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Contents

BULLETIN

New York Zoological Society

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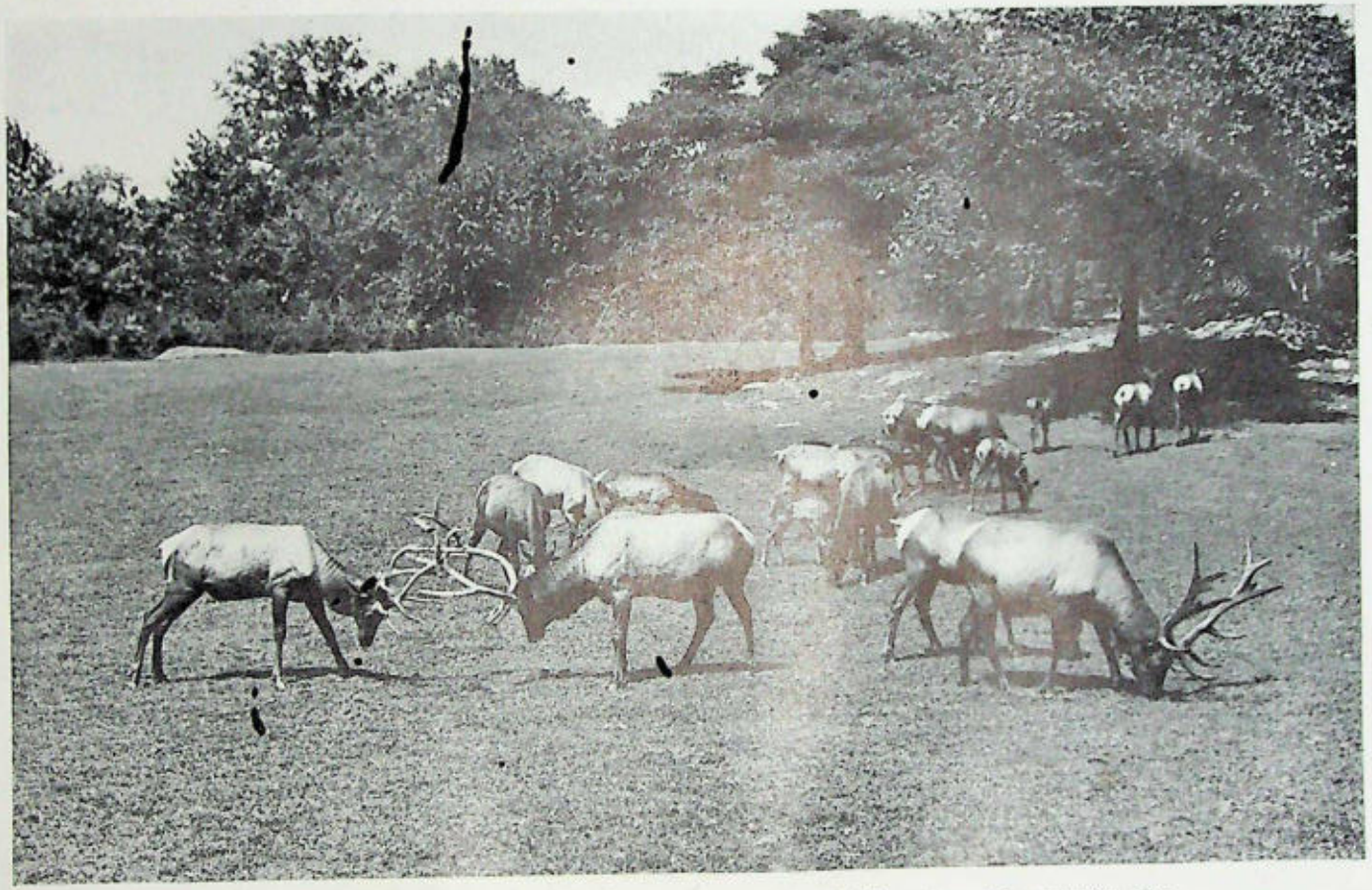

Wapiti sparring with their antlers. The bull wapiti may indulge in playful sparring with a companion after the velvet has begun to leave the antlers. At the height of the mating season the sparring assumes a serious intent and the bulls exert their full strength against one another. On rare occasions the tines spring past one another and interlock so firmly that the animals can not free themselves. This means death for both animals either from predatory animals or from slow starvation.

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Horns and Antlers

Their Occurrence, Development and Function in the Mammalia[1]

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Illustrations from photographs made in the Zoological Park unless otherwise noted

PART II

IT has been pointed out in the beginning of this article that antlers are bony in their nature as contrasted with true or hollow horns which are epidermal in their origin (with bony cores). Dr. Noback, in this issue of the BULLETIN, tells how antlers grow and describes the early stages of antler formation.

Antlers are the exclusive property of the deer, the Cervidae. Further than that, they are restricted (except in the case of the caribou) to the male deer. The males of all the living, typical deer (the Chinese water-deer is an exception) have antlers, but there are some deer, to be considered more or less aberrant (the musk-deer), which have no antlers on either sex.

Deer have always been featured in the chase as the favorite quarry of the hunter. In Europe the stag was royal game, in many countries reserved as the sole property of the king or of the nobility, and rather an extensive terminology has been built up about stalking and classifying the heads. A nomenclature was developed to classify the tines of the antlers, and the stag had various names to designate the degree of perfection attained by its antlers. A staggard is a stag of four years, not yet prime, a stag of ten has ten points, a royal stag has twelve or more points, et cetera. The term "antler"[2] was originally applied to the first branch of a deer's horn, but in time came to be applied to the whole deciduous structure.

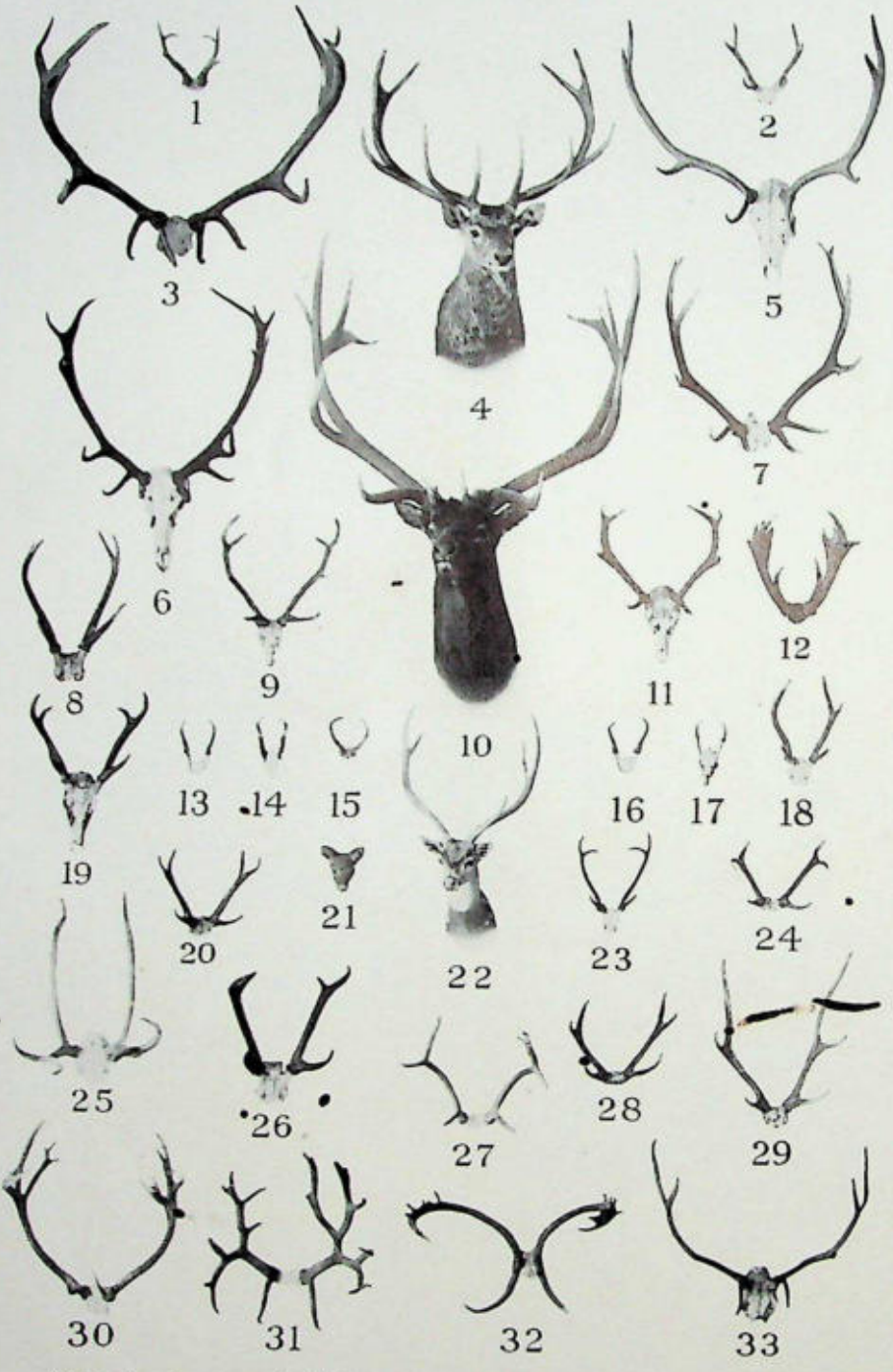
Antlers are like trees in their faculty for adding branches each year. With the exception of the few deer that have unforked horns, the general scheme of growth is to add one branch each year until the bucks become prime adults, when the number of tines remains constant. When the buck has passed its prime the antlers gradually decrease in size and in other ways display a less vigorous and well-controlled growth.

Freak or abnormal antlers are not very uncommon and are sometimes to be attributed to internal disturbances, of which we can understand little, or may be due to the more obvious effects of emasculation through injury or advancing senility. Abnormalities usually take the direction of excessive branching and multiplicity of tines, and in extreme cases the

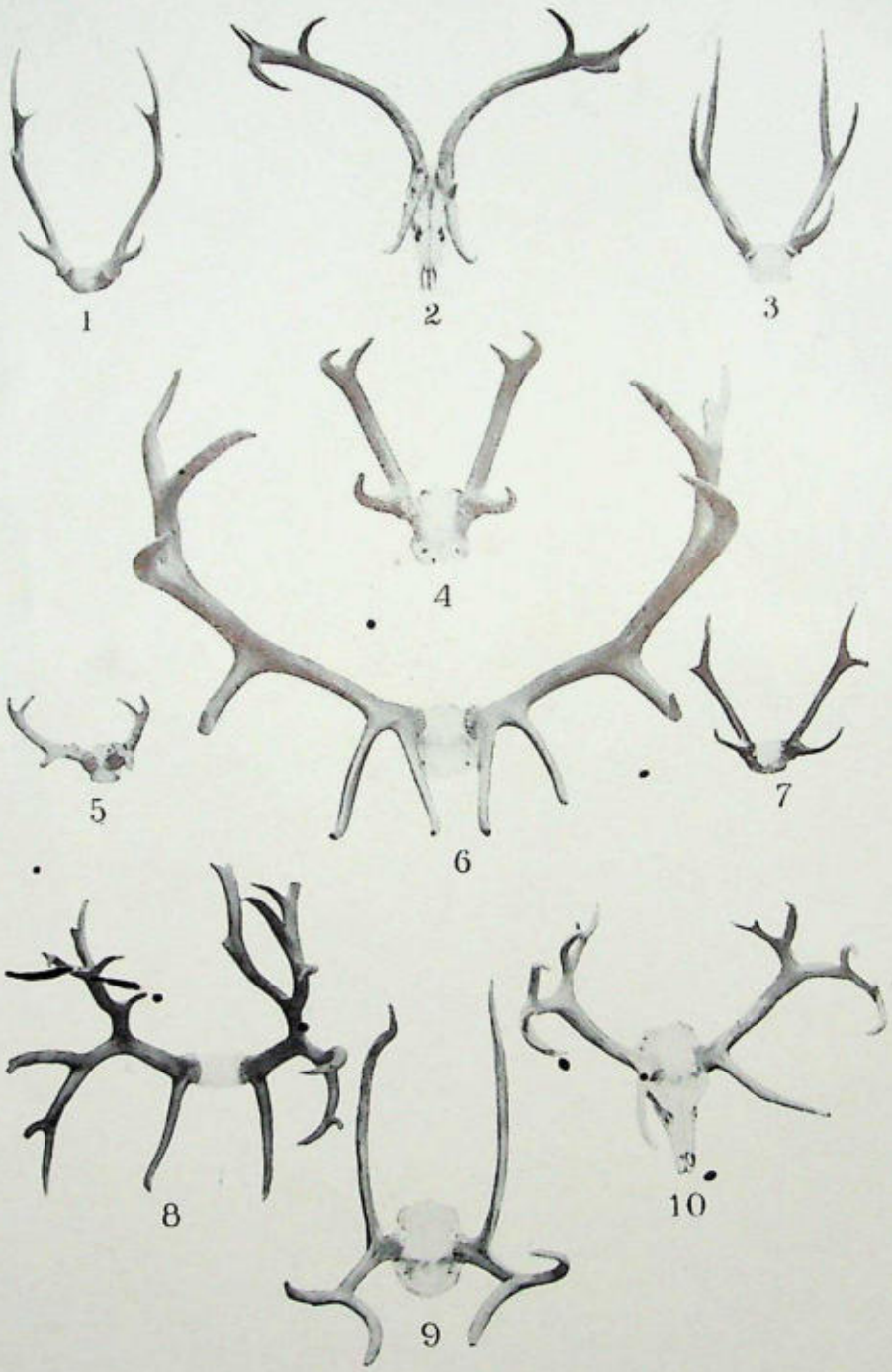
[1] The first part of this article, which discusses horns, appeared in the preceding number of the Bulletin.

[2] The derivation of "antler" goes back through the old French *antoillier* to a corruption of the Latin *antocularis*, before the eye.

Pleistocene deer of Europe and North America. (Above) Giant fallow deer or Irish elk of Europe. (Below) Deer-moose (*Cervalces*) of North America. Copyrighted. Restorations by Charles R. Knight, and published by permission of President Henry Fairfield Osborn, American Museum of Natural History.



Antlers of various types. 1. Siberian roe deer; 2. hog-deer; 3. Altai wapiti; 4. hangul; 5. Arizona wapiti; 6. Yarkand stag; 7. Manchurian wapiti; 8. Bornean sambar; 9. Japanese sika; 10. American wapiti; 11. Manchurian sika; 12. Malay sambar; 13, 14, 15, 16, 17. Various species of muntjac; 18. Basilan sambar; 19. Szechuan sambar; 20. Timor deer; 21. musk-deer; 22. axis deer or chital; 23. ketchang; 24. Luzon sambar; 25. Pere David's deer; 26. Indian sambar; 27. Pekin sika; 28. Formosan sambar; 29. Javan rusa; 30. barasingha or swamp deer; 31. Schomburgk's deer; 32. Eld's deer or thamin; 33. Thorold's deer. All figures to the same scale.



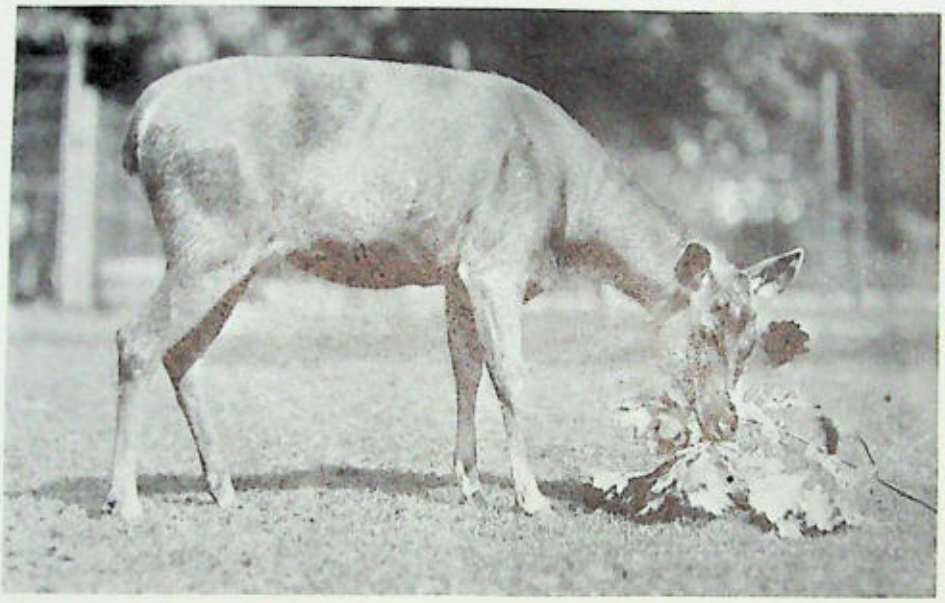
Different antler patterns; 1. Japanese sika; 2. Eld's deer or brow-antlered deer; 3. hog-deer; 4. Malay sambar; 5. roe deer; 6. wapiti; 7. Luzon sambar; 8. Schomburgk's deer; 9. Pere David's deer; 10. barasingha. All figures to the same scale.

Sketch to illustrate nomenclature of tines for red deer type of antler. 1, brow-tine or brow-antler; 2, bez-tine or bez-antler; 3, trez-tine, trez-antler or royal; 4, fourth branch and above form the crown or sur-royals. In the first year the buck develops merely a frontal protuberance, in the second year a simple spike, in the third year the brow-tine appears, and thereafter each year adds a tine until the maximum growth is attained.

typical pattern may be so obscured that the identity of the animal is difficult to ascertain from the antlers alone. Not infrequently the antlers of old bucks become stunted and otherwise retrogressive, and such heads, "going-back head," may differ noticeably from the normal pattern worn by the buck in his prime.

Mr. Madison Grant has noted the occurrence of an unusual type of antler carried by the white-tailed deer of the Adirondacks at the close of the last century. These bucks were known to the local guides and hunters as "swamp deer" or "meadow bucks" and carried antlers which were characterized by robust, heavy beam, extra points and tinelets, and rugose, papillate surface at the base. The "meadow buck" was recognized as something different from the other white-tails of the region and the antler difference appeared to be correlated with shorter legs, heavier body, dorsal stripe, and slight color differences on crown and antlers themselves. It is impossible to assert, with the data available, whether the peculiarities of the antlers of the "meadow buck"

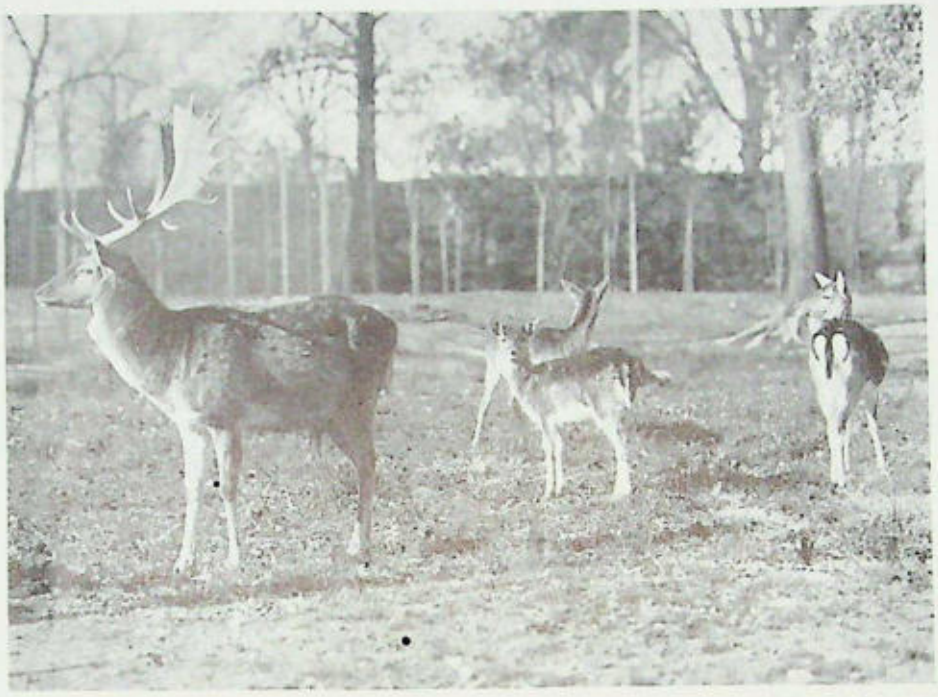
Two characteristic American deer. The antlers of the white-tailed deer, above, are characterized by a pattern of simple tines on an unforked beam; the antlers of the black-tailed deer, below, (this is true of both mule deer and coast black-tailed deer) have the main branches of the beam forked to give off tines in pairs rather than singly. The right antler of this black-tailed deer illustrates an abnormal development and is a "freak" antler; the left antler is typical.



Malay sambar deer. The sambar deer include a number of subspecies that range from southern Asia down through Malaysia to the Philippine Islands. The sambar antlers are simple in pattern and are not very large and spreading, although robust and strong. The lower figure shows the male sambar, and the upper a female, one of the very rare cases of a female with antlers. This female was kept in the New York Zoological Park for a number of years and the antlers did not appear until the deer reached an advanced age.

(Above) The American wapiti, or so-called "elk" of American sportsmen, has superb antlers which at their best are beautifully symmetrical. (Below) The Kashmir stag or hangul (not as old an individual as the wapiti, above) carries antlers very like those of the American wapiti.

The caribou displays antlers intermediate in character between the round and the palmate type. The main beam of the antler is round, but the brow-tines, the bez-tines, and sometimes the crowns are palmate. The upper figure is the Osborn caribou, one of the group of mountain caribou, and the lower is the Grant caribou, a representative of the group of barren-ground caribou.



The fallow deer, above, has antlers with broadly palmate crowns which contrast noticeably with the round type of crown, such as that carried by the axis deer, below.

Among the most beautiful of all sets of antlers are those carried by the mountain caribou, typified by Osborn's caribou. The brow-tines are broad and heavy, the beam is expanded and the whole structure is developed along imposing and majestic lines.

Brow-antlered deer or Eld's deer. The beautiful antlers of this deer are noteworthy because of the extreme development of the brow tine which appears to be a prolongation of the curving beam. The beam is set almost at right angles to the pedicle.

The antler of the muntjac or barking deer is set upon a greatly elongated pedicle which is densely clothed with hair. This pedicle is a conspicuous feature and is the cause of one of its vernacular names, "the rib-faced deer."

(a fine head killed by Mr. Grant and in his possession shows the apparent differences clearly) are, or were, heritable characters of real significance or merely variations within the range of possibility for normal white-tails. There seemed to be no heads intermediate between the "meadow buck" and the normal type, a rather suggestive state of affairs.

The range of individual variation for any given species of deer may permit of considerable antler modification. The abundance or scarcity of food has some effect upon the growth of antlers which, in the case of species like the moose, undoubtedly is a heavy drain upon the vitality of the animal. The surface of the hardened antler is colored, to some extent, by the objects against which the deer rubs to strip off the velvet.

The characters of antlers are sufficiently definitive to form a useful basis for a classification of the deer. While individual variation within a species may be considerable, the fundamental pattern of the antlers remains within limits sufficiently narrow to mark off one group from another. Antlers reproduce themselves on a given individual with remarkable consistency, and any little deviation from the normal that appears will probably reappear as an annual feature.

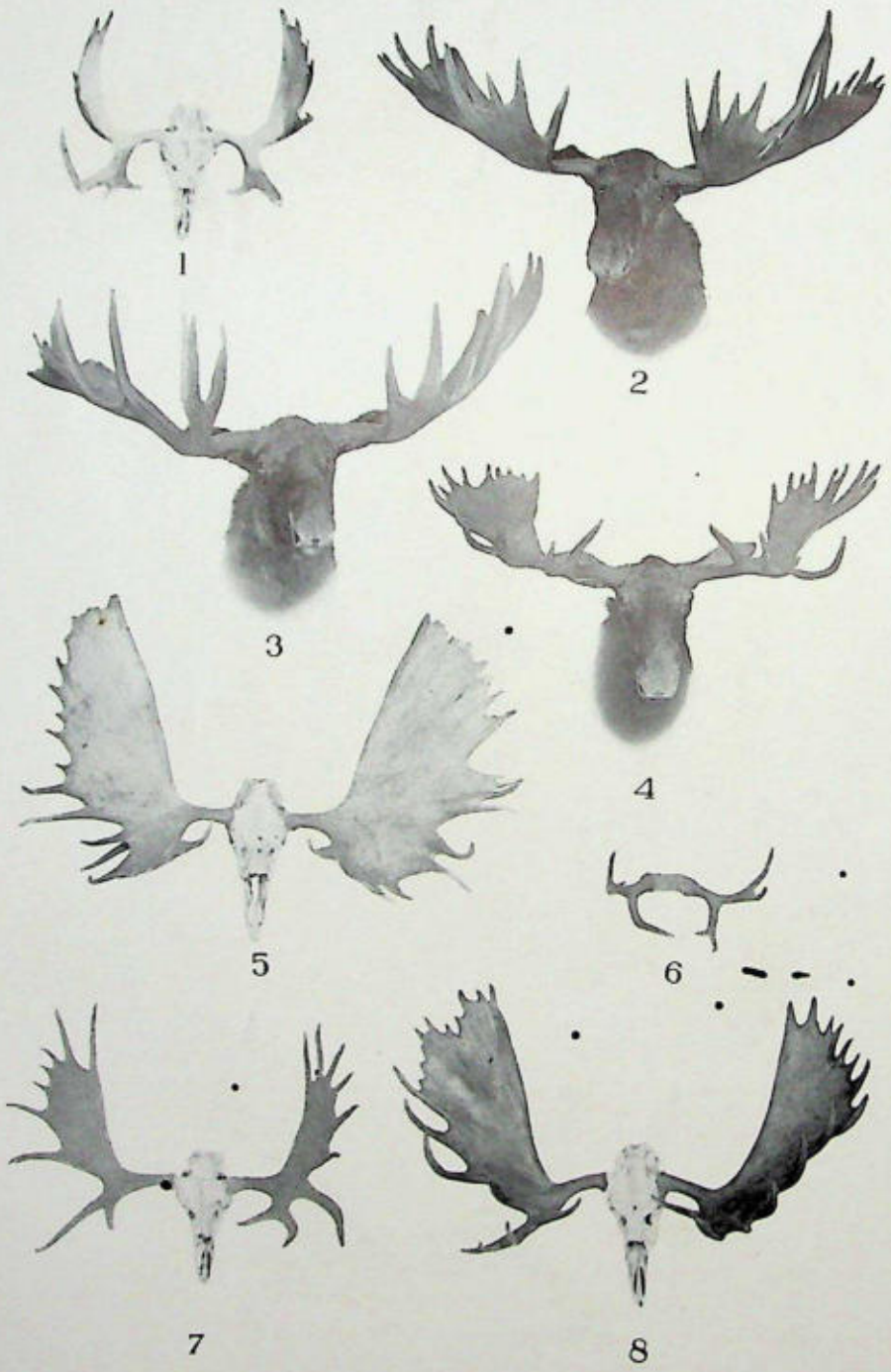
Deer have been grouped accordingly as the antlers have conformed to certain definite patterns. For example, the elaphine group (containing the European red deer and the wapiti, among others) is characterized by rounded, complex antlers which usually carry a bez and always a trez-tine, and the damine group (containing the fallow deer) is distinguished by antlers which normally lack the bez-tine and are more or less palmate above the trez. In the group of American deer the various subspecies of the Virginia deer have antlers the tines of which arise from a nearly horizontal beam and are upright, unforked spikes; the subspecies of mule deer and black-tailed deer carry antlers, the main branches of which fork dichotomously and present an appearance very distinct from the Virginia deer type. The extreme example of dichotomous forking is shown by Schomburgk's

The great moose of the Kenai peninsula, Alaska (*Alces gigas*), grows a massive pair of antlers that constitute the heaviest horns to be found on living mammals. When one realizes that this extensive structure is an annual growth and is dropped shortly after it has hardened and reached a useful stage, wonder is aroused at the wastefulness of the process. The yearly growth of such antlers as these must be a very heavy drain upon the vitality of the animal.

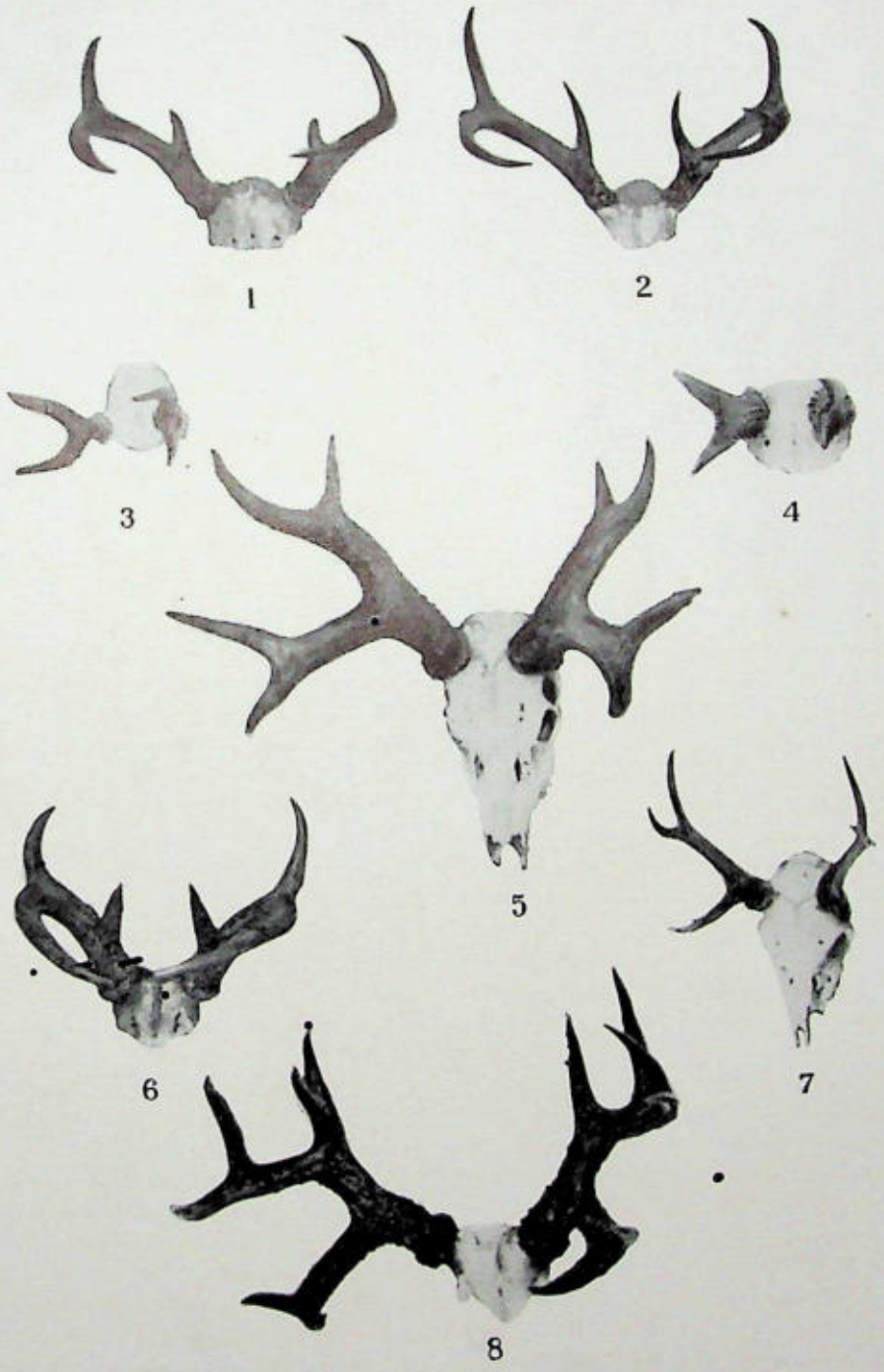
deer where the main branches fork again and again.

The simplest antler is the straight spike of the brocket deer. This is similar in form to the first-year antler of many other deer[2] but in the brockets the antlers remain simple and never branch. The brocket antler does not attain a very great length and seldom exceeds five or six inches. Between this simple type of antler and the complex, many-branched antler of Schomburgk's deer or the palmated, many-tined antler of the moose, there is a vast difference, but there are many intermediate

[2] The name brocket was first used for the young red deer stags and properly belongs to them, but has now become widely used for the small deer of Central and South America.



