of the Western Hemisphere

ERNEST THOMPSON SETON is publishing a new work on North American mammals. Volume I has just appeared, Volume II is on the press and will be followed in turn by two more volumes. *Lives*, as the publishers call the book on the cover, is an edition de luxe in this its first appearance, de luxe in size and make-up, and de luxe in the exhaustive treatment and characterization of the text. *Lives* is the expression of a lifetime of study and observation, or better said, of many lifetimes of observation, because the author has drawn upon the records of every one who has had a contribution to make to the subject.

No book written by Seton could be dull or uninteresting. Known to a vast audience of readers as the writer of interpretative natural history, such as *Wild Animals I Have Known*, he has been remarkably successful. But to a smaller audience he has been long known as the author of technical life-histories of mammals. His *Life Histories of Northern Mammals*, which appeared in two volumes in 1909, has been one of the most complete and authoritative mammal works of its kind ever published. But excellent as are the *Life Histories*, they are surpassed by Seton's new publication, which must remain for many years as the unquestioned leader of an almost unique class, presenting technical data in a most readable fashion.

Volume I of *Lives* is devoted to the life-histories of the cats, wolves, and

foxes. Under this category are included fifteen mammals, and as the book contains 640 quarto pages there is excellent opportunity for an exhaustive treatment. The geographical range covered by the work is, roughly, the North American continent from the Rio Grande northward.

The author has endeavored to meet halfway the systematic naturalist and the taxonomist, the latter a naturalist entrusted with keeping the mammalian register or *Who's Who*, and hence one who regards a name as something sacred. Seton has gone over all of their literature and has selected enough to give the basis for a classification conforming to the best accepted practice and yet not obscuring the fundamental, outstanding facts with involved refinement of detail. For instance, he uses sketches of skulls to point out characters in classification. *Lives* would not serve, however, as a handbook for the layman to identify all of the subspecies and local geographic races. This is no great disadvantage, since on many of the ultimate determinations the authorities themselves fall out, and eventually such a situation becomes a matter of tweedledum and tweedledee.

Seton has had unrivaled opportunities for first-hand observations of mammals, but this has not satisfied him. He has read everything published by other men on the subject of mammals and has kept a file of records and references that is seemingly all-

¹*Lives of Game Animals.* Vol. I. By Ernest Thompson Seton. Doubleday, Page and Company, 1925.

inclusive. One of the most valuable features of *Lives* is the bringing together from hundreds of scattered sources of everything worth while on the point in question. The authors quoted include every one of the recognized authorities. In addition Seton reaches out to take in travelers' accounts, hunters' tales, and trappers' yarns. It requires a nice judgment to sift from such sources—from orthodox authority to ridiculous yarns—all of the intimate details of a mammal's life-history, because of the great gaps in the picture; and sometimes the hunter's tale may not be entirely fiction, or again a fact may have been passed down along authoritative channels until it is, to say the least, far from the original source, and probably was subject to revision in the first place. Seton's preface to his second volume of *Lives* (see page 583, of this magazine) indicates this sifting process.

Seton undoubtedly will be criticized because he has included in his descriptions of mammal behavior many stories and accounts only partly or not at all verified by scientific observers. These stories might be roughly grouped in two categories, those that are probably true and more or less supported by observers of unimpeachable standing, and those that are interesting if true, but quite likely not true in their entirety. The first group of stories can do no harm because they are fitted in with the testimony of others and the reader will not be led astray. The more dangerous, second type of story, is so handled that it will be misleading to very few readers. Seton introduces these accounts by calling attention to their unusual nature and by cautioning the reader that they may be unworthy of full belief, or should be considered only as very remotely possible. But

before the treatment of any mammal is completed, the author sets forth all of the facts and near-facts; he vouches personally for none of the latter but places them before the reader only in the attempt to make the picture as vivid as possible; the reader is to interpret the evidence for himself or, to come back to the simile of the picture, he has at his disposal highlights which he may place on the canvas if he believes that the subject can stand them.

Personally, I like to read the "stories" about the mammals, and I believe that, in the main, a good selection has been made. I feel that any criticism of the "stories" will lose most of its force when it is noted that the names of all our best American naturalists appear constantly throughout the text and when one realizes the responsibility they have assumed for the greater part of the life-histories. The "stories" are offered as suggestions and to cause observers to be on the lookout for confirmation.

Seton has developed his subject with a wealth of detail that overlooks no fact, however trivial. In the extracts from Volume II of the *Lives*, following this review, it will be seen how the author has planned his work and how indefatigable he has been in executing it. As an example of the fullness of description devoted to each mammal the first few pages of the life of the skunk are quoted. All of the common names are listed, the scientific name or names are cited, and a long column of various Indian names follows. Nowhere have the vernacular names of mammals been set forth as completely as in this work of Seton's, and if one is to popularize natural history it must be admitted that this is a feature of prime importance. The reader then

comes to an exact and detailed description of the mammal, and since this is taken directly from specimens themselves, it may be relied upon explicitly. Seton has avoided the more restricted point of view of the taxonomist or maker of species and subspecies, and treated his creatures as individuals of more comprehensive identities. This is the only possible method of approach for a work intended for the general public and, after all, the life-history and behavior of the mammal is about the same whether it be subspecies "a" or "b" or "y" or "z," but if it should differ in detail and the fact has been recorded, you will find that Seton has mentioned it in his *Lives*.

In describing the life of the cougar, a typical example from Volume I, Seton employs no less than thirty-nine major headings, with one hundred pages of text. The known geographical range of the cougar is given on a full-page map, and the host of topics under which the data is set before the reader includes such items as Primitive Numbers; Haunts; The Voice of the Cougar; Powers; Speed; Spring; When the King-Cat Goes A-Hunting; The Chase of the Cougar, etc. etc. Two hundred and twenty-four foot-notes direct the reader to authors and original sources, and indicate the extensive background upon which the text is based. At the close of the account a comprehensive bibliography is given, should the reader desire to pursue his study of the cougar yet further.

The author has been very fair in giving full credit to any writer whose work he has quoted. Solely on its merits as a source-book, Volume I must be rated very high. The "lives" are written to instruct, they have a serious purpose, and yet in spite of this handicap they are so readable that they

form a time-consuming reference book on mammals. I mean by this that when one turns to the book to check up some point of mammal behavior, he encounters such interesting reading that he lingers far beyond the point where his question has been answered.

Seton has had the benefit of a large board of special advisors. He has sent manuscripts for a critical reading to many of the leading mammalogists, and the list of names given on the page of acknowledgments shows to what extent his work is sponsored by those who have made mammal study their life work. No other work on American mammals can show so strong a backing for the author.

The accounts of the various mammals are well illustrated by photographs and by Seton's own sketches and drawings. The photographs are excellent, and while many have been taken by the author himself, a complete list of the photographers whose work appears includes many well-known nature photographers. But the most useful, and in some ways the best of the mammal portraits, are from the pencil and brush of Seton, who has long had the reputation of being one of our foremost mammal artists.

Seton chooses his poses carefully and all his mammals have character and the fidelity to life that is essential to successful mammal portrayal. The artist is so fully in sympathy with his subject that he has been able to catch with pen and pencil subtle expressions and postures which it would be impossible ever to photograph. There is a humorous, whimsical touch in Seton's pen-and-ink headpieces and tailpieces which makes them a truly delightful feature of the book. They are crammed with the salient facts of the mammal's career and may epitomize the whole

life-history, for all that they are meant in fun.

There are also a host of detail sketches which answer questions very frequently asked and too seldom answered by books on mammals. The tracks of the mammal are figured, and the shape of its paws, or any other particular structures that require special emphasis. Artists seeking to sketch mammals will find *Lives* an invaluable reference book because of the many figures which show the position of the limbs, manner of holding the head, carrying the tail, and so on.

Because Seton has always had such a great interest in wild life and championed every mammal that was threatened with popular disfavor, a strong plea for conservation runs all through *Lives*. He would have no mammal exterminated, and for the most predatory species, those whose destruction is demanded because of economic pressure, he makes out a good case on sentimental grounds. Where the odds are so heavily against the predatory species, it is comforting to the cause of conservation to meet an author with the convictions of Seton and to enjoy his facility of expression.

While this review has thus far conveyed the impression that no fault could be found with *Lives*, the publication is no exception to the rule that the work of man cannot be absolutely perfect. It is true, nevertheless, that the faults are, for the most part, obscure, and the good features are so predominantly conspicuous that it seems captious to utter destructive criticism.

Occasionally the photographs show signs of retouching but, while the print

may have needed such hand-work and no part of the scientific value would be lost thereby, the retouching has been poorly done.

Because of its large size *Lives* will be open to the criticism that will always greet a de luxe edition; the volume is too large to be handled comfortably if one wishes to use it away from the library table. It is greatly to be hoped that such a useful work will be brought out in an edition of smaller size.

To sum up, Ernest Thompson Seton has produced a book so predominantly superior as to be beyond comparison with any other work of like scope. To the non-scientific reader it offers authentic, authoritative data which goes just far enough into the technical to meet average needs and yet stops short of overwhelming detail and subtle distinctions; to the dyed-in-the-wool mammalogist, *Lives* presents a veritable encyclopedia and compendium of facts, —facts frequently asked for and facts difficult to ascertain, only to be gathered by long and tireless search in literature. As a source-book it provides in well arranged form a quick contact with hundreds of references and workers. For all readers of whatever station Volume I of *Lives* will prove interesting and instructive, fascinating, and thought-provoking, a book to consult and enjoy frequently, and a possession to be prized and desired.

The following pages will afford a better idea of the general plan of *Lives* than I can give in a review, but they, too, are inadequate to bring out the full scope of Mr. Seton's epic production, which must be seen to be fully appreciated.



“Lives of Game Animals”

BY ERNEST THOMPSON SETON

THROUGH the courtesy of Doubleday, Page and Company, *NATURAL HISTORY* has been able to secure from Mr. Seton the following excerpts from the second volume of *Lives of Game Animals*, now on the press. The manuscript and pictures were selected to illustrate some of the many good features of this monumental work on North American mammals, and the arrangement of text, et cetera, is as nearly as possible that of the published book. There is, however, no continuity of thought in the order of presentation. These excerpts may be considered, therefore, as sample pages of Volume II and serve to demonstrate the points brought out in the review of Volume I, pages 579–82 of this magazine.—THE EDITOR.

PREFACE

VOLUME II is done. It has been delayed through the abundance of material, the superabundance of ideas, new and sometimes incredible, that continued to arrive and demand consideration. Some have been included that are not in the line of modern thought; that is, of the established order. As light on their significance, I offer two incidents, —a history and a fable.

In England, about 1770, smallpox of a deadly type was rife. A dairy-maid, allured by the high wages, offered to nurse those stricken with the disease. When warned that she was risking her life, she replied: “I cannot take that disease; I have had cowpox.” This old wives’ tale amused the doctors, and they dismissed it with a laugh. But one of the younger men said: “Let us investigate before condemning.” He did so, and thus laid

the foundation of the whole modern school of prophylactic medicine. His name was Edward Jenner.

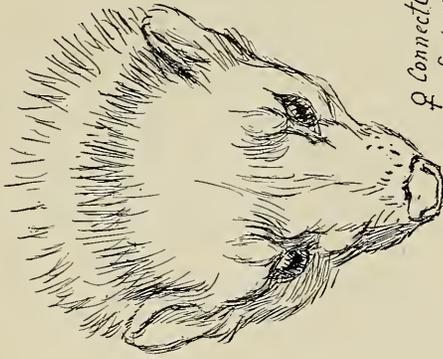
A venerable old man with a pen behind his ear, ink on his fingers, and a bag on his back, went up the main street of Humantown, calling out as he went:

“Lies! Any old lies today? Biscuits for lies today!”

He had a basket of sweet wafers, or biscuits, on one arm, and they were shaped like a human ear. These he was exchanging for the lies, that were very abundant in this town.

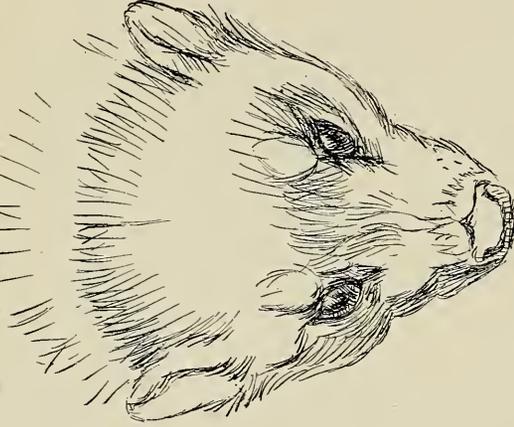
Most of the inhabitants freely gave them to the man; some even pressed them on him: but a few had to be repaid with at least a wafer. Very soon, the old man’s bag was full.

It was a new thing to collect lies, and many jokes were bandied about at the expense of the old man and his odd occupation.

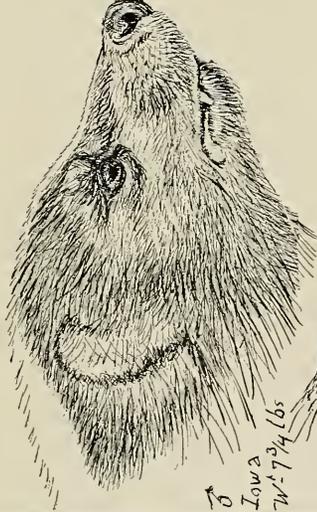


♀ Connecticut.
Sep. 1925-

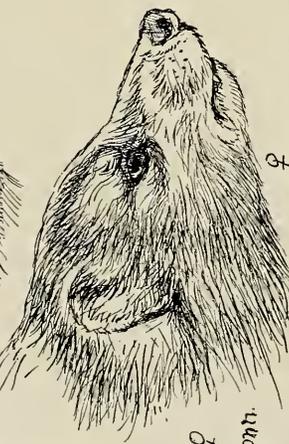
4 inches



♂ Iowa
3 Feb 1902



♂ Iowa
Wt 7 3/4 lbs



♀ Conn.

3 Types of Skunk.



Common Skunk



Hognose



Spotted

F.T.S.

Plate

The strange merchant left the main street, and a little child had the curiosity to follow him. The venerable one turned aside through a door into a beautiful garden in the very heart of the town, and yet quite unknown. He closed the door, but the child peeped through the keyhole, and saw the old man take the bag of lies and give it a good shake. There was a commotion and a seething inside for a time, and the mass seemed to be smaller.

"Ah, hear them eating each other

up!" chuckled the old man.

Another shake was followed by more commotion and another shrinkage. The collector's face beamed.

A few more shakes, and the bag seemed actually empty; but the old man opened it carefully, and there in the far corner, was a pinch of pure gold.

The child reported all these things, and the next time they saw the old man, the people demanded who he was. He answered:

"I am the historian."

LIFE XXVI—THE SKUNK

Common Skunk, Big Skunk, Alaska Sable, Black Sable, Striped Skunk, Smell-cat, Two-striped Skunk, Sachet Kitten, Mephitic Weasel, American Polecat, Big Polecat, Wood Pussy.

Mephitis mephitis (Schreber)

(*L. mephitis*, a pestilential exhalation.)

Viverra mephitis Schreber, 1776, Säugthiere, pl. 121.

Mephitis mephitis Allen, 1902, Science, n.s., Vol. 16, p. 115, July 18.

TYPE LOCALITY—Eastern Canada, i.e., Quebec.

FRENCH CANADIAN, *l'Enfant du diable; le Chinche; la Mouffette; la Bête puante*.
CREE, OJIB. AND SAUT., *Shee-gawk'*. In this, we see the origin of the word

"Chicago," meaning "Skunk-land."

YANKTON, SIOUX, *Mah-cah*.

OGALLALA SIOUX, *Mah-kah'*.

CHIPEWYAN, *Nool'-tsee-a*.

HURON, *Scangaresse* (Sagard-Théodat)

ABENAKI, *Seganku* (Rasles). The word "Skunk" is traced to the last two Indian words.

MEXICAN, *Zorilla*.

THE true Skunks belong to the Weasel Family Mustelidæ and to the subfamily Mephitinæ which is divided into three principal groups:

Big Skunks, genus *Mephitis* Geoffroy and Cuvier.

Spotted Skunks, *Spilogale* Gray.

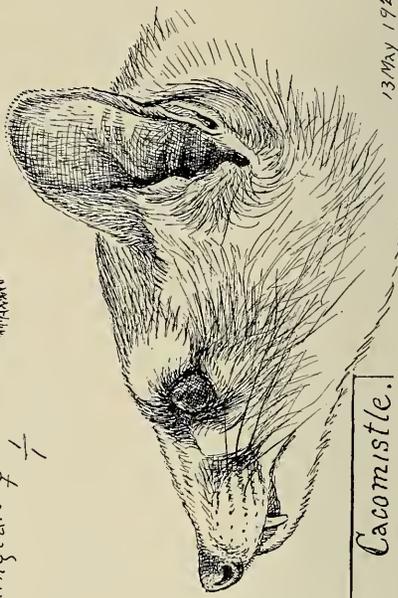
Hog-nosed Skunks, *Conepatus* Gray.