Types of moose antlers. 1. Shiras' moose (Wyoming); 2, 3, 5, 8. Alaskan moose; 4. Canadian moose; 6. Siberian moose; 7. Scandinavian moose.
All figures to the same scale



Antlers of South American deer. 1, 2. Colombian white-tailed deer; 3, 4. guemal; 5, 8. marsh deer; 6. Brazilian white-tailed deer; 7. pampas deer.
All figures to the same scale

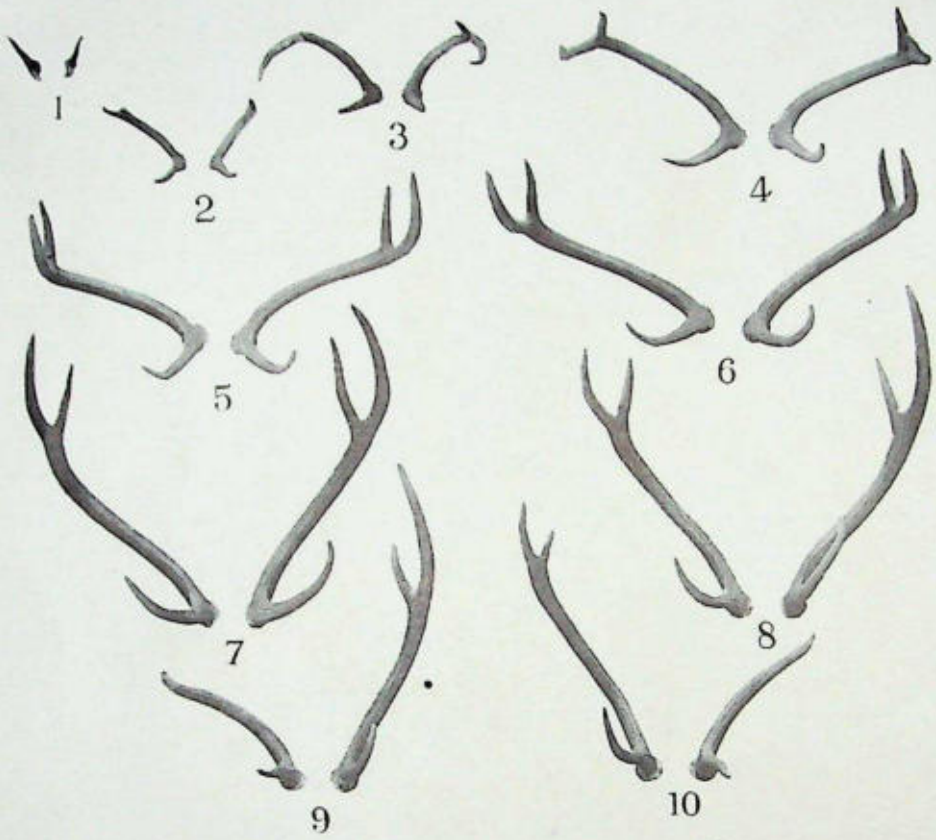
types of antler which bridge over the gap, and the transition is not abrupt. The illustrations will serve to call attention to the various types and patterns of antlers better than written descriptions.

Antlers came into the fossil records about in Miocene times. *Merycodus*, of the North American middle Miocene, had deer-like, branched antlers which may not always have been deciduous. The condition of the burs on some of the specimens indicate that the antlers may have been permanent. Prior to the Miocene the ancestral deer appear to have been hornless. Some writers believe that the deer antler was evolved from a giraffe-like horn, a bony process on the skull covered by undifferentiated skin. This skin was subject to injury, being soft and containing nerves and blood vessels. In due course of time the horn developed a bur or basal ring and the blood supply to the soft skin covering of the upper horn was cut off. When this skin died and stript off, the bony antler as it is known today was the result.

The function of antlers seems to be rather clearly that of a highly specialized sex character. With the exception of the caribou, antlers are carried only by males and become functional and of service to the animal for a limited time, namely, during the breeding season. For most of the year the male deer is either without antlers or the antlers are in the velvet and of no use as weapons. As a defensive mechanism for the group, antlers, therefore, have but little value. Even when carrying fully developed and hardened antlers, deer more often than not flee before attempting to employ these weapons against any formidable enemy. The males of most deer make more or less use of their antlers against one another during the rut, but even against their own kind it may be questioned whether antlers are necessary weapons. It has been noted in deer parks that the master bucks are sometimes possessed of but small antlers or may even be hornless. Antlers are not necessarily the *sine qua non* of domination.

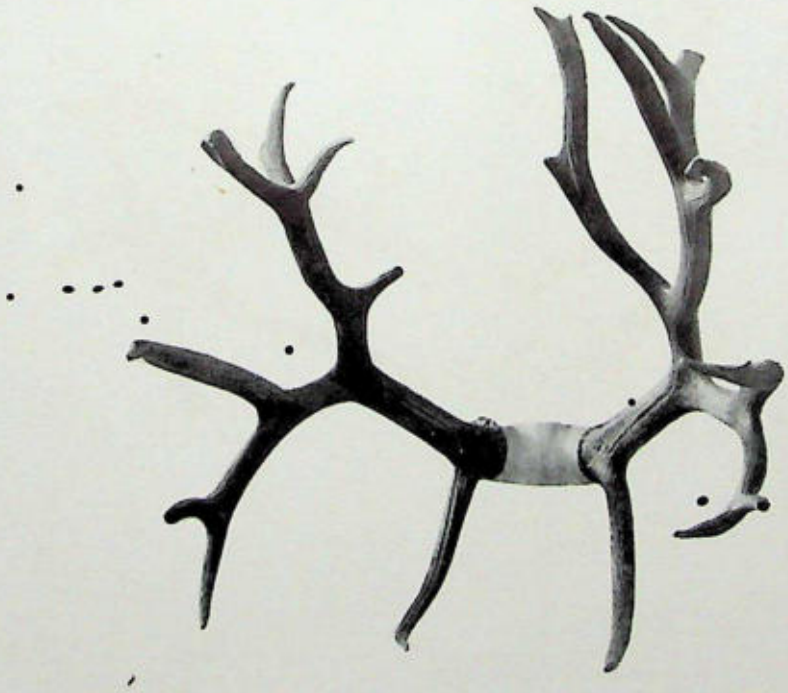
In the one genus (the caribous) where antlers are not obviously a sex-linked character, the antler of the female is conspicuously smaller than that of the male, but is carried for a longer period of time, not being shed until well on in the spring when the calf is born. It has been stated that the possession of horns is an advantage in the dead of winter when the animal must scrape snow away from the vegetation that is its food, and that the larger, hornless males are apt to go hungry at such a time. In this fact may lie the explanation for the horns of the female caribou, they are useful structures, originating and connected with the sexual cycle, but carried over through a period when the unborn young are threatened with a lack of nourishment. No species of hornless (females) deer range as far north as the caribou and we have no way of telling, except by inference, how hornless females would survive the rigors of a winter on the barren grounds. There may be no especial significance attached to the fact that female caribou are horned, but it is strange that no other female members of the widely spread and numerous family are so endowed and rather tempts one to speculate. It is significant to note that the male deer which do not carry antlers—water-deer and musk-deer—have developed the canine teeth into large keen tusks. The females of these species do not have the tusks which are, like antlers, to be considered as sex characters.

Antlers have figured rather extensively as artifacts of early man. The substance of antlers could be easily worked by him and yet was strong and substantial enough to serve a variety of uses. Fragments of antler served as handles to hold flint implements; the beam of an antler might be used with sinew to form a compound bow; or the head of a spear might be formed of the dense tip of an antler. As later uses of antlers might be mentioned the gun-racks of Europe and North America, the sword-racks of Japan, and the almost universal employment of stag-horn for small objects such as knife handles. The demand for stag-horn for handles has been great enough to develop an extensive use of bone, processed to imitate antler, as a substitute. Antlers were an early source of ammonia, and spirits of hartshorn takes its name from the fact that the distillation of antler shavings was formerly used to provide this ammoniacal preparation.



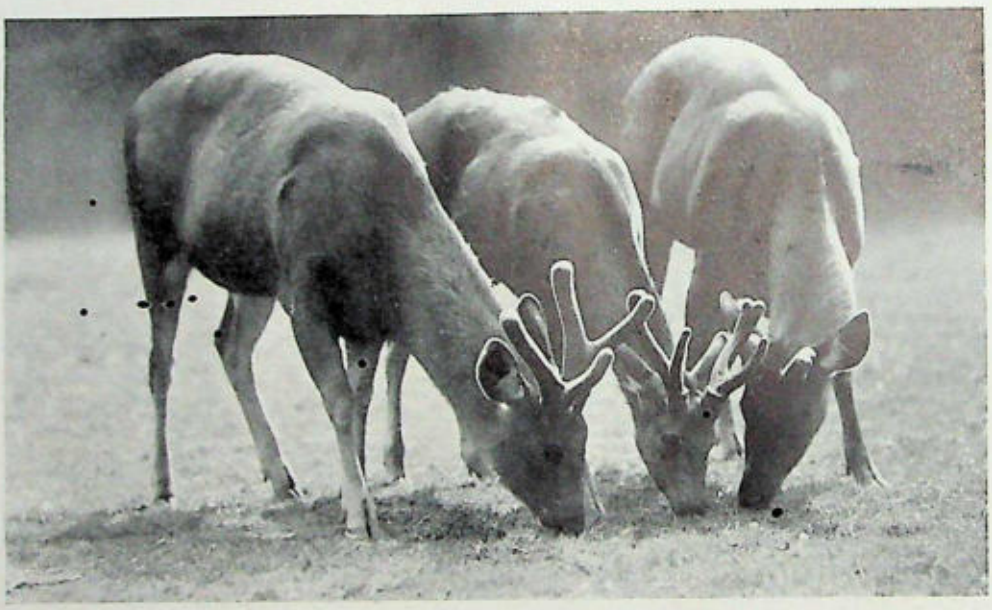
Series of antlers from the same individual. The antlers from an axis deer, in the New York Zoological Park, were saved each year to form an interesting series. It will be noted that there is a regular annual increase in size from the first set to the seventh, when the antlers have attained their peak. In the seventh and eighth sets the antlers hold at maximum size and then lose in the ninth and tenth seasons. The deer is figured with its final set of antlers which are distinctly stunted and degenerate.
Fig. 1—10 all the same scale

Asymmetrical antlers: Bucks past their prime may grow antlers that are not symmetrical, one side may be longer or of a pattern differing from the other. Injury to the growing horn may also cause asymmetry.



Unusual types of antlers. The antlers of the mule deer, above, are abnormal and belong to the class of "freak" antlers. Some disturbance in the internal control of the antler-growing mechanism has allowed a wide departure from the normal mule deer pattern. The antlers of Schomburgk's deer, below, are not "freak" growths but of the type habitually developed by this rare species.

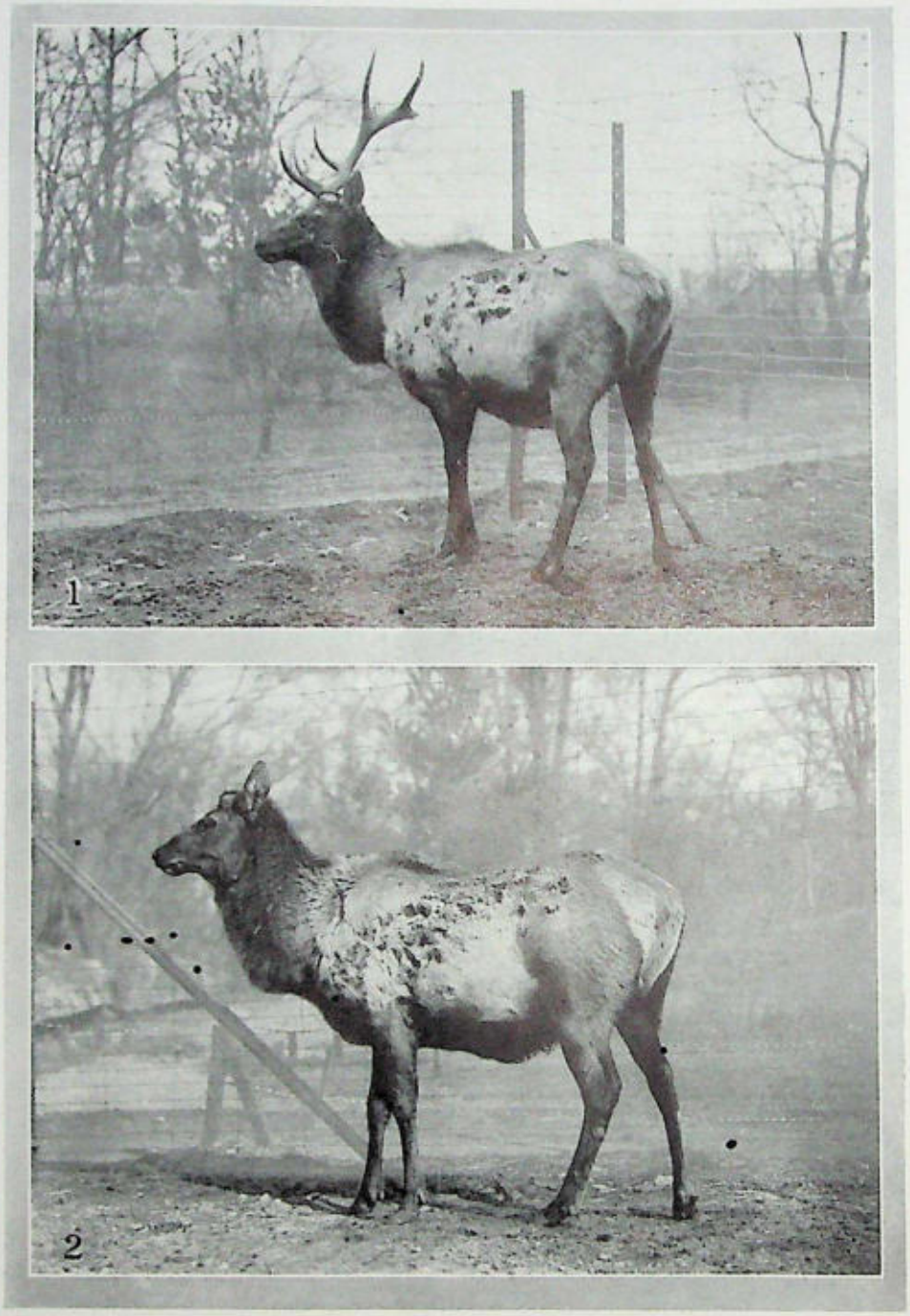
Interlocked antlers of Alaskan moose (above) and mule deer (below). The many-branched type of antler sometimes brings its wearer into difficulties and dangers unknown to the wearer of hollow horns. Fighting male deer may lock antlers so tightly that they can not be extricated, and this occurs oftenest among the species that carry antlers with many tines or branches. Antlers possess a notable degree of springiness and because of the configuration of certain patterns these may be sprung into a locked condition which will require more than the original energy to withdraw them. Also the impact which interlocks the antlers may gain energy from the unhampered freedom of the thrust, a momentum which the animals can not secure once they are entangled head to head.



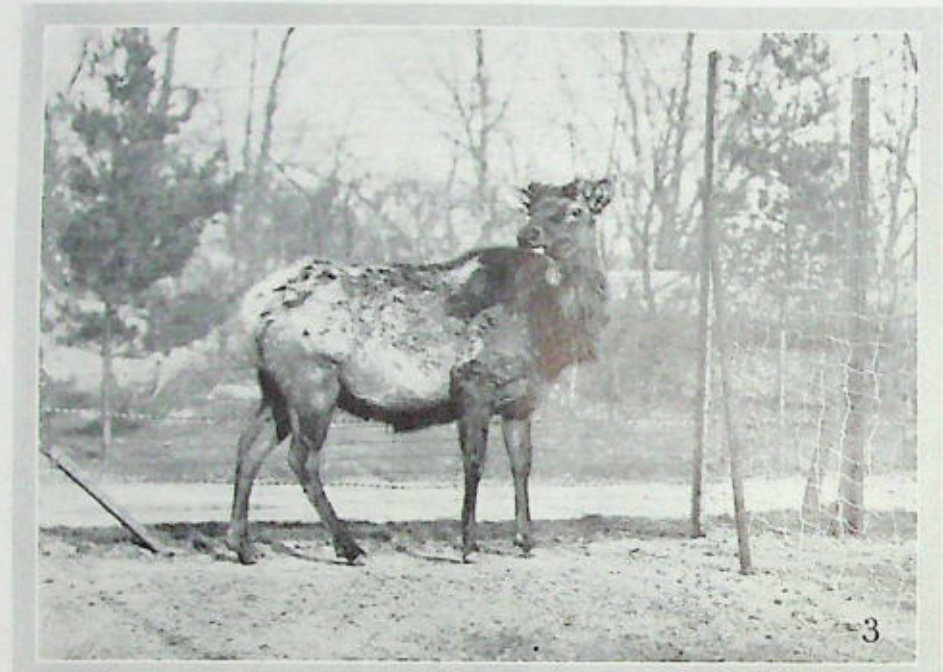
Intermediate stages in the growth of antlers. The soft covering of downy skin on the growing antler is known as "velvet" and is, in a sense, comparable to the tender bark on a growing twig. Under the "velvet" the blood is building up the bony tissue of the antler and each tine or branch follows the pattern set by the rapidly advancing "velvet." While the antlers are in the "velvet" the bucks are not aggressive and frequently associate in small bands. Not only do they feel none of the rivalry that will come later when the antlers are complete, but any use of the soft antlers at this stage of their development would result in considerable pain.

The Growth of a Wapiti Antler

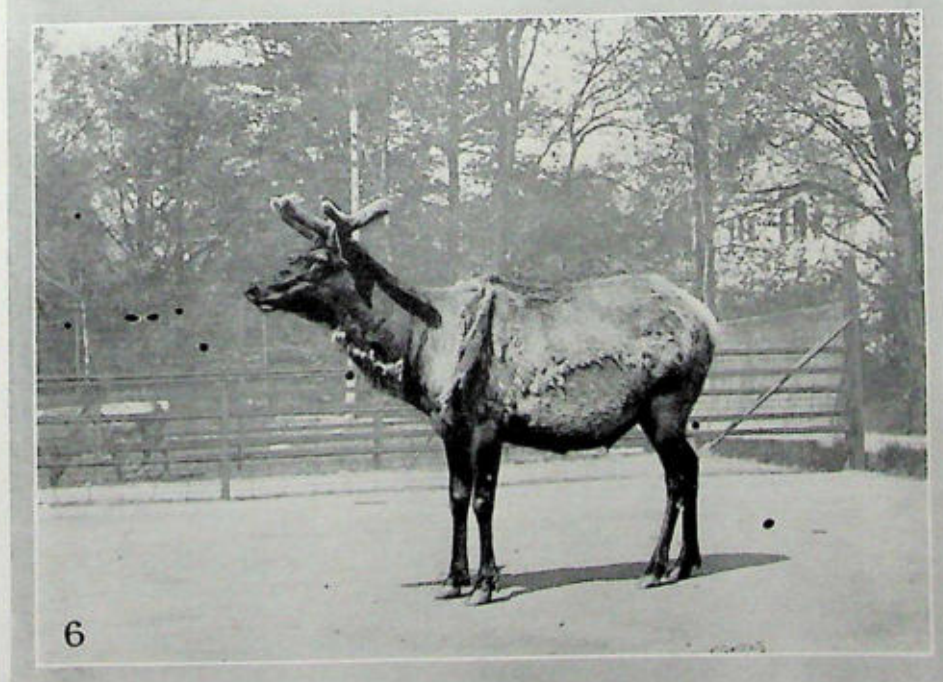
THE following series of photographs illustrates progressive stages in the development of the wapiti antler and, with the exception of Numbers 9, 15, and 16, all of the photographs show the same individual. The animal was observed daily and a photographic record made which extends over a period of several months. It should be noted that these pictures are an equally good record of the shedding of the winter pelage and the acquiring of the new coat. The series closes with two photographs, Numbers 15 and 16, selected to emphasize the change in demeanor of the wapiti when his antlers have become prime. Both of the latter pictures are records of the same animal. Photographed by Elwin R. Sanborn at the New York Zoological Park.



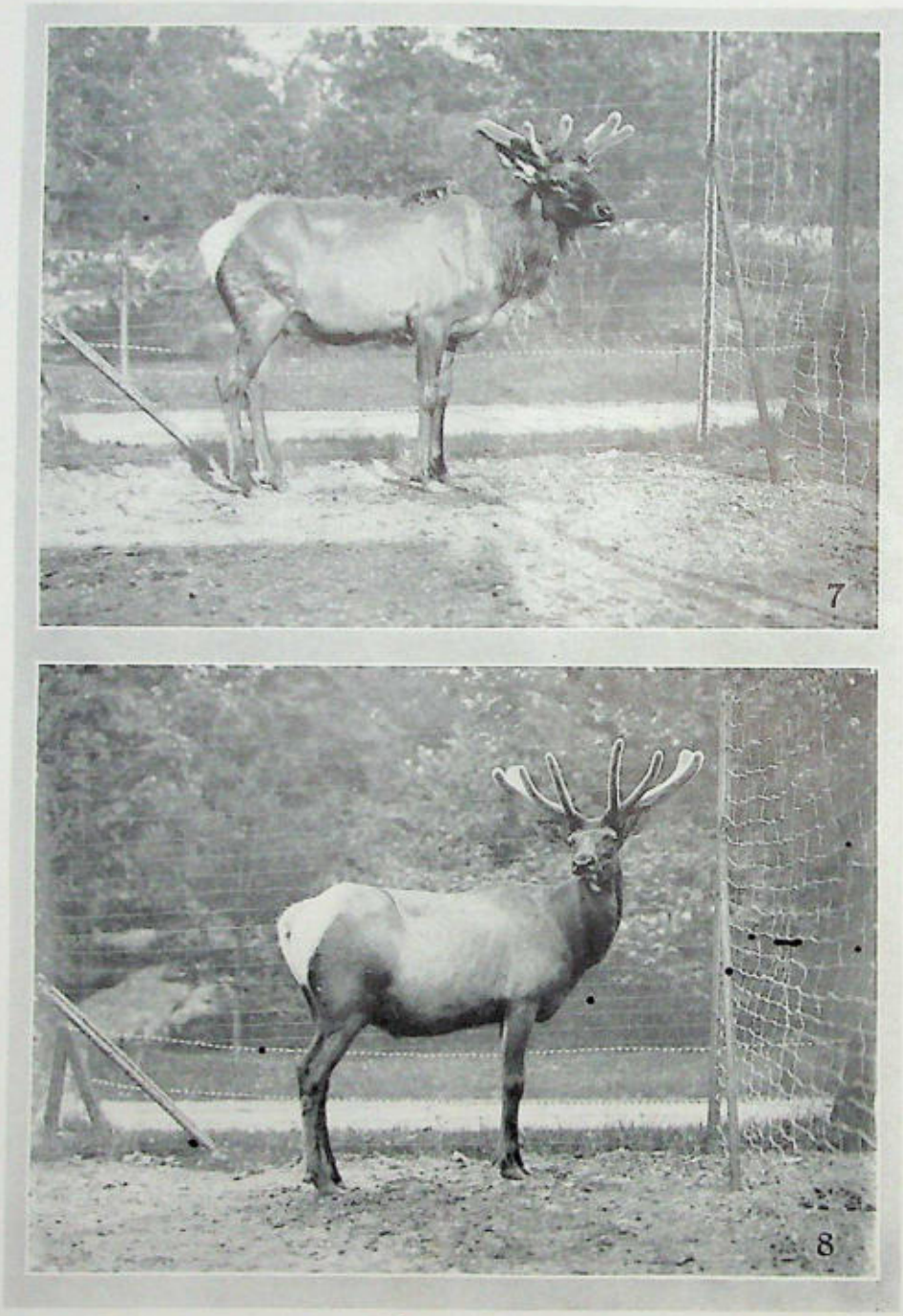
1. The wapiti has begun to shed the old antlers (March). One has already dropped and the exposed surface of the pedicle is readily apparent. The long winter coat begins to look rough. 2. Both antlers have fallen. At the proper time any slight jar or quick movement is sufficient to break the weakened attachment to the pedicle.



3. The new antler appears as a tumid bud on the pedicle (April 29); the winter coat has started to go. 4. The branches which will grow into brow-tines and bez-tines appear early (April 25).

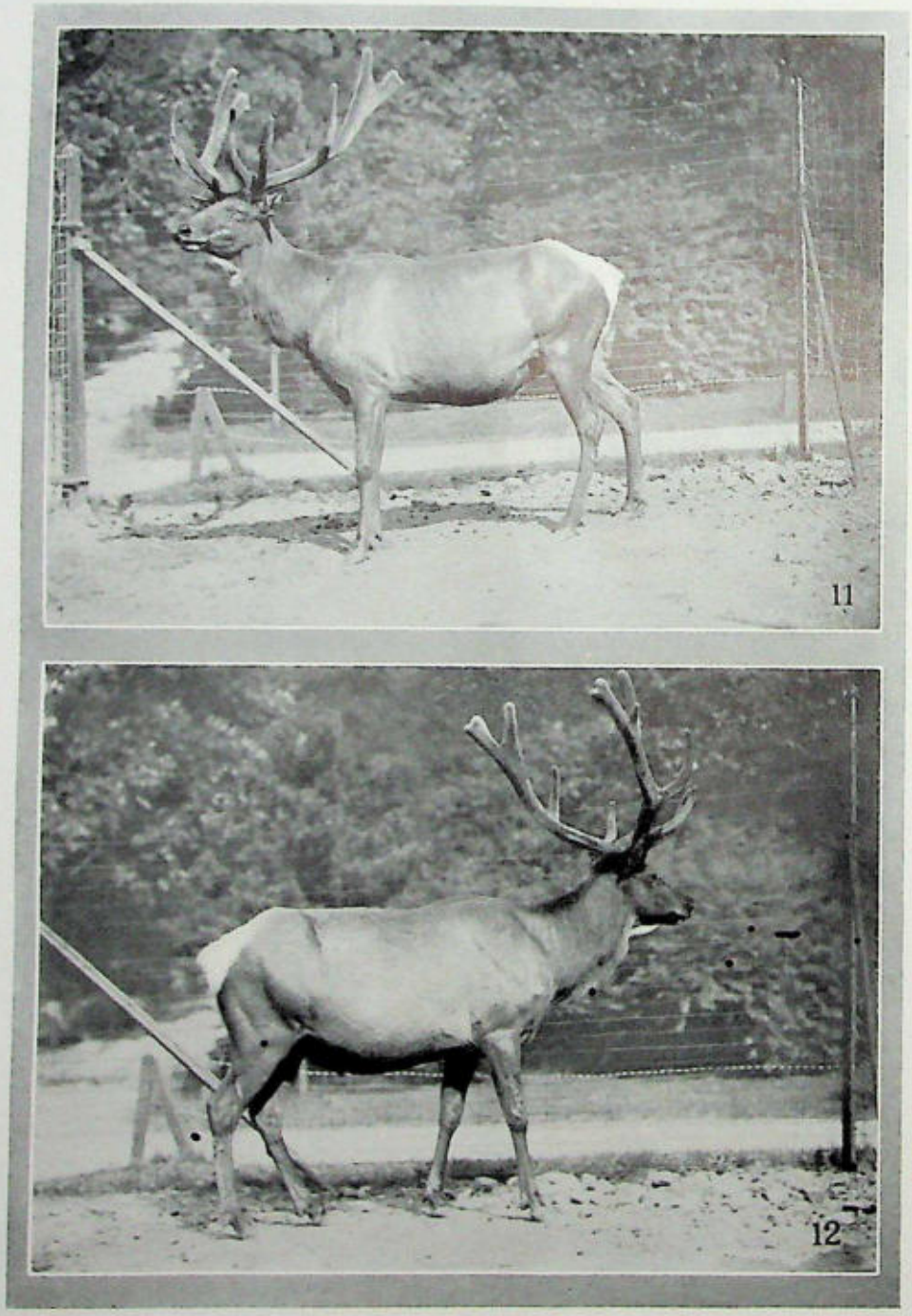


5. Every day sees an increase in the side of the antlers (May 5). 6. The branching begins to foretell the pattern of the final growth (May 9) and the last of the old hair is ready to shed.

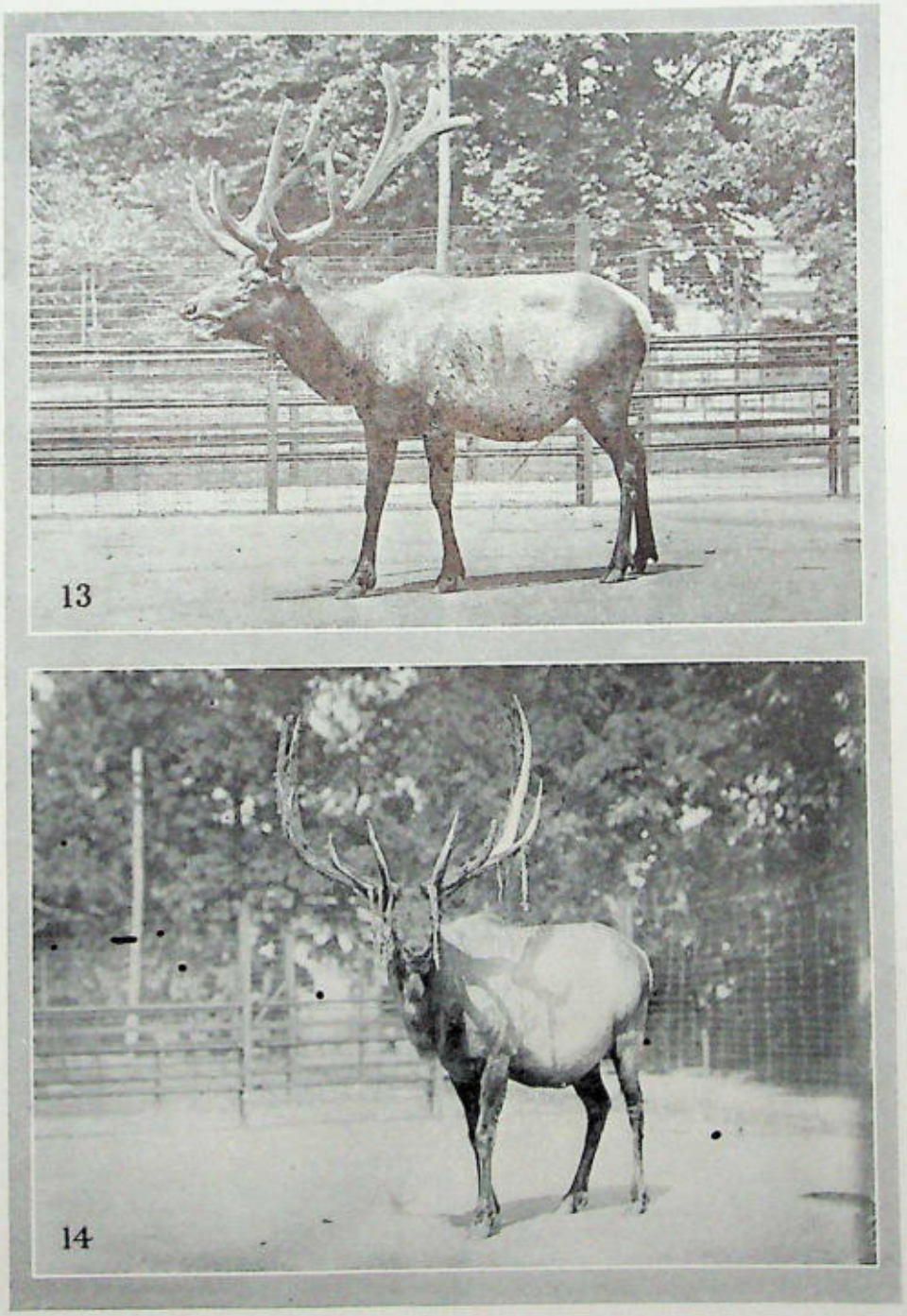


7. The wapiti needs plenty of green vegetation to meet the demands for antler growth, and by the time this structure is assuming breadth and height (May 16), plant life is well in foliage. 8. The antlers are now (June 1) the dominating feature of the animal's appearance; the new coat is established.