The genus *Mephitis* (Geoffroy and

Cuvier, 1795), are about the size of a common House-cat; have short ears, long fur, very large and bushy tails, are black in color, with a thin white stripe on the face and a broad one beginning on the nape, forking on the shoulders to reach to the hindquarters, or sometimes nearly to the tip of the tail; they are at least partly plantigrade, and have the foreclaws very

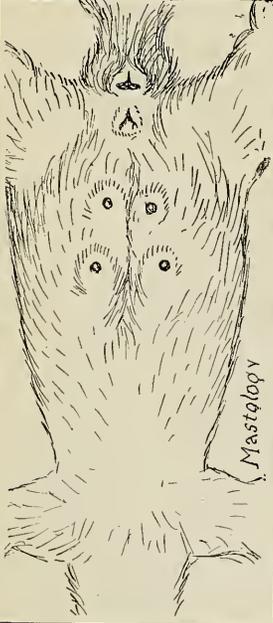


Ringtail ♀ 1

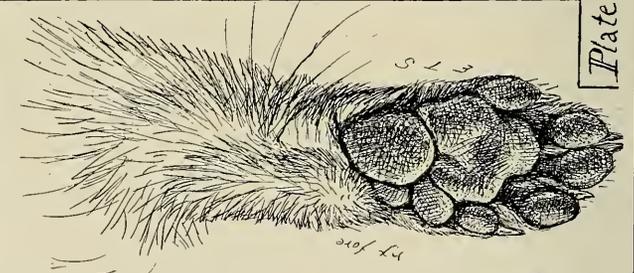


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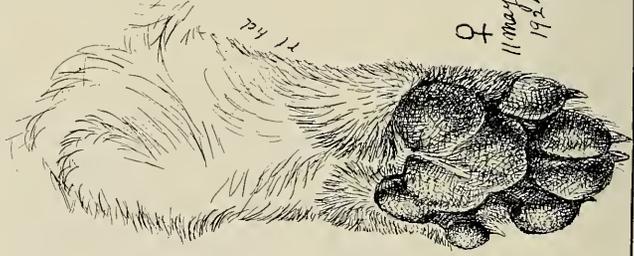
Plate *Cacomistle.*



Mastology



RF fore



RL hind

♀
11 May
1924

large and suited for digging; but above all, they have greatly developed anal glands which produce the liquid musk that they eject with such notable effect in self-defense.

The teeth are:

Inc. $\frac{3}{3}=\frac{3}{3}$; Can. $\frac{1}{1}=\frac{1}{1}$; prem. $\frac{3}{3}=\frac{3}{3}$; mol. $\frac{1}{2}=\frac{1}{2}=34$

In addition to these generic characters, the Skunk has:

Size. Length, about 28 inches (711 mm.); tail, $10\frac{1}{2}$ inches (267 mm.); hindfoot, $3\frac{1}{4}$ inches (82 mm.).

Weight. A full-grown male Skunk in my menagerie, April 25, 1925, weighed $5\frac{1}{2}$ pounds, a yearling $3\frac{1}{2}$ pounds, 7 females (*nigra*) respectively 4, 4, 4, 4, $4\frac{1}{4}$, $4\frac{1}{2}$, and 6 pounds. The last two were two-year-olds, the first five were yearlings. I have had several breeding females that weighed only 3 pounds.

A large male which I weighed in the Yellowstone Park, July 29, 1897, was $8\frac{1}{2}$ pounds; another, a winter specimen, taken in Iowa, weighed $7\frac{3}{4}$ pounds. In my menagerie, I have had several males that tipped the scales at 10 pounds. These were of the large Northern race *hudsonica*, and came from Winnipeg.

On October 2, 1883, while traveling on the prairies near Rapid City, Man., I shot an enormous Skunk who commanded me to "stop and go around." Alas, I had no means of accurately weighing him, but I was a strong young man at the time, and I know my hand holding his hind leg

(he was too long to lift by the tail), was tired out before I got him to the wagon two hundred yards away. I set his weight at 30 pounds. An old settler with me, a man accustomed to "hefting Hogs," said: "No, he don't weigh much over 20 pounds." These, of course, were "hunters' guesses," but I feel sure now that this old warrior was well over 15 pounds in weight; especially as I note Allan Brooks says of the British Columbia Skunk (*spissigrada*), during the salmon run: "They then get very fat, the ordinary weight of an adult then being 10 to 16 pounds." (*Recreation*, June, 1900, p. 434).

At birth, they weigh about half an ounce, and at eight weeks, $1\frac{1}{2}$ pounds.

Color. General color black, with a thin stripe down the face between the eyes, and the usual white patch on the nape from which a broad white, or creamy white, stripe goes back to the shoulders, where it forks and continues along the sides into the tail, which is of black hairs with white bases, and ends usually in a white tuft or pencil. There are endless individual variations, especially in the length of the back stripes.

Their *black and white color*, with their size, their slow movements, and their *immense bushy tail*, usually held aloft, will distinguish the true Skunks from any other animals found in North America.

Brown or cream-colored freaks of most kinds of Skunks have been found.

LIFE XXV—THE RINGTAIL

NELSON sums up its food habits thus: "Like its relative, the Raccoon, the Cacomistle, with a taste for a varied fare, takes whatever edibles come its way. It stalks

Wood-rats, Mice, and even Bats in their rocky haunts, and birds in bushes and low trees. About the southern end of the Mexican table-land, it is much disliked for its robberies of

chicken roosts, especially when these are located in trees. Insects of many kinds, larvæ, and centipedes are eaten, as well as a great variety of fruits, including that of the pear-leaved cactus, and dates, figs, and green corn." (W. A. N. A., p. 587). In amplification of the last, he says:—"Ring-tailed Cats regularly locate among rocky ledges, neighboring orchards, or other cultivated areas where they may gather some of the bounty provided by man. I found them more plentiful among the broken larva cliffs bordering date-palm orchards in Lower California than in any other place. When the dates were ripening, they prowled about under the palms after dark, with gray Foxes and Spotted Skunks, to pick up the fallen fruit." (W. A. N. A., p. 587).

The captives in my menagerie would eat any sort of meat or sweets. Dates and figs were especially acceptable. Sugar in any form, they would devour with avidity.

HIS WAY OF LIFE

What should it be for a creature that is a cross between a Coon and a Fox, with the fur of a Flying Squirrel? Dull and lethargic he may be during the heavy hours of sun heat, that all wise creatures give to sleep; but when the twilight has given place to the gloaming, and the gloaming to black dark, this bright-eyed, playful, nimble child of the high-holes, peers forth from his safe retreat, swings slowly at first like a Coon; then limbering up, he begins to leap and scramble like a Squirrel. His great ringed tail is swinging squirrel-fashion, as he courses up long, sloping limbs, or makes a flying leap across a five or six-foot space; and one wonders if it does not answer as a parachute in case of a fall.

At the slightest promising sound of bird on roost or in nest, or of catchable young Rabbits in the undergrowth, he freezes. Still as dead he holds, but every line and fiber of his make-up is tense with life and pent-up energy. The beautiful animalism of his whole body finds fit expression in his face. All who have marked those big liquid eyes, the mobile snout, the alert expression of the visage, are enthusiastic over its beauty and look of bright intelligence. Even the ears, so little moved in some creatures, are full of expression in the Ringtail; while the long, black, abundant whiskers do their part as vibrant feelers, and as features that show something of the little mind within.

His nightly prowls must be sometimes through the tree tops also, for he gathers the "high simmons" where they hang. But he is also much on the ground, for there are found many of his favorite foods; and there next morning, we find his endless chains of trail.

Though so nocturnal, the Ringtail has a sunlight habit that all the wood-wise indulge in from time to time as a tonic,—that is the periodic sun bath.

"Sometimes," says Audubon, "the Ring-tailed *Bassaris* may be seen squatted on the top of a branch, basking in the sun, and half rolled up, appearing almost asleep. On the slightest manifestation of danger, however, he darts into his hole (which is always within a foot or two of his basking place), and he is seen no more." (Q. N. A., II, p. 317).

A final paragraph by Audubon gives an entirely new chapter of the Ringtail's life, emphasizing as it does, the Squirrel side of its nature, and showing that it must be much less strictly nocturnal than the previous observations might lead one to suppose.



A. Grizzly

B. Brown-bear

C. Blackbear

E.T.S.

Plate Tracks. A Grizzly. Yellowstone Park, Sep. 7, 1912. B. Kodiak Brown-bear. Washington Zoo. C. Blackbear. Athabaska River, Sep. 30, 1907. The chief differences are in size; also the Grizzly often shows claws.

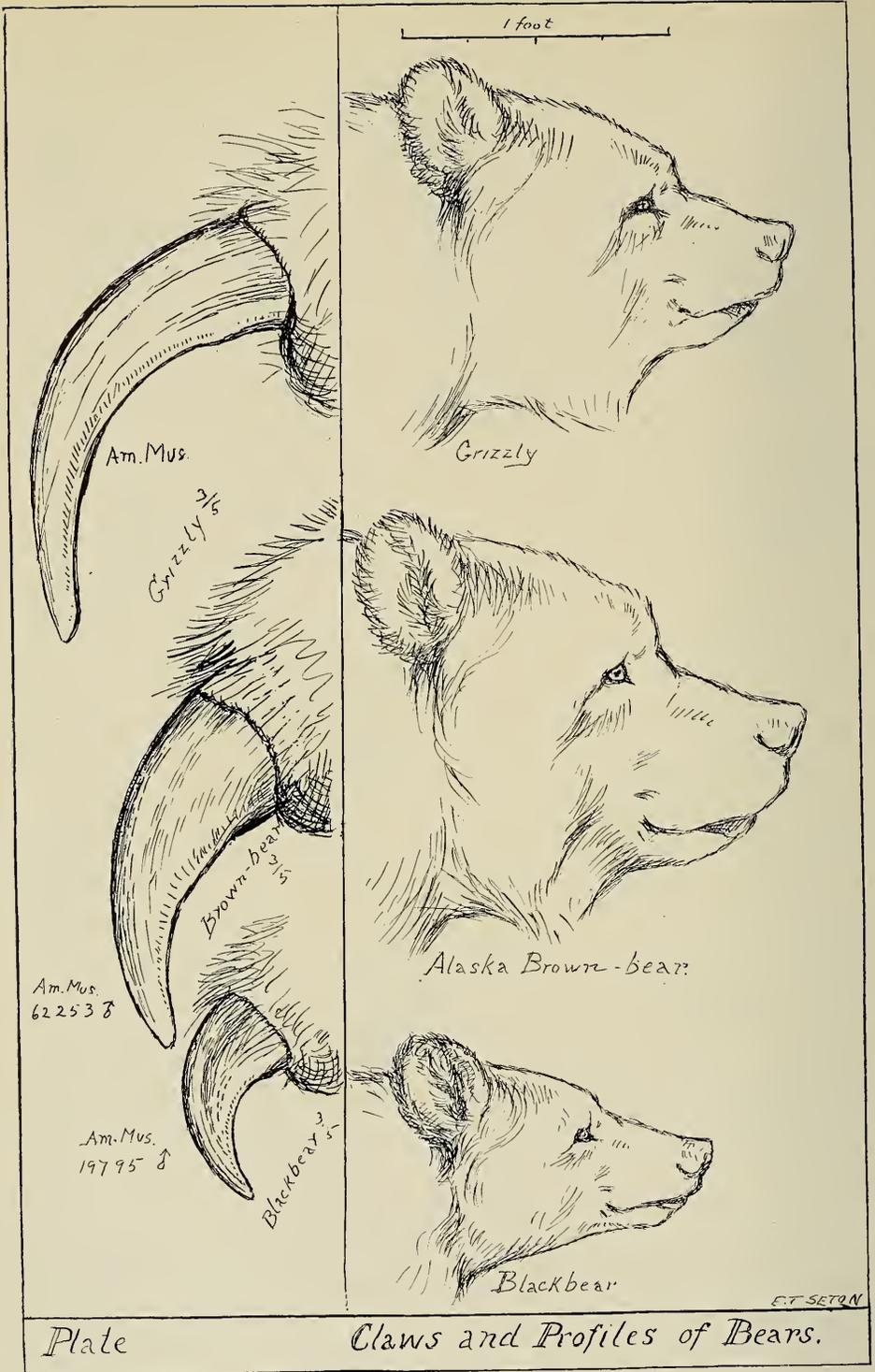
LIFE XVI—THE GRIZZLY

NEVER ATTACKS MAN

Notwithstanding the sinister reputation that has won for him the names *horribilis*, *grisly*, *ferox*, etc., the Grizzly, according to all the best authorities, never attacks man, except when pro-

voked. That is, he is a harmless, peaceful giant, perfectly satisfied to let you alone if you let him alone.

Even in the palmy days of the West, when he was the unquestioned monarch of the range, trapper and cowboy



Plate

Claws and Profiles of Bears.

knew right well that they need only exercise a little self-restraint, show some decent courtesy to this big dignified giant in the fur cloak, and they need not fear but that he would respond.

In their first recorded meeting with the Grizzly, Lewis and Clark say: "Those we had seen did not appear desirous of encountering us." (April 29, 1805). In the course of their journey, they had about a dozen encounters with Grizzly Bears. In each of these, with the possible exception of two, the Bears were peacefully disposed until attacked. The two cases are discussed later.

In 1820 Major Stephen H. Long wrote: "Notwithstanding the formidable character of this Bear, we have not made use of any precautions against their attacks, and although they have been several times prowling about us in the night, they have not evinced any disposition to attack us at this season." (Exped. Rocky Mts., 1823, II, p. 57).

In the early 40's Rufus B. Sage, the Rocky Mountain hunter, wrote of the Grizzly that he knew so well: "He will almost invariably flee at the sight or scent of man, and seldom attacks anyone unless wounded. When shot, he generally runs at full speed towards the sound, and woe to the unfortunate hunter who then comes in his way, unless fully prepared for a deadly encounter." (*Rocky Mt. Life*, 1857, p. 156).

About the same period, there was in California an old-timer named Walter Colton. He was a man of power, and for three years was Alcalde of Monterey. He left a journal of his term in office under the title *Three Years in California*. His opportunities of seeing game were unlimited, and under the heading of "Friday, December 11, 1846," is the following:

"The Grizzly Bear is the most formidable and ferocious animal in California; and yet, with all this ferocity of dispositoin, rarely attacks a man unless surprised or molested. The fellow never lies in wait for his victim. If the hunter invades his retreat or disputes his path, he will fight, but otherwise contents himself with the immunity which he finds in the wildness of his home and the savage grandeur of his nature."

Sir John Richardson says of his assistant, Thomas Drummond, who was the botanist on the Second Franklin Expedition, and made an important side trip to the headwaters of the Athabaska:

"Drummond, in his excursions over the Rocky Mountains, had frequent opportunities of observing the manners of the Grisly Bears, and it often happened that in turning the point of a rock or sharp angle of a valley, he came suddenly upon one or more of them. On such occasions, they reared on their hind legs and made a loud noise like a person breathing quick, but much harsher.

"He kept his ground without attempting to molest them, and they on their part, after attentively regarding him for some time, generally wheeled round and galloped off, though, from their known disposition, there is little doubt but he would have been torn in pieces had he lost his presence of mind and attempted to fly. When he discovered them from a distance, he generally frightened them away by beating on a large tin box, in which he carried his specimens of plants. He never saw more than four together, and two of these he supposes to have been cubs; he more often met them singly or in pairs. He was only once attacked, and then by a female, for

the purpose of allowing her cubs time to escape. His gun on this occasion missed fire, but he kept her at bay with the stock of it, until some gentleman of the Hudson's Bay Company, with whom he was travelling at the time, came up and drove her off." (F. B. A., I, pp. 27-28).

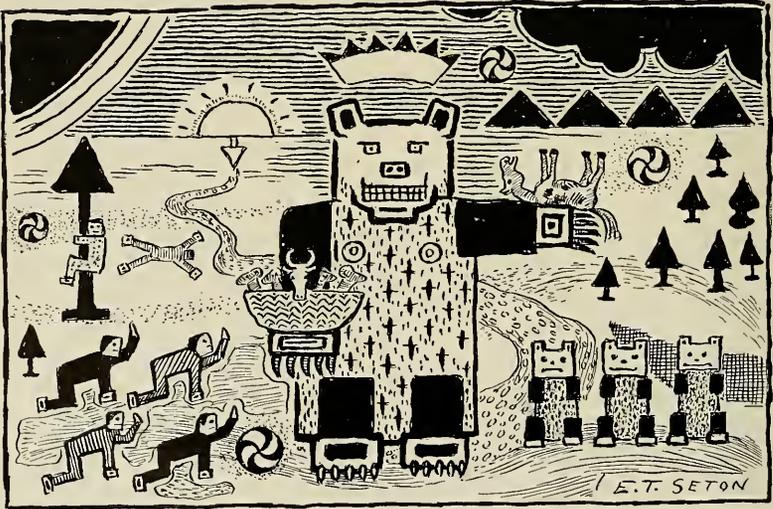
W. H. Wright, of Grizzly fame, writes: "Twenty-five years of intercourse with these beasts has taught me to regard them with the most profound respect. . . .

"I have never found him the ferocious, ill-natured brute that he has the reputation of being." (Grizzly Bear, p. 233).

On another page he tells of his hunting partner, Jack D. O'Brien, finding himself being watched by a Grizzly with three yearling cubs. His Dog

barked at them, thereby provoking a fight. The mother Bear charged and fought till she and the family were killed.

"This is the only instance," he says, "that I have ever known personally where a Grizzly attacked a man without provocation, and in this case I lay it to the Dog. The Bear was an old one with three yearling cubs; and the presence and barking of the Dog were naturally offensive to her. And as the cubs and the Dog were doubtless the reasons for her unprovoked attack upon the man, so also the cubs and the Dog proved his salvation. For the Bear left him again and again and returned to interpose herself between the barking Dog and her cubs, which had not crossed the creek." (Grizzly Bear, p. 93).



An Unusually Fine Example of Beaver Industry¹

By IRA A. WILLIAMS

Consulting Geologist, Portland, Oregon

I HAVE long harbored the desire to see a beaver at work. The industry of this little animal, though well known and frequently commented on, is so out of the ordinary that such an ambition may not seem widely out of place even in one whose professional interests lie in a quite separate field of science.