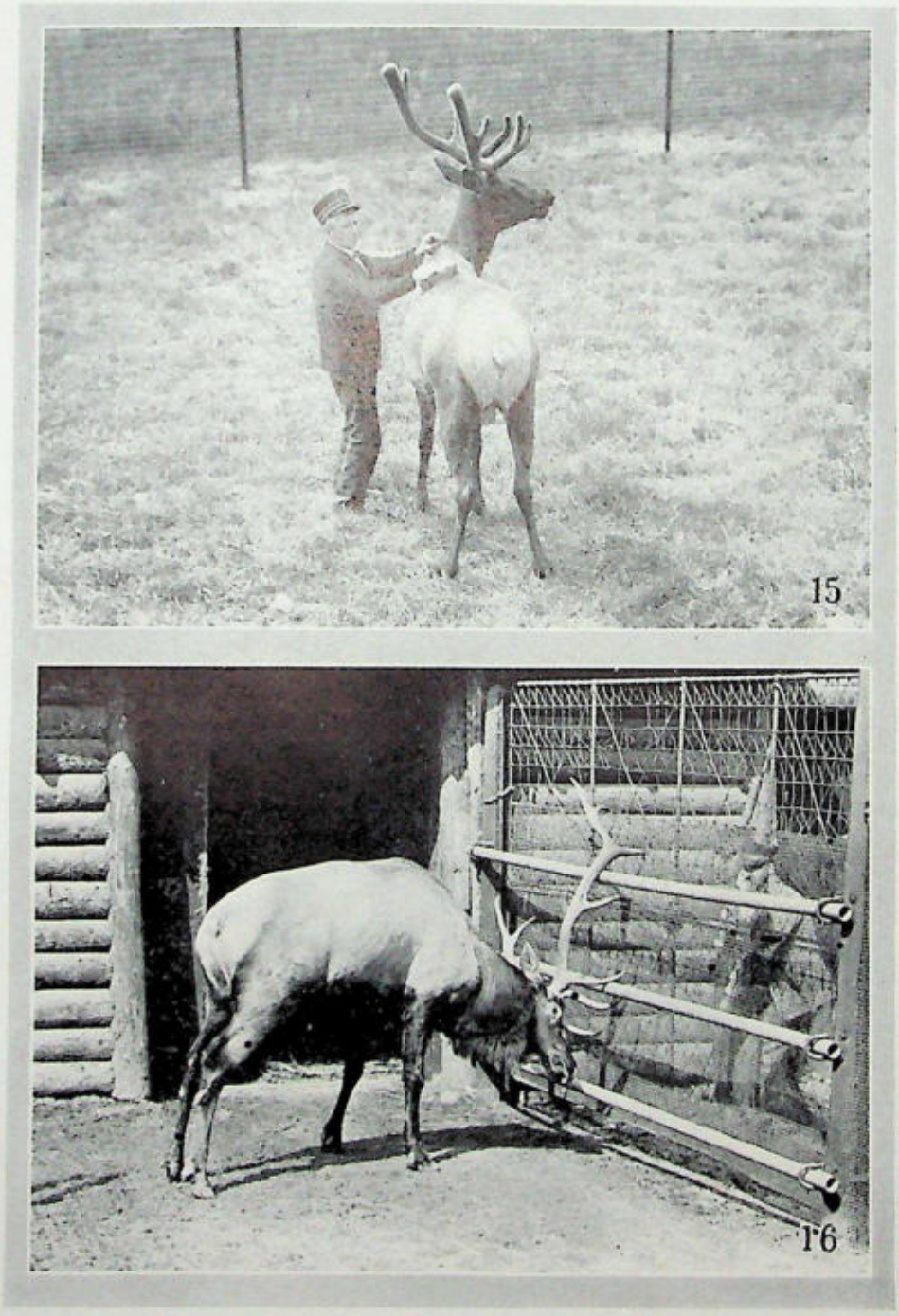
9. As the antlers become larger the wapiti will be forced to exercise greater care to avoid striking them against hard objects, for the velvet is still soft and filled with blood vessels. If injured it will bleed and an injury may deform the antler. Number 9 is not the same individual as the rest of the series; it is included to give a better idea of the antler in velvet. 10. The thick covering of velvet on the tips of the growing antlers makes the antlers look clumsy and club-like and masks the trim structure which will later make its appearance (June 25).



11. The antlers are entering into the final stages of size-development (July 6) and all of the branches and tines have been outlined. 12. The general condition of the wapiti has been improving as the season advances, and with the antlers assuming nearly their full extent (July 12) the animal's body is becoming sleeker and more rounded.



13. After the full pattern has been completed (August) the growth processes will be devoted to the hardening of the antler. (The wapiti feels the heat of midday). 14. The antlers are hard and serviceable (August) and the velvet has served its function. It is now dead tissue and can be stripped off in shreds. The wapiti rids the antlers of the useless velvet by rubbing them against brush and saplings. Note the plump, vigorous body.



15 and 16. These photographs show the same individual at different seasons. When the antlers are in the velvet (15) the park wapiti is docile and displays no eagerness to use its antlers. After the velvet has been stripped (16) the animal is decidedly untrustworthy and charges violently against the barrier in the attempt to reach the keeper.

The Internal Structure and Seasonal Growth-Changes of Deer Antlers

CHARLES V. NOBACK
New York Zoological Park

Illustrations from photographs made in the Zoological Park by Elwin R. Sanborn

THE following description of the internal structure and growth of the deer antler is based upon a study of three antlers from the Virginia deer (*Odocoileus virginianus*), and the head of a Columbia Black-tailed deer (*Odocoileus columbianus*). These specimens were obtained at the New York Zoological Park during the past year. The first, an antler in early velvet, representing about two months' growth, was obtained on June 1, 1928, as the result of its having been broken off accidently above the pedicle. The second antler, representing a growth of about four months, came from a buck which died on July 25, 1928. The third, representing about six months' growth, was secured on October 4, 1928. The head of the Columbia Black-tailed deer came from an old buck which died on January 28, 1929, four weeks after shedding its antlers.

These specimens were sectioned longitudinally while in a fresh state, photographed and preserved in Kaiserling's solution. The photographs accompanying this article will illustrate the internal structure of the antler at various stages of its seasonal growth.

A tough elastic substance known as keratin (from Greek keras—horn) is the essential constituent found in the outer layer of the skin covering the mammalian body. Keratin, which is insoluble in water and in very weak alkaline or acid solutions such as are found in nature, belongs to a class of chemical substance known as scleroproteins or hard proteins, and is composed of carbon, hydrogen, oxygen, nitrogen and sulphur. The odor of burning hair, horn, or hoof when horses are being shod, is characteristic of keratin. A similar substance, chitin (Greek chiton—tunic) coats the surface of higher invertebrates, such as crayfish, centipedes, insects and spiders.

The importance of keratin may be realized when we recall that it is the most important constituent of the corneum, which protects the delicate and sensitive structure of true skin from the effects of mechanical and chemical irritation, moisture, heat and cold. In this way nature uses keratin to protect the surface of the animal body. Those portions of the body exposed to friction and irritation are protected by a compensatory thickening of the epidermis together with a corresponding increase in its keratin content, as for example, the callosities on exposed parts of the body, the claws of dogs and cats, the nails of ape and man, the horn on the nose of the rhinoceros (rhino—nose; ceros—horn), and also the horns of cattle, sheep, goats and antelopes. The thin keratin layer of the skin functions somewhat as a coat of armor by protecting the body against invasion by ever-present invisible microorganisms, which are frequently more fatal than physical injuries themselves. As long as the keratin surface, or the corneum, is intact infection through the epidermis cannot occur.

Externally, there is a marked difference between horns and antlers. The hollow horn, or keratin sheath, in the Bovidae extends from the skin as an outgrowth of the epidermis and is reinforced by an osseous core growing out from the frontal bone. True horns are relatively permanent structures, continuing throughout the life of the animal, being gradually renewed as they wear out, similar to the renewal of hoofs, claws or nails. The horns of the prong-horned antelope, however, are shed annually.

With rare exceptions, all male deer (Cervidae) possess antlers which are deciduous, osseous growths springing from the pedicle of the frontal bone and are not encased in a keratogenous or horn sheath. None of the female deer possess antlers with the exception of the antler-bearing female reindeer (*Rangifer tarandus*).

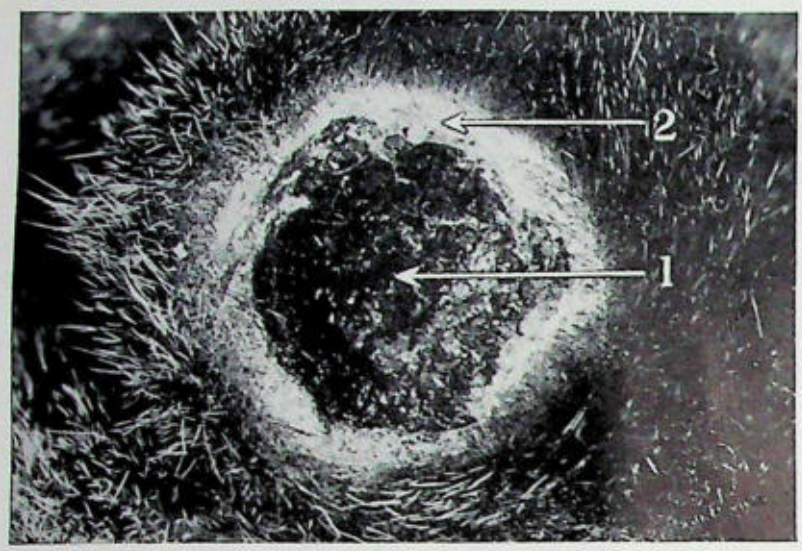


Figure 1

Tip of pedicle two weeks after the antler had been shed. 1. A thin layer of dried blood covering the pedicle tip. New connective tissue embryonic in character is forming just beneath the scab. This tissue is the beginning of a new antler. 2. Edge of the pedicle skin surrounding the denuded tip. The velvet, a form of skin, will evolve from this border and grow to completely cover and protect the delicate tip of a new antler.

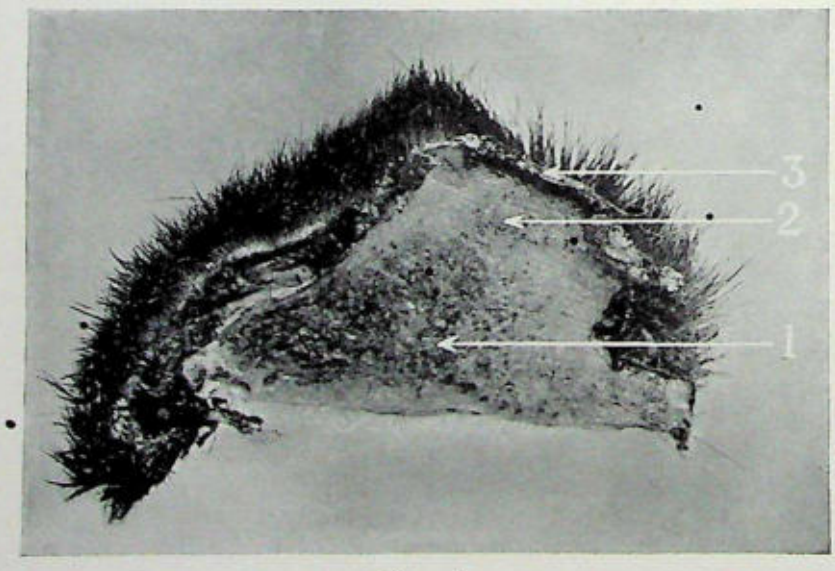


Figure 2

A longitudinal section of the pedicle shown in fig. 1. 1. Frontal bone, from which the new antler will derive its blood supply. 2. The pedicle, a cylindrical growth of bone from and a part of the frontal bone. It is from the tip of the pedicle that the new antler will grow. 3. A layer of dried blood covering the tip of the pedicle two weeks after the antler was shed. The velvet will evolve from the edge of the skin surrounding the pedicle tip.

The term horn, in its narrowest sense as used here, refers to the keratogenous sheath as it occurs in cattle and antelope, consequently it may be said that true horns are not present in deer.

In this latitude, during late winter or early spring of each year, the mature antler is shed, after which a new one grows from the tip of the pedicle. The exposed surface of the osseous pedicle (figures 1 and 2) is bare at the time of shedding. The marginal border of skin is the source of a cutaneous structure, the velvet, which soon envelops the free surface. While the velvet is developing a profound change is taking place within the tip of the pedicle, for simultaneously with an increase in the blood supply to this part, a mass of young connective tissue, embryonic in character (Macewen[3]) is beginning to form. This connective tissue becomes cartilaginous in character and is later replaced by bone. Bone formation takes place through the development of bone-producing cells (osteoblasts) within the cartilage together with the deposition of calcium and phosphate salts.

The growth of modified skin, the velvet, which later becomes covered with fine short hair, protects the cartilaginous cap and gives the tip of the pedicle an external appearance resembling a large brown mushroom. The velvet is highly vascular and sensitive, since it is richly supplied with blood vessels and sensory nerves extending to it from the adjacent skin.

It may be mentioned that the pedicle is a cylindrical outgrowth from and a part of the frontal bone of the skull. The relation of the frontal bone to the pedicle is shown in figures 6 and 7. The blood supply of the pedicle is derived from the internal vascular system of the frontal bone.

Growth of the antler seems to take place somewhat as follows: The cap of tissue resembling cartilage with its tip of young connective tissue "grows out" while the tissue at the base ossifies in being replaced by bone tissue. Bone formation is more intense within the wall of the antler so that on examination we find that the bone in the wall of the cylindrical antler shaft is very compact in comparison with that of the interior. The interior of the antler is filled with a mass of soft bone tissue, a veritable network of very fine tubes, which serve to supply the growing tip with an adequate amount of blood from the Haversian systems of the pedicle and frontal bone. The growing tip is dependent for its nourishment upon the blood received from the frontal bone through the pedicle.

With the formation of bone at its base the antler "sets" and does not materially increase in width. Growth continues until the predetermined antler pattern has been completed, by which time the cartilage-like cap ceases to grow and calcification continues until the mature antler consists of a mass of compact bone. While the following analogy is not exact, one might think of the growing antler as carrying on a process of growth similar to growth of the soft, delicate polyps on a coral tip. Just as the wall at the base of the antler hardens and "sets" as compact bone, so in a similar manner the mass of polyps on the tip of coral die and calcify to form coral. Both of these processes are forms of calcification. In the case of the antler, growth takes place by a deposition of calcium obtained from within the animal body through the blood stream while in the case of coral the growth is one of accretion where the calcium is obtained from without.

The gross internal structure of a young growing antler is illustrated in the accompanying photograph (figure 3) of a longitudinal section through a two months' growth of antler in velvet. The photographed specimen was secured on June 1 as the result of having been broken off accidentally. All the stages of growth in a growing antler may be seen in this photograph. A good view of the velvet and its hair may be seen in figure 4, the photograph of a cross section from the beam of the antler where numerous blood vessels in the velvet are plainly visible. The gross structure of the growing shaft is seen to consist of spongy bone richly supplied with blood, while the wall consists of more compact bone where calcification is more complete. At the tip one can clearly see how the growing bone sends fine, delicate processes into the cartilagious tissue above in such a manner as to leave no clear cut line of demarcation. The growing bone imperceptibly merges in with the cartilaginous tissue

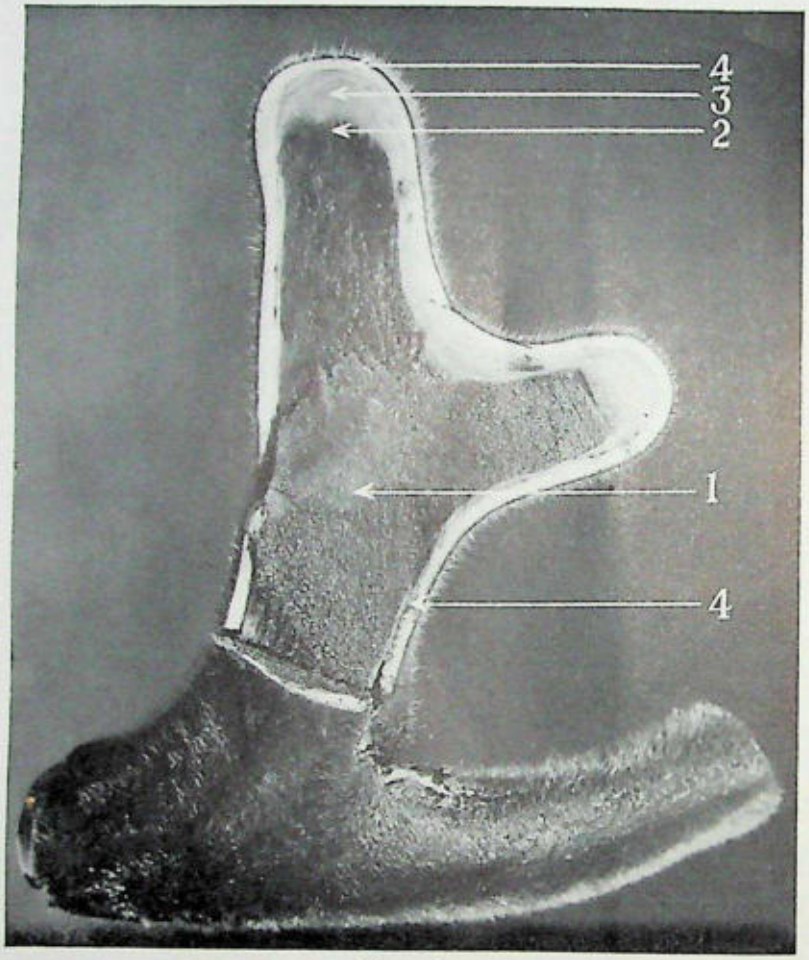


Figure 3

Longitudinal section of a two months old antler. The gross internal structure of a young growing antler is illustrated above. 1. Young newly formed bone, spongy and richly supplied with blood. 2. Area in which fine delicate processes from the tip of growing bone extend into the cartilaginous young connective tissue cap, which forms the tip of the budding antler. It is in this region (2 & 3) that the active process of growth and elongation takes place. 4. The comparatively thick white border enveloping the antler is the velvet. The thin dark border of the velvet is the pigmented layer just beneath the hair.

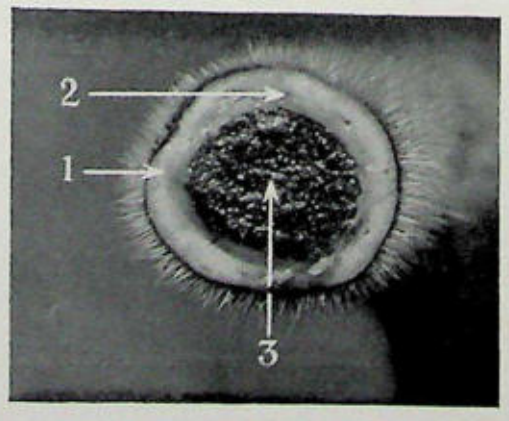


Figure 4

Cross section of a young antler. Cross section view of the two months old antler shown in figure 3. 1. The velvet, a thick cutaneous structure enveloping the spongy bone, 3, of the growing antler. The hair of the velvet is plainly visible. The abundance of short hair gives this structure an external velvety appearance, hence its name "the velvet." 2. Bloodvessel within the "velvet."

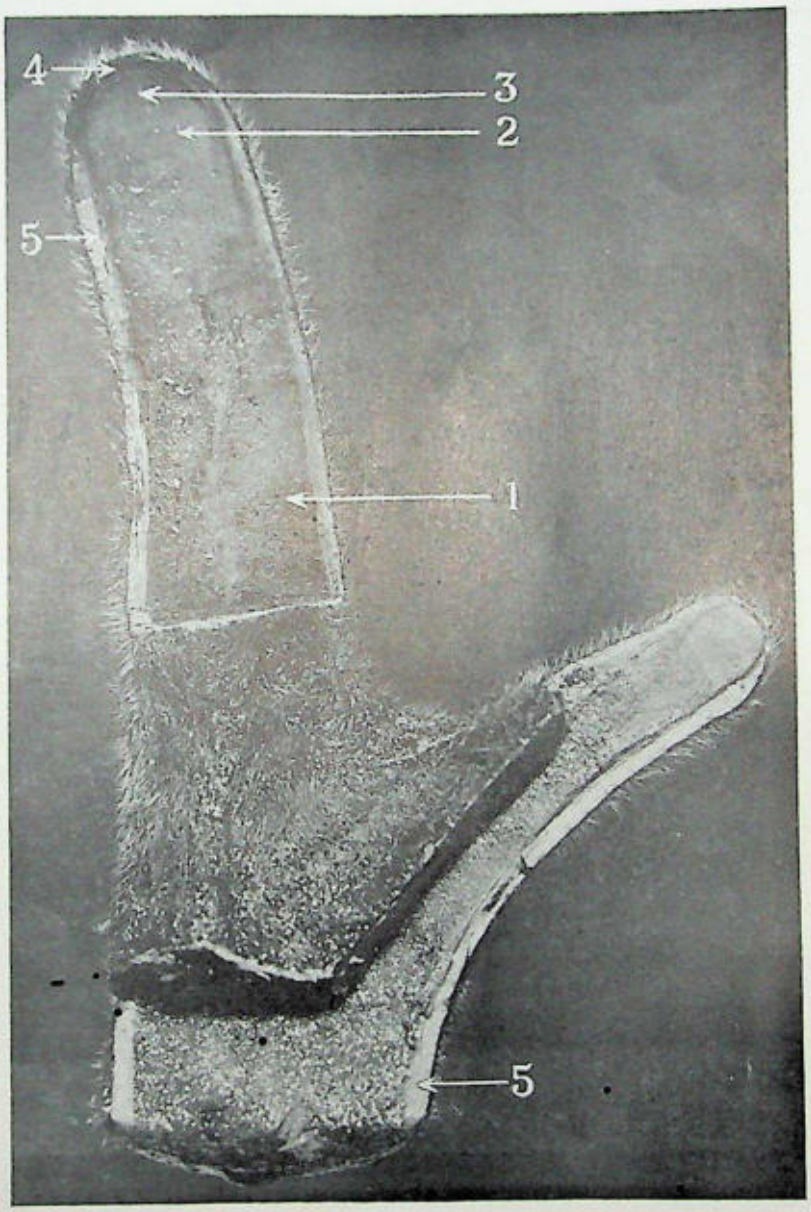


Figure 5

Longitudinal section of a four months old antler. The cartilaginous tip at this stage is practically replaced by young bone and the antler pattern has apparently been achieved. 1. The bony body of the antler is more compact at this stage indicating that its growth is being completed. 2. Hardening and ossification of the cartilaginous tip appears to have been completed. 3. Last trace of the disappearing cartilaginous connective tissue destined to be replaced by bone. 4. Velvet of the tip is dark, shriveled and dead. This is a point at which shedding of the velvet begins. 5. Living velvet still preserved below the tip.

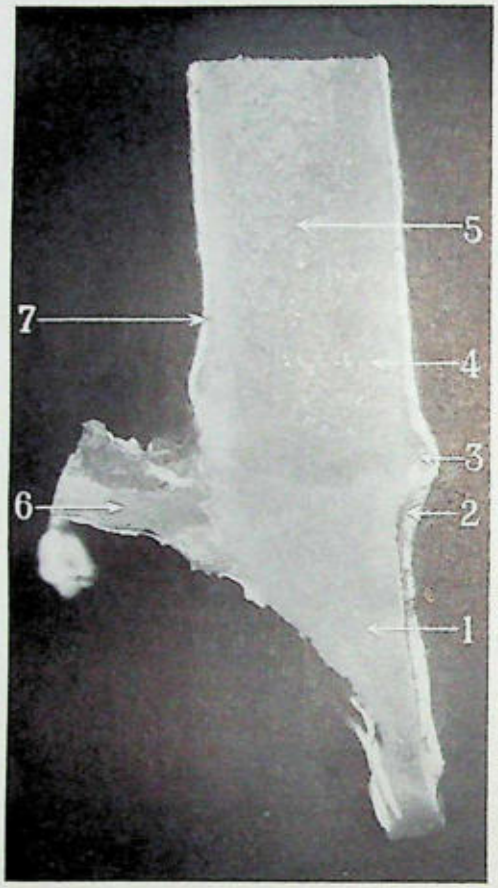


Figure 6
Longitudinal section through velvet antler, pedicle and frontal bone. (Four months antler). 1. Frontal bone with pedicle just above. 2. Skin covering the frontal bone. 3. The burr or corona at the base of the antler, an over growth of the base of the antler. 4. Wall of antler more compact than the interior. 5. More spongy interior of antler. 6. Part of parietal bone of the skull. 7. velvet.

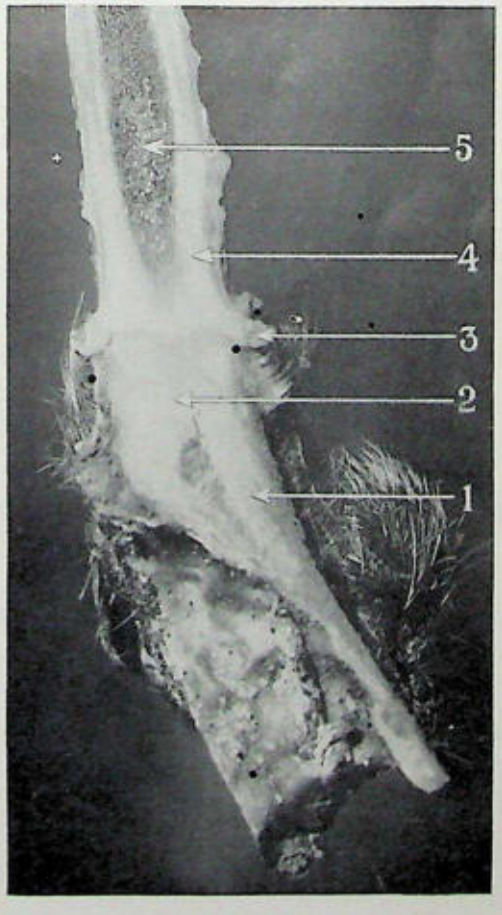


Figure 7
Longitudinal section of a mature antler. (Six months old). 1. Frontal bone with its center of ossification. 2. pedicle. 3. Burr or corona. 4. Compact bone wall and base of the mature antler. No velvet is present. The light area of the base of the antler stands out in contrast with the bone of the pedicle. It is along this line of demarcation that the separation of antler takes place when it is shed. 5. Spongy character of the interior of the antler.

Photographs by E. R. Osterndorff

so that these tissues dovetail one into the other. This juncture is the area in which the active process of longitudinal growth is taking place. It is here in this vital area that numerous primitive bone cells, called osteoblasts, are found which on calcifying replace the cartilaginous tissue and form the bony antler. This bone formation apparently serves as the base of new operations to continue the outward growth of the antler until its predetermined pattern has been completed.

Externally, enveloping and protecting the delicate mass of growing tissue we find the velvet, an outgrowth from the skin of the pedicle containing all the elements of true skin. The velvet is richly supplied with blood vessels, sensory nerves, glands and hair, and as it is very sensitive, causes the animal to avoid contact with hard objects. While in velvet, the antler may possibly be thought of as possessing a keratin coat because as the velvet is true skin, it possesses an external layer of keratin to protect it against abrasion and the entrance of microorganisms.

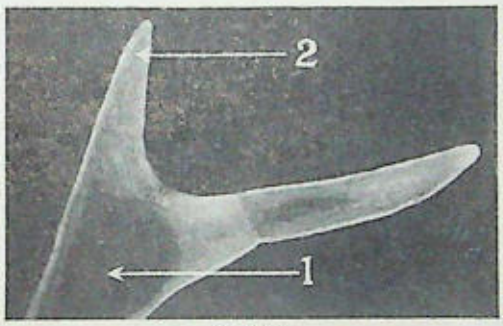


Figure 8
Completely ossified tip of the mature antler. 1. Spongy area of interior of mature antler. 2. Completely ossified tip.

A later stage illustrating the internal structure of a four-months-old antler is shown in figure 5. It will be seen that the clear cartilaginous tip has been practically replaced by young bone. A few traces of cartilaginous tissue are still present. The antler as a whole is becoming more compact as bone formation is being completed. Cessation of new cartilage formation and calcification of the tip indicate that the antler pattern has been achieved.

Another point of interest to note is that the velvet covering the tip of the antler has begun to degenerate, as indicated by its darkening and drying out. Below the tip, the velvet is still living and contains some blood, but the velvet covering the tip is dark, shriveled and dead. It seems that one of the areas where the shedding of the velvet may begin is at the tip of the matured antler.

Figure 6, illustrating a longitudinal section through the velvet, antler, pedicle and frontal bone, will serve to show the relationship of these four structures. It can be seen that at this stage the antler bone is less compact than the frontal bone. The line of demarcation between antler and pedicle is clear.

Figure 7 shows the internal structure of the mature antler, pedicle and frontal bone obtained by a longitudinal section. It will be noted that the antler is bare, free of velvet, and is composed solely of bone. The wall of the mature antler is seen to consist of hard compact bone while the interior still contains spongy, vascularized bone. The base of the antler is seen to consist of firm compact bone, with a ring of bone overflowing the base to form the corona or burr. The line of demarcation between antler and pedicle is clear and distinct. It is along this line that separation of the antler takes place when the antler is shed and it is from this region of the pedicle that a new antler develops. Complete ossification of a mature antler tip is seen in figure 8.

From the foregoing description and discussion it is evident that the antler is a deciduous bone growth proceeding normally from the frontal bone and pedicle. If viewed from within, both horns and antlers may be considered as osseous outgrowths from the frontal bone. In the case of animals with horns or a keratogenous sheath the growth is permanent, while in deer mature antlers are deciduous bare osseous growths.

Externally, the horns have a permanent keratogenous sheath which, with the exception of the prong-horned antelope, is never shed. In the case of deer the antler has an external covering, the velvet, which is a transitory structure whose usefulness is ended upon complete ossification of the antler, after which it is shed.

[1] The Growth and Shedding of Antlers. Macewen. (Maclehose, Jackson & Co., Glasgow, 1920). Page 34.

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BULLETIN

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Baird's Tapir, *Tapiridia bairdi*—1929.

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NEW YORK ZOOLOGICAL SOCIETY

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Tapirs, So Far As Known

WILLIAM T. HORNADAY
Director Emeritus, Zoological Park

Illustrations from photographs made in the Zoological Park

SEEING is believing; but seeing a tapir is not necessarily knowing all of it.

For years and years, the Malay and South American tapirs have been seen in large collections of living animals, both fixed and peripatetic; but to this day the life histories of even those seemingly familiar species remain on the same basis as that of the Baluchitheriums of the Gobi Desert, which is writable in a single line; they lived, ate and died.

And really, how much more than that does this wise world know about Baird's and Dow's giant tapirs of Central America? We know that they do live, eat and drink; that they swim and dive, marry and die. We suspect that they were born to feed hungry jaguars and hombres, and that none of them die of old age or disease; but we can not prove any of it.

Our trouble is that the three tapir species of Central and South America believe in keeping away from men and dogs, the fell Destroyers of other wild animals; and they figure it out that the thickest jungles they can find, where succulent vegetation and tepid water is plentiful and cheap, is the ideal home for them. To the hungry savage, and the equally hungry and relentless white man, a freshly killed tapir is a gift from the gods; and good men have starved to death through inability to find one at the zero hour.

In the books of jungle travel and adventure, the grand total of "Observations on the Tapir" rounds up about as follows:

"We saw a tapir on the bank. It fled into the jungle. The dogs pursued it, bayed it, and drove it into the water. It dived long, and swam well; but we killed it, and cut it up. At night we ate the whole of it, and wished for more."