Evidence of the presence of beavers in the Pacific Northwest, while no longer widespread, is nevertheless still plentiful in many places. Along many of the streams that flow westward from the Cascade Range of mountains in Oregon, beaver cuttings and their trails are rather common features. Their ponds, dams, and houses are less frequently seen.

While on a geologic reconnaissance in the upper reaches of the Clackamas River in the summer of 1924, some thirty miles southwest of Mount Hood, it was the almost ever present evidence of beaver that once more aroused, and to an unprecedented pitch, the smoldering longing to observe one, or a colony of these animals if luck should so prevail, at their daily tasks. That fortune should swing my way to that extent was scarcely to be contemplated, neither was the time available to seek out their haunts leisurely as would be the method of the accomplished naturalist. But it was mine to take things as they came, and though I failed to realize the ultimate height of my yearning, the accompanying photographs will perhaps testify to the nearness to which the coveted goal was approached.

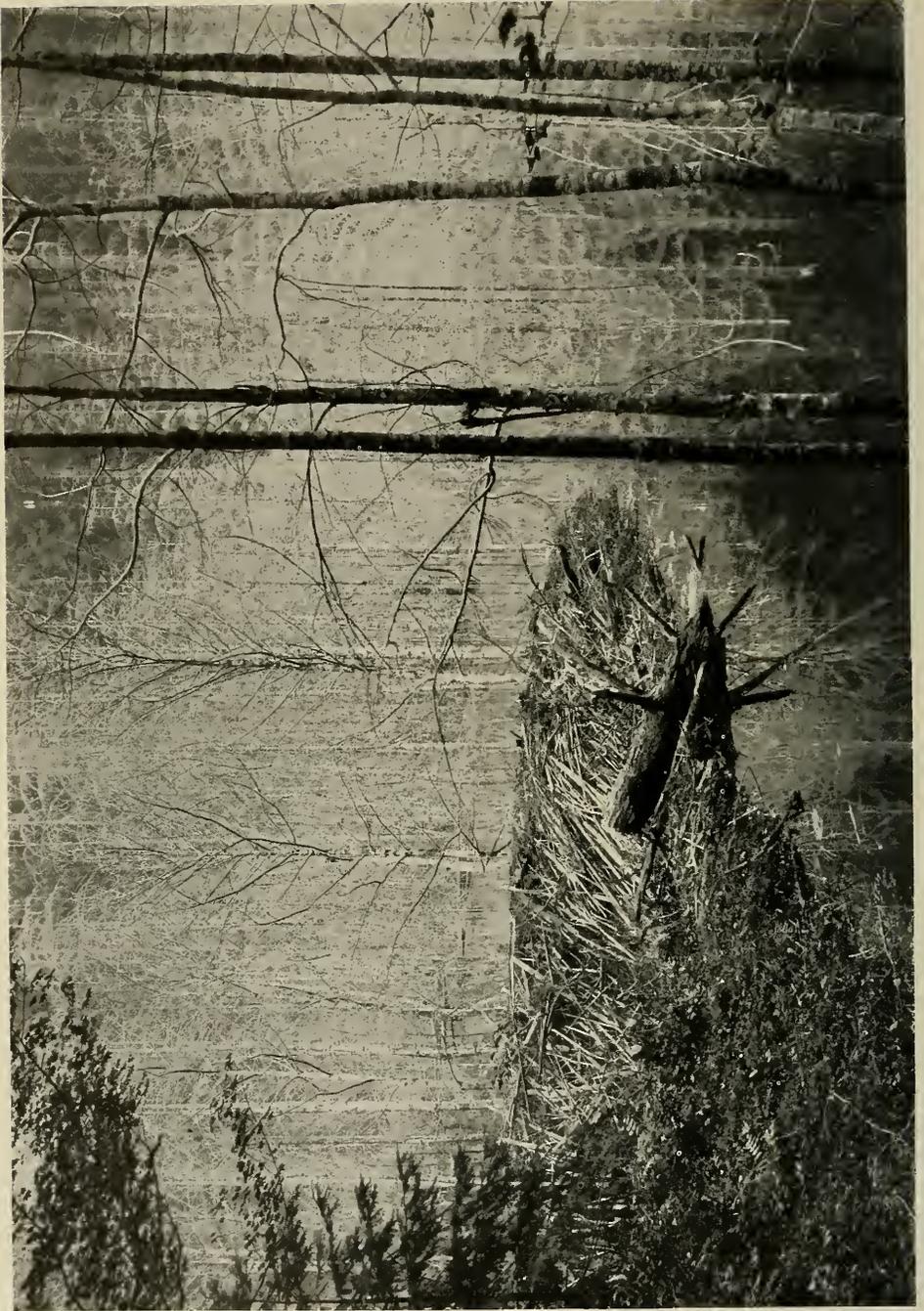
Our pack train left us on a late July day just above the union of the Oak Grove fork with the main Clackamas River, for the investigation of a stretch of morainal country.

It was during the course of our meanderings among indiscriminately spaced knobs of basalt, across glacial ridges and interspersed meadows or boggy flats, that we, Fred, Lloyd, and I, first came upon this most interesting example of beaver activity. It appeared at first sight but an open space within the forest, surrounded by a wide fringe of thickly set but lifeless firs and alders, many of the former from forty to fifty feet or more in height. Scarcely a second glance was necessary to note, however, that to the limit of this border every one of the dead trees stood with its roots submerged in water. Within this fringe, water was seen to cover an open area several acres in extent.

So obviously peculiar was this state of affairs that it could not but attract the attention of even one bent on the study of as practical a problem as the essentials of a water-power site. Here, to all appearances, a storage project had been brought into being very recently. For it so happened that Fred had, in summers past, many times pastured his saddle- and pack-horses in this very same forest opening, where what was now water had hitherto been a flower-besprinkled meadow of good grazing ground, lengthwise of which a small stream meandered its way.

Our first thought was naturally of the beaver, and we came at once to a

¹Photographs by the author.



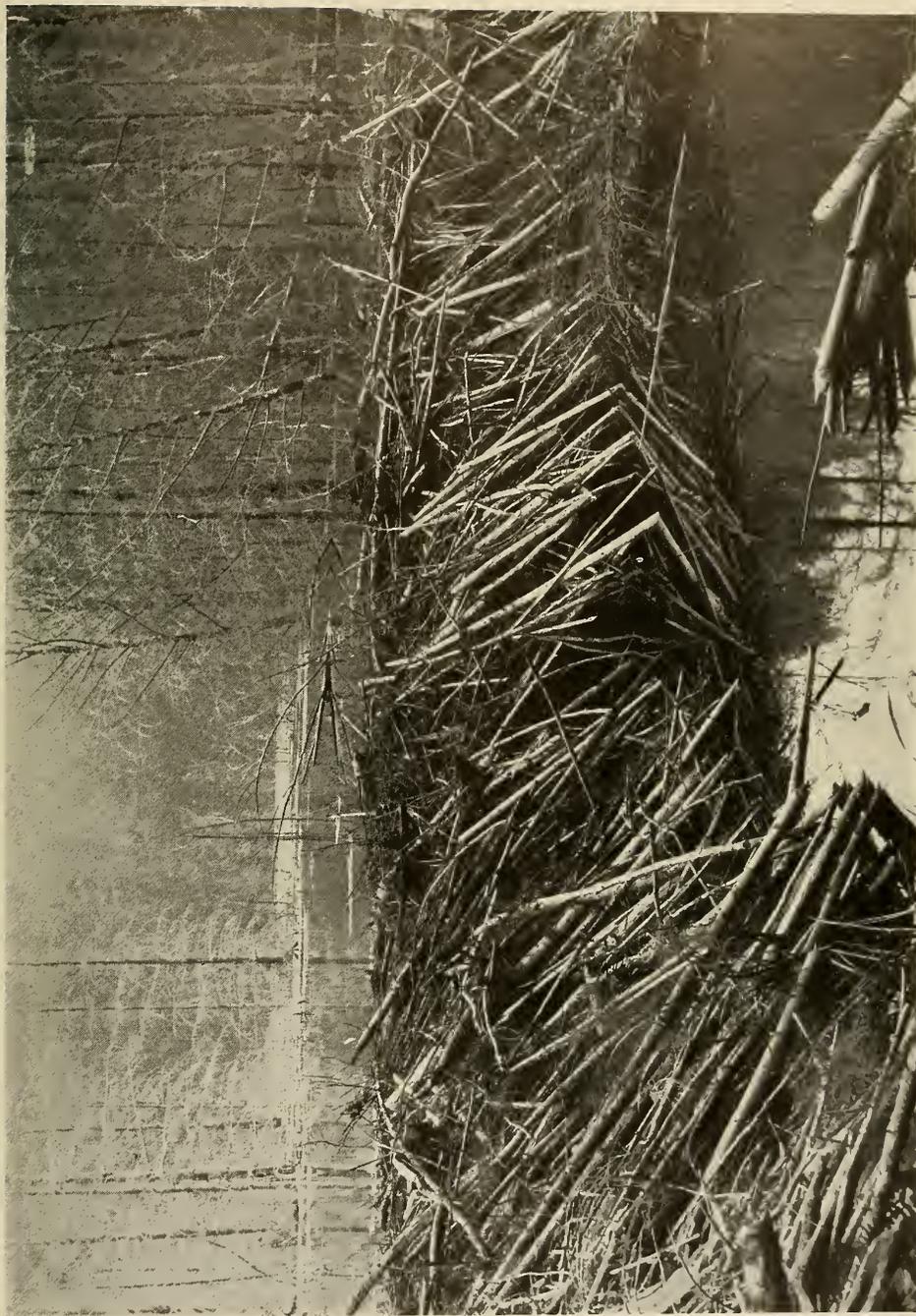
FROM EAST END OF DAM



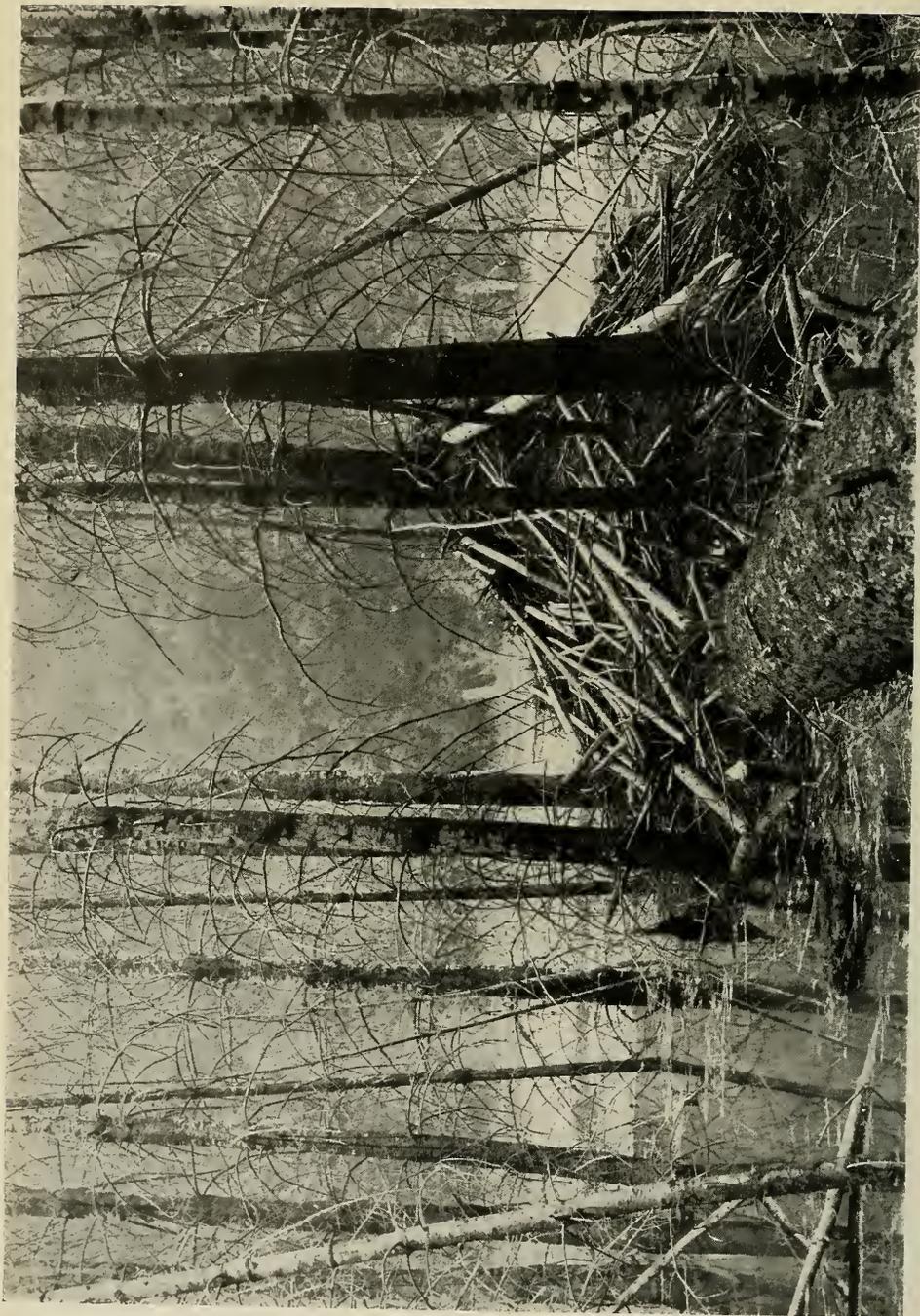
LAKE, AND DAM FROM WEST END



MAIN DAM AND ONE AUXILIARY DAM FROM BELOW



THE ARCHITECTURAL JUDGMENT OF THE BEAVER CANNOT BUT BE ADMIRERD



THE BEAVER HOUSE STOOD FORTY FEET OUT IN THE LAKE. TOWARD THE SHORE THE WATER WAS ABOUT EIGHTEEN INCHES DEEP BUT TOWARD THE CENTER OF THE LAKE IT WAS FOUR AND A HALF FEET DEEP

dam, thrown across a narrow break in the basin's rim through which the outlet had formerly flowed. No one having followed the progress of the dam's construction, it is of course not possible to say how rapidly it was built. Its appearance of newness and the evidently recent fateful rise of the water among the firs, made one feel that its beginning could not have been longer at the most than a couple of seasons prior to our visit.

That the members of this beaver community must still be there went without saying. Neither the manner of our coming, however, nor the lateness of the day, favored our catching a glimpse of any of them, even if they were at home. So with but a hurried casual inspection we passed along, away from this nucleus of beaver land, with the resolve to come again soon, when our movements might be so planned beforehand that the beaver, wary animal though he is, would be quite unwarned of our approach.

It was the afternoon of July 26 that we managed to come this way again. Cautious as we were, and with cameras prepared for whatsoever opportunity might arise, no sign of a ripple broke the quiet of the beaver pond. We were compelled this time, as before, to be satisfied with what could be seen of the works of this genius of the forest world.

So we trained our films first upon the main dam along whose crest we had walked a few days before. The structure is beautifully curved upstream, its top five and one half to six feet above the shallow water at its lower side. Its full length around the curve, abutment to abutment, is a little short of one hundred feet. The waters of the new-made lake stood four and one half feet deep against its upper side.

The architectural judgment of the beaver in design, if not his particular engineering skill in construction, cannot but be admired. Here were three dams across the same small outlet stream, the major structure against whose upstream face pressed the impounded water of the open pond, and below it two auxiliary dams both incomparably smaller in all dimensions. Aside from the question of size, however, I could not but ponder over the fact that the curvature of both of the smaller ones was just the reverse of that of the main dam. That is, their concave instead of convex side was faced in the upstream direction.

The first auxiliary dam, shown in the photograph, was about two and a half feet high, and backed the seepage water as a small pond against the toe of the larger one. The second, yet farther down stream and of still smaller size, bore a similar relation to the middle dam of the three. These two accessory structures are in each instance obviously measures of protection against possible erosion and undermining by leakage through, or the flow of water over the dams, for no spillways were in evidence, or other recognizable safeguard against times of flood.

The three dams were made entirely of peeled sticks, mostly poles of fir, alder, and poplar, the longest as much as six or eight or even ten feet in length. These were freshly cut as though felled recently at and near the site. What, if any, might be the system or plan of arrangement of these materials of construction within the body of the dams could, of course, be told only by the partial demolition of one of the structures. This thought or desire, however, never came to mind.

It could be seen from the exterior

that these sticks and poles were mudded together, and plastered on the upper side with a mucky soil which had been lifted from the adjacent bottom of the pond. It was not a perfectly water-tight job, for trickles were coming through the main dam here and there at all levels, in total amount apparently ample, at this time of the year, to maintain a *status quo* in the level of the big pond against its upper face.

It would be of interest to know whether by constructive skill or vigilance on the part of its builders, or by other means not disclosed, a similar degree of control is exercised over the movement of the waters in other seasons of the year. Nothing is seen to indicate that such may be the case. Nevertheless, in every feature of his work the beaver is acknowledged to be so ingenious an animal, that to leave subject to even an element of chance the possible destruction of this nucleal structure on which the peace of his entire community depends, seems not in keeping with his reputation for sagacity and foresight.

Some day we shall learn, we hope, what provision is made for such an emergency. Perhaps in case of threatened or actual damage to his works, this animal depends alone upon an indefatigable industry to thwart disaster. And if destruction comes, he may do as humans do, rebuild, or cast about for a more propitious site on which to found a structure more substantial than the old.