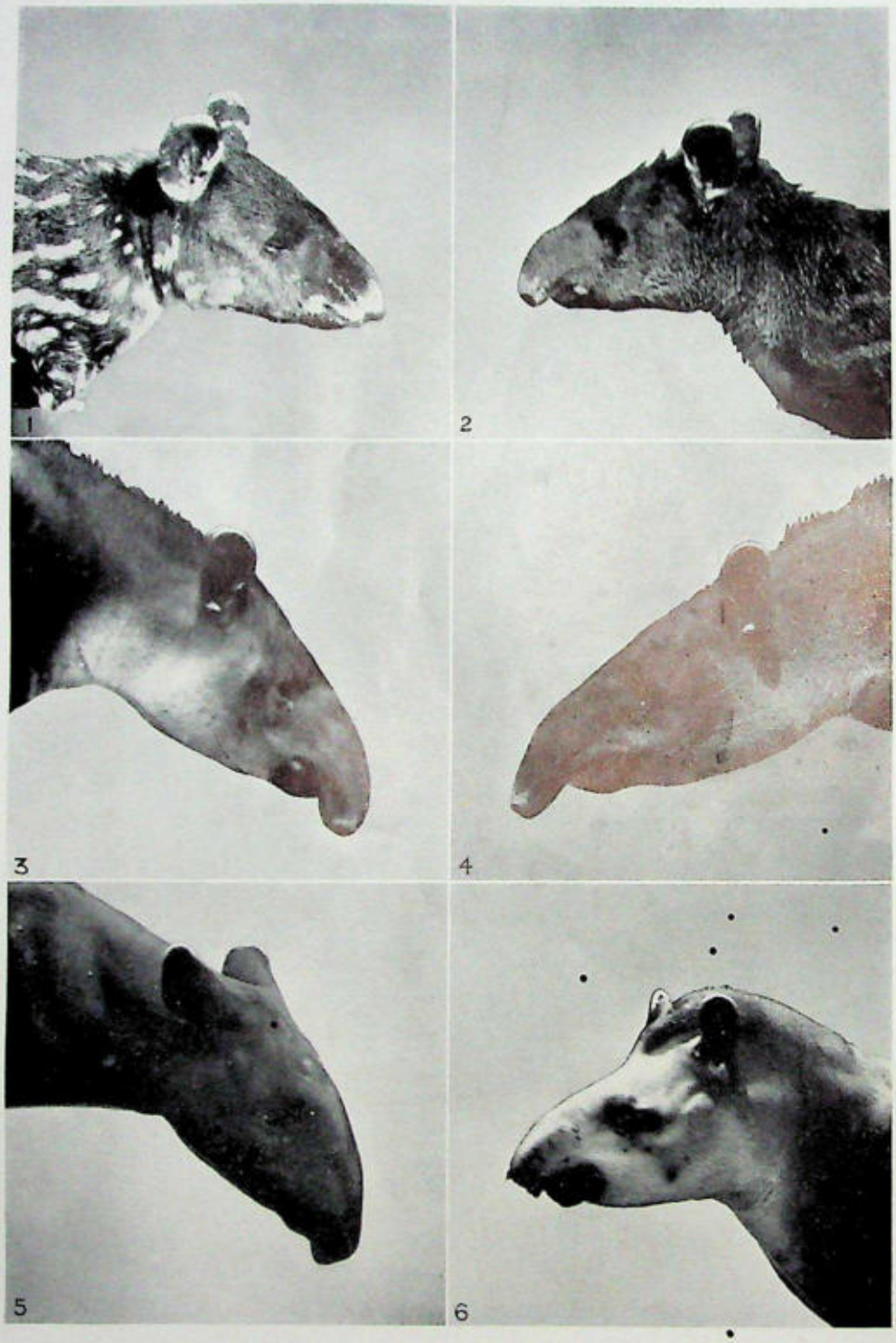
This is a very truthful exhibit of the best accounts of hunting the South American tapir that I ever have seen. Eugene André, in his thrilling and satisfactory Scribner book, "A Naturalist in the Guianas," (it should be "in Venezuela"), tells about killing eight tapirs and losing one more, along the middle third of the awful Caura River, a southern tributary of the Orinoco (South Central Venezuela), while he and his party ascended that queer stream at low water. To those animals the men were just wild animals, nothing more—until they began to shoot (badly enough), and loose dogs at them. Later on, when they descended the raging Caura at high water, practically no game could be found and killed, and the whole party almost starved.

When nature fashioned the first tapir, the old dame played *Tapirus* a mean trick. She should have equipped him with horns like a mountain goat, wart-hog tusks, and claws like a grizzly bear's own. Then he would have been on an

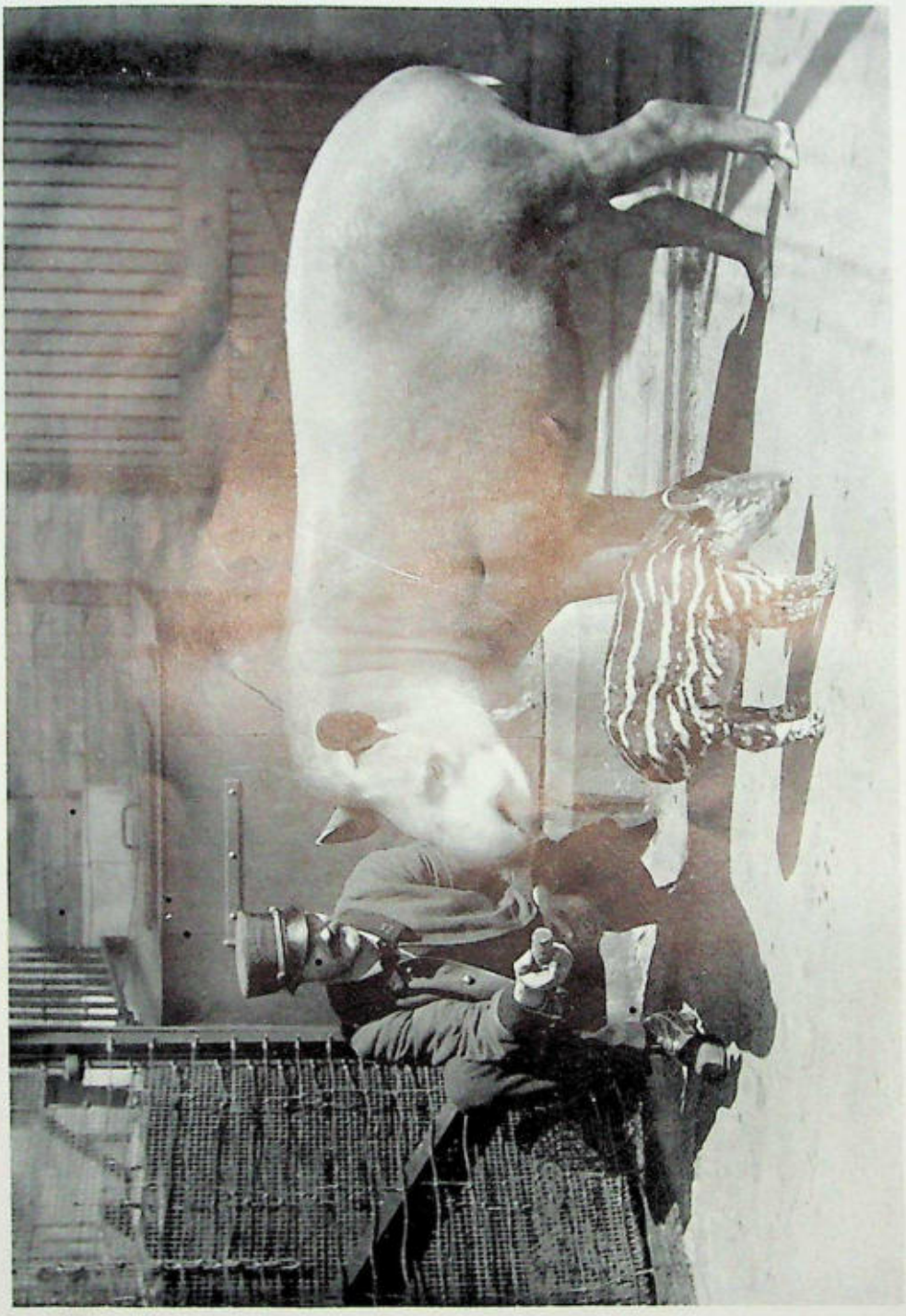
Baird's Tapir, *Tapirella bairdi*, imm. June, 1924.

Baird's Tapir, *Tapirella bairdi*, imm. October, 1924.

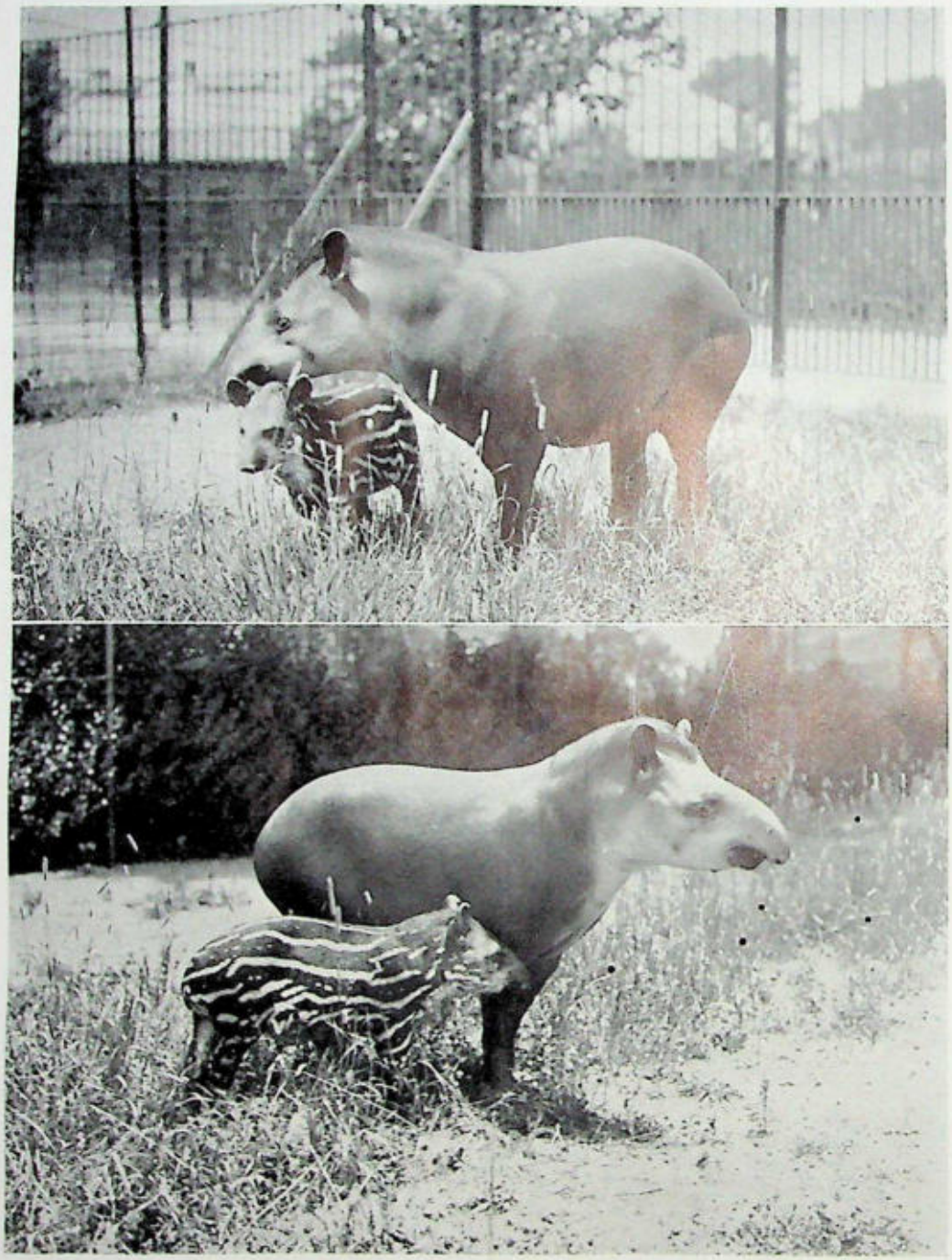
Baird's Tapir, *Tapirella bairdi*, July, 1927.



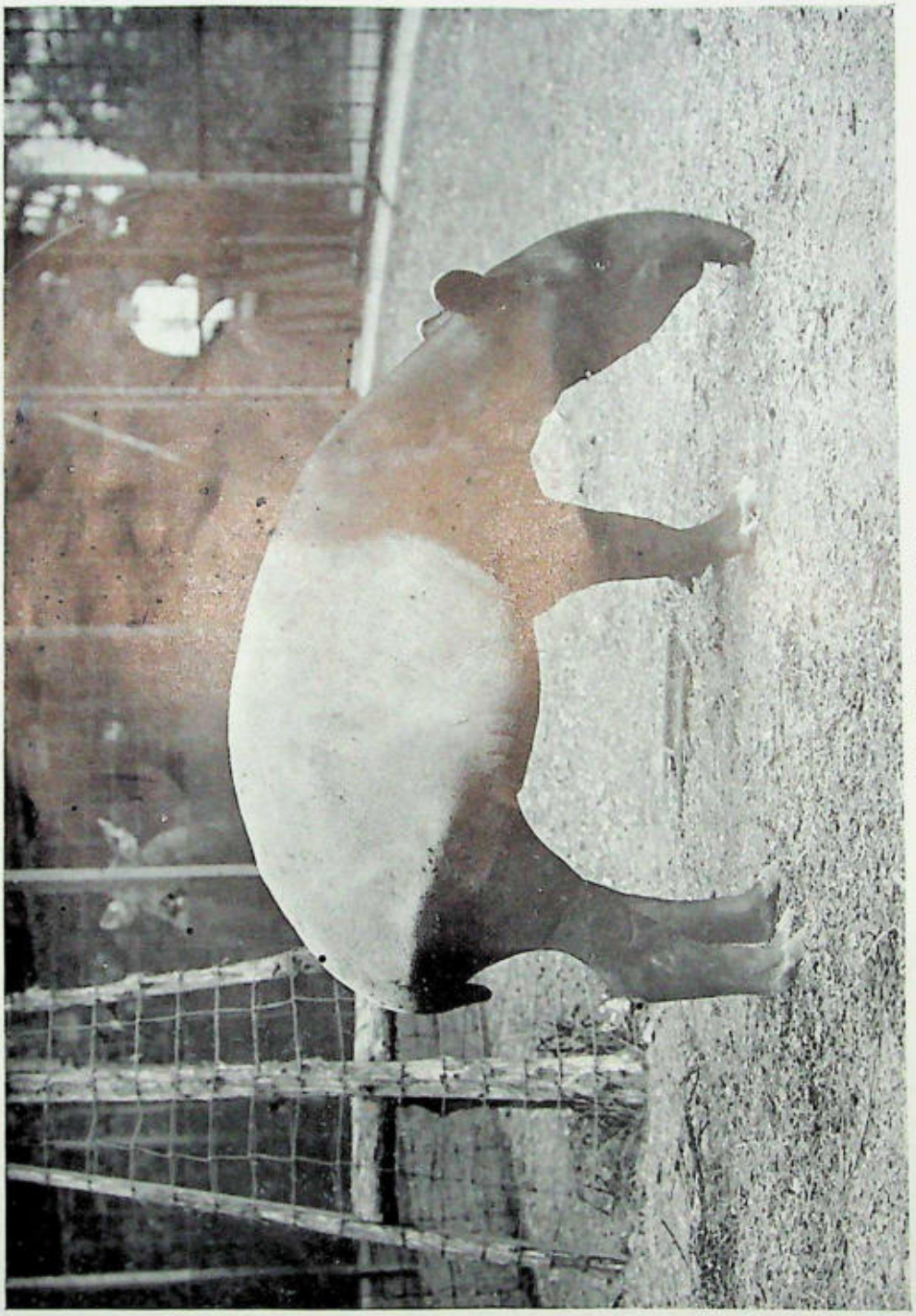
Heads of the various tapir species exhibited in the Park. 1, 2, 3, 4, Baird's Tapir, June, 1924; October, 1924; July, 1927, and April, 1929; 5, Malayan Tapir; 6, South American Tapir.



South American Tapir, *Tapirus terrestris* and young. April, 1928.
Photographed shortly after birth.



South American Tapir, *Tapirus terrestris*, and young.
Photographed July, 1908.



Malay Tapir, *Tapirus indicus*.

equal footing with the jaguar, puma, black bear, and mongrel dog. Instead of that, the poor tapir creature is like the succulent capybara—absolutely defenseless! And more than that, the low-country tapir species of Central America and India are not even good runners; all of which constitutes an evolutionary fall-down on the part of Nature. Now, if evolution is even the half of what it is cracked up to be, tell us why the tapirs of the world have not, at the very least, developed bony armor for covering, and skewer horns a la *Oreamnos* with which to puncture the tires of attacking enemies.

A typical tapir has many good points. When first captured by man it does its level best to accept and assimilate man's miserable makeshift food, until it either dies on him at the end of the fourth round, or defies him and elects to live and carry on. For himself and his owner, the period of food stabilization is the deadly period. If both parties survive it, the quadruped settles down in the good or the bad quarters supplied by the strange biped, and tries to make the best of it.

Having neither horns, tusks nor claws, the tapir has a temperament serene and patient, as becomes every unarmed pacifist. I have often recommended tapirs as household pets, because they can not possibly fight back against neglect and abuse. They start no disturbances. All they ask is 70° Farenheit, a clean bath, good housekeeping, plenty of food and not too much tapir society. It is queer, but common, for two big, lumbering Malay tapirs to flatly refuse to live together, even when they ought to like it.

There are just about four real species of tapirs, thus:

The big black-and-white Malay tapir inhabits the densest jungles of the Malay Peninsula up to Tenasserim, parts of Sumatra, and possibly Borneo; but on the last I refuse to commit myself.

The South American tapir holds forth in the jungly northern half of South America, along the river and lakes. It is of a uniform dark brown or purple color, more often found in captivity than elsewhere. It breeds freely in captivity, and endures exhibition with sang froid, even when the visiting list is at its worst. You may know it by its uniform dark complexion, and the fact that it usually has a look of having been oiled.

The big tapirs of Central America and Southern Mexico, and particularly including the Isthmus of Panama, have been for many years the least known of all the big game animals of the western hemisphere. For nearly fifty years a score or so of zoologists have known of the existence of the two big species, Baird's tapir and Dow's; but except for skeletal remains there have not been until very recently any specimens, living or dead, on exhibition to show how they look. Now, four of our large museums have mounted specimens; and others will have some, in time, as compared with Eternity.

For ten years or so we sought through the usual channels of "prominent citizens," hunters, travelers and officials, to obtain even one living giant tapir, but long in vain. Finally in Panama we hung up a fixed offer of $500 and in 1923 that price landed in New York the first living specimen that ever came to the United States. It was a funny-looking little beggar—a stocky, stolid baby that looked like a fat toy lamb covered with black-brown wool, with no white on it save the rims of its big ears. But that poor little creature had been badly used internally, its digestive organs were a wreck, and it lived only eight days.

In 1924 we had better luck. We secured a stronger and tougher specimen, and by three weeks of hard work Dr. Blair established it as a going concern. It lived, it thrived, and today it is a big, bulky beast, and large enough to afford a hundred men a square meal.

When this one arrived, it was still in its baby-striped brown-and-white coat; which reminds us to say that all little baby tapirs are rather beautifully marked with white and black horizontal bars and blotches. This "protective coloration" scheme helps to protect them from the eyes of hungry jaguars waiting on the lower branches of trees, and eye-searching the tangled jungle growth below, to see what they can find "for eat."

The two Giant tapir species (*Tapirella bairdi* and *dowi*) are roundly asserted by men who have hunted and killed them, to attain a maximum weight of 700 pounds. They are, to quite an extent, mountain-loving animals, and

Giant Horned Frog, *Ceratophrys dorsata*.

less given to hanging around rivers and lakes than the South American species. They are hard to find, and hard to kill, and usually it is impossible to find them, or to overtake them in a chase, without the aid of dogs who know the game, and play it well.

It should be noted that the South American tapir, also, is much given to frequenting jungle-clad mountains, away from water protection. On the whole it will be a good long time ere the Gran Chaco and similar fastnesses give up to "civilized" man the last of their tapirs. But the capybara is even more handicapped than the tapirs. Because they can not live on jungle-clad mountains they really must live along the river banks—or die.

The Giant Horned Frog

RAYMOND L. DITMARS
Curator of Mammals and Reptiles

Illustration from a drawing in color by Helen Tee-Van

IN the extensive family *Cystignathidae*, composed of a large number of genera represented in tropical America and Australia, are many remarkable frog-like species. Two of these are included in the series of amphibians exhibited in the Reptile House. The most remarkable is the Brazilian Horned Frog, *Ceratophrys dorsata*, recently presented to the collection by Dr. Afranio do Amaral, Chief of the Institute of Serum Therapy at Sao Paulo, Brazil. The specimen is illustrated by a colored drawing from life by Mrs. John Tee-Van.

The ten species of the genus *Ceratophrys* are great burrowing frogs, occurring from the Guianas into Argentine. Several of them have a bony shield hidden under the skin of the back, which is not, however, attached to the vertebrae. All are so brightly colored, broad of body and huge in head, with protruding, or horn-like development over the eye, as to be exceptionally grotesque—in fact, astonishing. They look more like big toys, brightly painted, than living creatures, and their habits are in keeping with their appearance.

These big frogs are actually savage. They will make short jumps at an intruder, utter barks and wailing sounds during such exhibitions—and actually bite. Such habits are unique among frogs and toads. The bite of a large *Ceratophrys*, owing to the strength of enormously developed jaws and row of sharp teeth, will pierce the skin and may be distinctly painful. I remember an illustration of this some years ago at the Reptile House in the London Zoological Gardens. The veteran reptile keeper, James Tyrrel, came out on the floor one morning with a bandage around his finger, and surprised us by saying he had been bitten by a frog. He showed us the specimen, an example of *Ceratophrys ornata*, about four inches long. The wound on Tyrrel's finger was as pronounced as if it had been inflicted by a fair-sized turtle.

In burrowing, these frogs use the shovel-shaped, bony tubercles on the hind feet in pushing aside loose soil to produce a crater and thus sink the top of the body to the surface level. Some of the soil is then thrust upward toward the back, so the creature is partially hidden. The blotched green or brownish back blends with the soil and vegetation. All of the species are markedly cannibalistic, although they also feed upon small rodents and the larger insects.

Our specimen is approximately six inches long, and nearly as broad—upon gross examination appearing nearly circular. This effect is produced by its enormously wide and blunt mouth. It spends most of the day partially imbedded in a trough of soil, but is quite active at night. It seldom goes into its tank of water. This specimen represents a species confined to equatorial Brazil.

Another member of the *Cystignathidae* in the collection is the big Brazilian Painted Frog, *Leptodactylus pentadactylus*, which has been in the Reptile House for about twelve years. This creature is a combination of bronze, brown and scarlet, laid on in bold blotches like splashes

of paint. Members of the genus to which it belongs are remarkable in laying their eggs in a small puddle, which they produce by building a wall of mud at the edge of a pond, in which the tadpoles must remain until the rainy season, when the mud walls of the enclosure are disintegrated, collapse, and the tadpoles are released.

The New Guinea Expedition

THE Zoological Society's Expedition to New Guinea returned to New York on March 21, 1929, bringing forty birds of paradise, of nine species, about two hundred other birds and mammals, six thousand feet of moving picture film and numerous still photographs.

Mr. Crandall, our Curator of Birds, left New York on August 9, 1928, and at Sydney, Australia, he was joined by Mr. J. E. Ward, an Australian naturalist of considerable experience in New Guinea. The party proceeded to Port Moresby, Papua, thence sixty-five miles west to Yule Island. From this point, the expedition penetrated a distance of about seventy-five miles into the mountains of the interior, where the birds of paradise were secured.

The total cost of the expedition was less than the $12,000 allotted for the purpose, and the value of the living specimens brought back is estimated at about $20,000. The following list includes a number of rare Australian species, secured on the return from New Guinea, as well as those collected in the latter country:

16	Lawes' Six-plumed Birds of Paradise	*Parotia lawesi lawesi*
2	Long-tailed Birds of Paradise	*Epimachus fastosus meyeri*
6	Lesser Superb Birds of Paradise	*Lophorina superba minor*
1	Hunstein's Magnificent Birds of Paradise	*Dyphyllodes magnificus hunsteini*
2	Count Raggi's Birds of Paradise	*Paradisea apoda raggiana*
7	Prince Rudolph's Blue Birds of Paradise	*Paradisornis rudolfi*
3	Horned Manucodes	*Phonygammus keraudrenii jamesi*
2	Black Manucodes	*Manucodia ater alter*
1	Blue Manucode	*Manucodia chalybata orientalis*
1	Black-headed Catbird	*Ailuroedus melanotus melanocephalus*
1	Fawn-breasted Bower-bird	*Chlamydera cerviniventris*
1	New Guinea Friar-bird	*Philemon novaeguineae brevipennis*
2	Dumont Mynas	*Mino dumontii dumontii*
10	Purple Glossy Starlings	*Aplonis metallicus metallicus*
2	Green Glossy Starlings	*Aplonis cantoroides cantoroides*
2	Gray-headed Mannikins	*Munia caniceps*
8	Parrot Finches	*Erythrura psittacea*
2	Gouldian Finches	*Poephila gouldiae*
8	Chestnut-breasted Mannikins	*Munia castaneithorax*
6	Diamond Finches	*Steganopleura guttata*
3	Cherry Finches	*Aidemosyne modesta*
2	Bicheno Finches	*Stizoptera bichenovii bichenvoii*
4	Sydney Waxbills	*Aegintha temporalis*
4	New Guinea Pittas	*Pitta atricapilla*
1	Chestnut Shrike-thrush	*Pitohui dichrous monticola*
4	White-rumped Wood Swallows	*Artamus leucorhynchus leucopygialis*
6	Yellow-breasted Robins	*Eopsaltria australis australis*
11	Superb Blue Wrens	*Malurus cyaneus australis*
6	Australian White-eyes	*Zosterops lateralis lateralis*
6	Black-and-white Fantail Flycatchers	*Leucocirca tricolor tricolor*
2	Wonga-Wonga Pigeons	*Leucosarcia melanoleuca*
1	Reinwardt Pigeon	*Reinwardtoena reinwardtsi griseotincta*
1	White-throated Pigeon	*Columba vitiensis halmaheira*
6	Brown Pheasant-pigeons	*Macropygia amboinensis cinereiceps*
2	Blue-billed Pheasant-pigeons	*Macropygia nigrirostris*
7	Golden-headed Fruit Pigeons	*Sylphitreron ornatus gestroi*
4	Painted Fruit Pigeons	*Ptilopodiscus coronulatus coronulatus*
1	Superb Fruit Pigeon	*Ptilinopus superbus superbus*
1	Lilac-shouldered Fruit Pigeon	*Chlorotreron iozona iozona*

2 Red-crowned Fruit Pigeons	*Ptilinopus pulchellus pulchellus*
8 Yellow-heart Pigeons	*Gallicolumba rufigula rufigula*
1 Black-fronted Amethyst Pigeon	*Gallicolumba jobiensis*
1 Bustard-Pigeon	*Otidiphaps nobilis cervicalis*
8 Stephanie's Pigeons	*Chalcophaps stephani*
3 New Guinea Green-winged Pigeons	*Chalcophaps indica chrysochlora*
7 Red-necked Rails	*Tomirdus tricolor grayi*
2 Australian Stone Plovers	*Burhinus magnirostris magnirostris*
2 Giant Laughing Kingfishers	*Dacelo gigas gigas*
4 Blue Grass Parrakeets	*Melopsittacus undulatus var.*
2 Cobalt Grass Parrakeets	*Melopsittacus undulatus var.*
4 Barraband Parrakeets	*Polytelis swainsonii*
4 Yellow-rumped Parrakeets	*Platycercus flaveolus flaveolus*
2 Mealy Rosella Parrakeets	*Platycercus adscitus palliceps*
2 Barnard Parrakeets	*Barnardius barnardi*
4 King Parrakeets	*Alisterus cyanopygius*
1 Blue Bonnet Parrakeet	*Northiella haematogaster xanthorrhoa*
4 Crimson-winged Parrakeets	*Aprosmictus erythropterus*
2 Blue Mountain Lorikeets	*Trichoglossus novaehollandiae*
2 Echidnas	*Echidna hystrix*
2 Great Red Kangaroos	*Macropus rufus*
1 Agile Wallaby	*Macropus agilis papuanus*

Our Black Hooded Vulture

A brief account of his capture and early training. From a letter by N. C. NELSON, *Curator of Archaeology, American Museum of Natural History.*

"THE black hooded vulture in the Bronx Zoological Park, credited to the Third Asiatic Expedition, was taken as a fledgling from the nest by Dr. Ralph W. Chaney (of the Carnegie Institution) and myself, on June 25, 1925.

"Parenthetically, I may claim to have brought "him" up and to be perhaps in some measure responsible for his gentle disposition. Everybody else in camp, including Dr. Chaney at times, despised the bird; but in the end most of them learned to appreciate his fine points.

"The vulture's home was a little west of Central Mongolia, i.e., in the northern foothills of the Baga Bogdo mountains a few miles southeast of Tsagan Nor lake. The spot is very near the intersection of 45 degrees North Latitude and 101 degrees East Longitude; in other words, 815 miles northwest of Kalgan or roughly 1,000 miles northwest of Peking. Altitude about 4,500 feet.

"We found the nest—flat and made of a large collection of sticks—on a small rock jutting out of a steep talus slope some seventy-five feet up from the canyon bottom. There were two birds on the nest when we first saw it and there were two (or more)? birds circling in the sky not very far away. When Dr. Chaney had almost reached the nest, one of the two inmates—another fledgling, we suppose—flew away. The other, "Conny," as we baptized him, was hopeless but showed signs of viciousness. He weighed, we guessed, about twelve pounds. His beak and claws were well developed; but his feathers were little more than half out and he could neither stand up nor fly. We stuck him tail end first into a duffel bag which we tied to the saddle horn and made off. The older birds meanwhile kept on soaring high above us and they followed us to the mouth of the canyon, where they finally settled on a crag.

"Conny refused boiled meat the first day but from the second, when we reached the main camp, he ate ravenously of fresh antelope, kite, fish—anything except liver—and he kept up his appetite until mid-September, when I had to turn him over to the mercies of Mr. Andrew's servants. He also drank a lot of water, especially on hot days.

"In less than two weeks the bird was able to walk about and in less than three weeks he often faced strong gusts of wind, spread his wings, took running jumps, and tried to rise. I finally clipped one wing and for a time nothing came of his attempts to fly, but by September 1st he occasionally flew across consider-

Black Hooded Vulture "Conny" on his nest, Hung Kureh, 837 miles from Kalgan; *Lower*: "Conny" and Mr. Nelson at Kholobolchi Lake, 867 miles from Kalgan, June, 1925.

able ravines and even rose and circled several hundred yards. One evening he departed in this way from camp, but was back the next morning.

"The bird very early began to show signs of friendliness and even playfulness. He waded into the lake to take his bath. He wrestled in his way with our Mongol puppy dog, and when the latter became too rough Conny paid him back in his own coin. The bird I think showed a distinct preference for certain members of the camp. However, a few days' confinement and neglect in the expedition compound at Peking changed him considerably and he became a dejected disreputable looking specimen. At that time I scarcely expected him to stand the journey to New York.

"I have twice been up to see Conny since my return last July and while I wouldn't affirm that the bird recognizes me, he certainly still seems to court human companionship."

In a later letter Mr. Nelson speaks of the altered disposition of his old friend Conny who still is living in the Zoological Park:

"I am slightly surprised to learn of the bird's temper and wonder if the keepers may not themselves be to blame. Sunday before Christmas, when Chaney and I visited the Bronx Park, we found the vulture quite ready to have his head patted and scratched, as in the old days. In the Gobi I, of course, had to handle him almost daily, picking him up to put him in his box which was lashed to the running board of the car. He cursed something awful—or so it sounded—and he often fought. Once he yanked one leg out of my grasp and closed on my hand, putting his claws almost through the palm."

Wild Life Conservation

At the annual meeting of the Board of Managers of the New York Zoological Society held on December 27, 1928, the following resolution was passed:

WHEREAS, the Wild Life Protection Society of South Africa has succeeded in having set aside 5,000,000 acres of park lands as a game sanctuary to be known as the Kruger National Park, and

WHEREAS, the objects of the Society are to bring about improvement in the observance of the laws dealing with the protection of wild life in South Africa and to use all reasonable ways and means to increase the existing species of valuable fauna and to prevent its unreasonable destruction, therefore be it

Resolved, that the New York Zoological Society go on record as endorsing this far-seeing policy of the Wild Life Protection Society of South Africa, and be it further

Resolved, that the New York Zoological Society contribute the sum of $500 to encourage and advance the objects of the South African Society.

At the Annual Meeting of the New York Zoological Society on January 8, 1929, the following resolution was passed:

WHEREAS, one of the primary objects of the New York Zoological Society is the preservation of our native American animals; and

WHEREAS, the indiscriminate killing of predatory animals without a thorough study of their value in any given area is unscientific and unfair; and

WHEREAS, the introduction of exotic species may become a dangerous factor in disturbing the balance and natural condition of our native American game, therefore be it

Resolved, that the New York Zoological Society, while recognizing the fact that a certain control of predatory animals is at times necessary, is strongly opposed to the extermination of any single species of our American Wild Life; and be it further

Resolved, that the federal government be urged to adopt for our National Parks a policy whereby all wild life should be studied intensively with a view to determine scientifically to what extent its regulation is advisable and that the policy of destroying the predatory animals be suspended until such policy has been considered, and that this Society tender its services to the national government for the purpose of aiding in the efforts to reach a proper decision, and be it further.

Resolved, that the New York Zoological Society strongly opposes the introduction of non-native animals into our National Parks and urges the National Parks Service to prohibit all such introductions.

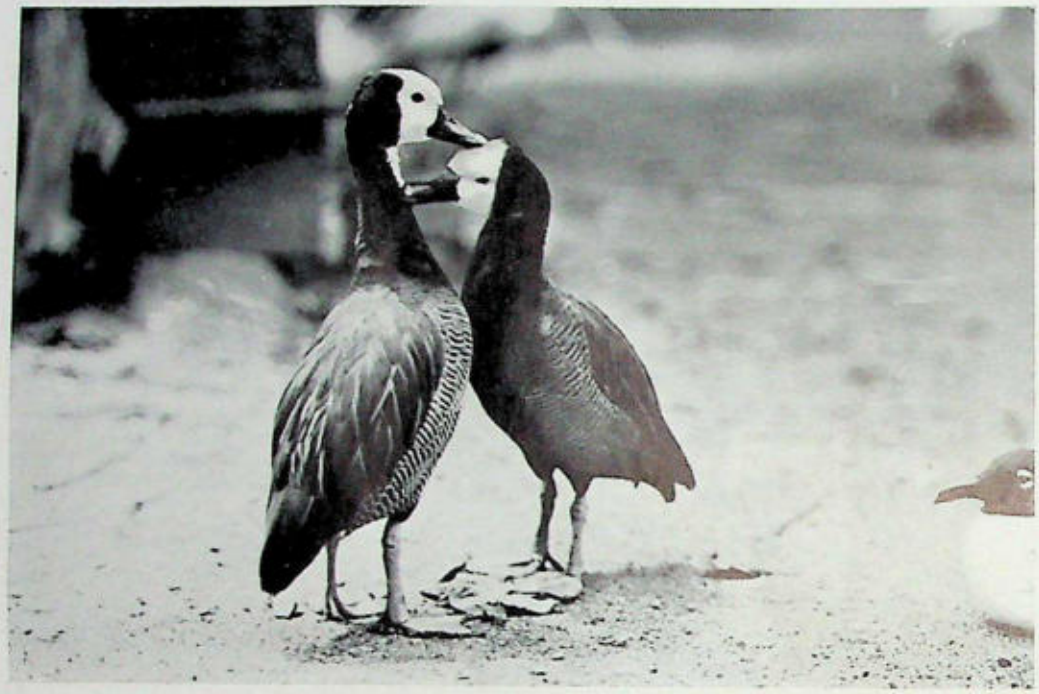
Bermuda Oceanographic Expedition

Honorary President Henry Fairfield Osborn, who recently visited the headquarters of the Society's Bermuda Oceanographic Expedition on Nonsuch Island where Dr. Beebe and his staff are engaged in the study of shore and deep sea life, reports that the work of the Station is well under way, and the results already obtained indicate the success of the expedition.

During April Dr. Beebe reported that the deep catches have resulted in obtaining ninety species numbering 3,600 specimens. In the well equipped laboratory the staff is studying the viability, color shape, activities and photographic records of the fishes. The trawling is done from three to twelve miles off shore, shoutheast of Nonsuch.

This is the 12th Expedition of the Department of Tropical Research, under Dr. Beebe's leadership, and was made possible through the generosity of two members of the Board of Managers, Messrs. Mortimer L. Schiff and Harrison Williams. W. R. B.

Griffon Vulture. The griffon is found in southern Europe and in Africa as far south as the Sudan. In South Africa, it is replaced by the smaller and grayer Kolbe vulture. Although it is a large and powerful bird, it has the cowardly disposition characteristic of the vulture and ordinarily does not attack living prey.



White-faced tree Duck. This beautiful little duck has a wide and curious distribution, being found in the West Indies and tropical South America, as well as in Africa and Madagascar. After the breeding season, it congregates in huge flocks.

The Problem of Bird Protection

Dr. A. K. Haagner

Illustrations from photographs made in the Zoological Park

IN the interests of wild-life conservation, a law has been passed in the Union Parliament prohibiting the export of all birds without a special permit from the Minister of Agriculture. This permit is granted very sparingly in regard to species not injurious to agricultural and pastoral pursuits. This law was a step in the right direction, but went much too far on the one hand, without getting at the root of the evil in bird destruction in South Africa. It was like getting hold of the wrong end of the stick. It hinders legitimate export for scientific purposes on the one hand as aviculture has certainly elicited many facts in connection with bird-lore, which had long remained obscure or even unknown. The study of birds in captivity is moreover a fascinating one, and young people should be encouraged to keep and look after their bird-friends, in the right way. It will teach them many things.

The law as it is administered in South Africa today makes it difficult to export such birds as waxbills, seedeaters and soft-billed birds, thereby making it almost impossible to carry on a legitimate trade overseas, whereas on the other hand thousands are caught with birdlime in every district, and more often than not are allowed to die for want of proper attention, while thousands more are caught in snares and shot with catapults, air guns and saloon rifles. The little native herd boys capture and otherwise destroy large numbers of *useful* birds, which they eat. They rob the nests of the half-fledged nestlings and devour these little creatures quite oblivious of the anguish of the unfortunate parents. As a case in point, take our beautiful lilac-breasted roller (*Coracias Caudatus*). This bird was at one time fairly common throughout the Transvaal bushveld, and especially so in the Pretoria District. It has been on the protected list of birds for a considerable time, but this has not prevented its

Eared Vulture. In Africa, flocks of vultures gather to feed on the carcasses of game and cattle. The eared vulture is the largest of these birds. Because of its size, strength and aggressive disposition, vultures of other species stand in awe of it and maintain a respectful distance until the "king" has eaten its full.

gradual extermination, nor will the export prohibition law help it one jot. The little native herd boys have nothing to do all day long but set snares, hunt for nests, etc., and the toll they take is enormous. One Sunday in the bushveld, forty miles north of Pretoria, I came across two little black boys with four rollers in their possession, which they were busy plucking, preparatory to roasting over the coals. The game and bird protection laws are almost unknown to the natives, and even if they did know them, it would make very little difference. How are we going to control these laws in the "backblocks" where the police are few and far between? While these lovely birds are being decimated by the natives, the dealer has great difficulty in obtaining a permit to export—we will say—half a dozen pairs of a species.

It has been suggested that a law be enacted preventing the keeping of birds in cages. I have kept birds for many years, and whenever one or more escapes these seldom leave the place, but remain in the vicinity of the aviary until recaptured. These birds would appear to be perfectly happy in their captured state. I am of course opposed to keeping birds in too confined a space or in a semi-starved condition. I am also against the wholesale and promiscuous catching of birds going on at present. I think that this should be under control, only suitable and reliable men being allowed to catch birds, —men who know how to catch, handle, feed and transport their little feathered captives. If it were made compulsory to take out a permit to capture birds, the town-boy and country native, who has no real interest or knowledge of birds, can be eliminated to a certain extent. I say to a certain extent advisedly, as South Africa is a country of wide spaces sparsely populated, and meagerly policed, and it is next to impossible to control the whole country efficiently. This we know from our experience in the operation of the game laws.

Much has also still to be learned regarding the true economic status of many of our birds. Mr. Fitzsimons, the Director of the Museum in Port Elizabeth, a man who has written much on the subject of bird protection in South Africa, informs me that the bird life generally has decreased much during recent years in that locality. It certainly has done so in the Pretoria district, except in a few favored spots, such as the Fountains Valley, the Zoological Gardens grounds, and on the hills adjoining the townlands, where birds have been more or less protected by enactment and by private people.

With increasing agricultural activities a lot of the wild cover frequented by birds has disappeared. Bush has been cut down and swampy ground drained to make room for the plough, and thus much of the natural cover loved by birds has been destroyed. With the increase of cultivated fields, certain birds have increased, 'tis true, but these comprise hardy species, such as the weaver birds, which do an appreciable amount of damage to the ripening grain crops and are in consequence not much loved by the farmer.

A peculiar phenomenon I have noticed from time to time is an occasional increase in the bird population of one species, followed often by a corresponding decrease. This applies to seasons, to particular districts, and even to the country as a whole. What was the reason for this increase and decline in numbers? In the case of the South African griffon vulture (*Gyps kolbei*) the reason may be explained by the sudden increase in the food supply and subsequent falling off of this supply. During the Boer War and during the time of the rinderpest (a scourge which decimated the bovine herds in South Africa) the food supply increased enormously, which upon the conclusion of the hostilities on the one hand and of the epidemic on the other, has suddenly decreased. But this explanation will not hold good for other cases I know of, except the increase of locust-eating birds during the period of invasion of swarms of these insects.

The southern ostrich, in its wild state, is still found in the Pretoria Bushveld, where there are fairly large tracts of unfenced country. For the rest it has betaken itself to the wilder parts of the country—the northern Cape Province, Bechuanaland, Northern Transvaal and Rhodesia.

The wild ducks of various species seem to have become scarcer during the past few years. I have been residing near a river now for the past twelve months, which has two dams, and all the ducks I have seen were a few black

South African Ostrich. Africa boasts several forms of ostrich. The South African species, distinguished by its dark blue legs and neck, is the smallest of all. Nevertheless, it is the most valuable, and was once kept in great numbers on farms devoted to the purpose. Dame Fashion is again smiling shyly at the ostrich plume and the industry of former days may be revived.

duck (*Anas sparsa*) a couple each of yellow-billed and redbilled teal (*Anas undulata* and *Anas erythrorhynchus*) and about a dozen white-faced tree ducks (*Dendrocygna viduata*). Wild duck of various species are still found in fairly large numbers on many of the big inland waters, and even on large dams and vleis. The Pratincoles (*Glareola*) are nothing like so numerous as they used to be (at least I have not seen many during recent years) and yet they have long been on the protected list. Another fairly scarce bird in most localities is the blacksmith plover (*Hoplopterus armatus*). A pair have taken up their summer residence on a spruit (rivulet) about half-way between Hammanskraal and Pretoria (about fourteen miles north of the Capital), where they are evidently breeding. The common crowned lapwing (*Stephanibyx coronatus*) is also not so plentiful as it used to be.

The bustards, I am told, have multiplied considerably on the Orange Free State "flats" since they have been protected. This is, however, not the case in the Transvaal. The red-crested bustard or bush koraan (*Lophotis ruficrista*) has become much scarcer in the Pretoria District, although protected by law. The cranes are becoming very much less in number, the wattled or bell crane (*Bugeranus carunculatis*) being seldom seen nowadays. Even the once common blue or Stanley crane (*Tephtrapteryx paradisia*) is not always procurable today, and is seldom seen in flocks of from eight to sixteen individuals—a not uncommon sight twenty years ago—yet these have long been on the protected list. It is, however, being constantly persecuted by the natives as it is easily trapped and forms quite an excellent meal.

I have already mentioned the common vulture. The black or eared vulture (*Otogyps auricularis*) seems to have become scarcer than ever. It never was a common species.

Owing to the fact that so many of the South African birds are partial migrants or "district" migrants, it is not easy to give an opinion as to which species have become scarcer and which more numerous, except in a few instances.

This is particularly the case with the hawks and owls and most of the Passeres.

The barbets appear to have become scarcer, but not so the colies or mouse birds. I have already mentioned the lilac-breasted roller. The other species of the roller are much scarcer, generally speaking. I have seen two specimens of the European roller, during the ten months I have been at Hammanskraal. The hornbills are still fairly common, especially the yellow-billed (*Lophoceros leucomelas*). Kingfishers have become very scarce in some localities, a fact I cannot account for. In others they are quite common. Crows have become scarce in some districts, but appear to be still fairly common in others.

Some of the smaller birds, including seed-eaters and waxbills, have become a little scarcer, but not to an appreciable extent, except in a few districts where the natural conditions are not so favorable as they used to be.

Still there are spots nearly denuded of bird life, which would appear to be suitable enough for many varieties. The cause of the absence of bird life is often very obscure, and much yet remains to be done in the intensive study of the general distribution and economic value or status of our avi-fauna.

The oxpeckers (*Buphaga*) have become rare, and the reason for this was, to a certain extent, explained to me by a farmer-friend of mine, who puts this down to the dipping of the cattle. The birds devoured the arsenical dip-impregnated ticks in such numbers that the dip killed off the birds in no time. The explanation seems feasible enough, although it is not so apparent with other species, such as the buff-backed egret (*Bubulcus lucidus*). These birds are still fairly common between here and Pretoria. I have recently seen flocks on the road in at least two localities.

With reference to the export and destruction of birds, another case has just been brought to my notice, viz., that of the red-headed or Nyassa lovebird, in Rhodesia. The Government restricts and has tried to stop the export, but I understand from Mr. Mackenzie Walker, of Chomo, that the species is very common, occurring in large flocks along the Zambesi River and other favorable localities, where the natives trap and catch them in thousands and eat them. They are very destructive to crops, especially Kaffircorn and millet.

Paradise Crane. All of the cranes are noted for their grace and beauty but the Paradise or Stanley is much the finest. The long, drooping secondary feathers of the wing are so extended that they drag upon the ground.

DEPARTMENT OF TROPICAL RESEARCH

Bermuda Oceanographic Expedition

The Twelfth Expedition of the Department of Tropical Research

ON March 13, Dr. William Beebe, with seven members of his staff, left New York on the S. S. *Fort Victoria* of the Furness Line, bound for Bermuda where they will carry on work in the field for six months.

H. E. The Governor Sir Louis Bols, the Honorable F. G. Gosling and the Legislature of Bermuda have granted to Dr. Beebe the use of the Island of Nonsuch as a base for deep sea work off shore. The financing of the Expedition, aside from salaries, has been assured by the generosity of Mortimer Schiff, Harrison Williams, Burt Massee and other gentlemen.

The island of Nonsuch consists of 25 acres, partly wooded with ancient cedars, with alternating coral rock and sandy beaches, and is provided with buildings in perfect condition for use as laboratories. Directly off shore, deep water approaches closer to Bermuda than elsewhere, a mile depth being found only two and a half miles beyond the one hundred fathom mark. With the sea-going tug *Gladisfen*, daily trawling in from one to two miles of water will be carried on for many months, and by the aid of pressure tanks, dark rooms both on the tug and on shore, and a fully equipped laboratory, the abyssmal fish will be studied, both alive and dead.

The efficiency of carrying on this work from the deck of a tug was demonstrated by Dr. Beebe during the past summer in the Hudson Gorge, and the richness of the deep-sea life in the particular area off Bermuda was proved several years ago by station hauls of the *Arcturus*. After a thousand net hauls have been drawn in the deep sea off Nonsuch, these should result in considerable definite knowledge of the life histories of organisms and the general ecological conditions existing in this black, cold, high-pressured and almost unexplored field of life.

The fish life of the reefs and shallow water will be studied intensively with the aid of diving helmets, submarine cameras and a fleet of six boats, while constant observation will be carried on of certain limited areas of coral reefs, within a few yards of the island. Laboratory work will be confined to observations bearing directly on life histories and ecological associations, and such problems as the osteological development of larval and young fish.

Among the members of the staff are the following:

William Beebe, Sc.D., *Director;* John Tee-Van, *General Assistant;* William K. Gregory, Ph.D., *Scientific Associate;* Dr. C. J. Fish, *Scientific Associate;* Mrs. C. J. Fish, *Scientific Associate;* William Merriam, *Field Technician;* Gloria Hollister, B.S., M.A., *Technical Associate;* Mrs. Hayne Boyden, *Laboratory Assistant;* Helen Tee-Van, *Artist;* Sven Von Halberg, *Field Assistant;* Robert Whitelaw, *Photographer.*

Professor and Mrs. Henry Fairfield Osborn will spend the month of April with the expedition, and among other well-known scientists or visitors will be Prof. E. Newton Harvey, Prof. Sayles, Dr. Mees, and Mr. V. Drake.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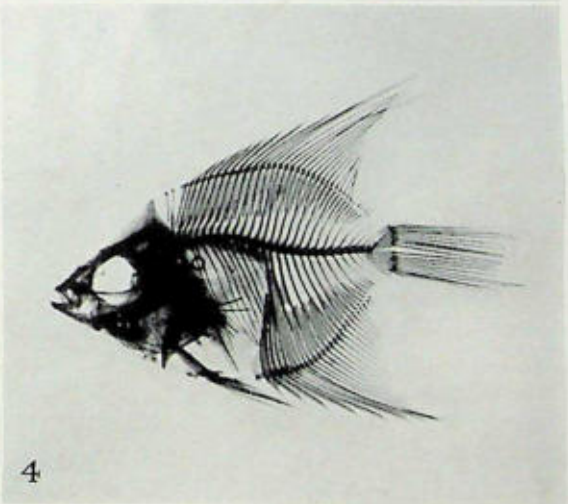
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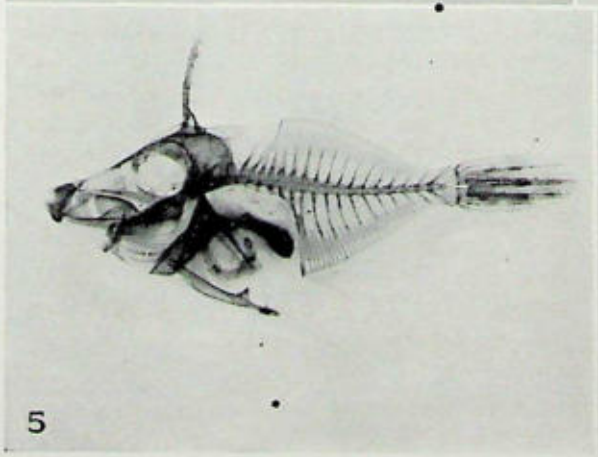
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The Architectural Beauty of Fish

New Adaptations of an Old Method

WILLIAM BEEBE

Illustrations from photographs by William Beebe and John Tee-Van

WHEN I was a student at Columbia, I first began to try experiments with the well-known Schulze technique of clearing tissues and staining skeletons, a method which has been used successfully for many years by Dr. R. M. Strong of Chicago and others. For several years in my department we have been making translucencies (to coin an appropriate word) of deep and shallow-water fish. Not, however, until the last twelve months has this method been developed in my laboratory to that really satisfactory point, when the final results deserve the word of transparencies. Miss Gloria Hollister, Technical Associate of the Department of Tropical Research, after months of intensive experimenting has prepared several hundred specimens which are as perfect as could be desired. The scales, flesh and internal organs of the fish are perfectly transparent, and the bones of the skeleton appear in their proper places stained a glowing scarlet—the most delicate of ossified centers and slivers standing out with brilliant clarity. Very recently the same success has attended the staining of cartilage. The clearing technique in reptiles and birds is a comparatively simple matter (Figures 1 and 2) but the cartilage of most fish is resistant to vital stains to a discouraging degree.

Figures 3 and 4 illustrate the extreme achievement in this clearing method. Figure 3 is a specimen of the Amazonian Wingfin, a fresh-water tropical fish, *Pterophyllum scalare*. Figure 4 shows the same after clearing and staining. The rapidity with which results can be attained with careful manipulation of our readaptations of this method is astonishing. Figure 5 shows a young Triggerfish, *Monacanthus*, entire except for the removal of the eyes, forty-eight hours after its capture in the waters of Bermuda. It must be realized that these photographs are in no sense X-rays but are of actual specimens permanently preserved in glycerine.

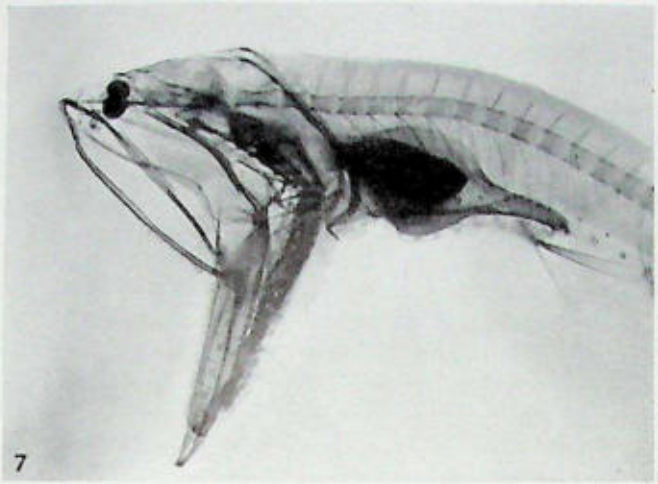
Figure 6 is a young, deep-sea Viperfish, *Chauliodus sloanei*, from a mile down, with the anterior part of the backbone just beginning to show bony substance. After being cleared it was discovered that the fish had swallowed another fish—a *Cyclothone*—almost as large as itself. The head of this engulfed fish was, in its turn, outlined in scarlet. From the number and arrangement of the light organs on the body of the victim it is possible to tell the species and even the subspecies—*Cyclothone signata signata*.

An enlarged and cleared head of one of these *Cyclothones* is shown in Figure 7, where the eyes, stomach and backbone are clearly seen, as well as the marvelously elongated and attenuated bones of the head. These are adapted, to a much greater degree even than in a serpent, for permitting the opening of the jaws to the widest extent.

Figure 8 is *Sternoptyx diaphana*, a silvery, highly illuminated fish in life, living about half a mile beneath the surface. The cleared body as shown in this photograph appears filled with a beautiful filigree of slender bones, and reveals the strong strut which supports the transparent area of the lower portion of the outline. Of the function or use of this hyaline bit of what should be part of the actual body of the fish, we are wholly ignorant.

A baby deep-sea Flounder (Figure 9) is an architectural joy, palisades of needle-like cartilage bounding the as yet unhardened backbone. The necessary bones of the head are, even at this age, strongly ossified, while an almost complete halo about the body, of bony fin-rays, shows how important are these structures to the life of the immature flatfish. A greatly enlarged view of the head (Figure 10) reveals each element, either clearly formed and functioning, or faintly adumbrated in cartilage.

Finally I show photographs of two deep-sea fish which I have been studying in detail. In Figure 11 are seen the slender bones of a cavernous-mouthed *Melanocetus*, or Black Whalelet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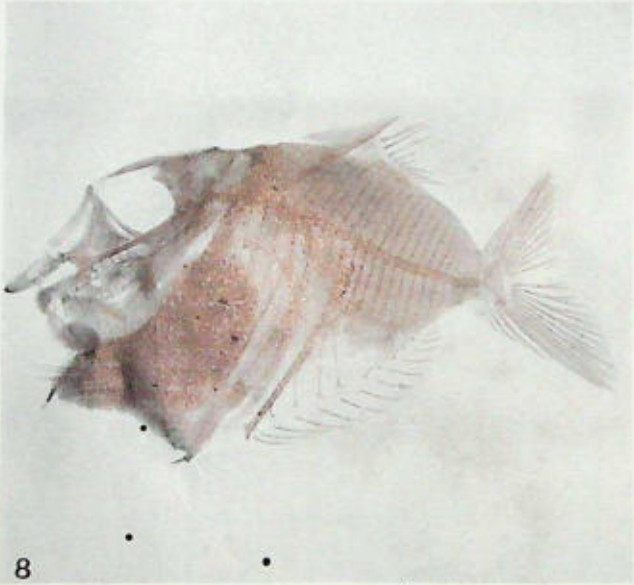
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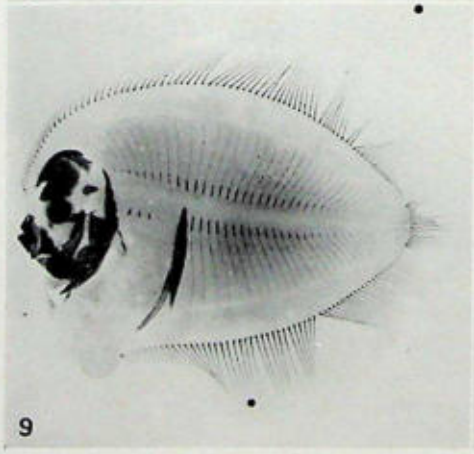
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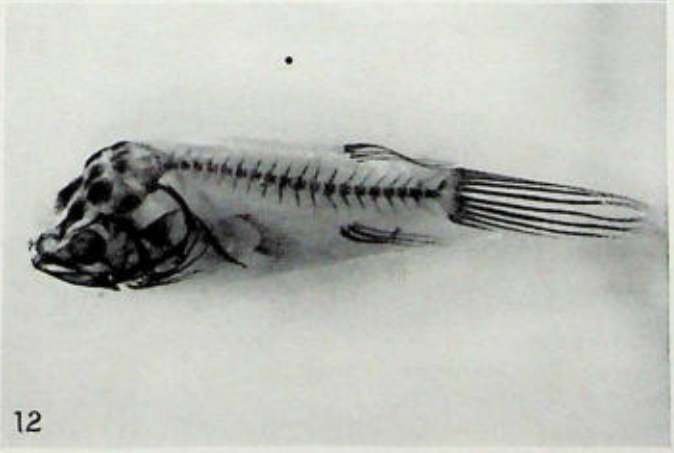
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Figures described in the text.

of the deeps, with its brilliantly illuminated beacon suspended on the tip of a long tentacle, and the huge mouth furnished with serried teeth. The pukka body of this fish is a mere posterior fraction of the whole.

The last photograph is the side view of a new species of *Haplophryne* (Figure 12) recently brought up from the depths of the Hudson Gorge, and showing every detail of the skeleton. A monograph of this species will soon be published in Zoologica. Around the whole fish can be faintly discerned the strange, thick, balloon-like external envelope of skin in which it is encased. Notice especially the separate elements of the skull, the curious, detached, dermal denticles at the front of the upper jaw, and the diminutive but perfect tentacle extending far out from the forehead, but still beneath the outer skin surface. In sharp contrast to the fish in Figure 4 this species shows no signs of ribs, and only the tail fin is thoroughly effective in locomotion, the others being for the most part embedded in the outer tissue envelope.

With the whole process reduced to a period of much less than a week, and with both cartilage and bone stained—the one blue and the latter scarlet—and the body tissues made as transparent as the glycerine in which the fish floats, new and interesting discoveries concerning specific development and systematic relationships are being easily and accurately made. Dr. William K. Gregory and I have spent many evenings in enthusiastic study of the various cleared forms. It is a means which is of value to scientific research, as well as a thing of artistic beauty, appealing even to the persons to whom the only use of a fish bone is to keep it out of one's throat.

Fishing a Mile Down in the Hudson Gorge

William Beebe

Illustrations from photographs by William Beebe and John Tee-Van

The best known Hudson Terminal is a tunnel in lower New York about a year and a half old. The original Hudson Terminal is a canyon, one hundred miles south-east of New York City, lying one mile below the surface, and excavated about a million years ago. Long after the last animal and insect from the heart of Africa and New Guinea has been collected and named, and the north and south poles have been crossed and recrossed with tourist planes, strange fish and other creatures will still be brought to light within a day's motor boat run of New York City.

I had to spend most of the summer of 1928 in New York City, and yet I longed to be exploring on the edge of known things. How could I manage both at once? There came to mind a cartoon in which Skippy and his small friend stand for a long time gazing out to sea. Throughout three layers of cartoon strips not a word passed between the two urchins. At last, without turning his head, Skippy said, "You know, that's only the top of it."

That cartoon set me thinking, and brought to mind the Hudson Gorge, silent, black, cold,—with its sunken vastness filled with unknown forms of life. If I could manage to find transportation one hundred miles from land, and means for reaching down even a half mile I could explore without neglecting my laboratory researches in the City. My thought spread and took fire in other minds and one day in early July I found myself on an ocean-going tug, backing out of a Brooklyn slip, on the way to test my newly-thought-of world. The tug was the *Wheeler* and the god-in-the-machine was Mr. L. F. V. Drake, President of the Salvage Process Corporation. Mr. Drake is now a life member of the Zoological Society and keenly interested in every phase of our undertakings.

Twenty-five thousand years ago I could have walked the hundred miles out to sea dry shod, for at that time there was so much water locked up in ice on the continent that the ocean's level was more than three hundred feet lower than now. Ages before this, the Hudson, fed by five river-tributaries, had cut its way still farther, through a valley now deep beneath the surface,

Firola; a deep-sea mollusk eight inches long which has lost its shell and developed a fin for swimming.

and through a gorge with water-falls higher than anything on earth today.

We start in the evening and on the first trip sleep but little for there is a magnificent display of northern lights—flashes and ribbons and radiating spokes of yellow and rose and green. At eight o'clock the next morning the little tug is rolling gently on the threshold of our New York mystery—something more than one hundred miles out at sea, with the blueness of mile-deep ocean stretching all around to the rim of the world. The only life on the planet is our tugful of selves and a quartet of Mother Carey's chickens.

My small *Arcturus* winch is uncovered, given a breath of steam, and the wire begins to uncoil. To it a series of great silk nets is fastened, and they go billowing back in the wake, settling slowly out of sight. A mile and a half of wire is run out and for several hours we crawl along at a speed of two knots.

I put my hand on the taut, vibrating spider web of steel, my eye follows it down into the sheer liquid ultramarine, and I pray to Neptune, or perhaps better to Slid—god of the uttermost deep—where, it is said, "he may sit and smile, or creep among the ships, or moan and sigh round islands in his great content."

In a metal helmet I have walked in comfort ten fathoms down, and once a diver in full suit touched forty-six fathoms and came back alive. But the rest of the under water world is hidden, and for the present, the North Pole is far more accessible than where my nets are trailing.

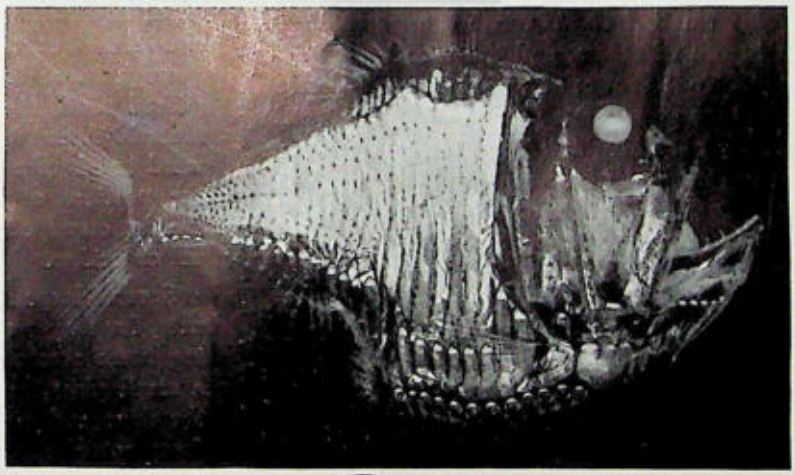
I wave my hand, the bell in the engine room clangs, the propeller rests and the sturdy bulk of the tug begins to rock, swinging to the wind. Slowly the wire reels in, and finally the great nets, bulging at their apex, come dripping aboard.

Into big jars and aquariums flows the pink treasure, glittering and gleaming, trembling with strange vitality, every spoonful a cosmos of hundreds of living beings. There looms through the translucent mass a long black and bronze snake, or eel, or as it finally proves a scimitar-fanged sea-dragon. I pick it out and at the first touch feel almost pain from the bitter cold. In the heat of a quiet July day, my hands become numb as I dip them into the living gelatine, and the mysterious character of this deep world begins to shape itself in my mind.

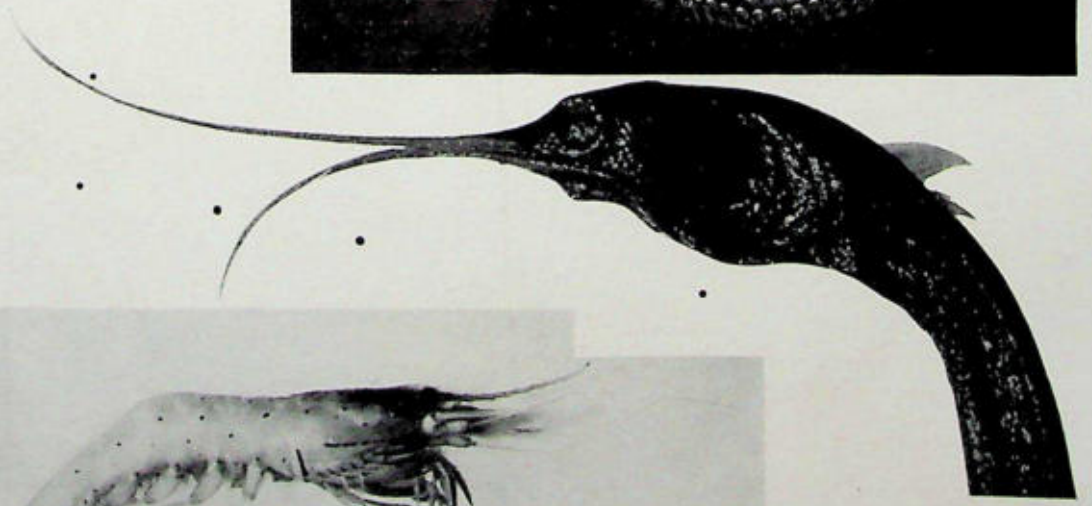
At the surface the water is 68°, five hundred fathoms down it is 40°, and at the bottom of the Hudson Gorge the thermometer records 31°. This would be impossible in lake or river, where the fresh water turns to ice at 32°. As I pick up the dragon fish, the mouth opens unbelievably wide, as wide as the gape of a sabre-toothed tiger, and the long, needle-like teeth come together with a snap. I had wondered how such teeth could be managed, and I now saw that the two longest went straight through concealed holes in the head and appeared above the skin near the eyes. A long tentacle thread from the dorsal fin drooped forward in advance of the head—a feeler recalling the portiere of dangling cords which warns freight crews of the proximity of a low tunnel or bridge.