And the beaver house? We had nearly given up before we found it. In the main pond some two hundred yards up from the dam it was, forty feet in from the water's edge among a sizable stand of drowned firs and hemlocks. Leading to it from the shore was a large down-fir which may, one might

imagine, have served for the busy carpenters who built it, as it did for us, as a pathway along which to come and go. Being semi-aquatic in their nature, however, it is more likely that even this seemingly convenient log would be to them an obstacle rather than a help in bringing into place the materials of construction.

This beaver house was made of miniature peeled logs, twigs, and sticks, held in place by a plastering of mud, upon which among the final layers of thatching some green sod had managed to make a start. It was conical in outline and built symmetrically around a standing fir which rose as the center-pole of a tepee, out of its very apex. The water on the shoreward side, in August, stood eighteen inches deep above its base, while the greatest depth was four and one half feet toward the open part of the lake.

No life was seen about this place of residence, though in its environs were abundant signs of its immediate presence. Much-used beaver trails led to the water from the surrounding slopes in many places. Newly-felled trees were plentiful along the shores, many of them entirely too large to be moved on land, yet well above the highest high-water line. Some were only partly cut, then obviously abandoned; others were yet alive, at which the beaver ax-men were still engaged.

But amidst all this evidence of beaver activities, and while the camera was deliberately trained upon their works, not a rustle of the shrubbery or ripple in the water gave sign that our visit was recognized, not to say a welcome one. Neither was there token of resentment, though we cautiously and respectfully stood upon the roof of the house in which they dwell, sounded quietly the depths of

the pond in which they play, and walked carefully from end to end their dam, the nucleal feature of it all.

Our methods certainly could not be likened to those of one who is fully familiar with the habits of the beaver in his home, regardless of our innermost desires and expectations. I conceive

that such a person might have shown us, at this very time, the object of our longing. As it was, however, we were destined to depart not completely satisfied, it is admitted, but with camera records well worth while, and the thrill of a yet unrealized desire whose fulfilment must await some future day.



Falls of the Clackamas River



The grass lands at Metto, an oasis in the bleak lava fields of Danakil where herds of milk camels, goats, and sheep feed on its borders. It is bounded on the north by monumental "ant" houses ten and fifteen feet in height

Through the Land of Sheba

By BARNUM BROWN

Associate Curator of Fossil Reptiles

ABYSSINIA, although but a fragment of ancient Ethiopia, is one-tenth the size of the entire United States and is one of the few remaining world empires. Centralized on mountainous highland plateaus of forbidding approach, surrounded by desert and sea, its self-contained people, approximately 8,000,000 strong, have for centuries remained cut off from contact with the outside world, where they have perpetuated a civilization that found inspiration in Solomon's court.

And it bids fair to remain an empire with Egypt at its back and flanked to the eastward by a fringing seacoast equally divided among British, French, and Italian possessions, each jealously protesting any encroachment upon the hinterland of the other. Lying wholly within the tropics, chiefly between 5° and 15° north latitude, its nearness to the equator is counterbalanced by the elevation of the highlands, so that the climate ranges from cool temperate on the plateaus to torrid in

the desert in Dankaliland and the Haud of Somaliland.

In early times there was an intimate relation with Egypt and an extensive commercial intercourse with the Hebrews. According to tradition, the Queen of Sheba, who visited Solomon, ruled Ethiopia and from their son Menelek (second self) subsequent rulers have claimed descent. But the ruler in many cases has been recognized through force of arms rather than through purity of lineage, since during the last three hundred years the country has been composed of several provinces, each ruled by a feudal chieftain, some of whom have at times overlorded all.

Christianity was adopted about 330 A. D. and the country reached its greatest expansion in the sixth century, after which it gradually contracted through aggression of the Mohammedans until, as Gibbon says, "encompassed by the enemies of their religion, the Ethiopians slept for nearly 1000 years, forgetful of the world by whom they were forgotten."

Subsequent to the general invasion of northern Africa, followers of the Prophet encroached upon Ethiopian territory and mingled to a large extent with the Christians, especially in the lowlands where they are now dominant.

The outstanding figure of Ethiopian history is Menelek II, a leader of exceptional ability and a man in sympathy with the progress of the outside world. His name is recalled throughout Abyssinia today even as we speak of Washington.

At the death of King John (1889) Menelek proclaimed himself Negus Negusti (Emperor, King of Kings) and to his court most of the great powers sent representatives. During his reign Abyssinia developed slowly and became a crystallized, unified government, though functioning quite differently from any other modern government. In 1909, while the Emperor was seriously ill, his grandson, Lij Yasu, a boy

of thirteen, was publicly proclaimed Menelek's successor.

The exact date of Menelek's death, some time in 1913, is unpublished, as are many other facts in this land of intrigue and feudal chieftainship. Lij Yasu was said to be a handsome, daring youth beloved by his people, who thought him an ideal successor of Menelek, but serious thought of his position and responsibility were secondary to him at this time. His advisors were not of the best, and during one orgy he was photographed in Mohammedan costume. This evidence was sufficient, with the aid of "Dame Rumor" and intrigue, to establish him as a full-fledged Mohammedan whose thoughts were of conquering the world for Islam. Such a thing was intolerable in a Christian country and Lij Yasu was outlawed. It is true that a large number of Lij Yasu's followers from the lowland countries were Moham-



The Regent Ras Tafari, foremost mounted figure and Queen Zaoditou surrounded by armed retainers as they entered Adis Ababa, returning from a religious pilgrimage to Mount Entoto



Eucalyptus-bordered street in Adis Ababa, with the palace buildings in the distance

medans, but his best fighting chieftains were Christians.

Among the opposing Christian chieftains Ras Tafari, Prince of Harrar, was chosen leader. He wisely refrained from proclaiming himself emperor and rallied the people to fight for Zaoditou, Menelek's daughter, to be made queen, Ras Tafari to be regent and inherit the throne after her death. Two bloody battles were fought, one by mutual agreement on a plain outside the capital to avoid destruction of buildings, a battle where men fired one round, threw away their guns and fought with swords, and at the conclusion of which, four thousand lay dead on the field. In both battles Lij Yasu's followers were defeated and he himself was driven into Dankaliland. In 1924 he was captured and imprisoned near Adis Ababa. And so we reach the present day when Abyssinia is actually ruled by a triumvirate, the Queen Zaoditou, the Regent Ras Tafari, and the *Abuna*, or Archbishop.

Although the latter does not appear in government affairs, his opinion is equally expressive, for it is backed by many thousands of rifles.

The Abyssinians are of mixed Hamito-Semitic stock, in general a well-formed, handsome people with regular features, straight or kinky hair, according to admixture of negroid blood, and in color range from pale olive to sooty black. Slavery by purchase or capture is practised throughout the country, which accounts for considerable of the mixed blood, but the highland people resent any statement that they are not of the Aryan race and, since defeating the Italian army at Adowa in 1897, appear rather haughty to the white residents. Among the better classes civilities are courtly, verging upon ostentatiousness. One comes away from Abyssinia feeling that he may have visited descendants of one of the lost tribes of Israel.

The language, like the people, is of mixed Hamitic-Semitic origin. State

documents are written in Amharic, while Geez is used by the priests, and the spoken tongue consists of dialects of the old Hamitic language.

The Abyssinians are an agricultural people who, because of burdensome taxes which impoverish the industrious, produce only sufficient crops to sustain the family. Land is not held in fee simple, but is subject to the control of the State or Church.

I might say that fighting is a pastime, for every man is a potential soldier ready to take rifle and leave his field at a moment's notice. In general a feudal system is followed, and each officer contributes his given quota of men to the army.

Farms are usually of small dimensions, without fences, and cultivated areas extend far up on the mountainsides where the terraced plots cling precariously to the highest peaks. Indian maize and barley are cultivated extensively where soil and conditions are suitable. Teff, a kind of millet, is indigenous and takes the place of wheat in many sections. The grain is extremely small and when ground into white flour is very palatable—cooked usually in thin cakes like American pancakes. In the temperate lowlands, in places particularly suited to it, cotton is an important crop, for this country is free from the boll weevil. Coffee of superior grade is grown extensively in some parts; in fact, the coffee plant probably originated in the province of Kaffa.

In the highlands there is a considerable variety of fruits which, like the domestic animals, could be greatly improved by cultivation, but Abyssinians do not care particularly for fruit. The people usually live in small villages surrounded by stockades, and one rarely sees individual houses scattered over the landscape.

Their legal system is based upon the Justinian Code and the principles of the Mosaic Law are chiefly followed, but with right of appeal to the Emperor. For murder the death penalty is exacted, and in the market place of Adis Ababa there are several favorite



Abyssinians are decidedly argumentative and most questions of minor nature are settled at wayside courts to which all comers are eligible

trees where it is not unusual to see three corpses hanging, each with a placard below stating the crime and the reason for execution.

For conviction of theft an offender is fined. If guilty a second time he is fined heavily and warned of drastic punishment. If thrice convicted he is taken to the market place, where his right hand and left foot or his left hand and right foot are cut off. A witness of this terrible punishment may not aid the offender, or he too is equally guilty. Strange to say, some recover and regain their standing in society.

The Abyssinian church agrees in general with the Monophysite Copts in ritual and practice. Saints and angels are revered, but graven images are forbidden. Fasts are rigid. The Monophysites believe that Christ was one person, with one nature made up of an indissoluble union of a divine and a human nature, but that these two natures remained distinct, unfounded and separate though insepar-



The market place of Adis Ababa fascinates the visitor with its varied assortment of wares brought together from distant places. Old bottles, bits of iron and much used clothing are quite as important as black leopard skins, ivory and grain

able. On all other points of dogma the Copts agree with the Greek church. The *Abuna* or archbishop, is appointed from Egypt. The churches are usually circular in form, although in Tigre they are square or oblong, and for the most part the arrangements are based upon Jewish traditions.

The country has potential possibilities in agriculture but not for foreign development, and mineral resources likewise are difficult to develop under prevailing ideas.

An investigation of mineral resources afforded me the opportunity to travel over a considerable part of the coun-



Coptic priests dancing before the ark seen just in front of the tent. This ceremony is a yearly religious festival of great importance. On the hillside may be seen a native village

try when, granted a year's leave of absence from the Museum, I joined the "Dudley Expedition" to explore Harrar Province, and, thanks to the generosity of the Directors of the Anglo-American Oil Company, the American Museum secured an extensive collection of invertebrate fossils and ethnological and herpetological material from new or little-known areas.

From the Red Sea port, Djibouti, in French Somaliland, to Adis Ababa, the Abyssinian capital, is a journey of 500 miles through desert and lava fields on the plains and through picturesque mountain scenery as the highlands are approached—a journey that lasts two days, for the trains do not run at night.

Following the usual mistaken custom of organizations that visit Ethiopia, the Dudley Expedition bore rich gifts to the rulers—a diamond necklace for the Queen, an electric-light plant for the palace, diamond watches, gold watches, a cinema, and smaller gifts for the chieftains. Isay "mistaken custom" because frequently such gifts arouse the suspicion of the rulers. At the presentation I am sure that Europeans smiled as our party rode to the (Gibby) palace—men in full evening dress astride donkeys under a hot midday sun!

Hordes of spectators lined the roadsides, as curious to our eyes as we were to theirs. The gates opened upon other throngs of white-draped figures, and finally we were ushered into the royal presence. Queen Zaoditou was seated amongst cushions and muffled to the eyes, Prince Regent Tafari seated near

by. Ministers, officers and diplomats standing filled the room, making a picturesque, thrilling scene never to be forgotten. This was the official presentation, with many speeches and much salaaming. I rode away feeling that I had participated in a chapter from the *Arabian Nights*. Other audiences followed in which business was discussed, but it is extremely difficult for an Abyssinian to commit himself definitely, and an



Among high types of Abyssinians the women are completely covered by a loose flowing toga-like drapery of white cotton sheeting. The men are usually barefooted and wear white cotton-sheeting trousers. The heavy black native wool poncho coat is worn in the highlands, and during rain storms the peak above the left shoulder is drawn over the head

agreement which could have been consummated within an hour elsewhere required two months in Adis Ababa, where apparently the motto is "Never do today what can be put off until some time in the future."

But time did not hang heavily upon our hands, for besides sightseeing there was much to be done in caravan preparation—a small army of men to secure, drill, and train, mules to purchase for the highland journeys, and camels for the lowlands.

The capital is dominated by tall eucalyptus trees planted during the time of Menelek. Stone alternate with frame buildings, and mud-walled, grass-thatched *tukels* are scattered along irregular streets. The roads are never more than trails along which travel crowds of people walking to and from



A highland chieftain with two armed retainers each wearing the manes of lions they have killed. The shields are made of hippopotamus hide

the markets, with now and then a chieftain from some distant part on horseback, accompanied by many retainers on foot.¹ It was a daily panorama of intensely interesting scenes.

All things end even in Abyssinia, and just before our train pulled out for Diré Daoua a minister came with our belated caravan passport from the Regent. This much-prized document is quaint in diction:

"From Ras Tafari, Heir Presumptive to the throne of Abyssinia, to Dijazmatch Imourou: How are you? I am well, with the help of the Al-

¹Since Ras Tafari returned from Europe last year the roads in Adis Ababa have been repaired and at present there are about one hundred motor cars in the capital, mostly Fords.

mighty," etc.

Its effect upon distant tribesmen was magical, producing instant compliance with our wishes even in the remotest districts.

Mules and horses were purchased and men hired in Adis Ababa, because the highland type of each is preferable and the range of choice greater. Half of the men selected were Christians and half were Mohammedans, so that in case of an argument the white men should retain the balance of power. Rarely has a caravan so well equipped and with such conveniences trekked through Africa.

A mule caravan in Abyssinia is like an appetite, it grows continually and is difficult to curb. We finally started with fifty servants trained and armed as soldiers, and sixty mules and horses. With a man leading each mule, single file, our caravan, a mile in length, was an imposing spectacle and an event wherever we traveled, furnishing a record date for the people long afterward.

Diré Daoua, on the railway, was headquarters. From this point a trail winds up the jagged limestone face of the Harrar plateau, 4,000 feet above the plain, then through fields of durra and maize to Harrar, which in size and importance is the second city of Abyssinia. Founded by the Arabs in the seventh century, it now contains a population of about 40,000 people. From a distance it is compact and imposing. The high ancient wall which surrounds the city is encircled in turn by a belt of refuse heaps and cemeteries which press closely upon it. Inside of the wall, buildings shoulder each other in precarious fashion along narrow, rough, cobbled streets which also function as sewers. Dead cats, bones, and refuse contribute to make Harrar

the most evil-smelling and the dirtiest town on the face of the earth.

Westward from Harrar our route paralleled the Tschertscher Mountains. Their southern foothills are black lava peaks representing several distinct flows that abut upon the plateau. In these uplands, steep-walled cañons a thousand feet deep trench the plateau every few miles, tributaries of the Webbi Shebeli, their fertile valleys producing abundant grain and excellent coffee. The people of this district are all "foot" men and their power of endurance is great. Our caravan averaged not more than from ten to fifteen miles daily, and it was not unusual for a messenger to cover as much in one day as we did in four. In the Gara Mulata Mountains there are antelope, nyales and bushbuck, but few fell victim to our guns, for primarily this was not a sporting expedition. Jackals howled on the hillsides every night and hyænas prowled about. One of the chief entertainments after dark was to give flash lights to the soldiers, who at a signal flashed them into the darkness, and when gleaming eyes reflected the light the white men would fire. One morning there were four hyænas lying a short distance from camp as a result of this practise, all so mangy that the skins could not be preserved.

At Dogou the Dijazmatch Vake, Governor of Gara Mulata, passed us, leading his army against a raiding party of the Mad Mullah's Somalis who had burned several villages, killing the men and carrying off the women and cattle. Vake made a successful trip and brought back a large number of prisoners, among them the Mad Mullah's father-in-law who had been leading the raid. It fell to our lot to give medical treatment to several of his soldiers.

A few days later, on reaching the Governor's headquarters at Grau, we were royally entertained at a banquet, where the native Abyssinians were given raw meat, which they prefer. For the white men, cooked meat highly seasoned with pepper and herbs was served in a common pot without knives or forks, but with plenty of thin teff cakes which took the place of tableware. Beakers of tej (fermented honey), and arraki, both national drinks, were served copiously during the feast. Afterward we presented the Governor with champagne and rum, which pleased him greatly, but he remarked, "It is rather a mild drink for a fighting Abyssinian."

Finishing the trek westward on the high plateau, our return route again passed Harrar on to the lower, more open plains of Djidjiga. Here we divided our company and I, with good old Hassan, a Mohammedan, as headman, seventeen picked riflemen, five camels, and two saddle mules, started for Hargeisa, British Somaliland, a journey of four days without water, where the camels must carry sufficient water for both men and mules. Eastward the plain gradually becomes more level and toward the international boundary line is covered with tall grass—a country of wonderful grazing possibilities, but mostly unused through lack of water. Thousands of gazelles were seen daily in herds of a dozen up to three hundred.

The Mohammedans would not eat food that had been defiled by Christian touch and *vice versa*, nor would either eat anything that white men had visibly handled. When shooting game, I would announce that this was a Christian or a Mohammedan animal, and when it dropped, two men of that faith would rush forward to cut the throat



The western part of Harrar Province is a white limestone plateau trenched every few miles by precipitous cañons, tributary to the Webbi Shebéli. All are erosional, and eons of time were required to sculpture them 600-1000 feet in depth



There are sizeable forests of deciduous trees in the Tschertscher Mountains, but at elevations of 4000-5000 feet on the plateau, *Euphorbias* take their place, some of giant size. Near Harrar they are planted as fences around the fields, and they border all the trails



An army of 3000 men under command of the Governor of Djidjiga protects the eastern frontier. It comprises infantry, cavalry, a camel corps, and artillery, the latter composed of one six-pounder mountain piece and one old Maxim gun which despite their feebleness are put into action quickly. Lack of rigid military formation does not impair the fighting quality of an Abyssinian army



This telephone station is a mimosa tree on the Harrar Plateau far from habitation. Necessity compelled us to use this amateurish line strung from tree to pole to tree, connecting a remote district with the capital, and at the end of the second day we had established speaking contact

before it died. If the animal had stopped kicking before they reached it, neither would eat the meat.

I quote extracts from my diary:

Dec. 3. Last night there was a fairly heavy dew and this morning the grass was quite wet, which explains why the gazelles



A tame hartebeest at Djidjiga. Mothered by a goat when orphaned, he thrived in the village, losing all fear and respect for man

and other antelope can live for months on these grassy plains without water. Traveled nearly all day in mimosa and acacia forests of low trees, passed many deserted zaribas of nomadic Somalis who herd over these areas during the rainy season. Cemeteries containing from one to twelve graves and enclosed by thick brush were passed at intervals all along the trail. Each may represent the season's dead of an itinerant village, or they may be family plots covering several years. There are so many that they arrest one's attention.

A Somali camel caravan with two men and two women arrived after dark, camping in the zariba with us for protection.

Our pack camels are marvelous beasts. They go without water four days and carry 400 pounds each. Their rhythmic, measured tread is exasperating to one in a hurry, but they are sure as heartbeats. When the loads are removed, they stray out among the trees, preferring the sparse leaves and thorns of the

mimosas to the thick grass. When brought into the zariba (circular thorn enclosure) at night they are forced to kneel down, and with feet doubled under, each has his front legs tied so that he cannot rise. All are grouped close together, with their tails to the wind, the Arab drivers sleeping in front of them.

Dec. 4. Saw many more thousands of gazelles and one large antelope, probably an eland. At eight o'clock met a large camel caravan of Somalis without guns, but with a few spears. A lion jumped into their zariba last night and seized a sleeping man, but was driven off after the man had been mortally wounded. Lions are most numerous in this section near the international boundary. While camp was being pitched in an old zariba, I strolled out and saw a lion, but when the gunbearer arrived I had lost sight of it. We killed two sheep within ten feet of the zariba, and I instructed the guards to call me if the lions came during the night. There was one false alarm, and in the morning I found tracks of the lions within ten feet of my tent but they were not seen by the guard.

Just beyond the international boundary the quartzite hills of Doubbouro appear. Near these hills aloes begin in abundance and the entire fauna and flora change within a few miles. Apparently these hills are a part of the divide that separates the coastal fauna and flora from that of the high plateau region. In the aloes we saw dozens of beautiful little dik-dik, the smallest of antelopes, about the size of a jack rabbit, and usually in pairs.



A young Abyssinian lion.—The lion is symbolic of Abyssinia. He is a fierce, fearless beast, less stocky than the southern variety and with shorter mane



In the water holes at Djidjiga, thirty feet deep, five men are stationed, one above the other. The man below throws a basket of water to the one above and receives an empty one in return

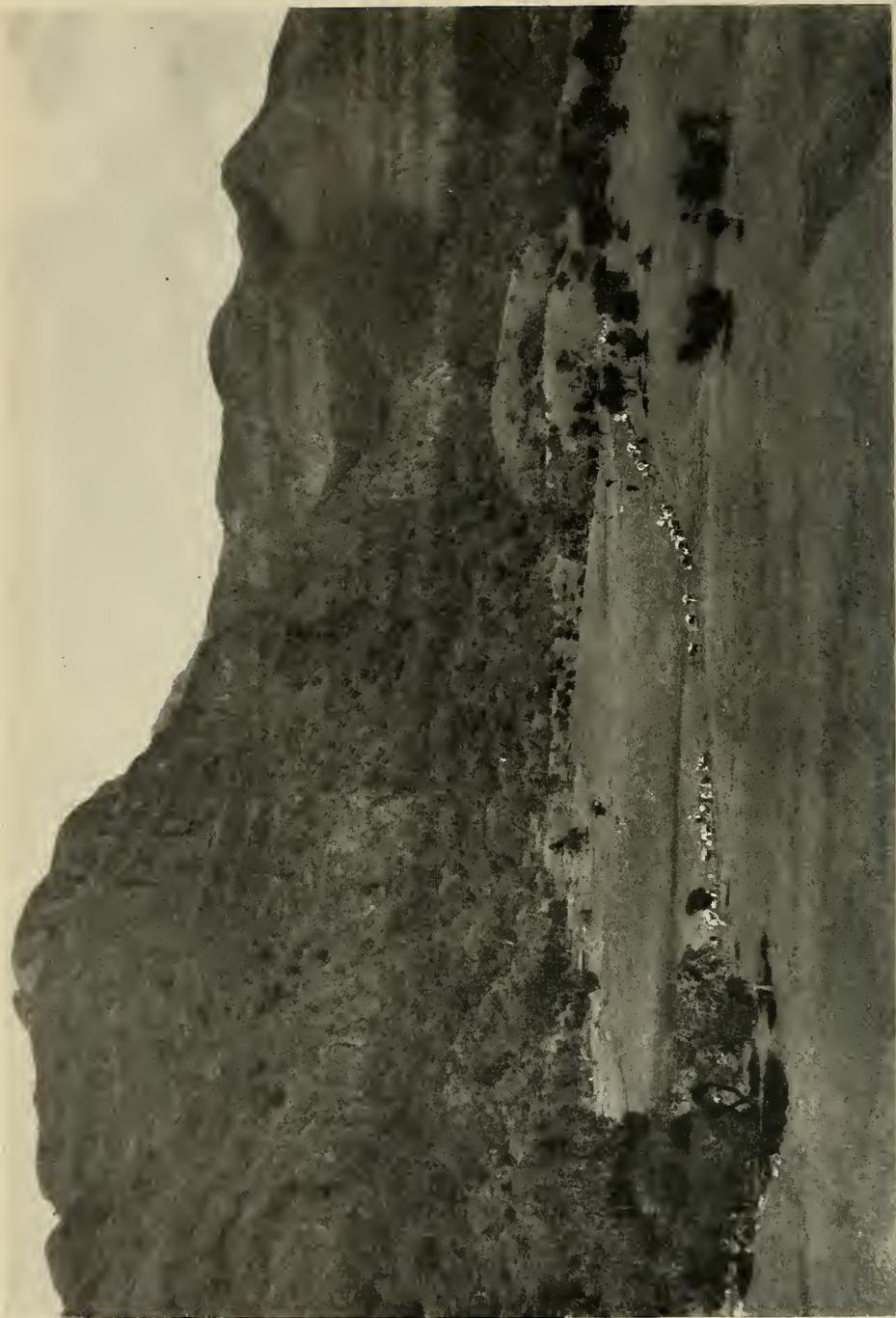
Hargeisa is a Somali village with a shifting population of two or three thousand people, a wireless station, and headquarters for the British camel corps of native police. It is composed of two or three compact groups of grass-



In British Somaliland east of the Abyssinian boundary, a short camel-day's journey, there is a low chain of quartzite hills, part of the divide that separates the coastal flora and fauna from that of the plateau region. Near these hills aloes begin in abundance and the entire fauna and flora change within ten miles

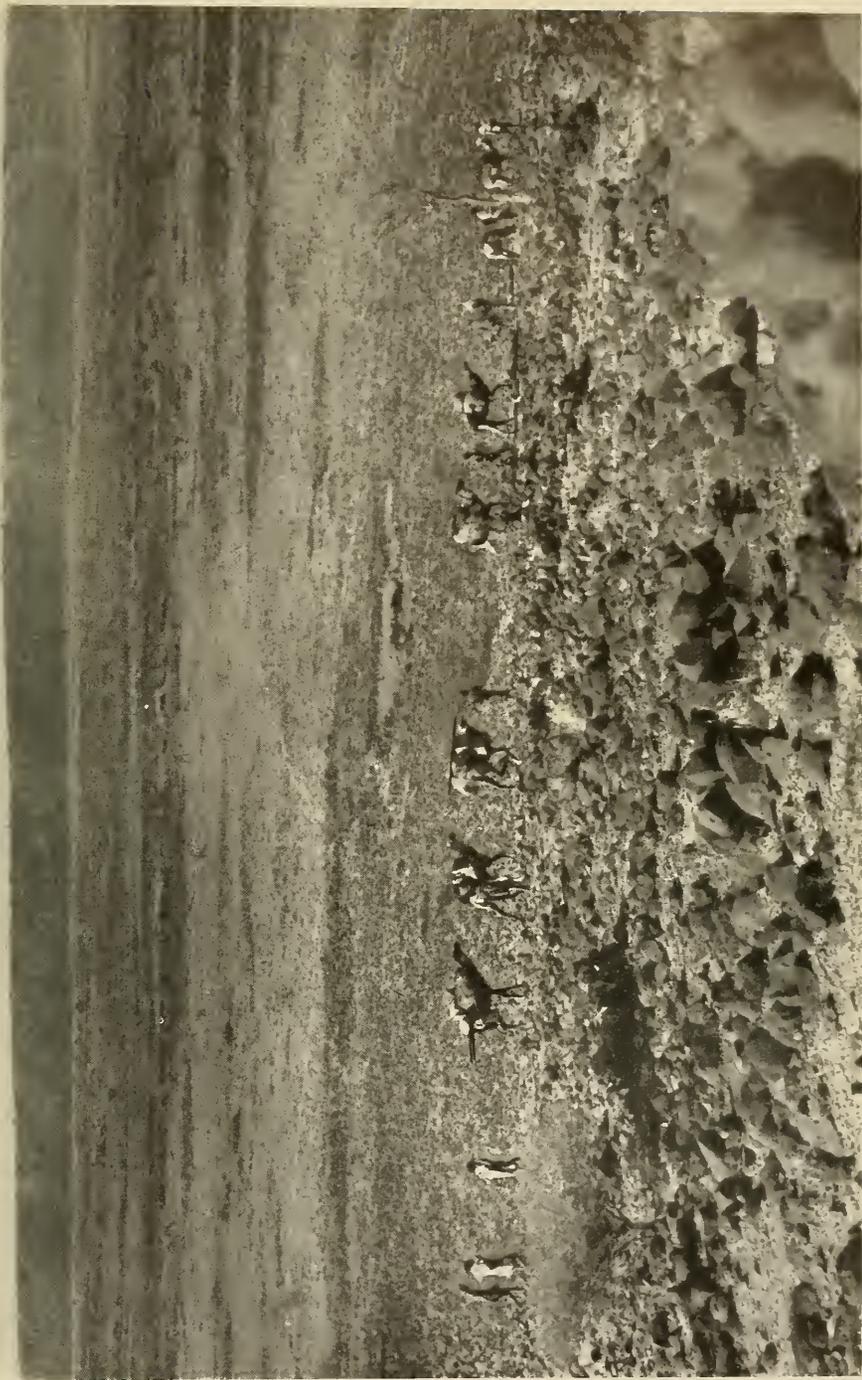
mat huts established here because of permanent water holes in the river bed. Immense trees (neems) are clustered in the river bottoms, some of the large ones shading an area nearly 200 feet square. Hyænas are numerous around the village and they frequently steal in and carry away babies and small children. Several deaths have resulted in this way. At this season there were two native gardens from which I obtained roasting ears, radishes and papayas, which shows what can be done with water. A cheap system of irrigation would have a far-reaching effect upon the natives.

From Hargeisa I returned to headquarters at Diré Daoua and re-outfitted with the same guards and headman but different camels for a journey to the northern plains at the foot of the Harrar plateau.



MULE CARAVAN ON THE HARRAR PLATEAU

A forested section at the foot of the Gara Mulata Mountains, lava masses that at a distance resemble stratified rocks. In the foreground is a section of our main mule caravan



MY CAMEL CARAVAN IN THE DANAKUL LAVA FIELDS

East of the Harrar Plateau, in less than five miles all sedimentary strata completely disappear, covered by lava that has welled up through the great rift fracture. Here trails are merely discolored streaks over the sharp lava blocks where our average rate of travel was 1½ miles an hour

Again I quote from my diary:

Dec. 29. Followed up a valley and then on to the lava cliffs and level plateau covered with low, scrubby thorn trees—the Gorgouro Somali country, a very poor herdspeople, much lower in development than other tribes of Somalis. Their mat houses are never more than four feet in height and are very mean in appointments. It is not a numerous tribe. The lava trails are extremely hard on the feet of the camels and mules, and we rarely accomplished more than a mile and a half an hour. . . . Saw three wild boars, many gerenuk and gazelle. Killed one wild boar weighing about three hundred pounds, taking head and hams—an exciting experience. The Mohammedans of course would not touch it, nor are the Christians allowed to eat pork except under certain conditions. Two of my men who were *croix-de-guerre* soldiers during the great war and who had learned to eat pork in France, took advantage of the fact that the taboo on food is lifted in case of illness, and conveniently became sick.

Dec. 30. Came to a wonderful tall-grassed district called Metto, where the grass completely covered the mules as we rode through. Here were great herds of milk camels feeding around the edges and out on the plain. Camel's milk is the exclusive food and drink of many nomadic Somalis, and I found it more palatable than cow's milk. Not far away there are immense termite turrets, some fifteen feet high and ten feet in diameter. Thick timber lies to the west of this depression where there are many Issa and Somali zaribas and huts on the border of the forest.

Jan. 1. Left camp for Donkaliland, accompanied by a heavy guard. Our Gorgouro guide would not go with me for fear of the Donkalis. Traveled eleven hours to the distant hills in Donkaliland on the edge of a local lava flow that has come from the northward. Deserted Donkali houses made of lava are scattered around the edge of this flow. This is disputed territory fought over by Issas and Donkalis. A magnificent mountain, evidently an extinct crater resembling Mount Tacoma, rises majestically out of the plain west of us. This peak, fifty miles distant, is many thousands of feet in height. None of my people knew its name. Saw ten ostrich, magnificent birds, a half mile distant, but could not stalk them. Measured the tracks of one, which showed an eight-foot stride. Saw one lone oryx of a large species

seen also near Djidjiga, and about thirty half its size, several hyenas and jackals. On our return to camp we were mistaken for Donkalis and a number of Issa warriors came out to fight us. When they discovered that I was a white man they wanted baksheesh. Passed villages at Metto, and the Issa women were very indignant when I photographed them.

Finishing this short journey, I returned to headquarters, because my camels were worn out in the lava fields, and with a new caravan again went into the lava field west of the railroad at Addagalla. The Somali camel men were very inferior to the Arabs. The second day after leaving the railroad we were joined by a prominent chief known to Hassan, and superior to all the Issas I had seen—tall and stately, with an intelligent face, keen eyes and a bushy head. An impressive individual. On his right arm, above the elbow, he wore a large elephant tusk bracelet, signifying that he had killed more than ten Donkalis. One of our young camel drivers wore a brass bracelet, which signified that he had killed two Donkalis. Passed through some shallow depressions in the lava field, where there were fragmentary bones and teeth of *Elephas* of Pleistocene age, but nothing worth collecting.

Jan. 8. Went down a deep, steep cañon tributary to the Hawash, to a deep water hole described to us by the Issa chief. We reached there at four A.M. Saw hippopotamus tracks on nearing the water hole and followed them to the pool. Presently I heard splashes and grunts from the rushes and spied a hippo just as he became submerged, but could not get a shot. Although we stayed there five hours, he never came up. The natives say that the animals sometimes remain submerged all day.

This was a beautiful pond of water two hundred feet long by thirty wide, fringed with cat-tail rushes and tall plumed grass. I spent the rest of the morning fishing and longing for dynamite. Caught seven large catfish. Fishhook and line were a sight of great interest to the large number of natives who collected along the bank and watched. They had never before seen fish caught in this manner.

Jan. 9. Trekked nine hours—the longest day of the season; a terrible heat with mirage distorting everything; lakes and rivers of water in all directions, but not a drop to drink. This is the time of the "Ramadan," the Mohammedan month of fasting, when none may

eat nor drink while the sun is above the horizon. Every Mohammedan carried his wooden water bottle and a leather prayer rug. He washes his hands and feet at the hour of prayer, but not a drop of water passes his parched lips. This was a long day and all the men were famished. Hassan had to beat them away from the water cans and ration the water, for they are thoughtless of tomorrow. Ten natives drank a camel can of water (eight gallons) at one sitting.

Jan. 10. Climbed up to the top of a lava flow and traveled until we came to the edge of a cliff bordering an old lake, Debu, many miles in extent, but now dry except in the rainy season—a wonderful sight. The walls surrounding this lake are three hundred feet high and in places are eroded into columnar form. In cross section the mass appears to be made up of lava flows of successive dates and of different constituency. A few natives were camped along the rim and as soon as they saw us in the distance all the men and young women ran away with their herds of goats, fearing that we were Abyssinian tax collectors. At one end of the depression are the hot springs of Takale. Here the natives come from many miles' distance for water.

Jan. 14. Rode toward Mount Marmar—brilliantly colored peaks or volcanic plugs, but there is no flow of lava near by. These beautiful peaks are most weird and picturesque, in brilliance of color rivalling Turner's sunrise scenes of Venice.

As the caravan was strung out today, the men in advance scared three wild boars in a ravine, one as tall as a burro—a magnificent beast and larger than any I have ever seen or read of. As soon as my gunbearer reached me I spurred after them at top speed into the wood, but never got a shot.