Several large shrimps drew my eye like magnets, for they were of the most intense, vibrating flame scarlet conceivable. I put one into a small glass, ran down to a dark cabin, shut the door and watched magic. Little by little from out of several pores there flowed a fluid within fluid—a foggy mist sifting and billowing through the water, a mist which suddenly took fire and in the darkness I saw I was holding a glowing glass—the water alight with soft radiance. As a squid escapes through his own sepia smoke-screen, so this deep-sea shrimp was covering his tracks with a dazzling cloud of flame. A second realization came to me—the utter darkness of the path along which the net had come. Sixty feet below the surface I have watched fish swim in what seemed brilliant tropical moonlight, while at two hundred fathoms submerged photographic plates tell us the illumination is of the strength of starlight. But the twilight of the depths is not the gloaming of land, for as we descend beneath the waters the red goes first, indigo and violet last. So, at his great depth, my scarlet shrimp would be as black as black—there being no red rays to reflect from him. In fact, until I brought him up he was *not* and had never been red.

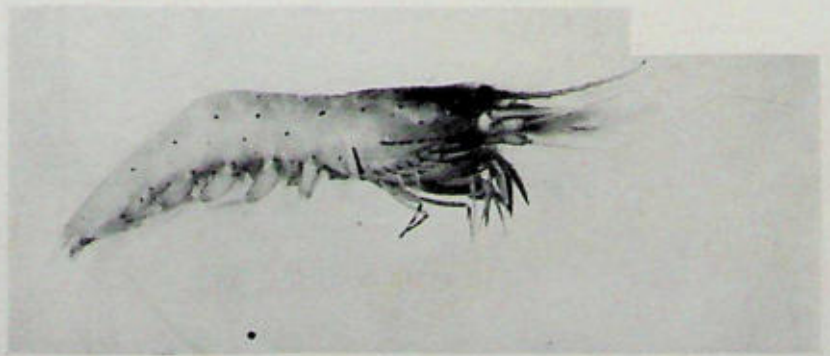
A deep-sea squid, deep maroon in color, with several thousand glowing spots of light.



Argyropelecus or hatchet fish, gleaming with a skin of silvery tissue, lighted with clusters of various colored lights.



Snipe-billed eel from a mile down. The function of the jaws is unknown.



Acanthepyra, a scarlet shrimp from zones of darkness. When frightened it pours forth a blazing, luminous cloud of phosphorescence, dazzling its enemies and escaping through the glowing mist.

Melamphaes, jet black with turquoise scales; dwells far below the zone of sunlight.

A true sea-dragon, the fish known as *Chauliodus sloanei*. Although it is but thirteen inches long, it is a dreaded foe by all fish near its size.

Sabre-toothed viper-fish of the black depths of the Hudson Gorge.

Salpa zonata. A single glassy segment of a long string of living creatures. One of the failures that made a futile attempt to develop as a back-boned animal.

Stylophthalmus, strangest of living fish, with pale thread of a body lined with scores of glowing portholes, a beak like that of a duck, and eyes on the tips of enormously elongated stalks.

A shrimp which rears its young inside the glassy barrel home of another animal, thus protecting her offspring from ravenous sea-devils.

We think of the blackness and we look at the great teeth, and a connection at once occurs to us — plants cannot grow without sunlight, so, far beneath the surface, every creature is carnivorous. We know indeed that some are confirmed cannibals, and many have stomachs so elastic that they can swallow a fish several times their own length.

If absolute and perpetual midnight should suddenly envelop our city, only those of us could survive who had access to adequate illumination, or who by blind skill could manage to avoid danger and find food. As we study our deep sea creatures we learn that the same thing holds good in the gorge of the Hudson. Many of the fish and shrimps and squids are covered with powerful searchlights, or dotted with lesser beacons, and their eyes are large and all-seeing. In others we find long feelers reaching out in all directions and blind or nearly blind eyes. As a blind man hangs a lettered sign about his neck—a sign he himself can never read—and sits patiently waiting for it to attract pennies, so occasionally we find a blind fish with the sockets of its eyes turned into glowing headlights. We can explain it only as a lure to draw small victims close enough for some other sense to detect them.

The flabbiness of the fish, their relaxed bodies and loose scales remind us of the gentle pressure upon our own bodies compared with that which exists at great depths. A mile down, the water bears upon every inch of surface with the weight of a ton, and only because we have brought them up so slowly are the fish still alive and in fairly good condition.

In every net there are hundreds of unsolved problems. A tiny white thread of a fish has perfectly good eyes far out on the end of impossibly slender stalks, each half as long as the body, a boon indeed for the watcher of a parade, but in our present ignorance of no conceivable use to the fish; another fish is round and of glowing silver, and has all its batteries of green and violet lights turned downward while it forever stares immovably and piously upward; a third fish has series of great curved teeth along the jaws, but outside at various angles on the skin, where they seem utterly useless.

Now and then we see something which needs no explanation, but demands only appreciation and wonder; a curious, pale violet, humpbacked shrimp with a brood of tiny humpbacked offspring. All are gathered on the inside of a transparent, fluted barrel which the mother has taken from its original owner, and, like a more unselfish Diogenes, used it for a nursery. With her swimmerets she is able to kick her house along so that a stream of water and food pours through. Though hosts of hungry dragons may nose about the sides (we can scarcely say that their mouths water) yet the shrimp and her brood are safe. The courtships and battles, the comedies and tragedies of family life in this underworld will some day yield delightful tales of ingenuity, horror, and devotion.

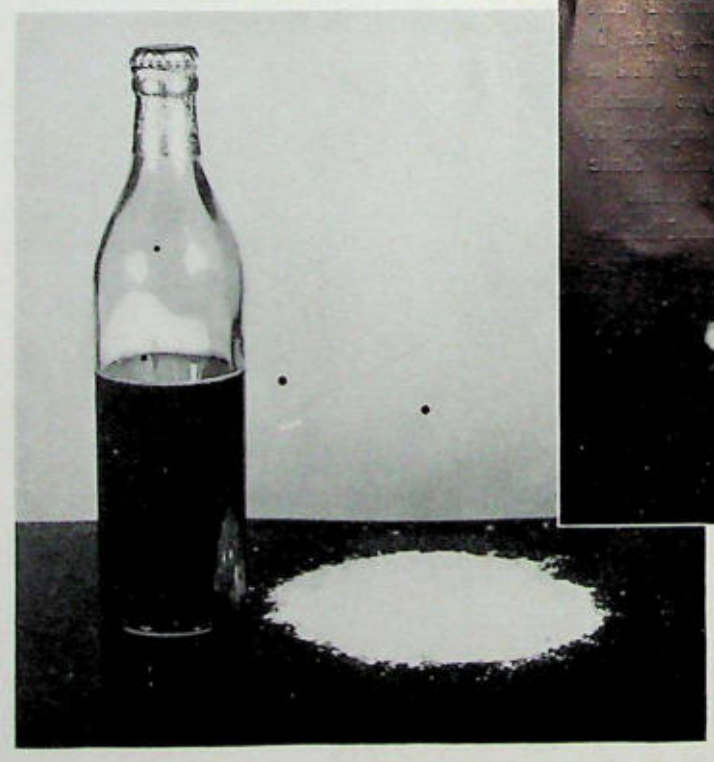
With all this strangeness there is also beauty beyond words. In and out through the mass of life swim active opals—gleaming and scintillating as they twist and turn—tiny, oval, living tissues of flame and ash, which glow as brightly after death, for their colors are due not to pigment but, like a hummingbird's throat, to a myriad prisms.

With our present meagre facilities we can best revive the glories of the sea depths by taking the new caught beings into a darkened room, and watch the shift and play of colored lights, the lines upon lines of glowing portholes, each beacon as complex as an eye, with lens and reflector; other lights arranged in certain patterns along the sides are perhaps for recognition by members of the same school, and finally, we watch the penetrating flashes which, as they are different in the two sexes, may be of use in finding and securing a mate.

My body cramped from a day of long and intensive activity, my mind completely withdrawn, I am roused by a steady throbbing, and look up to see that the tug is headed homewards. Far off on the horizon is a tiny black smudge in the sky, and I realize that there is another world than this of the ocean deeps—that on the great liner on the horizon people are playing bridge, gossiping, looking at the water with unseeing eyes, while in the dimming light of day the sea dragons beneath their keel are beginning to swim slowly upward on their tigerish quests.

Periphyllum, a deep-sea jellyfish living in absolute darkness. When brought up into sunlight its color is a rich maroon and turquoise.

A Siphonophore, a drifting colony of animals with gas-float adapted to pressure at a half-mile depth. It has a supporting umbrella around the rim of which are feeding and reproductive individuals.



A bottle before and after being lowered to the depth of a mile or more. The enormous pressure of the water crushed the bottle, and reduced the glass to the mass of white, vitreous powder which appears as a white circular patch in the picture.

The tug churns cityward; I look back over the sea oxydizing in the last gleams of sunset, and to quell any possible sentimentalizing, I prefer to let four lines of Kipling crystallize my thoughts of the deep hidden gorge:

"The wrecks dissolve above us; their dust drops down from afar—
Down to the dark, to the utter dark, where the blind white sea-snakes are.
There is no sound, no echo of sound, in the deserts of the deep,
On the great grey level plains of ooze where the shell-burred cables creep."

* * *

Note—So important has seemed this first inauguration of investigation into the Hudson Gorge that I have considered the work carried on during the last summer as an independent expedition, the Eleventh of the Department of Tropical Research of the New York Zoological Society. Two papers are now in press and will soon appear as numbers of Zoologica: *An Annotated List of the Deep Sea Fish of the Hudson Gorge*, and *A Monograph of the Osteology of a New Species of Haplophryne*. Fifty-five species of deep-sea fish were taken in Stations 113 and 114, of which five are new.

The success of this work carried on from the aft deck of an ordinary tug has led to the institution of the same method of work in Bermuda, where corresponding depths can be reached within a radius of several miles of Nonsuch Island. It is intended in the future to resume deep-sea work in the Gorge, and ultimately to study and report on a comprehensive collection of these fish, and to place them on exhibit at the American Museum, as representatives of a fauna wholly new to the hundred mile radius of New York City.

In Bermuda plans are being made to experiment with pressure tanks in an ice cold and black environment, in the hope of being able to keep some of the strange fish of the deeps alive for hours or days. If this is successful, it will be possible in time to come, to bring the specimens taken in the Gorge to New York City and our Aquarium, for exhibition while still alive and glowing.

The photographs accompanying this article are all of organisms secured on the Zoological Society's Expedition to the Hudson Gorge.

Rearing and Photographing Fishes

The interesting experiments of an amateur fish culturist, and some of his photographs.

J. Stuart McLees

OF recent years the literature of Ichthyology has acquired decided interest and some additional degree of accuracy by the use of illustrations reproduced from photographs. Most persons, scientific or otherwise are naturally attracted by reasonably good pictures, and in response to this popular appreciation the art of book illustration has made wonderful advances, based largely on photography and the printing processes made possible by it. Recent work of this kind leaves nothing to be desired from the standpoints of beauty or accuracy, and the field is being rapidly covered by photographers who are attached to all the major scientific institutions.

The writer has experimented in the difficult field of fish photography for his own amusement and the edification of his friends and for this purpose, as well as to gratify his interest in their habits and his pleasure in their grace and beauty, he maintains in a number of small tanks such members of the local fish fauna as are able to withstand the change to domesticated conditions. Returning from a recent visit to the local fish hatcheries with a number of eggs of several species of trout, the thought occurred that here was a corner of the field as yet hardly touched by the new methods; a corner, moreover, that, if it lacked the opportunity for highly artistic and spectacular results, nevertheless had considerable interest and scientific value.

The first problem presenting itself for consideration was the care of the eggs. These require running water of uniform low temperature, and as no special tank was available for their reception they required to be protected from the other occupants, some of which surely would regard such dainty morsels as a very desirable change of diet. Trays therefore were made, patterned after those in use by fish hatcheries, of wooden strips one-half inch by one

Eggs of the lake herring, *Argyrosomus artedi* ready to hatch: *Lower*: newly hatched fry.
Both photographs greatly enlarged.

inch, with a bottom of ordinary mosquito netting. Placed in the tank these sank until they held about half an inch of water and they served very well to protect the eggs, but, as we shall see, they had to be modified when the fry appeared. The tank was already supplied with pure running water and the temperature was found to vary by slow changes between 46 degrees and 52 degrees Fahr.; which variation falls within the permissible limits as is indicated by the successful hatching and rearing of the fry.

Hatching began late in February and new fry continued to appear daily for about three weeks. Attracted by the movement of the fry some of the larger fishes contained in the tank stationed themselves beneath and in their efforts to seize them bumped the bottoms of the trays. The disturbance caused the fry to answer to their instinctive desire to burrow, thus getting their heads between the meshes of the mosquito netting, where they literally lost their heads. The principal offender was a six-inch bluegill (*Lepomis pallidus*) who sometimes was able to pull the whole of the little fish through the mesh. Sheet zinc, perforated with very small holes, was substituted for the netting and the loss from this source stopped at once.

For photography of this kind the writer uses a five by seven view camera, equipped with an f. 8 Velostigmat rapid rectilinear lens of eight-inch focus with shutter working at various speeds from 1/2 second to 1/100 part of a second. A second lens, a five-inch anastigmat, f. 6. 3. in a similar shutter, can be used in place of the "Velostigmat" when somewhat larger magnifications are desired. Any equipment having a long bellows-draw and a focusing device will give good results, but for subsequent enlargement the crystal sharp image given by the anastigmat lens is to be preferred. Printed on a glossy bromide paper all the delicate detail is retained.

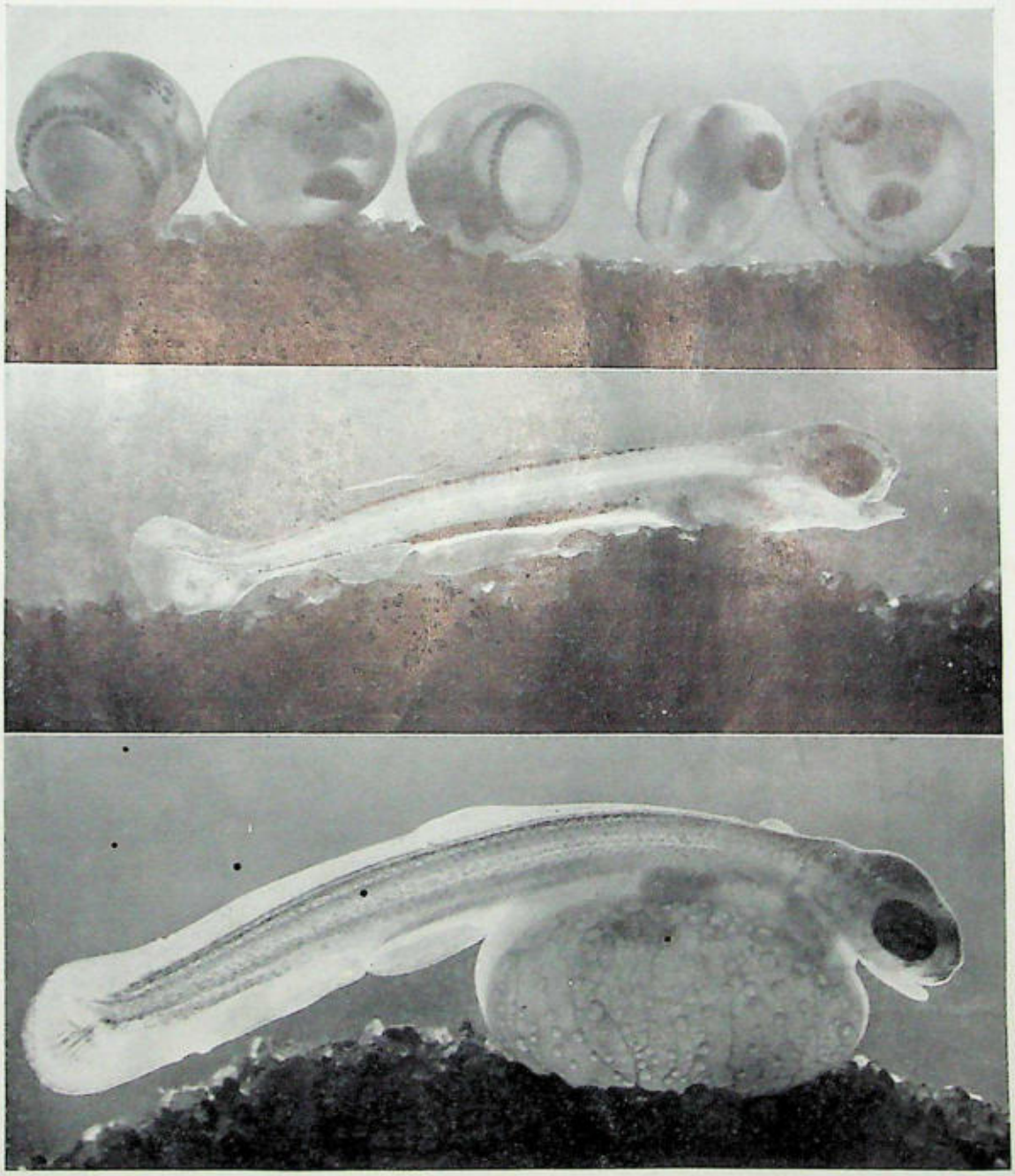
To hold the eggs or fry within a very short focal range and to permit of photography by transmitted light a special cell of plate glass was made, previous attempts to photograph the subjects in glasses, bottles, etc., having resulted in distorted images of various kinds. The cell consisted of five pieces of one-quarter-inch glass cemented together with the household cement used to repair broken china and glassware. Two pieces, each five by three inches, formed the front and back, one piece, one by five inches, became the bottom, and two pieces, each one by two inches, made the sides. A clear central space, the thickness of the glass, was left, and a little coarse sand or fine pebbles placed in this before the eggs or fry were introduced gave a suggestion of natural foreground and saved the necessity of including the harsh line made by the cemented glass.

There are two sources of trouble to be watched if success is to be had: The first is due to the presence of air in the water contained in the glass cell; when placed in the sunshine the water rapidly rises in temperature and this air is deposited in tiny bubbles on the surface of the glass. The other is due to the presence of tiny particles of dirt in the water; when working by transmitted light the bubbles and the dirt give noticeable images which become very prominent when enlarged.

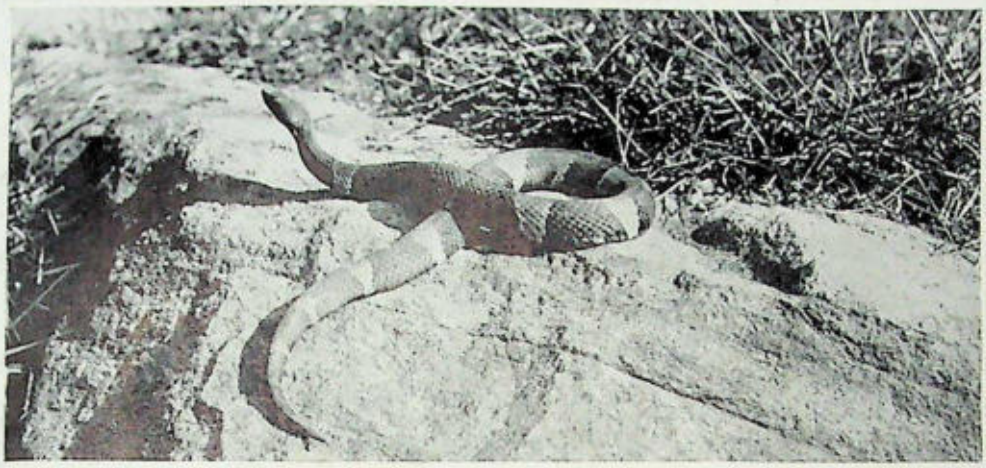
The accompanying photographs were all made by daylight in the sunshine streaming through a south window. With the shutter opening one inch in diameter and the camera extended eighteen inches, i.e., at f. 18, exposures from 1/10 second to 1/50 second were found to be approximately correct but for the sake of greater depth of focus it was often found desirable to stop down to f. 64, with proportionate increase of exposure.

Predatory Animal Survey

At the spring meeting of the Board of Managers held in the Zoological Park on May 16, Mr. A. Brazier Howell, Corresponding Secretary of the American Society of Mammalogists, was designated a representative of the Society in his contemplated study of the conditions affecting the destruction of predatory animals in the West. By resolution the Board authorized the contribution of $250 toward Mr. Howell's expenses in making the preliminary study of this important conservation matter. W. R. B.



Whitefish, *Coregonus clupeiformis;* eggs ready to hatch: *Center*: Whitefish fry forty-eight hours after hatching; *Lower*: Lake trout, *Cristivomer namaycush*, fry, forty-eight hours after hatching. All photographs greatly enlarged.



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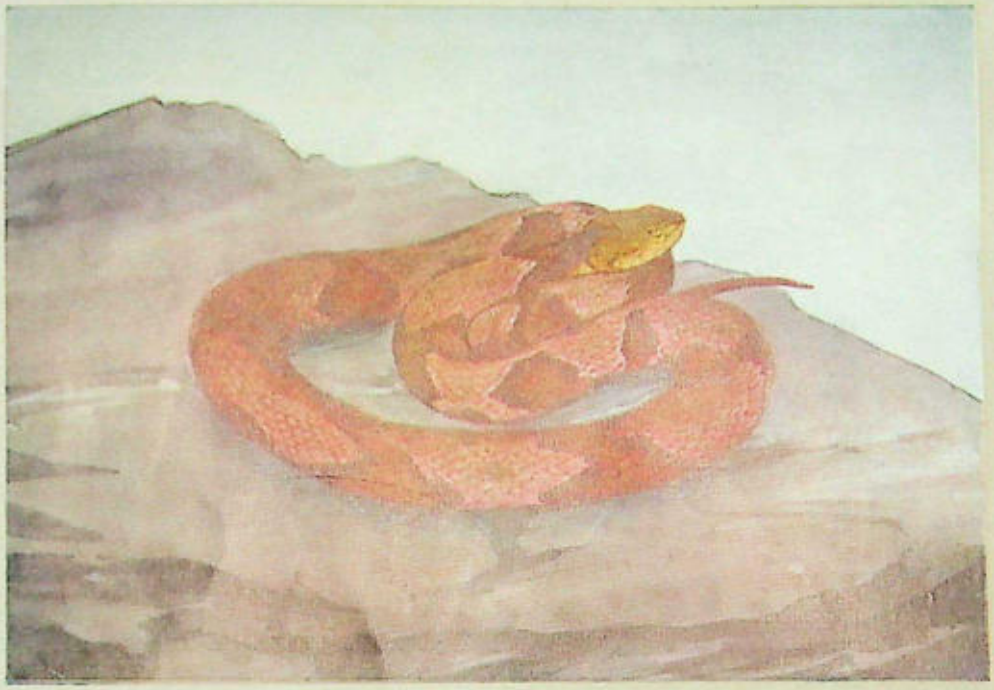

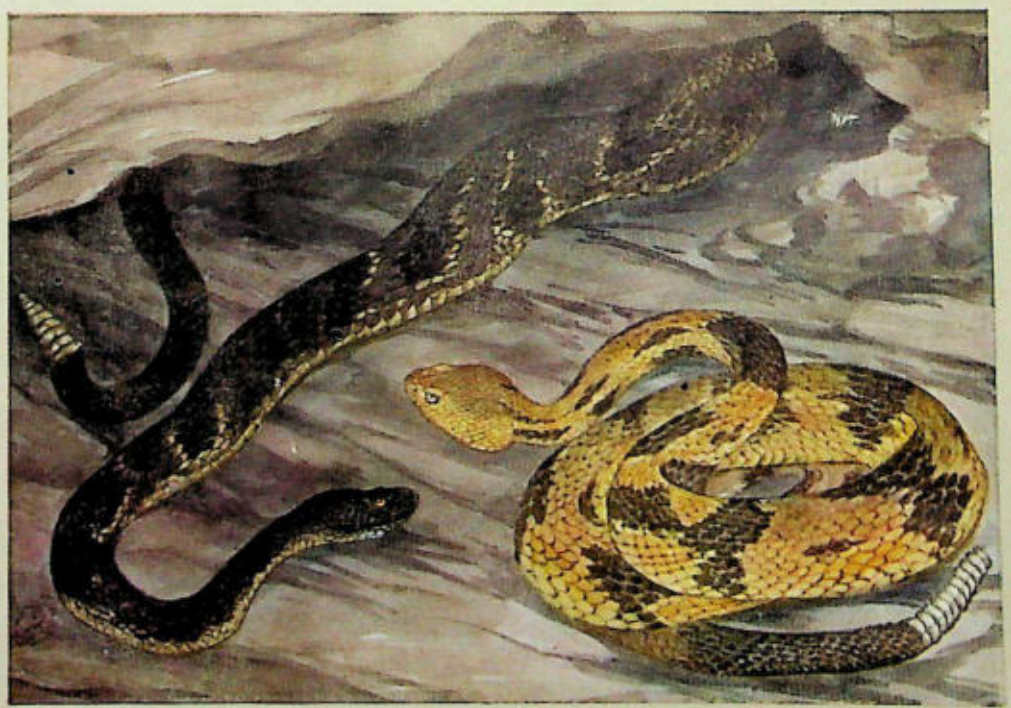

Upper: Copperhead snake *Agkistrodon mokasen.*
Lower: Timber rattlesnake *Crotalus horridus.*

These species and the massasauga (a small rattlesnake) are the only poisonous serpents of the northeastern States.

BULLETIN
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Serpents of the Eastern States

The venomous and non-venomous Snakes of the North Atlantic and New England States with descriptions of the various species.

RAYMOND L. DITMARS
Curator of Mammals and Reptiles

Illustrated with photographs made in the Zoological Park by the Author and E. R. Osterndorff and a color plate from a drawing by Helen Tee-Van

MORE than two and one-half million visitors come to the Zoological Park each year. We also answer a heavy correspondence, which is largely in the form of queries about animal life. Frequent queries from visitors, and in letters, indicate the need of a simply prepared, although complete explanation concerning the kinds of serpents to be found in the northeastern area of the United States. This should clearly explain how to distinguish the poisonous from the non-poisonous species, and point out those, among the latter, which are of distinct economic value. It should also describe something of characteristic habits, and show the kind of terrain frequented by various species. All of these points were considered in developing this article.

The array of serpent life in the area covered is rather imposing. There are twenty-one distinct species. Of this number, however, only three are poisonous or in any way dangerous. These are the timber rattlesnake, the massasauga and the copperhead. As both of the former are rattlesnakes and positively characteristic in possessing the warning appendage on the tail, it may simplify the definition of the poisonous reptiles of our northeast to point to two *kinds* of snakes, the rattlesnake and the copperhead.

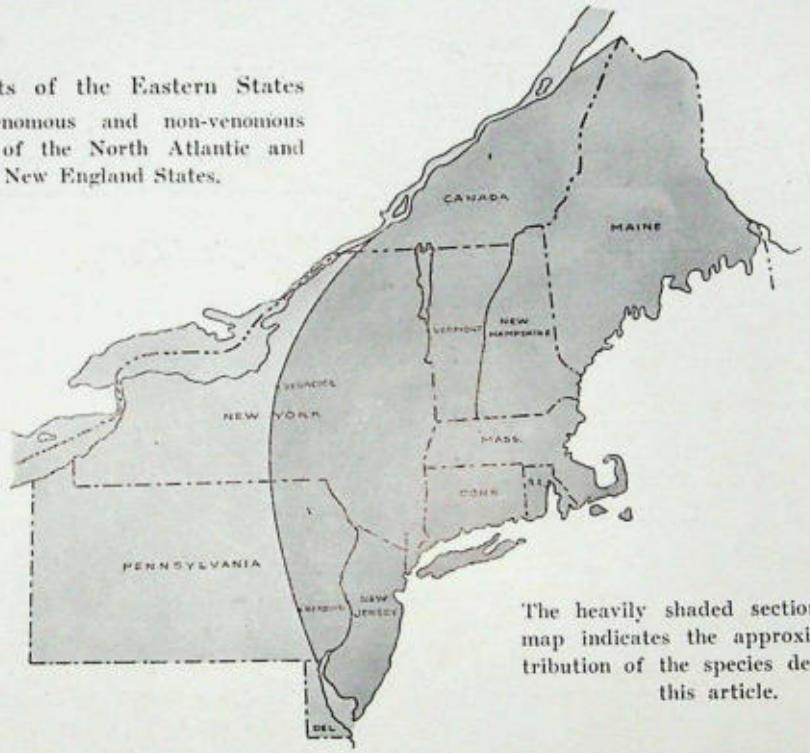
In extensive scientific works for the precise identification of serpents, there are many species, which, on superficial examination appear similar. In such works, definition is through technical differences of head scalation, number of rows of scales around the body, the number of abdominal shields, and relative size and arrangement of the teeth. Coloration and pattern have a part in such descriptions, but as unrelated species may be similarly marked, extremely detailed descriptions are necessary to separate them.

Fortunately this is not the case with our local serpents. The number of species is so moderate and differences so marked, that simple outlines will plainly define each species. No scientific study is necessary in making immediate identification of these local snakes.

The terrain inhabited by the twenty-one species is varied. Some are more commonly found in wild meadows, others rather persistently frequent the immediate course of brooks, small rivers or the margins of ponds and lakes. Some wander rather widely over varying ranges and may be seen almost anywhere on low or high ground. One species shows a marked preference for the arid, sandy stretches immediately back

Serpents of the Eastern States

The venomous and non-venomous Snakes of the North Atlantic and New England States.



The heavily shaded section of this map indicates the approximate distribution of the species described in this article.

of ocean beaches, another for the pine areas of New Jersey and to the southward. The prevailing type of rattlesnake is far more commonly associated with the vicinity or the actual slopes of the mountainous areas, and this condition, though to a lesser degree, is indicated for the more generally distributed copperhead snake.

A key for the identification of the northeastern serpents may be based upon four simple points. These relate to (1) the kind of scales—whether smooth or keeled, (2) the pattern and coloration, (3) size, and (4) shape of the pupil of the eye. This latter character, alone, immediately separates the poisonous species on gross examination. The scales of serpents are either quite smooth, or have a ridge or keel running lengthwise along the center. With some, the keel is faint; with others, like the harmless water snake, garter snake and flat-headed "adder," the keel is very distinct. The local poisonous serpents have strongly keeled scales.

Following is a key to the species, arranged without regard to technical classification, except that the venomous species are in sequence, and conclude the list:

Key to the Species Described

Non-Venomous

1. Pupil of Eye Round
   - A—Scales Smooth
     - *Size—Small*
       - Brown above; pinkish beneath ..... Worm Snake
       - Brown above with minute black dots; yellowish-white beneath ..... Smooth Brown Snake
       - Pale green above; white beneath ..... Green Snake
       - Dark gray above; a yellow ring around neck; yellow beneath ..... Ring-necked Snake

Size—Moderate

Gray, with chestnut or olive blotches above; square patches of black and white beneath ..... MILK SNAKE

Size—Large

Black, with narrow yellow or white chain-like, or narrow cross-ring markings on back; black and white beneath ..... KING SNAKE

Satiny black above; black or dark gray beneath; chin and throat white ..... BLACKSNAKE

B—Scales of Back Feebly Keeled

Size—Moderate to Large

Grayish or yellow, with vivid, deep crimson blotches along back; black and white beneath. (Distinguished from the similarly marked Milk Snake by its feebly keeled scales.) ..... CORN SNAKE

Size—Large

Polished black above; beneath white, blotched with gray. Some scales of the sides show narrow white edges. (Distinguished from the Blacksnake by its feebly keeled scales.) ..... PILOT BLACKSNAKE

C—Scales Strongly Keeled

Size—Small

Brown above; pink beneath ..... DEKAY'S SNAKE

Brown or gray above; bright red beneath ..... STORER'S SNAKE

Size—Small to Moderate

Uniform pale green above; yellow beneath ..... KEELED GREEN SNAKE

Brown or black above, with vivid yellow stripe on back and a similar stripe on each side on third and fourth rows of scales from underside ..... RIBBON SNAKE

Size—Moderate

Brown or black above, with a more or less distinct yellowish stripe on back and a light stripe on each side on second and third rows of scales from underside ..... GARTER SNAKE

Brown, with three narrow black stripes on back and a bright yellow stripe on each side. Three dark stripes on abdomen ..... QUEEN SNAKE

Size—Moderate to Large

Dark brown or blackish above, with more or less distinct reddish transverse bands; white or yellow beneath, spotted with red ..... WATER SNAKE

Brownish, olive or grayish, with rather bold darker transverse markings; broad head, snout upturned and sharp ..... FLAT-HEADED "ADDER"; HOG-NOSED SNAKE

Size—Large

White, with strong blackish or brown blotches; abdomen marble white; head conical or pointed ..... PINE SNAKE

Venomous

2. Pupil of Eye Elliptical. Scales Keeled.

Size—Moderate to Large

Light chestnut brown or pinkish-gray, with a series of dark-brown transverse bands, narrow on the back and becoming much wider on the sides.....Copperhead Snake

Tail ending in a rattle

Grayish, with a series of dark blotches on the back. Top of head with large, symmetrical shields.....Massasauga

Size—Large

Yellowish or grayish, with dark transverse bands; sometimes dark tan or uniform black. Top of head with small scales.....Timber Rattlesnake

The preceding key, coupled with an examination of the illustrations, should suffice in most instances for identification, but the following detailed descriptions will clarify points of doubt and show the arrangement of the species as they appear in systematic lists, although this is of little import in the present instance, owing to the elimination of large numbers of related species occurring outside of the area under consideration. The scientific names have been brought to date, there having been important changes within past years, affecting both generic, and in several instances, specific names.