These incidents of travel are introduced to show the nature and conditions on the plains of Danakil at the foot of the great Harrar plateau where 4,000 feet of displacement were measured and where within a distance of five miles the faulted blocks of plateau limestone completely disappear, engulfed in lava.

The eastern part of Abyssinia is drained by the great Hawash, a river that in size equals the Delaware. It

rises in the highlands and flows north-eastward, following the general trend of the great Rift, a part of that profound geologic movement that separated Africa from Arabia. In the lava-covered plains of Danakil the Hawash rushes through a steep-walled cañon and in its lower reaches spreads out into a series of lagoons; a small part of it reaches Lake Aussa, but none of its water empties into the sea.

Some of the men who had visited the marshland around these lagoons described it as a region of big game, with hippopotamus, rhinoceros, zebra, and the larger antelope in considerable numbers, a field that would furnish much valuable information upon the modification of species in a restricted habitat.

Since historic times the distribution of big game in Abyssinia has been greatly changed. Elephants and rhinoceroses, formerly numerous as far eastward as Diré Daoua, are now found mostly in the west, especially in the Sobat valley. The hippopotamus is also found, chiefly in the western rivers, and likewise the giraffe, while the ass and zebra usually appear in the highlands bordering the Sudan. Wild boars are still fairly numerous in the lowlands at the foot of the Harrar plateau, while nearly all members of the antelope family of northern habitat are found in the eastern lowlands of Abyssinia. Leopards, spotted and black, are numerous in the mountainous highlands; hyænas and jackals are common through nearly the entire country. Lions are now most numerous in the eastern lowlands and the Haud of Somaliland, although they formerly had a much more extended range. The lion is the national emblem of Abyssinia, and Menelek II, great king of this country, fittingly signed himself "The Lion of Judah has conquered."

Reviews of the Recent Work of Australian Mammalogists

By H. C. RAVEN

Assistant Curator, Comparative and Human Anatomy

The Vertebrate Animals of Tasmania.

By Lord and Scott. Oldham, Beddome and Meredith, Hobart, Tasmania, 1924. 8vo., pp. 1-340.

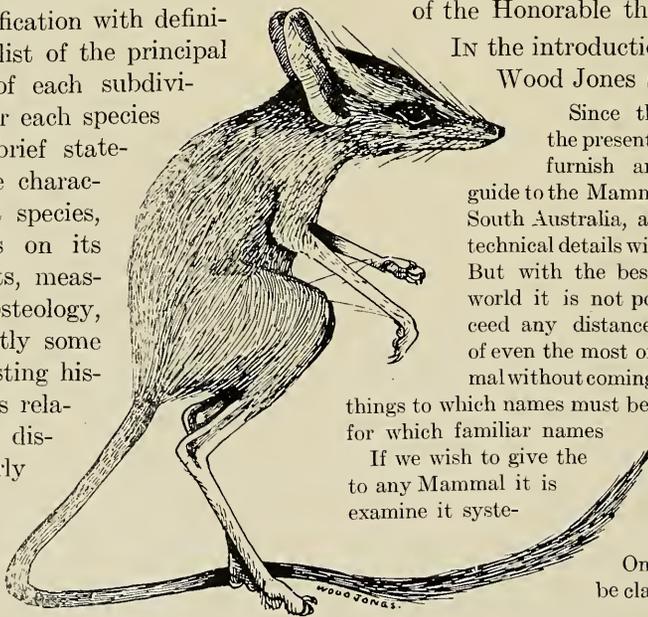
THIS is a volume of convenient size which will prove to be a great help to anyone interested in the vertebrates of Tasmania. Nearly one hundred pages are devoted to the mammals, which include monotremes, marsupials, and placentals. The majority of the genera of mammals listed from the Island State of the Australian Commonwealth are cetaceans and pinnipeds, though the greater number of the terrestrial mammals belong to the Marsupialia. At the beginning of the treatment of each subclass there is a brief outline of the classification with definitions, or a list of the principal characters of each subdivision. Under each species is given a brief statement of the characters of that species, some notes on its range, habits, measurements, osteology, and frequently some very interesting historical notes relative to the discovery or early records of the animal. An attempt

has been made to picture the greater number of the land mammals, but unfortunately the illustrations are very poor. As a synopsis of the vertebrates of Tasmania the work is a most welcome one, containing much valuable information for all students of the region.

"The Mammals of South Australia," by Frederick Wood Jones. Part 1—The Monotremes and Carnivorous Marsupials, 1923, pp. 1-131. Part 2—The Bandicoots and the Herbivorous Marsupials, 1924, pp. 133-270. Adelaide. "A part of a series of *Handbooks of the Flora and Fauna of South Australia*, issued by the British Science Guild (South Australian Branch) and published by favor of the Honorable the Premier."

IN the introduction Professor Wood Jones states:

Since the purpose of the present volume is to furnish an elementary guide to the Mammals inhabiting South Australia, all unnecessary technical details will be excluded. But with the best wish in the world it is not possible to proceed any distance in the study of even the most ordinary Mammal without coming across certain things to which names must be assigned, and for which familiar names are lacking. If we wish to give the proper name to any Mammal it is necessary to examine it systematically and to measure it. Only then can it be classified, and its



Antechinomys spenceri, two-thirds natural size. One of the 190 admirable text figures from *The Mammals of South Australia* by Wood Jones. Among the Australian marsupials hopping forms have developed in three distinct families: the kangaroos, the bandicoots, and the dasyures,—to which *Antechinomys* belongs

identity finally settled. Certain features require special examination, since all parts of an animal are not of equal importance in the determination of its status. Here we will be almost entirely concerned with external characters, but it must be remembered that these external characters are not in themselves sufficient to diagnose, beyond all doubt, the proper position of an animal in the scale of nature. Other, deeper, and more complex details must be considered. Nevertheless, external characters alone will lead a long way, and it is, therefore, worth while to pay some systematic attention to them.

The remainder of the introduction is devoted to a very clear exposition of the characters of use to the student in determining the taxonomic position of the various mammals, how to measure them, etc.

Under the heading, "The Classification of the Mammals," the author defines the three subclasses, Ornithodelphia, Didelphia, and Monodelphia, and illustrates each by means of a very clear diagram of the female reproductive system.

Another section is devoted to "Special Problems Connected with the Mammalian Fauna of Australia." In this the author discusses and briefly reviews some of the theories of the origin and dispersal of the mammals of Australia. Regarding their migration, the author's views are in agreement with those of the famous zoögeographer, Alfred Russell Wallace. In the concluding paragraph of this section, Professor Wood Jones makes a plea for the Australian mammals in the following words:

Every member of the fauna is worthy of study for its own sake, and around the whole assemblage of species is woven a meshwork of the grandest and most important biological problems. In the Ornithodelphia and the Didelphia, Australia has a heritage for which it must accept responsibility; it must be prepared to conserve the living, to collect and preserve the dead, and to make provision for the proper study of the fauna in all its aspects.

All vertebrate zoölogists realize the importance of Professor Wood Jones's statement and many of them have endeavored to bring about measures for the protection of the Australian mammalian fauna, the principal enemies of which are, at the present time, the people engaged in killing and exporting the skins of these mammals, that is, the skin and fur trades; and the animals introduced into Australia by man, which have become feral and overrun much of the country.

The two parts of this work, which have been received together, contain 270 pages and 190 text figures. All the figures are reproductions of pen drawings from the actual specimens by the author. The figures are admirable illustrations, serving to compare the various animals and, what is most important, to show their morphological characteristics.

"The Zoögeography of Marsupials."

By Heber A. Longman, F. L. S.,
Director, Queensland Museum.
Mem. Queensland Mus. 1924, VIII,
part 1, pp. 1-15.

IN this article Mr. Longman very ably reviews the literature bearing on the marsupial fauna of the Australian region, its origin and distribution, past and present. He first considers the views of such eminent writers on the subject as Mr. H. O. Forbes, Sir Baldwin Spencer, the late Professor Haswell, and Mr. Charles Hedley. Then in turn are considered the families of recent polyprotodont marsupials—Dasyuridæ, Peramelidæ, and Notoryctidæ, with notes on the distribution of, and evidence to be deduced from, each group. Under the heading "Diprotodontia" is given a brief summary of the distribution of this group, with the names of recently

described genera, most of which occur on the islands of the Indo-Australian Archipelago, to the north of Australia. Special paragraphs undertake a resumé of the following: Tasmanian Fauna, Syndaetylism, Fossil Marsupials, Myrmecoboides, South American Fossils, and Wynyardia. Under the heading "Brief Notes on the Non-Marsupial Fauna" the Monotremes, Rodentia, Reptilia, Amphibia, Fishes, and Flora are discussed with regard to the part they take in relation to the distribution of the marsupials.

The following paragraphs from the latter part of Mr. Longman's paper will give an idea of this involved problem.

The assumption of a continent in the Antarctic in early Tertiary times, in order to account for related elements in the faunas and floras of South America, Australia, New Zealand, various Pacific Islands, Madagascar, and South Africa has proved a veritable Pandora's box to biologists. In order to explain many of the difficulties raised, it is suggested that this circumpolar area had radiating land bridges, inconstant in direction and dimension, apparently reaching out on the one hand to deposit certain types in Pacific archipelagoes; elsewhere stretching to Madagascar to transfer iguanas; extending to New Zealand to allow other forms to gain new land; and independently reaching Tasmania to enable the ancestors of our marsupials to complete a trans-polar journey and find a congenial refuge.

The presence of more extensive land areas in the Antarctic in Mesozoic times is apparently demonstrated, but it seems improbable that these areas were faunal land bridges for vertebrates. On the other hand, the presence of "ancient continental" islands to the northwest, as shown by Russel Wallace in *Island Life* and the *Geographical Distribution of Animals*, is undoubted. That the evidence of these "ancient continental" islands is incomplete is doubtless due to partial or entire submergence. In this connection it is interesting to note that Weber and Beaufort (1912) in their analysis of the fresh-water fishes of Timor found that this fish fauna was "almost totally composed of immigrants from the sea," the inference being that the island

had been largely submerged in Tertiary times.

Possibly fossils from the Austro-Malayan-Asiatic regions will one day be forthcoming to strengthen the view that our marsupials had a northern origin probably before "Wallace's Line" had significance as a partial barrier. But even on existing evidence, it seems to the writer that the alternative route of Antarctic land bridges involves us in far greater difficulties and anomalies.

Mr. Longman's views for the most part are in agreement with those of the greater number of students of the zoögeography of marsupials. His paper, containing an extensive bibliography, is a valuable contribution to this very interesting subject.

BESIDES the papers already reviewed there are many others of interest. Professor Launcelot Harrison of the University of Sydney has published, 1924, *Australian Zool.*, III, part 7, pp. 247-63, a paper on "The Migration Route of the Australian Marsupial Fauna," in which he comes to conclusions about the opposite of those reached by Mr. Longman on the same subject.

Professor T. Thomson Flynn of the University of Tasmania has contributed a number of papers on the embryology of the marsupials. Messrs. Scott and Lord of Tasmania have written several papers on the fauna, fossil and recent, of the Island State; their papers are usually to be found among the *Papers and Proceedings of the Royal Society of Tasmania*. From the Australian Institute of Anatomical Research, Melbourne, come some papers on the comparative anatomy of the monotremes and marsupials by Dr. William Colin MacKenzie.

Mr. Harry Burrell, who is very widely known as one of Australia's foremost students of the life history of the monotremes, has contributed articles to the *Australian Zoologist* and other

publications for the past several years. The titles to some of his articles in the *Australian Zoologist* are as follows: "The Deposition of the Eggs of Monotremes" (1917, I, part 4, p. 87); "Field Notes on the Life History of Monotremes" (1920, I, part 8, pp. 231-40, text figs. 1-6); "Preliminary Note on the Breeding of *Ornithorhynchus* in 1920" (1921, II, part 2, pp. 20-23, Pls. I-II); "Note on Some Natural Habits of Echidna (*Tachyglossus aculeatus*)" (1924, III, part 7, pp. 268-69); "Practical Observa-

tions of *Ornithorhynchus* Beneath Water" (1925, IV, part 1, pp. 4-7, Pl. II, figs. 2 and 3); "Field Notes on Natural Habits of Echidna, (*Tachyglossus aculeatus*)" (1925, IV, part 1, p. 8). Mr. Burrell's articles contain a quantity of interesting original information about the subjects he has chosen for his studies.

Among other writings of Mr. Burrell is the following verse, which has been published in the *Australian Museum Magazine*:

THE MUD-SUCKING PLATYPUS: A BRIEF HISTORY

BY HARRY BURRELL

O! thou prehistoric link,
Kin to beaver, rooster, skink,
Duck, mole, adder, monkey, fox,
Palæozoic paradox!

Beak of shoveller, spur of fowl;
Cheek of monkey (pocket jowl);
Trowel of beaver, gait of skink;
Dope of adder, foxy stink.

Mode of digging a la mole,
Fur much richer on the whole;
Feet palmated, ditto paws;
Latter webbed beyond the claws.

Swimming, diving, most expert,
Wary, nervous, cute, alert.
Food—aquatic creatures (small),
Sediment, and mud with all.

Ear and eyelid all in one;
Young have true teeth, adults none;
Snarls like cheeky pups at play;
Bites like gander when at bay.

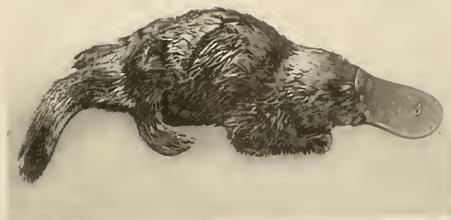
Adult female spurless quite;
Teatless udder—contents white;
Egg-producing, capsules soft;
One to three, but two more oft.

Epipubic bones support
Dimpled abdomen; in short,
In that slight depression she
Incubates her progeny.

Warmth increased for eggs and young
By her tail, well underslung;
Snugly cuddled to her breast,
Mother nature does the rest.

Day-old youngsters in the nude,
Beakless, sightless, contour crude;
Sleep essential, rapid growth,
Spurs project in sexes both.

Mother's duties never done;
Father's (when not flirting)—none;
Hail! O paradox supreme,
Prehistoric Monotreme!



Ornithorhynchus anatinus, the Australian duckbill.
Negative owned by the New York Zoological Society

NOTES

THIRD ASIATIC EXPEDITION

THE THIRD ASIATIC EXPEDITION of this year was larger and its program more ambitious than in either of the preceding years. It was, in fact, the largest land expedition of a similar character that has ever gone into the field.

The American Museum was represented on the staff by Mr. Roy Chapman Andrews, Leader; Walter Granger, Charles P. Berkey, Frederick K. Morris, Clifford H. Pope, N. C. Nelson, and George Olson. Those on the staff not of the Museum were: Ralph W. Chaney, J. B. Shackelford, J. McKenzie Young, Norman G. Lovell, Tzokto Badmajopoff and others,—40 men all told, 12 Americans, 2 British, 14 Mongols, and 12 Chinese. The sciences represented were palæontology, archæology, geology, botany, topography, and photography.

The means of transportation were 125 camels, 5 motors, and two one-ton motor trucks. The camels left Kalgan, China, on February 15, carrying 3500 gallons of gasoline and food for the party of forty for five months. The camels were to await the motor party 700 miles from Kalgan, in the center of the Gobi Desert. The Scientific Staff left Peking April 15. The Expedition traveled 5000 miles in the Gobi Desert, along the northern and southern bases of the Altai Mountains, west beyond the longitude of Uliassutai. Twenty-two thousand miles of this journey was exploration in a new country.

The results secured this year are the most important scientifically thus far obtained by the Expedition. For the first time archæology added to the value of the investigations made. In the Gobi Desert were discovered two Palæolithic (or Old Stone Age) human cultures and one Neolithic culture. Such widely separated horizons indicate that the whole chapter of Stone Age history may be deciphered in Asia as well as in Europe. It follows that light can be thrown on the origin of primitive races of the world and their migration if the investigations in Asia can be further prosecuted.

While no bones of members of primitive races were found this year, the scientists of the party are convinced that in some localities such bones must have been preserved and will eventually be found. Crude stone scrapers of Mousterian type were found, which in Europe are contemporaneous with Neanderthal man.

A late Palæolithic culture, somewhat corresponding to the Azilian culture of Europe but probably twice as old was discovered. The party named these people the "Dune Dwellers" because they inhabited the sand dunes on the shores of ancient lakes. They date back some 20,000 years. The remains consist of old fireplaces containing ashes, bits of charred bone and wood, together with thousands of flint chips, scrapers and drills.

A Neolithic, or New Stone Age culture was evidenced by stone arrow and spear points, finely worked scrapers, flint knives, and crude hand-made pottery.

The belief that Central Asia was the point of origin for much of the mammalian and reptilian life of the world has been greatly strengthened by these recent discoveries, for example, the evidence of the existence in Mongolia of several great groups of mammals which hitherto have been known only as from Europe or America. Also forty more dinosaur eggs, some ten million years old, have been found. In its search for dinosaur eggs, the party took as its slogan "Bigger and better eggs," and 12 eggs in one nest are finer than any previously discovered. Further, several new types of dinosaur eggs were found. New and very perfect skulls and skeletons of dinosaurs were collected and the scientists were able to make out the complete story of why and how the dinosaur eggs were preserved in this locality.

Six skulls of Cretaceous mammals were found in the dinosaur egg strata. Mammals were extremely rare in the Cretaceous Age (Age of Reptiles). With a single exception, these are the oldest mammal skulls in the world. They represent transitional steps in the evolution of mammals from reptiles.

The feet and part of the legs of the largest mammal that has ever lived (the giant *Balu-chitherium*) were discovered. Approximately three million years ago the huge beast sank in quicksand and was fossilized in an upright position.