Descriptions of the Species

Non-Venomous

The Worm Snake, *Carphophis amoena* (Say), (Figure 1), is a very small species and while fairly abundant in some areas is not often observed owing to its secretive habits. Occurrence is "spotty," the species being common in some districts, yet never found in similar terrain but twenty miles or so distant. Thus it is abundant in northern New Jersey, particularly so in the area immediately back of the Palisades along the Hudson, where it hides under stones, burrows into the ground, or under decaying logs. Its occurrence along the eastern portion of the Hudson River valley is problematical, however. Records indicate that it occurs in a number of areas of New Jersey, but is rare north of Connecticut, probably not going into the northern New England states.

The Worm Snake is characteristic with its smooth, shining and cylindrical body and sharp snout. Above, it is light brown or brownish gray; the underside is a delicate shade of pink. It seldom exceeds a length of eleven inches and is usually smaller.

This little serpent might be confused with Storer's snake and DeKay's snake, both of which are of similar size, and inclined to hide under stones. It may be immediately recognized, however, by its smooth and glossy scales. The other two similarly-colored species have keeled scales, imparting a dull, lusterless surface to the back.

The food of the worm snake consists largely of earthworms and soft-bodied insect larvae. It is an oviparous, or egg-laying species.

General range: Southern New England to Florida; westward to Illinois.

The Ring-Necked Snake, *Diadophis punctatus* (Linne), (Figure 2), is so unique in coloration and pattern that it may be distinguished at a glance. It is small, seldom thicker than a quarter of an inch or five-sixteenths of an inch, its smooth scales are lustrous gray or bluish-black, with a brilliant yellow ring around the neck, immediately behind the head, in vivid contrast to the body coloration. Beneath, the color is orange yellow and there is usually a single row of black spots along the center of

the abdomen. The length of adult specimens is from ten to fifteen inches.

Ring-necked snakes frequent damp woods and may be found under flat stones or burrowing beneath the bark of decaying trees. Numbers of them are sometimes to be found under the top stones of old, broken dams which no longer act as spillways. Distribution is quite general, although the species is more abundant in hilly areas.

The food consists of small salamanders and earthworms. The species is oviparous.

General range: Southern Canada to Florida; westward to Illinois.

The Hog-nosed Snake; Spreading "Adder"; Hissing "Adder." *Heterodon contortrix* (LINNE). (Figures 3, 4, 5). This is a very interesting snake. No other species among the local harmless serpents exhibits such marked, characteristic habits. When frightened, it will flatten a considerable portion of the neck, by means of elongated ribs which are spread laterally. The head also becomes broad and flat, is tilted to one side, or slowly waved in threatening fashion, while the reptile exhales the breath in long, sharp, hisses. During these manifestations it presents a sinister appearance. It is quite natural that this harmless species has an evil reputation.

Most of these snakes are slain during their harmless bluffing and have no opportunity to exhibit the final resort to escape the intruder. This is in feigning death. The hissing ceases, the body writhes as though in pain, the neck is arched and the jaw drops open. The reptile then rolls on its back, with the appearance of being dead. However, there is one inconsistent phase in the maneuver. If turned with a stick upon its crawling surface, it returns with agility to the former position. Apparently it is convinced that the only position for a dead serpent is lying on its back.

With proportionately the thickest body of any of the local non-venomous serpents, and a wide, distinct head, this snake is often mistaken for the copperhead, from which it differs in its irregular pattern, sharp, shovel-shaped snout, round pupils, and double row of plates under the tail. Moreover, the copperhead never assumes any air of bravado.

The scales of this species are keeled. A large specimen is three feet long, but the greater number of adults are two to two and one-half feet long. Coloration and markings are extremely variable, but the usual hue is yellowish or brown, with dark brown or black irregular cross-bands. Some specimens have bright shades of yellow or red, the latter color being particularly evident anteriorly. Occasional specimens are entirely black.

This snake is most abundant in sandy areas, and is found in considerable numbers in some portions of Long Island, immediately back of the sea beach. It is also common in sandy areas in New Jersey. It is by no means confined to sandy regions, however, as it is also found in the mountains, although sparingly. The greater number of uniform black specimens are observed in elevated areas.

Quite recently its specific name was changed to that by which the Copperhead was known—*contortrix*. Its name was formerly *Heterodon platyrhinus*, but Dr. Thomas Barbour, after a careful examination of the later editions of Linné, finds that owing to an error in early nomenclature, confusing two species, the hog-nosed snake was renamed *contortrix*, in the 12th edition, thus rendering that specific name untenable for the copperhead, the specific name of which is now noted in the systematic lists as *mokasen*.

The hog-nosed snake appears to feed largely upon toads and frogs. It is oviparous.

General range: Very extensive. From Massachusetts to Florida; westward in the south to Texas and in the north to Minnesota.

The Green Snake, *Liopeltis vernalis* (HARLAN) (Figure 6). An easily identified species of small size, with smooth scales and uniform pale green hue above, whitish beneath. It is a dainty creature, eighteen to twenty-four inches long, and seldom of greater diameter than three-eighths of an inch. Just before shedding the skin, most specimens are of a greenish-gray hue. Its smooth scalation and whitish underside immediately distinguish it from the following species, which also is uniform green above.

The Green Snake is most frequently found in wild meadows. Its occurrence is erratic. It

is common in some portions of the Kittatinny Mountains and the Catskills. There are equally favorable areas, from the viewpoint of topographic conditions, where it is seldom seen. Its occurrence is thus "spotty" in the whole northeastern area.

This is one of the few insectivorous serpents. It feeds largely upon soft-bodied insect larvae, crickets, grasshoppers and spiders. It is oviparous, depositing elongate, soft eggs under flat stones.

General range: Southern Canada to Florida; westward to the central States and in the south to New Mexico.

Keeled Green Snake, *Opheodrys aestivus* (LINNE), (Figure 7). Except in New Jersey, this species is rare in the area under consideration. It has been recorded in Connecticut and Pennsylvania, but does not appear to occur in the northerly New England area. It is pale green above and bright yellow beneath, the under hue making it distinct from the other local green snake. A point for instant identification, however, is its keeled scales, imparting a rough appearance, in place of the satiny surface of the common species.

This is essentially a southern species. New Jersey and southern Pennsylvania might be considered as the northerly limit of the normal range. Daniel Carter Beard, council officer of the Boy Scouts of America, has written that he has found the species at Hawley, Pennsylvania, which is north of the latitude of Port Jervis; and a number of years ago, I found several specimens of this snake near Waterbury, Connecticut. They were in a grapevine, which was attached to the side of an old farmhouse. It is a larger species than the smooth green snake, attains a length of about three feet, and is more arboreal in habits.

Feeding is similar to the former species, and it is also oviparous.

General range: Pine barrens of New Jersey, to Florida; westward to southern Illinois and south to New Mexico.

The Blacksnake or Black Racer, *Coluber constrictor* (*Linne*), (Figures 8, 9). This is the largest of the broadly distributed local serpents, with the exception of the somewhat similar mountain or pilot blacksnake. The two species are often confused on gross examination. The black racer is of satiny luster, with smooth scales. It is of uniform black above, both scales and skin. The only break in its monotone is a white patch on the chin or the lower labial plates.

The blacksnake is of interest in being alert, extremely swift, and savage if cornered. Occasional specimens, in the breeding season, which is May, will actually attack. They will glide toward an intruder on the ledgy hibernating quarters, striking madly at one's feet or legs. If among dried leaves, it will vibrate the tail, producing a buzzing sound. This is also the habit of the mountain blacksnake, corn snake, pine snake, king snake, milk snake and the poisonous copperhead.

This serpent is not an enemy of the rattlesnake, nor is it a constrictor, as the scientific name implies. Both species have been noted in close proximity, basking in the sunshine, apparently in entirely normal, fraternal association.

The food consists of frogs, small rodents and small birds—rodents forming the greater portion of the food. It is of economic value, and should be preserved. The eggs are laid under flat stones during June or July, and hatch in from six to eight weeks' time. They are unique among the eggs of the local, oviparous serpents, in appearing as if sparsely sprinkled with grains of coarse salt. The young are grayish and strongly blotched when hatched, and retain this pattern up to the following summer, somewhat resembling young milk snakes, but distinguished by the proportionately large eyes and by the tendency of the blotches on the back to become very narrow as they approach the tail, practically disappearing posteriorly. Adult specimens attain a length of six feet.

General range: The typical black racer inhabits the entire eastern United States, extending westward to the great plains, where it gives way to a paler variety, grayish or bluish, with yellow undersurface, the blue racer of the plains, which extends westward to the Pacific Coast.

The Corn Snake, *Elaphe guttata* (LINNE), (Figure 10), is a southern species and seldom is found north of Maryland, but as it has been

recorded several times from the state of New Jersey, comes within the scope of the present listing. Dr. Henry W. Fowler, of the Academy of Natural Sciences of Philadelphia, writes: "Specimens were taken at Chatsworth, New Jersey . . . and this is the only locality I know it from in the state limits." We received a small adult specimen which had been picked up by an automobile party in what was described as the central part of the pine barrens, probably not far from where Dr. Fowler recorded it.

Coloration and pattern are very striking. The ground hue is gray, tan or reddish. On the back is a series of large, crimson saddles, narrowly bordered with black. There is a series of similar blotches, though smaller, on the sides. The abdomen is white, with large black squares. The pattern is rather similar to that of the milk snake, but the corn snake has faintly keeled scales. In its southerly range it attains a length of six feet. The name of corn snake is derived from its habit of frequenting fields of ripening grain, where rodents may be plentiful.

Food consists of small rodents and birds. The species is oviparous.

General range: Southern New Jersey to Florida; westward to the Mississippi.

The Mountain Blacksnake or Pilot Blacksnake *Elaphe obsoleta* (Say), (Figure 11). The largest local species, attaining a length of eight feet, and a diameter of two inches. A specimen captured near Forestine, Sullivan County, New York, was eight feet four inches long, and during its struggles to escape, disgorged a full-grown red squirrel. It is a powerful constrictor.

As previously explained, this species is quite similar to the black racer, on gross examination. However, it may be distinguished by the faintly keeled scales, wide head, stouter body, and tendency of the scales to show narrow white edges; also, by a considerable portion of the abdomen being white.

Distribution of this species points to its preference for higher ground. It often climbs into trees, living on heavy horizontal branches which terminate near a sheltering crevice formed by the disintegration of a rotted knot. Specimens were found living in a great tree and sheltering in a hollow area immediately beneath a colony of wild bees. They have been noted in the Kittatinnies, the Hudson Highlands, the Ramapo Mountains and elevated portions of Connecticut. A six-foot specimen was taken on a hill near the reservoir immediately outside the city limits of White Plains, in Westchester County, New York.

The food consists of rodents and birds, apparently never cold-blooded prey. While alleged to commit depredations among small birds, its rodent-destroying habits should be noted. Also, the fact should be remembered that this reptile existed as a part of the natural fauna long before human ideas resulted in lists of so-called "vermin" and "predatory animals" to be destroyed, with the view of improving Nature's original plans. The species is oviparous.

General range: Central Massachusetts to Michigan; southward to Florida and Texas.

The Pine Snake, *Pituophis melanoleucus* (Daudin), (Figure 12), occurs only in the southerly pine barren regions of New Jersey, and southward. It is fairly common in the New Jersey area.

This is one of the largest and heaviest species of serpent in the northeastern states. Specimens six feet in length are not rare. The coloration is intense and rather characteristic. The usual marking is dull white on the back, becoming intensely white on the sides. Down the back is a series of large black blotches, closer together and not sharply defined on the forward portion, but posteriorly wider apart and in vivid contrast. The greater portion of the abdomen is marble white. The head resembles that of a turtle, being proportionately small and the sharply pointed snout protrudes over the lower jaw.

When annoyed, the pine snake takes a deep breath, opens the mouth slightly, and by means of a small, voluntarily erectile appendage in front of the breathing passage or glottis, is able to eject the air with a loud, hissing sound. It is a constrictor.

Food consists of rodents and birds. It is oviparous.

General range: The pine barrens of southern New Jersey, to Florida.

The King Snake, *Lampropeltis getulus* (LINNE), (Figure 14). Like the pine snake, corn snake and the keeled green snake, this is a southern reptile, barely extending its range into the area of this list. Its status is rather like that of the corn snake, though possibly more king snakes have been noted in New Jersey. Dr. Fowler, who prepared a list of amphibians and reptiles of New Jersey, explains: "The King Snake is known to me only from the region of the coastal plain of New Jersey."

Northern specimens are seldom longer than four feet. The scales are smooth and lustrous, and the average specimen is black with narrow yellow or white cross-bands, which fork on the sides and connect in chain-like fashion. The abdomen is black with large patches of white or yellow.

A decided tendency toward cannibalism renders this species unique. It attacks and kills other snakes of dimensions closely approaching its own, and kills and devours copperhead snakes and rattlesnakes. It is immune to the bites of poisonous species. Rodents form a considerable part of its food and the species may be regarded as of definite economic value. It is particularly docile and quickly tamed. Like all of the preceding species, it is oviparous.

General range: New Jersey to Florida; westward to the Mississippi Valley.

The Milk Snake or Checkered "Adder," *Lampropeltis triangulum* (LACEPEDE), (Figure 13). Consideration of this species brings us to a reptile inhabiting the greater part of the northeastern area. It is brightly marked, of fair size, and the numerous specimens sent to us for identification indicate that it is often mistaken for the copperhead, from which it may be immediately distinguished by the smooth scales. Although generally distributed, it is not usually common.

Coloration is yellowish brown or gray, with a series of irregular, chestnut-brown or reddish blotches, edged with black. On some specimens these blotches are dark olive. On the sides are smaller blotches in alternation with those on the back. It is white beneath, with small oblong spots of black.

It has acquired the name of "milk snake" from its habit of prowling into stables, where it is alleged to steal milk from the cows. This is rather a ridiculous theory and proof of the deed from careful observers is wanting. Captive specimens are quite indifferent to milk. As the species feeds largely upon small rodents, its presence in stables and barns may be accounted for as a search for mice and young rats. It is a constrictor, and oviparous, laying twenty or more eggs with soft, leathery shell. Young specimens are marked like the parent but are of more vivid coloration.

General range: Massachusetts to North Carolina; westward to Illinois and Wisconsin. Varieties, with brighter red markings, extend southward to the Gulf of Mexico and southwestward nearly to the Pacific Coast.

The Striped Water Snake; Queen Snake, *Natrix septemvittata* (SAY), (Figure 15). When young, this species looks somewhat like a dark garter snake without a dorsal stripe, but retaining yellow stripes on each side. It is readily separated from that species by three pronounced, dark stripes extending along the abdomen. It is a small and rather slender snake, usually two feet in length, or slightly longer. Adults are dark brown, with three narrow black stripes on the back, which may be indistinct. The bright yellow stripe on the lower portion of the side covers one-half of the first and second rows of scales.

This is a persistently aquatic reptile, sometimes hanging on the bushes above brooks or small streams of rather rapid motion. In the area outlined in this work, the Striped Water Snake appears to avoid sluggish streams and ponds.

Food consists of frogs and toads. The species is viviparous, bringing forth the young alive.

General range: Western Pennsylvania to Wisconsin; southward to the Gulf.

The Water Snake, *Natrix sipedon* (LINNE), (Fig. 16, 17). This persistently aquatic serpent, seen along ponds and streams, should not be called a "moccasin." That term properly designates a poisonous water snake of the South, and is also applied in some southern areas to the copperhead, where the latter is referred to as the highland moccasin.

Our local water snake, member of a genus represented by about a dozen semi-aquatic species, in south-central and southern areas, is an ugly looking reptile and savage when restrained. However, it is in no way related to the poisonous moccasin or "cotton mouth" snake. The northerly limit of the latter is southern Virginia.

The body of the water snake is rather stout, with strongly keeled scales; the color is brown, with broad, irregular cross-bands of reddish brown, which show more plainly on the sides. The abdomen is yellowish white, usually brightly marked with red spots and blotches. Large or old specimens may appear a uniform dull brown or almost black. The young are quite different from the adult, being gray, with the cross-bands blackish and very distinct. Large adults are four feet long and fully two inches in diameter. The average size is two and one-half to three feet in length.

While there are allegations about the water snake being harmful in destroying game fish, this is not at all likely. The game fish, as a rule, are too active for the snake to catch them. It pursues the slower-moving fish, as well as frogs and toads. Frequenting the margins of ponds and lakes, large and small streams, old dams or the stone bases of roughly-constructed bridges, the water snake may often be seen basking on a rock, stretched on the bank or even on branches overhanging the water, into which it plunges when alarmed. This is the second species so far considered which is viviparous. The young are produced alive, and as many as three dozen or more in a litter. They are born during late August or early September.

General range: Northern and northeastern United States.

De Kay's Snake or Brown Snake, *Storeria dekayi* (Holbrook), (Figure 18). There should be little difficulty in identifying this, and the closely allied Storer's or red-bellied snake of the same genus.

The coloration is brown, or brownish gray above, with a minute series of black spots in pairs, these usually present on the back. The central area between these spots is sometimes of a lighter tint than the ground color, imparting, on some specimens, the effect of an indistinct stripe. Beneath, the color is pinkish white. The scales are strongly keeled. The average length of full grown specimens is about one foot.

This snake still occurs in several areas in Central Park, hemmed in on all sides by the congestion and bustle of New York City. There is an old cemetery, less than a city block square, in the Borough of the Bronx, New York City, where these little serpents are fairly abundant. Occurrence in the northeastern states is general, except in elevated areas where this species appears to be replaced by the allied Storer's snake.

The Brown Snake is frequently found hiding under flat stones. In such places it can find its food which consists largely of earthworms, and is unique in surviving in localities where other serpents, even the common garter snake, have long disappeared. Its secretive habits, diminutive size and dull coloration aid in its protection. It is a viviparous species. The young are very dark, with a whitish ring around the neck, and resemble the young of the ring-necked snake, but may be distinguished by their keeled scales.

General range: Southern Canada and eastern United States; southward to Mexico.

Storer's Snake; Red-bellied Snake, *Storeria occipito-maculata* (Storer), (Fig. 19, 20). Similar in form and upper coloration to the preceding, although many specimens are a bit smaller. It may be distinguished by the vivid, vermilion undersurface. There is a tendency to have a paler band on the back. Some specimens are a rich brown and others slaty gray. The gray specimens usually have the strongest defined dorsal band, which is intensified by being bordered with rows of minute black spots. The average length is eight to ten inches.

This is a species of the more elevated and wilder areas, and does not occur in the immediate vicinity of New York City. Together with the ring-necked snake, it occurs in portions of New England where the winters are very severe and other serpents (except the striped snake) are rare or entirely absent.

Food consists mainly of earthworms. The species is viviparous and the young are black, with whitish ring around the neck.

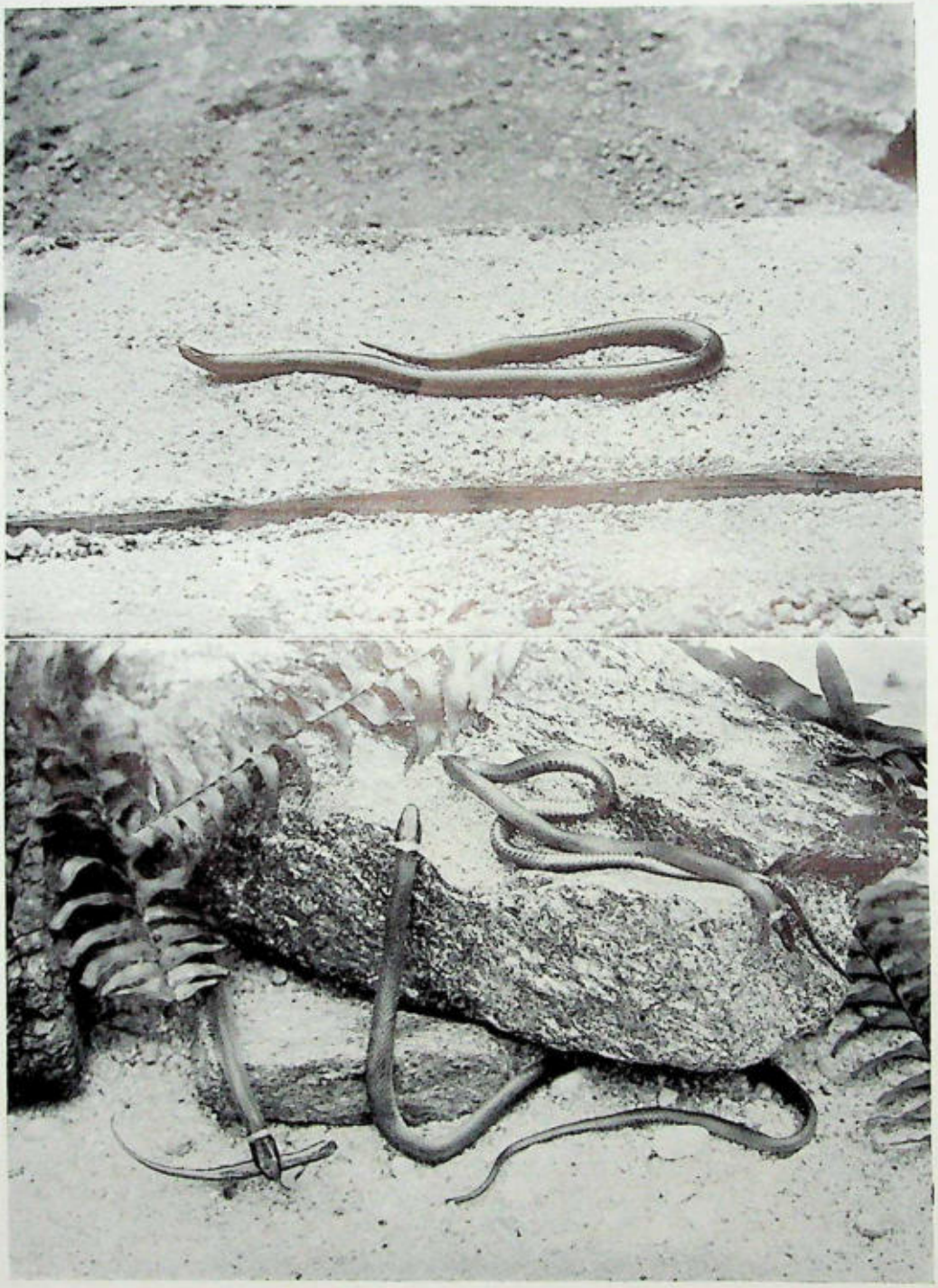


Fig. 1. Worm Snake, *Carphophis amoena*. A burrowing species which is rather common, but seldom observed. It is brown, with smooth and polished, almost opalescent scales. The food consists of earthworms and insect larvae.

Fig. 2. (*Lower*) Ring-Necked Snake, *Diadophis punctatus*. This species is unique in coloration. The smooth and satiny scales are lustrous gray and in contrast to this coloration there is a brilliant yellow ring around the neck. It is secretive, and lurks under flat stones or old fallen tree trunks.

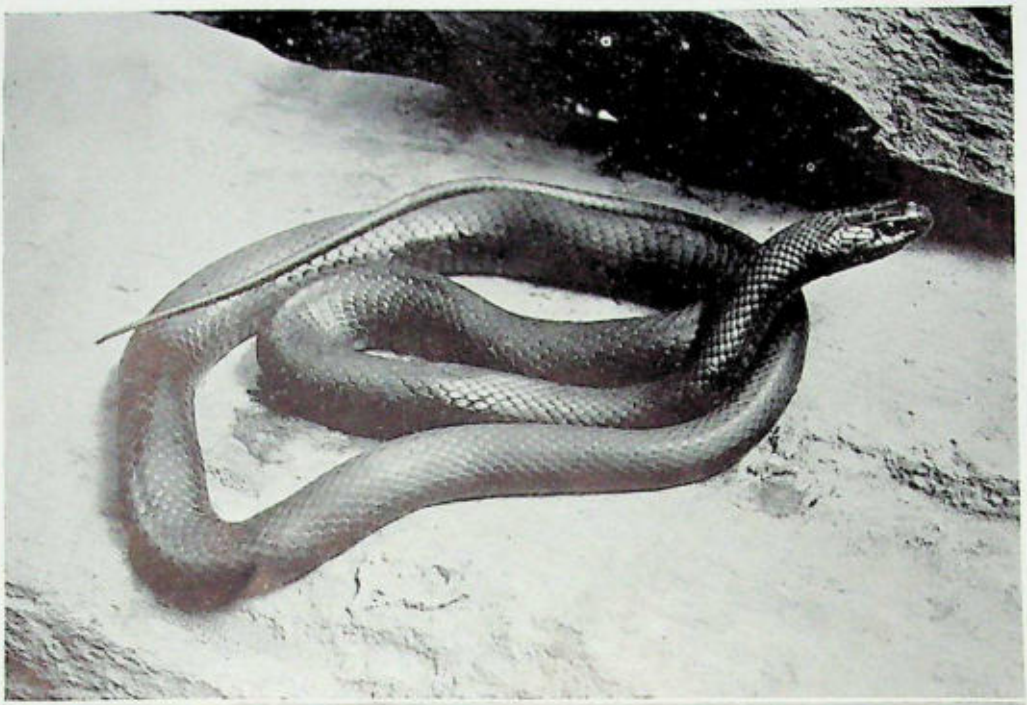
Fig. 4. Hog-nosed Snake: Spreading "Adder." Hissing "Adder." *Heterodon contortrix*. Characteristic among the local serpents in its ability to flatten the head and neck to wide extent and emit sharp hisses. If further alarmed, it rolls upon its back and feigns death. It seldom attemps to bite.

Fig. 5. (*Lower*) Black Hog-nosed Snake. A dark variation of the species figured above. The typical form is more frequent in sandy places, while black specimens frequent elevated areas.

Fig. 3 Hog-nosed Snake; Spreading "Adder," *Heterodon contortrix*. Some snakes lay eggs and others produce living young. The former are designated as oviparous and the latter as viviparous; or, to be technically exact, ovo-viviparous, meaning that the eggs are retained within the oviduct until the young are fully developed. The oviparous species bury their eggs in soil or under flat stones, where they hatch, without parental care, in about six weeks' time.

Fig. 6. Green Snake, *Liopeltis vernalis*. Occurs in wild meadows, but is not frequently seen, owing to its protective coloration. The scales are of satiny luster and leaf green in color.

Fig. 7. (*Lower*) Keeled Green Snake, *Opheodrys aestivus*. While similar in coloration to the species figured above, there is a marked difference in the texture of the scales. With this species they are keeled, each showing a raised line or ridge running lengthwise along the center. Both of the green snakes feed upon insects.



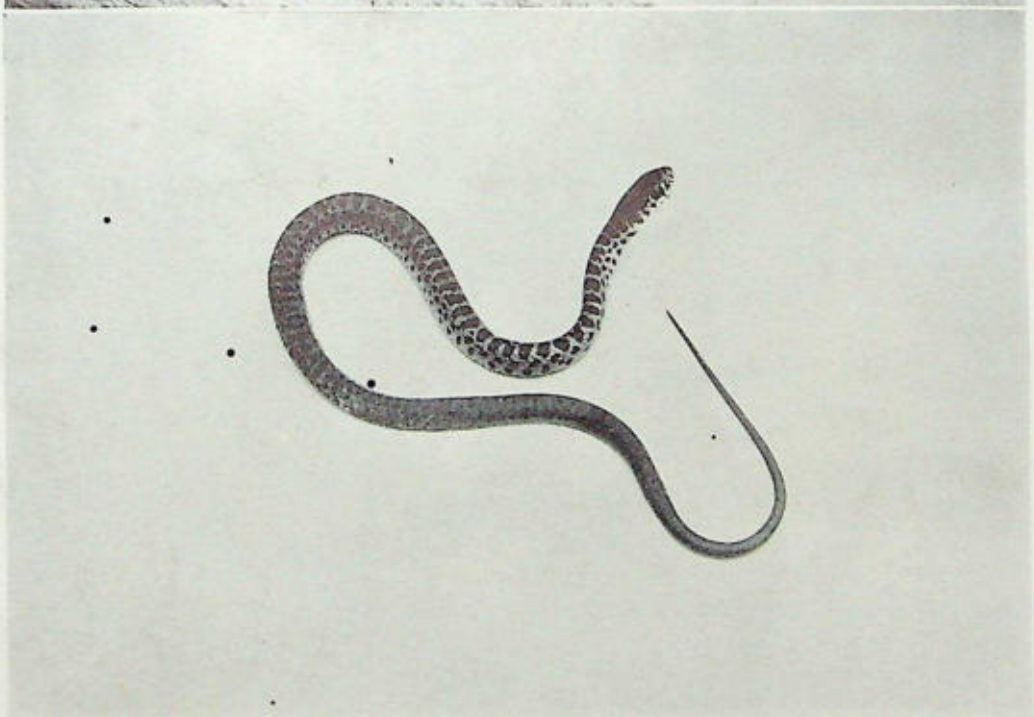


Fig. 8. Blacksnake; Racer, *Coluber constrictor*. This and the pilot blacksnake are the largest of the broadly distributed local serpents. The scales are smooth and satiny, distinguishing the species from the other blacksnake, with which it is often confused. The racer is a useful reptile as it feeds largely upon rodents.

Fig. 9. (*Lower*) Young of the common Blacksnake. The eggs are laid early in July and may take nearly two months to develop. The young are spotted until late the following year.

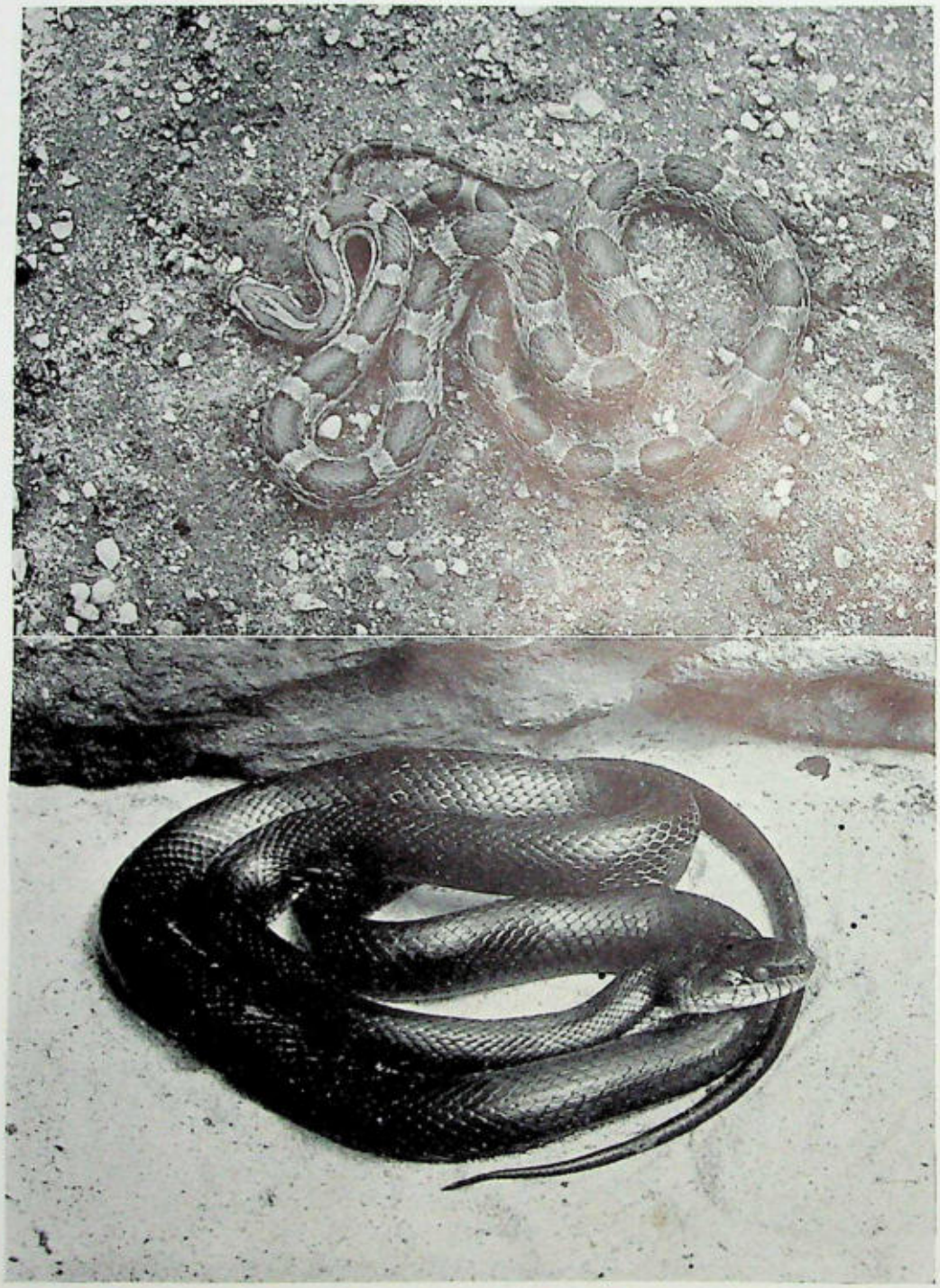


Fig. 10. Corn Snake, *Elaphe guttata*. A southern species, extending northward only into southerly New Jersey. Coloration and pattern are striking, the back being grayish or tan, with large crimson blotches.