The skull of a strange double-horned animal, entirely unknown to the scientists of the party, was found. New and exceedingly rich fossil fields were discovered where the skulls, jaws, and bones of countless animals lie interlaced.

The scientific party of the staff determined that Mongolia is the oldest continually dry land in the world; that it has been a continu-

ously dry continent since late Palæozoic times, probably for twenty million years; that in Palæozoic times a great sea way extended through the Central Asia plateau from the Caspian to the Pacific; that the Central Asian plateau was never invaded by an ice sheet similar to that of Europe and America; that there was a "climatic cycle" in Mongolia. In other words, there were successive wet and dry periods with an ever-increasing aridity; that during the last 50,000 years the drying up has been rapid. These scientists have further discovered that in Oligocene times, about three million years ago, a vast redwood forest extended in Manchuria from Mukden almost to Vladivostock. The trees of this forest were similar to the giant redwoods of California, and the redwoods were accompanied by other trees, alder, maple, and oak.

A collection of several thousand living plants, well representing the flora of Mongolia, was made. Thousands of specimens of fish, reptiles, and mammals were taken, many species new to science being among them.

An accurate survey route from Kalgan, straight through the center of the Gobi Desert for more than a thousand miles, has been run. The most accurate maps ever attempted have been made.

Twelve thousand feet of a motion picture film have been made, showing among other things, a herd of 50,000 antelope and 1000 wild asses. Also many thousands of still photographs have been taken.

When the party returned to Peking on September 15 it found widespread news reports to the effect that the party had been expelled from Mongolia, it being falsely stated that the party was responsible for political propaganda, had made military maps, and had not adhered to its agreement with the Mongolian Government.

When the leader of the Expedition, Mr. Roy Chapman Andrews, left Urga early in June, his relations with the Mongolian Government were on a cordial basis of coöperation. He took with him two Mongol officials who were to learn the methods of field work and to see the localities where the Expedition had discovered fossils. One of these men remained with the Expedition and assisted in passing the customs at the frontier between Outer and Inner Mongolia.

The Expedition had written permission from the Mongolian Government to make the itinerary and locality maps, as well as to

pursue all the investigations which it carried on. The Third Asiatic Expedition has never concerned itself with the politics of the countries in which it has carried on its explorations, and never will. To do so would, indeed, be the height of folly. The party is not made up of politicians, but of scientific explorers.

THE VERNAY-ANGOLA EXPEDITION

THE VERNAY-ANGOLA EXPEDITION has been brought to a successful conclusion and Mr. Vernay has returned to the United States. Mr. Vernay was accompanied by Messrs. Lang and Boulton, who made large and important collections. Mr. Vernay succeeded in shooting splendid specimens of the prized great sable antelope. The material, which has been already received at the Museum, includes more than 1500 mammals, 1300 birds, 3000 reptiles and batrachians, 2000 fish, besides many mollusks, crustaceans, insects, and Cretaceous invertebrate fossils.

In the following note Mr. Vernay narrates briefly the capture of the sable antelope:

"Our purpose was to obtain a group consisting of two bulls, two cows, and a calf. Unfortunately the time we had chosen to hunt for the sable was not the most appropriate, as one should hunt them between the 15th of September and the 1st of January. In the second half of September there are intermittent rains and the serious rains begin early in October, which makes tracking quite simple; whereas the only time we had at our disposal was the first two weeks in August. Consequently the ground was very hard and dry and it was impossible to track at all. Apart from this, the country had recently been burned over and in only a few places had the young grass begun to grow, with the result that feeding spaces were few and far between.

"Our first three days in the sable country were wasted, owing to our being misinformed by natives that sable had recently been seen in the district. After using up these three days in scouring the country, no tracks of sable were seen at all. We moved deeper into the country and camped on the Teti River near Chisongue, where the salt pans are situated. In the meanwhile we had picked up a very savage-looking native named Tarti, who had a great reputation as a hunter amongst the various tribes. As Tarti would pass through a village, the headman would come up, clap his hands, and say, 'Ohosie, Ohosie,' whereupon the hunter would reply:



Specimen of Varian's sable antelope secured by Mr. Arthur S. Vernay

'Ondombo, Ondombo'—meaning that he was greeted with 'Lion, Lion,' and the reply was, 'Great, Great.' They thereupon would smile and clap their hands three times as greeting.

"I found it necessary to discard Tarti after a time, as he would not crawl over open spaces on account of the stubbly burnt grass; also he was continually taking snuff and making so much noise with sneezing and coughing that he was a bad man to have in a country where the animals are as shy as the sable antelope.

"I had with me young Alan Chapman who was born in Angola. It was for his grandfather that the Chapman zebra was named. Our plan of attack was that Alan should go north and I south, he go west and I east, or whatever arrangement might be best so that we should cover the whole country as much as possible. The first day out I was rewarded by getting two cows, one old cow and one

young cow who had had one calf. The next day a calf was the bag.

"Two days after that Alan obtained a young bull with 39-inch horns. And time went on—and our anxiety increased as we now had only three days left; I decided to send Alan to camp on the Tunda River, which was about 15 kilometers away, as only a few days before I had seen tracks of a large bull which I thought he might possibly find. In the meanwhile I covered another part of the country. The understanding was that he was not to return until 9 o'clock of the morning we had to break up camp. This would allow him a few hours after daybreak to make a final hunt before reporting.

"I had no news from Alan and finally had only one day left. After having made a fairly thorough inspection of the country, I considered it almost useless to go out the last day—the natives' feet were in bad condition

and we were all tired—but finally I decided that we would make one last attempt and make a big detour around a feeding ground where I had seen a large bull at dawn a few days previously.

"I started out at a quarter to five with Sakafuta, an Ombundu native, and one other. At a quarter past seven I saw to the left, about 150 yards in the bush, a magnificent bull sable walking majestically through the bush returning from the feeding ground. Sakafuta and the other native had not seen him as they were looking in the other direction. However, at a signal, they immediately went down on the ground and disappeared in the grass, which was up to our waists. The bull in the meanwhile disappeared behind a large dead tree which had fallen. It was an anxious moment, wondering whether he would keep on or possibly turn away into the bush, which would mean that I should have to move and he probably would see me. However, he fortunately came out from behind the tree and was shot. In this way a magnificent specimen was obtained, which completed the group of the sable antelope.

"Sakafuta literally danced for joy, clapping his hands to his chest and smacking himself on the head. I had sent the other native back to camp for my camera, and Sakafuta sat down and jabbered to me for half an hour, such was his delight not only that we had obtained the bull, but I think he had also a little contentment realizing that his tramping was at an end.

"The sable area is limited, being between the Cuanza and Luando rivers, and is roughly 40 miles across and 80 miles long. Unfortunately the country is gradually being opened up, the railway has at last reached the Cuanza River, well north of our ground, and in time, I fear, this superb antelope will disappear, unless stringent laws are made limiting the number that a sportsman may shoot, and also making it an offense to sell or buy horns."

BIRDS

TWO MORE PINK-HEADED DUCKS (*Rhodessa caryophyllacea*) have been presented to the American Museum by Mr. Alfred Ezra, the well-known aviculturist of Foxwarren Park, England, since the last number of NATURAL HISTORY went to press. They are a male and a female obtained alive with several others for Mr. David Ezra of Calcutta. These two ducks died in captivity,

and two others escaped, it is said, in the harbor of Calcutta. Of those which reached England alive, Mr. Alfred Ezra now writes us that he has a drake and two ducks in fine condition; and so with luck he expects to be able to breed them next season.

The arrival of these ducks in England is an event of great interest to aviculturists. Very few have ever come to aviaries in England, one pair in 1874, and a few more in 1897, but none in recent years.

The exact spot where the birds were captured has of course not been revealed by the Indian bird-dealers, but it is probably in somewhat the same region of northern India where the specimens were obtained for the Faunthorpe-Vernay Expedition.

Our two specimens from Mr. Ezra are mounted, and excellently preserved. Even if the pink-headed duck is doomed to ultimate extermination, the American Museum will possess ample material to illustrate its unique coloration and other peculiar characteristics.

CONSERVATION

PROTECTION FOR THE BIG GAME OF THE BELGIAN CONGO.—Early in 1924 a society known as the Cercle Zoologique Congolais was formed by the zoologists of the Section of Natural Sciences in the Congo Museum at Tervueren, Belgium, together with a number of other men specially interested in the Congo. The aims of the society include the study of the fauna of the Congo, the gathering of specimens for the Congo Museum and the Antwerp Zoological Garden, the popularization of the results of this study, and the protection of the fauna wherever necessary. Among the honorary members of the society are President Osborn and Messrs. Lang and Chapin of the American Museum.

The *Bulletin* issued by the Cercle during the past two years has been filled with notes and articles of value both for the zoologist and the colonial administrator. Under the leadership of Doctors Schouteden and Derscheid an intensive campaign has been opened on behalf of the big game of the Congo, particularly the elephant and some mammals of greater rarity, such as the okapi, the white rhinoceros, and the gorilla, menaced by the increasing activity of civilized hunters as well as by the incessant persecution by natives.

To the sanctuary for gorillas in the Kivu volcanoes, first advocated by Mr. Carl E. Akeley of the American Museum and now

happily established by King Albert, the Cercle Zoologique Congolais gave its full and enthusiastic support. It offered to the Minister of Colonies the expert counsel of Belgian zoölogists, especially those most familiar with the Congo fauna, in projects for its protection.

Some of the members of the Cercle, now in the Congo, are writing for the *Bulletin* on conditions as they find them there. Dr. R. Van Saceghem, for example, predicts the total extinction of the elephant throughout the Congo within fifty years if the present killing goes on unrestricted. He even questions the right of the native to slaughter elephants not only for food but in the search for ivory, which now brings unprecedented gain. Agriculture and animal husbandry in the Congo, he argues, would undoubtedly be benefited if the native could be induced to divert his activity from wasteful elephant hunting to the cultivation of his own lands. There can be no doubt of the menace to the future stock of elephants through the indiscriminate massacre of old and young of both sexes in pits and traps.

The success of the experimental station at Api in the Uelle district has proved that the African elephant can be domesticated and taught to work, provided it is captured young. No fewer than forty elephants are now in training at Api, and a second station for the same work is to be established in the Eastern Province of the Belgian Congo, in the hope of relieving the natives, eventually, from most of the hardship of portage.

With regard to the other large mammals needing protection, the Cercle Congolais calls attention to the success of the British colonies in tropical Africa in regulating hunting so as to attract sportsmen, increase the revenues of the colony, and yet keep intact the stock of wild game. Wise laws strictly and impartially enforced are the sole means to this end.

Conditions in the highlands of the border districts of the Congo are essentially similar to those in the Sudan and East African colonies. But it must be remembered that the forested lowlands of the central Congo basin offer difficulties which are perhaps more serious. Game is not found in herds, nor so plentifully that it would attract the sportsmen for the pleasure of hunting, nor is the climate suited to healthful exertion. On the other hand, the native population is relatively dense and virtually

without domestic animals from which to draw a supply of meat. Severe restrictions on the possession of firearms by natives, and the prohibition of wasteful methods of destruction are the fundamental measures to be taken, but will require ceaseless vigilance.

The creation of game refuges in the less populous districts will prove of value, while careful study by trained zoölogists on the spot will suggest further means of perpetuating the fauna, despite the exigencies of civilizing influences. The Cercle Zoologique Congolais is thoroughly aware of the need of further collecting of specimens for museums and zoölogical gardens of recognized scientific standing, and is pledged to favor every effort to spread knowledge of the animal life of the Congo basin. Only scientific investigation of the fauna can assure its survival.

PROTECTION OF FAUNA IN QUEENSLAND.—Following are some excerpts from an article contributed by Heber A. Longman to *Save Australia: A Plea for the Right Use of Our Flora and Fauna*, edited by Sir James Barrett, K. B. E., Melbourne, 1925:

"Owing to its immense area (670,500 square miles), and the variety of environmental zones, Queensland possesses a wealthy fauna containing many forms of special interest."

"In November, 1921, a new Act, known as 'The Animals and Birds Act of 1921,' containing important revisions and restrictions, was passed, and this valuable measure put Queensland into the front rank of civilized countries so far as legislation is concerned."

"In April, 1922, the Department of Agriculture and Stock issued large notices, in which the birds that are *not* protected, or partially protected, were listed, whilst in large type it was emphasized that all other wild animals or birds were totally protected during the whole year throughout Queensland. Special publicity was given to this notice by posting it on railway stations. . ."

"In March, 1923, Queensland had no less than 108 sanctuaries, including such large areas as Hinchinbrook Island (97,280 acres), Bellenden Ker Reserve (79,000 acres), Stradbroke Island (78,720 acres) and the Lamington National Park near the border of New South Wales (47,000 acres). . ."

"The Government of Queensland has been most sympathetic to the requests of nature-lovers, and the Hon. W. N. Gillies, Minister for Agriculture and Stock, and his officers have done valuable work. Many large and

important reserves have been recently proclaimed, and additions are frequently being made. Among important proposals for the future is a reserve by the side of the main Southern railway, where travelers by mail trains will be able to see large kangaroos, wallabies, and emus in a state of nature. . . ."

"Among the school children excellent propaganda has been done by the Gould League of Bird Lovers, now merged into the Nature Lovers' League of Queensland. . . ."

"Although this short account deals with mammals and birds only, it is of interest to note that the world-famous *Ceratodus* or Queensland Lung-fish, is totally protected by legislation. Special placards to this effect are posted on the banks of streams in South-eastern Queensland where this 'living fossil' is either found naturally or has been introduced."—H. C. R.

SOUTH AFRICAN NATIONAL PARK.—A Bill for the permanent establishment of a great National Park and Sanctuary for wild animals will shortly come before the Union of South Africa. The Transvaal, in which the proposed park is located, has the credit of being the first state in Africa to realize the importance of protecting wild life. In March, 1898, two years before the Conference of African Powers called by the late Lord Salisbury led to the establishment of reserves and sanctuaries in many parts of Africa, the Transvaal Government had set apart a district on the Sabi River as a sanctuary, in which it was forbidden "to hunt, shoot, seek, or in any way to intimidate, to chase, or to drive, or in any way disturb any game or birds in the game reserve." During the South African War the regulation was not enforced but immediately afterward it was again proclaimed. In 1903 the sanctuary received important additions, and now occupies an area of approximately 200 miles by 60. A warden and rangers were appointed and an adequate native staff provided. In the succeeding quiet years the game, free from the attacks of man, steadily multiplied.

Elephants have been coming back from the Portuguese Territory, and with encouragement would establish themselves permanently. There are still a few black rhinoceroses and the possibility has been suggested of transporting to the reserve the few remaining white rhinos of South Africa. Hippopotami are still plentiful. Giraffes, since the war, have been numerous. Buffaloes are present and only require the protection of the sanctuary.

Zebra, wart hogs, and bush pigs exist in great numbers. Antelopes, eland nyala, kudu, roan, sable, blue wildebeeste, waterbuck, and many of the smaller forms are fairly numerous. There are lions, leopards, cheetahs, caracals, servals, hunting dogs, and hyenas. The bird life is extraordinarily rich.

EXTINCT ANIMALS

EXPLORATIONS FOR FOSSIL VERTEBRATES.—

The most important field work during the season was the Third Asiatic Expeditions' explorations in Mongolia. The results of this brilliantly successful season will be summarized by Mr. Andrews in a later number of *NATURAL HISTORY*. In addition, three expeditions were sent to the Western United States through the support of Mr. Childs Frick. The first, in the Santa Fé basin of New Mexico, was personally directed by Mr. Frick, and secured a large number of skulls, jaws, and parts of skeletons of Miocene mammals, principally deer, camels, horses, rhinoceroses, mastodons, dogs, bears, cats, and other characteristic animals of the later Tertiary period. These represent a stage in the succession of western faunas that has been imperfectly known and poorly represented in our collections.

A second expedition, in charge of Albert Thomson, continued work in the Snake Creek fossil quarries, obtaining considerable collections, although chiefly of fragmentary material, from two horizons, one older, the other later than the Santa Fé fauna just mentioned. Among the interesting finds was a skull and part of the skeleton of a rare genus of three-toed horse, *Archæohippus*. Especial search was made for additional remains of the famous *Hesperopithecus*, which was discovered in these quarries. The results of this search will be announced later after the material has been critically examined.

A third party, in charge of Doctor C. C. Mook, visited various small, scattered fossil localities in southwestern Montana and secured a number of specimens of the little-known Tertiary mammals of this region, among them skulls of squirrels, horned rodents, oreodonts, and others. An interesting fragment was an opossum jaw from the Middle Miocene, the first definite record of a marsupial from this horizon in America.

MAMMALS

MUSEUM TO HAVE GROUP OF OSBORN CARIBOU.—Mr. James L. Clark, assistant director of the American Museum of Natural



A herd of Osborn caribou (*Rangifer Osborni*) on the very top of a high mountain. The great expanse of country in the background is all caribou barrens and all well above timber line. The average herd usually contains several big bulls, which may be distinguished by their conspicuous white necks

History, in charge of preparation, has recently returned from an expedition into the Cassiar Mountains of Northern British Columbia, where he went to obtain material and studies for a habitat group of the Osborn caribou.

Since the type specimens of these fine animals were secured in 1902 by Andrew J. Stone, and described and named in honor of President Henry Fairfield Osborn, by Dr. J. A. Allen, no others have come to this Museum. This variety of caribou, which is the richest in color and largest in horn and body of all the great caribou group, is to be shown in the Hall of North American Mammals, and it is befitting that this group should be one of the finest in the whole Museum.

Facts regarding the extent of range, or even the approximate number of these caribou, are very meagre, and when in May, 1925, news was broadcast of a great gold strike in this locality, there was much concern about their welfare and that of the other game of this country.

Leaving New York August 9, Mr. Clark went from Wrangell, Alaska, up the Stikine River to Telegraph Creek, where he outfitted and proceeded by pack train to the southeast section of Dease Lake. Here he found the caribou very abundant: it was not unusual during a single day for him to observe many herds, averaging from thirty to forty animals.

Many thousands were seen in the three weeks that Mr. Clark was in their locality, and he estimates that he examined fully three hundred big bulls while engaged in selecting the largest and most typical male for the group.

He found the caribou ranging extremely high, at times on the sky-lines of the highest mountains, and always above timber line (which here is about 6,000 feet), on the great rolling moss- and grass-covered plateaus of these mountains. No place seemed too high or too cold for them. They were even up on the peaks among the last year's snows, where one would expect to find only the mountain sheep. They migrate south to these undulating uplands for their summer feeding, and late in the fall return to the more open and wind-swept barrens of the North, where the snows are not so deep. It is evident, however, that a few remain throughout the winter, as some shed antlers were found.

Seven specimens in all were secured: two fine large males, two females, and two young bulls. The horns of the cows and the bull calf were still in the velvet, and this phase will be shown in the group.

PRONGHORNED ANTELOPE INCREASING.— Friends of the pronghorned antelope will be glad to learn through Dr. E. W. Nelson's report on the "Status of the Pronghorned

Antelope, 1922-1924," *U. S. Dept. of Agriculture Bull.* No. 1346, August, 1925, that the numbers of this unique American species are actually on the increase in many places. Doctor Nelson gives, in his full and comprehensive summary of conditions, many interesting facts and figures. A few passages from this authoritative paper will afford a glimpse of existing conditions:

"Where the pronghorn occurred with the buffalo, people best qualified to judge consider that it exceeded that animal in numbers. It has been estimated that the buffalo herds at one time numbered from thirty to sixty million animals. In view of the greater territory occupied by the pronghorn and its known abundance, it may be considered a conservative estimate to place its probable original numbers at not less than thirty to forty millions, and possibly more.

"As against the many millions of pronghorns once inhabiting this continent a recent census, taken through the Biological Survey and detailed elsewhere, shows approximately 30,000 survivors.

"The hunting of antelope is now forbidden by law almost throughout its range. In the United States, of the 16 States in which these animals still occur, Wyoming is the only one in which their hunting might be legalized."

"The number of game animals of each species to be maintained in each area should be determined by a careful study of the conditions in the area by trained experts having practical knowledge of the requirements of the different species. It should be clearly understood that at the present time and for some years to come antelope need strict protection practically throughout their range, the one probable exception being in a limited area in Wyoming."

THE LION IN EUROPE.—Mr. Madison Grant presents some interesting evidence from Herodotus as to the existence, 480 B.C., of lions in Macedon, a country lying north of ancient Greece; he also cites a paragraph from Sir Harry Johnston's *The Story of My Life* as to the presence of lions in North Africa in 1880. Here is the lion statement:

"Herodotus, Book VII, verses 125, and 126, describing the march of Xeres through Macedon:

"Upon this march the camels that carried the provisions of the army were set upon by lions, which left their lairs and came down by

night, but spared the men and the sumpter beasts, while they made the camels their prey. I marvel what may have been the cause that compelled the lions to leave the other animals untouched and attack the camels, when they had never seen the beast before, nor had any experience of it.

"That whole region is full of lions and wild bulls, with gigantic horns which are brought into Greece [Note by M. G: this is the urus—*Bos primigenius*]. The lions are confined within the tract lying between the river Nestus—which flows through Abdera—on the one side and the Achelous which waters Acarnania, on the other.

"No one ever sees a lion in the forepart of Europe east of the Nestus, nor through the entire continent west of the Archelous, but in the space between these bounds lions are found."

THE LION IN NORTH AFRICA.—Sir Harry Johnston in *The Story of My Life*, p. 66, says, speaking of lions in 1880:

"... on a high and densely wooded plateau with the higher mountains of the Aurès mass rising to about seven thousand feet. It seemed a superb country, strangely little inhabited, the last refuge of the lion, which in those days was seemingly quite common—Allégo had a tame, half-grown lion cub at his house in Bône [near to Tunis-Algerian border]; one heard the lions roaring at night time not far away, and I actually saw the male and female lion already referred to. They were killed—prosaically enough—by poisoned bait. The French had accumulated a great herd of cattle . . . and their presence at the camp attracted the lions and leopards. In the course of a few more years the lion in these regions and elsewhere in North Africa became completely extinct. The leopard still lingers, here, in Western Algeria, and Morocco. Those I have seen—dead or stuffed—in Morocco-Algeria, struck me as being exceptionally large, compared to the two or three varieties seen in India, Malaysia, and tropical Africa. Their rosettes are larger, more jaguar-like, and some of the males attain the dimensions of a large jaguar."

A NEW HANDBOOK.—The department of mammals has just published, as No. 61 of the *Guide Leaflet* series, a handbook on "The Capture and Preservation of Small Mammals for Study," by H. E. Anthony. This paper has been written for those who wish to learn

how to collect and make study skins of small mammals. Frequently sportsmen have inquired how they could preserve and bring back for the Museum the many interesting small mammals they find while hunting for big game, or younger men searching for museum technique and collecting experience have asked for some handbook on the subject. "The Capture and Preservation of Small Mammals for Study" devotes about fifty pages to the more important details, and has twenty-four illustrations showing how to skin small mammals, make a collecting chest, etc. Copies of the handbook may be purchased at the sales booth, Memorial Hall, or at the library.

OTHER MUSEUMS

THE NATURAL HISTORY MUSEUMS OF LENINGRAD AND MOSCOW.—Curator Bashford Dean is returning from one of his annual tours of Europe in the interests of the Metropolitan Museum of Art and the American Museum of Natural History. From Leningrad he sends to Professor Osborn a letter, dated July 18, 1925, describing the present progress of the Russian museums of art and natural history, which contains most gratifying news to lovers of art and of nature. The following is a free transcription of his letter:

"Professor Karpinskii still presides over the Zoological Museum of Leningrad, where we enjoyed a glimpse of veritable treasures. The last boreal mammoth (*Elephas primigenius*) is mounted just as it was found hunched up in a little gully at the mouth of the Lena River. True, it is somewhat 'doctored,' for the back had been eaten off by dogs or wolves, the face badly damaged, and the trunk was missing, but the fine long 'wool' shows its ruddy color, and the stumpy tail is quite unlike that of the second fine skeleton, which suggests that the first tail was not 'right.' So fresh was the meat that the zoölogist in charge of the party ventured to cook and eat a bit of it; it nearly killed him—three weeks abed of ptomaine poisoning! The skeleton is mounted near by and is the only one absolutely complete (one foot is plaster-boned, but the real foot is close at hand in a jar of alcohol). Pity that we cannot land such a monster in the American Museum! The ice rhinoceros heads are quite as good in their way, the latest one so good that it is, alas, smelly! It is a miracle to see these beasts in the flesh.

"There is, too, a fine Steller's sea cow which lacks only its flippers. I went over the material of *Rhytina* which is in their storeroom, and there is unfortunately little to tempt one. There are about thirty skulls, quite a lot of vertebrae, a few complete ribs and parts of others, but sketchy at the best. I think of Doctor Townsend's chances to get a quantity of this material in the North Pacific in his "Albatross" days! The extinct cormorant I did not see; it has been carried off to the safe against possible troubles here.

"Palaeontologists would be delighted with the Stegocephalians and Theromorphs. The Leningrad Museum has a lot of them; in a cliffside a whole cemetery has been unearthed where the whole beasts come out in consecutive lumps. That there are Permian mammals the people here doubt not at all. I saw, too, all the material of Karpinskii's queer shark teeth *Helicoprioni*, which seems to straddle the balance spring of a huge watch; how the great creature would have appeared living is a problem indeed!

"We are much impressed by the interest which the present government is giving to museums. There are forty museums, open and active in Moscow, including one of the best art museums I have ever seen, and thirty-seven in Leningrad. The museum galleries are full of students of all ages, guided by instructors. I learn that everything possible is being done toward giving scientific education to the young."

BICENTENARY OF THE RUSSIAN ACADEMY OF SCIENCES.—The American Museum was one among many scientific institutions invited to attend the bicentenary of the Russian Academy of Sciences. As we were unable to send a personal representative, Professor Peter Sushkin carried for us the following letter to the President of the Academy:

"DEAR PRESIDENT KARPINSKII:

The comparatively youthful American Museum of Natural History, founded in 1869, sends its greetings to the Russian Academy of Sciences at Leningrad on the celebration of the two-hundredth anniversary of its foundation. On this auspicious occasion the members of our scientific staff desire to reaffirm our admiration for Russian achievement in every branch of Natural History and our desire to continue and to strengthen our scientific intercourse with Russia in every branch to which Russian naturalists have devoted their lives,

"In zoölogy we especially acknowledge our indebtedness to the explorations and writings of Pallas, Middendorff, Eversmann and, Przewalski. In paleontology we honor the names of Kovalevski, Amalitzski, Cherski, Borriasiak, and Pavlov. In embryology and comparative anatomy we place on our honor roll the names of Metchnikoff, Kovalevski, Zalenski, Wolff, von Baer, Severtzov; in invertebrate zoölogy, those of Korotneff Bobretski, and Nassonov. We pay tribute in geology to Inostrancev, Mushketov, Karpinski, Pavlov, Obruteher; in ichthyology to Grimm Kessler, von Baer, Eichwald, Berg, Schmidt, Nordmann, Borodin; in the explanation and description of bird life to Severtzov, Menzbier, Zarudny, and Sushkin; in mammalogy, besides the early explorers mentioned above, to Satunin and Nassonov; in anthropology, to Anutehin and many others.

"For the past half-century the explorers of the American Museum of Natural History have been welcomed to the study and examination of the collections in Russian museums, have been conducted through the paleontologic and geologic wonders of the Russian country, and have been welcomed in their own explorations, geologic, palæontologic, and anthropologic, to the farthest zones of Russian culture and civilization. Thus in science have been maintained the bonds of mutual good will and interchange of thought and interest which have also been maintained between the Russian and American peoples at large.

"With our felicitations and best wishes for the new century,.

HENRY FAIRFIELD OSBORN,
President."

SCIENCE OF MAN

In the hall of the Age of Man, American Museum, is a fine exhibit of the fossil remains of the most primitive known member of the human family, the *Pithecanthropus erectus* Dubois, the ape-man of Java. This exhibit has been prepared and arranged by Prof. J. H. McGregor of the department of zoology, Columbia University. Explanatory cards and labels clearly set forth the significance of each fossil and cast, so that "he who runs may read."

APPOINTMENTS

THE UNIVERSITY OF VIENNA has called Professor Jan Versluys of Hilversum, Holland, as chief of the Morphologische Institut; he

takes this position October first. Dr. Wilhelm Marinelli, who has been carrying on his researches in the American Museum during the past six months, is leaving here to take the position of assistant in the Institut. Coordinated with morphology in the University is the Physiologische Institut for the directorship of which no appointment has as yet been made. Both Doctor Versluys and Doctor Abel, of the Paleobiologische Institut of Vienna, have had intimate relations for many years with the American Museum, and in saying good-bye, Dr. Wilhelm Marinelli takes to Professor Versluys President Osborn's congratulations and the assurance that the American Museum will always be ready to coöperate, so far as is in its power, with this new branch of the great Austrian university.

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SINCE the last issue of NATURAL HISTORY, the following persons have been elected members of the American Museum, making the total membership 8324:

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PRESENT RACES OF MAN

JANUARY - FEBRUARY

The first number of *Natural History* for 1926, edited by Dr. Clark Wissler, curator-in-chief of the division of anthropology, is to be devoted to present-day man with special reference to his physical characters. In this issue Prof. Raymond Pearl of Johns Hopkins stresses the distinction between the stationary upper limit or span of life and the mean or average length of life which is now being rapidly increased. Dr. Rueben Ottenberg puts man into four classes according to the presence or absence of two substances in the red corpuscles of the blood which may by mixture cause it to coagulate.

Dr. Milo Hellman explains the relation existing between the shape of the human face and the form of the jaws and teeth. Dr. Charles B. Davenport discusses the several methods which have been employed in recording skin color and sets forth the advantages of the color-top with glass disks of various colors which are blended by spinning.

The Indians of California are classified according to bodily form by E. W. Gifford of the University of California. He finds three main types, one of which, the largest, is again divided into three subtypes.

Professor Fay Cooper Cole of the University of Chicago writes on the races of Malaysia which include a supposedly aboriginal population of pygmies and immigrants of other types, one of which has extended its range throughout the Pacific Islands. In connection with their racial characteristics he describes their customs.

Two little known tribes of Colombia, one on the mountains and one on the coast, are contrasted as to physical appearance, customs, and general bearing, by Dr. John Alden Mason, assistant curator of Mexican archæology.

Prof. Frank G. Speck of the University of Pennsylvania describes a night under the stars during midwinter in Labrador and suggests that at one time houses had only one side wall and no roof.

Dr. Gilbert L. Wilson, who in times past made many visits to North Dakota for the Museum, gives in a dialogue a view of the difficulties a man of mature years must undergo to change his ways of life.

Prof. Osborn discusses in biological terms the varieties of living men, the evolutionary results of man's past life, and suggests what might result in the future if certain occupations should be continued for many generations.

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Subscriptions by check and inquiries regarding membership should be addressed: George F. Baker, Jr., Treasurer, American Museum of Natural History, New York City.

FREE TO MEMBERS

NATURAL HISTORY: JOURNAL OF THE AMERICAN MUSEUM

NATURAL HISTORY, published bimonthly by the Museum, is sent to all classes of members as one of their privileges. Through NATURAL HISTORY they are kept in touch with the activities of the Museum and with the marvels of nature as they are revealed by study and exploration in various regions of the globe.

AUTUMN AND SPRING COURSES OF POPULAR LECTURES

Series of illustrated lectures, held in the Auditorium of the Museum on alternate Thursday evenings in the fall and spring of the year, are open only to members and to those holding tickets given them by members.

Illustrated stories for the children of members are presented on alternate Saturday mornings in the fall and in the spring.

MEMBERS' CLUB ROOM AND GUIDE SERVICE

A room on the third floor of the Museum, equipped with every convenience for rest, reading, and correspondence, is set apart during Museum hours for the exclusive use of members. When visiting the Museum, members are also privileged to avail themselves of the services of an instructor for guidance.

THE AMERICAN MUSEUM OF NATURAL HISTORY has a record of fifty-five years of public service, during which its activities have grown and broadened, until today it occupies a position of recognized importance not only in the community it immediately surrounds but in the educational life of the nation and in the progress of civilization throughout the world.

Every year brings evidence—in the growth of the Museum membership, in the larger number of individuals visiting its exhibits for study and recreation, in the increasing activities of its school service, in the wealth of scientific information gathered by its world-wide expeditions and disseminated through its publications—of the increasing influence exercised by the institution. In 1924 no fewer than 1,633,843 individuals visited the Museum as compared with 1,440,726 in 1923 and 1,309,856 in 1922. All of these people had access to the exhibition halls without the payment of any admission fee whatsoever.

The **EXPEDITIONS** of the Museum have yielded during the past year results of great value. The collections being made by Mr. Arthur S. Vernay in Angola, Africa; the studies of Andean avifauna pursued by H. Watkins in Peru; the three fossil expeditions in the western United States, in New Mexico, and Nebraska and Montana; the extensive survey of Polynesian bird life conducted by the Whitney South Sea Expedition; the work pursued in selected faunal areas of Venezuela by Mr. G. H. H. Tate; the field observations and collections made in Panama by R. R. Benson; the studies of microscopic pond life of Mt. Desert Island by Dr. Roy W. Miner and Mr. Frank J. Myers; and the continuation of the brilliant work of the Third Asiatic Expedition during the past season—these (and the list might be extended) are among the notable achievements of the past twelve months.

The **SCHOOL SERVICE** of the Museum reaches annually about 7,000,000 boys and girls through the opportunities it affords classes of students to visit the Museum; through lectures on natural history especially designed for pupils and delivered both in the Museum and in many school centers; through its loan collections, or "traveling museums," which during the past year circulated among 433 schools, with a total attendance of 1,479,914 pupils. During the same period 598,132 lantern slides were loaned by the Museum for use in the schools as compared with 440,315 in 1923, the total number of children reached being 5,407,525.

The **LECTURE COURSES**, some exclusively for members and their children, others for the schools, colleges, and the general public, are delivered both in the Museum and at outside educational institutions.

The **LIBRARY**, comprising 100,000 volumes, is at the service of scientific workers and others interested in natural history, and an attractive reading room is provided for their accommodation.

The **POPULAR PUBLICATIONS** of the Museum, in addition to **NATURAL HISTORY**, include *Handbooks*, which deal with the subjects illustrated by the collections, and *Guide Leaflets*, which describe some exhibit or series of exhibits of special interest or importance, or the contents of some hall or some branch of Museum activity.

The **SCIENTIFIC PUBLICATIONS** of the Museum, based upon its explorations and the study of its collections, comprise the *Memoirs*, of quarto size, devoted to monographs requiring large or fine illustrations and exhaustive treatment; the *Bulletin*, issued since 1881, in octavo form, dealing with the scientific activities of the departments, aside from anthropology; the *Anthropological Papers*, recording the work of the staff of the department of anthropology; and *Novitates*, devoted to the publication of preliminary scientific announcements, descriptions of new forms, and similar matters.

For a detailed list of popular and scientific publications with prices apply to:

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