Fig. 11. (*Lower*) Mountain Blacksnake; Pilot Blacksnake, *Elaphe obsoleta*. Largest of the local species. It attains a length of eight feet. Occurence is largely confined to the more elevated areas. This serpent is frequently confused with the common blacksnake, but may be distinguished by its faintly keeled scales, many of them narrowly edged with white.

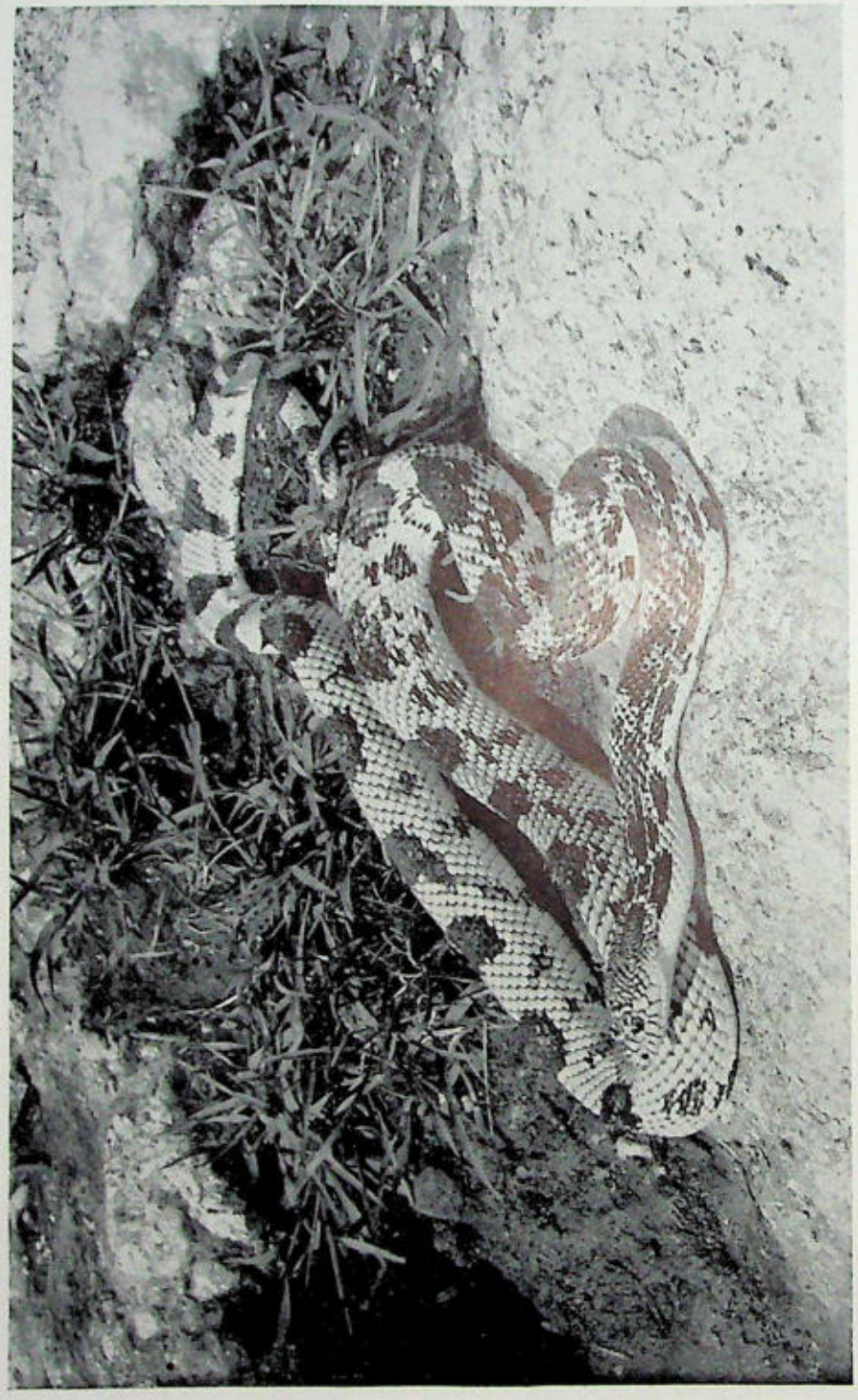


Fig. 12. Pine Snake, *Pituophis melanoleucus*. In the local area, the distribution extends only into the pine barren regions of New Jersey, where this large species is fairly common. The habitat extends southward to Florida. This powerful species is one of the largest serpents of the East, and is characteristic in taking deep breaths when annoyed, opening the mouth slightly, and producing a loud, hissing sound by expelling the air against an erectile appendage in the lower jaw.

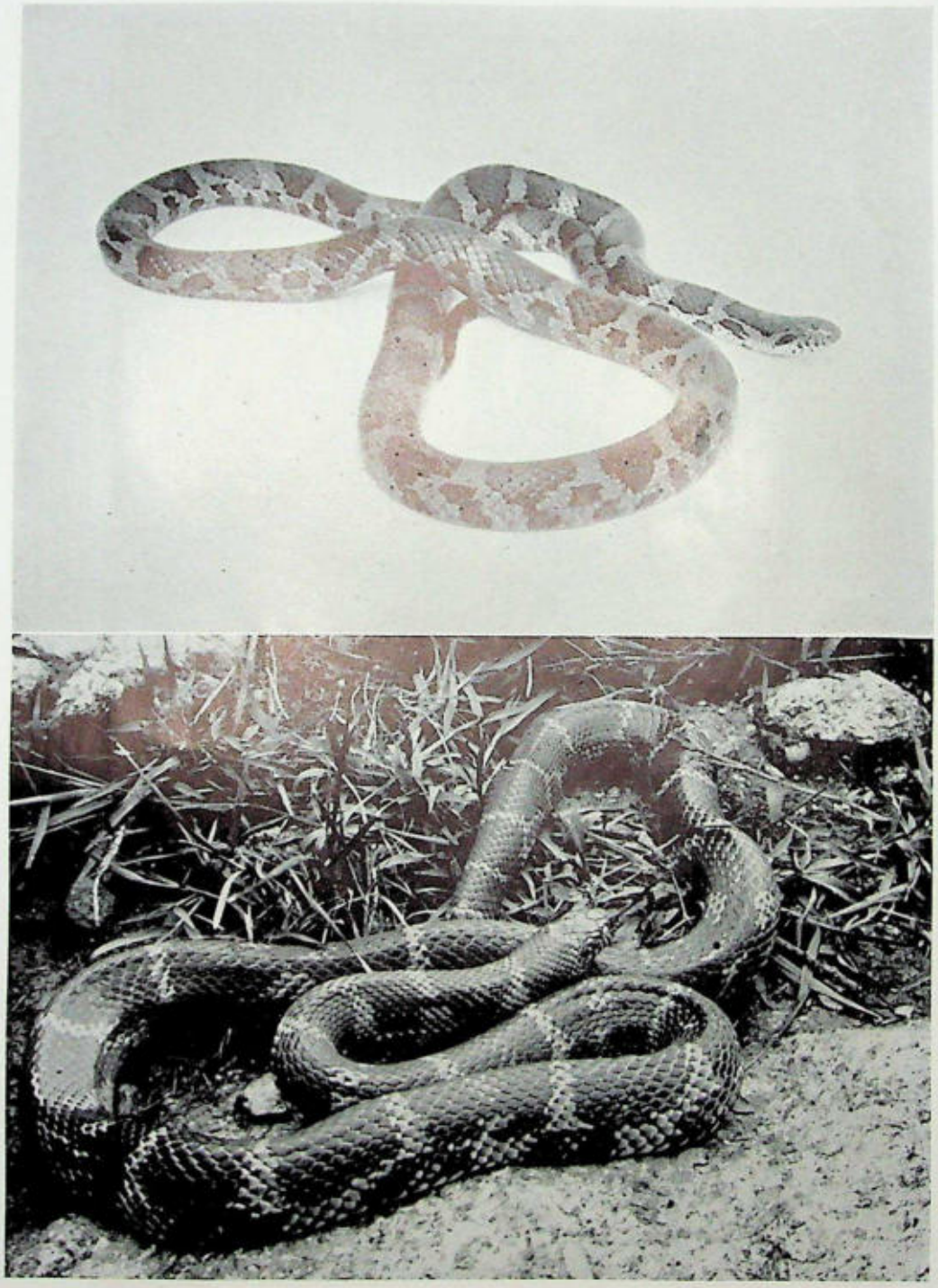


Fig. 13. Milk Snake, *Lampropeltis triangulum*. Of economic value, yet branded by a common myth alleging that it lurks around barns to steal milk from the cows. It frequents old buildings in search of small rodents, upon which it feeds. The brown blotches also result in specimens being mistaken for copperheads.

Fig. 14. (*Lower*) King Snake, *Lampropeltis getulus*. A southern species, ranging into central New Jersey. It is immune to the poison of venomous snakes and will constrict and eat well-grown copperheads and rattlesnakes.

Fig. 15. Striped Water Snake, *Natrix septemvittata*. The range of this species extends but slightly into the westerly portion of the local area covered in this article. When young, this species looks somewhat like a dark garter snake without a dorsal stripe. Adults are dark brown with three rather obscure dark stripes on the back. Brooks and rather swift streams are the usual lurking places, where specimens sometimes may be seen in bushes overhanging the water.

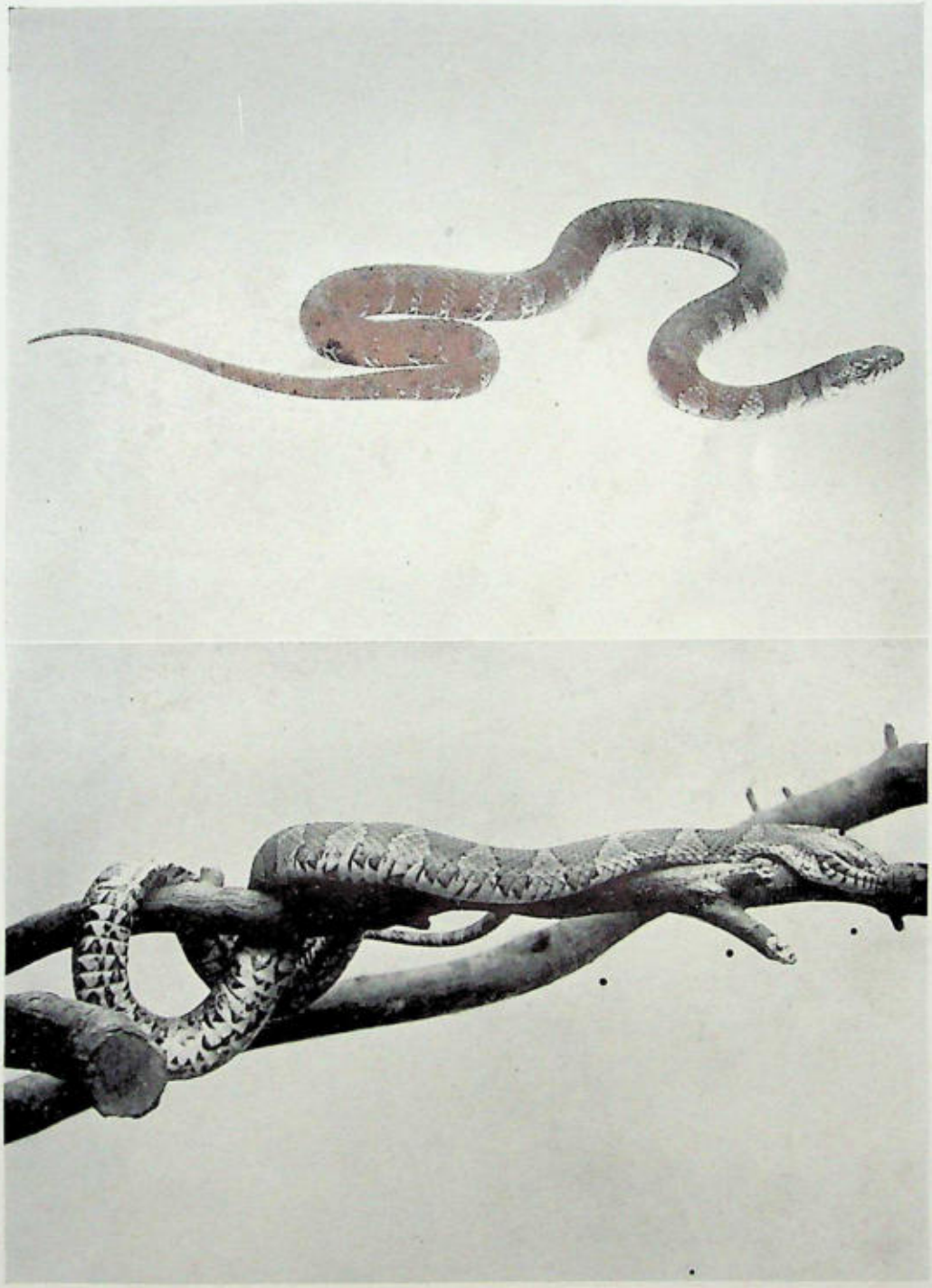


Fig. 16. Water Snake, *Natrix sipedon*. This is the common brown water snake, which is broadly distributed and so frequently seen along the margins of ponds and brooks, near the crevices of foundations of old bridges, or lurking among the flat stones of disintegrated dams. It is improperly called "water moccasin," a name confusing it with a poisonous water snake of the southern states. There is no poisonous water snake in the Northeast.

Fig. 17. (*Lower*) Young Water Snake, showing distinct markings. Old specimens are usually dull brown above.

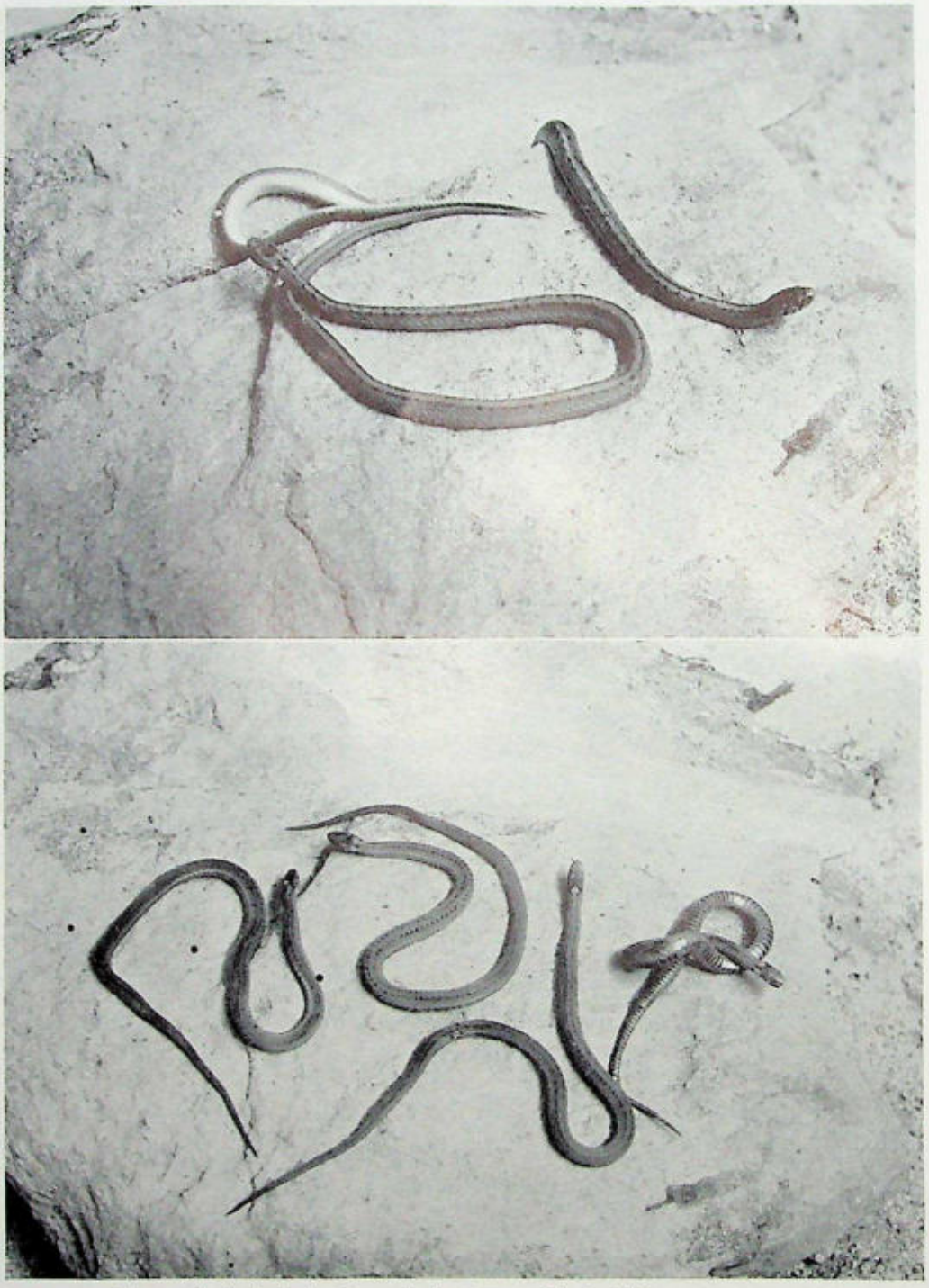


Fig. 18. De Kay's Snake; Brown Snake. *Storeria dekayi*. Seldom over one-quarter of an inch diameter, dull brown in colors and because of its habit of hiding under flat stones, this unobtrusive little serpent has survived in areas where other snakes have long since disappeared.

Fig. 19. (*Lower*) Storer's Snake; Red-bellied Snake. *Storeria occipitomaculata*. Similar in form and upper coloration to the species figured above, but distinguished by the brilliant red under-surface. The distribution is largely confined to the more elevated areas. Several color phases are shown. The upper central figure is a slaty gray specimen from the Catskills.

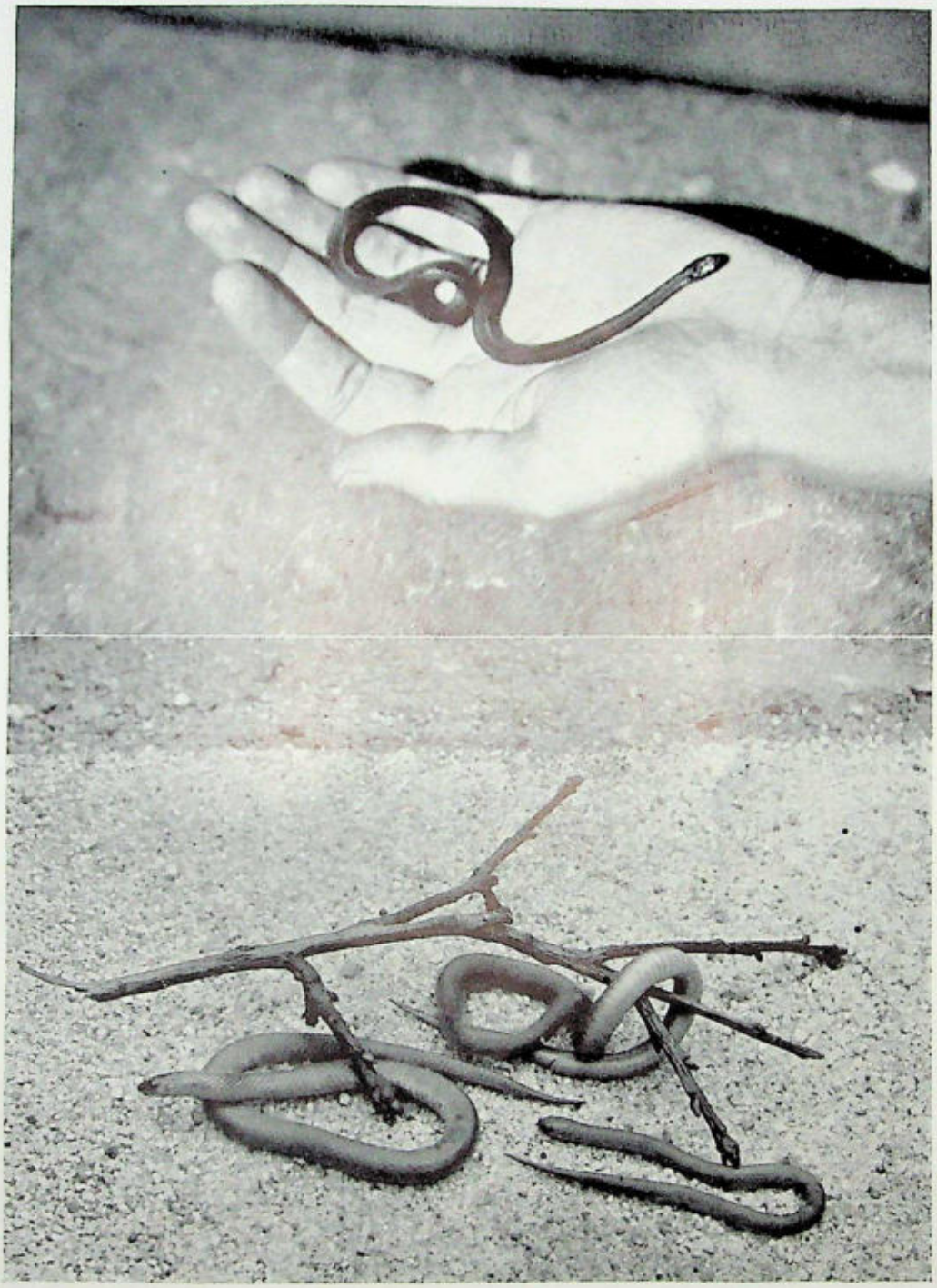


Fig. 20. Storer's Snake; Red-Bellied Snake. Indicating the dimensions of an adult specimen from Sullivan County, New York. The food of the three species of little brown snakes (including the species shown below) consists largely of earthworms, although the young are so diminutive they search for the soft-bodied larvae of small insects.

Fig. 21. (*Lower*) Smooth Brown Snake, *Virginia valeriae*. Ranges only into the extreme southerly area of the northeastern states. Immediately distinguished from the other brown snakes by its smooth scales.

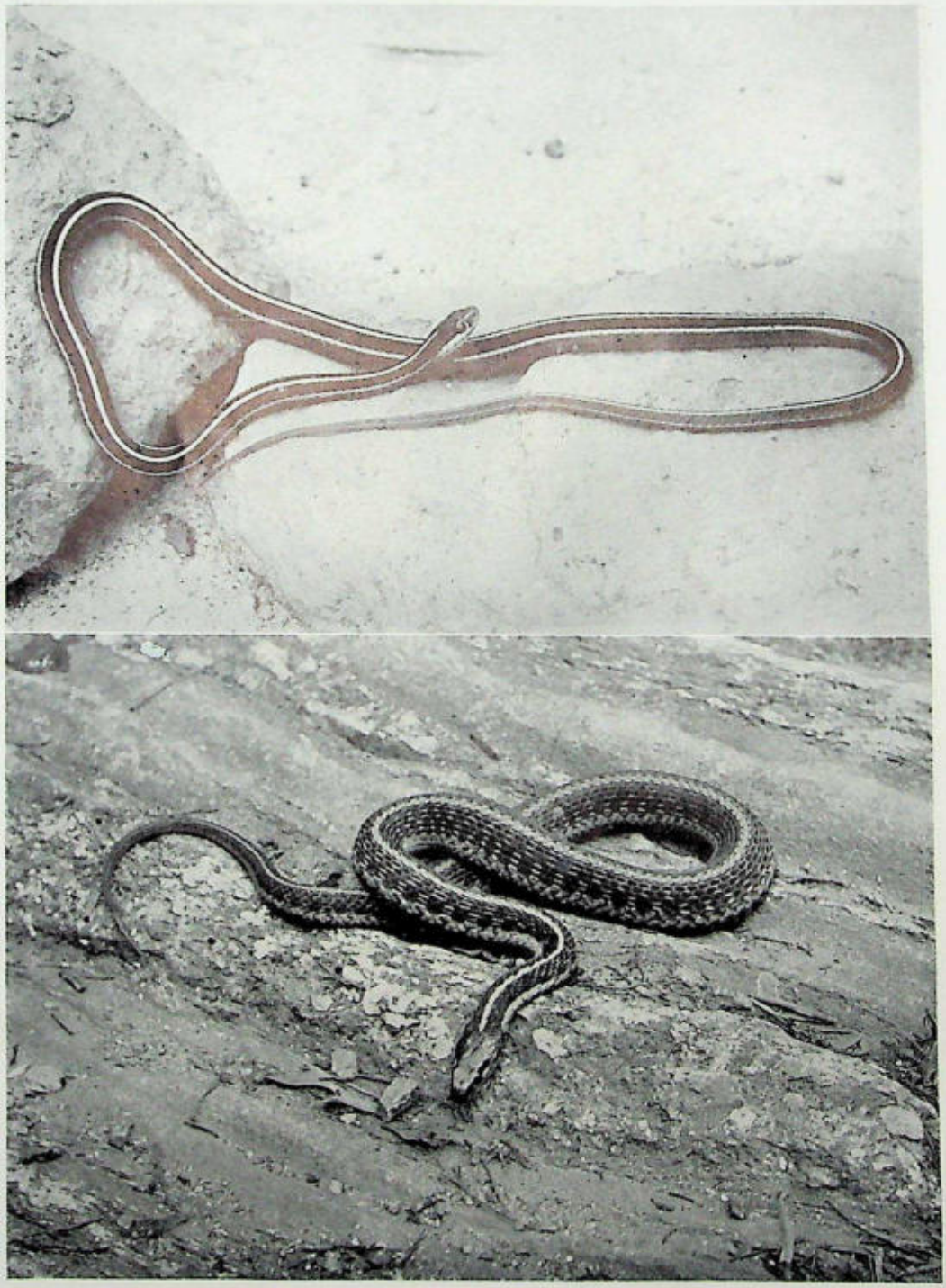


Fig. 22. Ribbon Snake, *Thamnophis sauritus*. Two closely related striped snakes occur within the local area. Their general characteristics are clearly shown in the cuts on this page. The Ribbon Snake is considerably more slender and its side stripes are higher up on the sides than those of the commoner Garter Snake.

Fig. 23. (*Lower*) Garter Snake, *Thamnophis sirtalis*. Most abundant and generally distributed of any of the local species. A large specimen is about three feet in length. The central stripe is indistinct on occasional specimens.

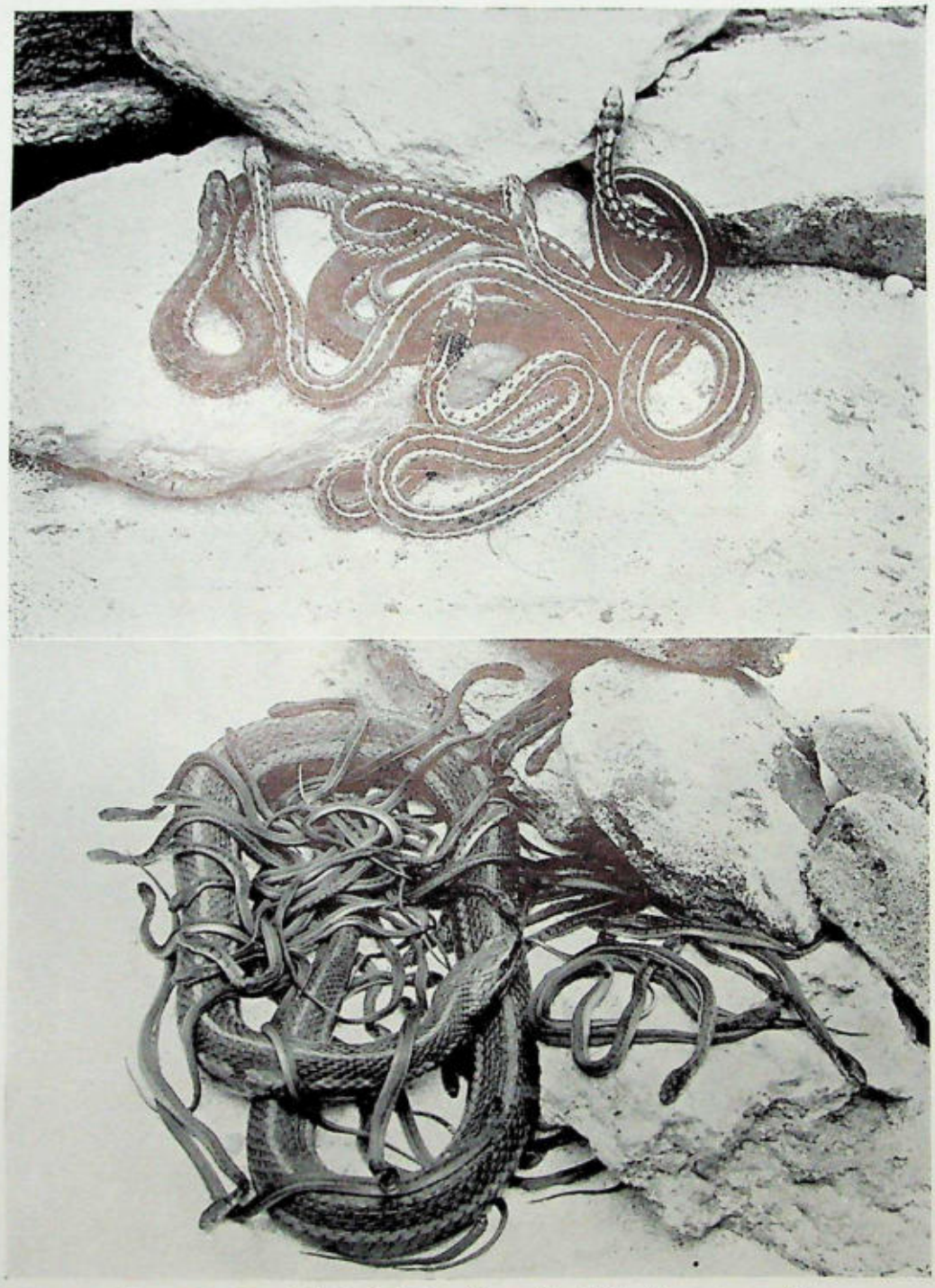


Fig. 24. Varieties of the Garter Snake, *Thamnophis sirtalis*. The specimen at the left is from the Kittatinny Mountains, and the central or dorsal stripe is lacking.

Fig. 25. (*Lower*) Garter Snake and young. The presence of the young near a viviparous parent does not indicate parental care. The young reptiles are immediately ready to shift for themselves when born, although they may incidentally remain near a crevice where the mother is sunning. Litters of garter snakes and water snakes vary from a dozen to over fifty.

General range: Similar to the allied, preceding species, but extends farther north into Canada.

The Smooth Brown Snake, *Virginia valeriae* Baird and Girard, (Figure 21). Owing to its smooth scales and small size, there is a possibility of confusing this species with the Worm Snake, (*Carphophis*) but it ranges only into the extreme southerly area of this list—southern New Jersey.

Its snout is not so sharp as that of the Worm Snake, and the scales are of rather satiny luster. The color is dark chestnut or grayish-brown, usually with two rows of minute black dots on the back. The abdomen is yellowish-white. Average length is between six and eight inches.

The Smooth Brown Snake feeds on worms and soft-bodied insect larvae and is viviparous.

General range: Southern New Jersey to Georgia; westward to Tennessee.

The Ribbon Snake, *Thamnophis sauritus* (Linne). (Figure 22). The two striped snakes occurring in the local area may be separated by difference of form, intensity of pattern, and location of the lateral stripe.

The Ribbon Snake is the more slender, and its pattern considerably more intense than the related garter snake. Coloration is dark brown or black, with a bright yellow stripe down the back and a similar stripe on each side, situated on the *third and fourth rows of scales* from the plates of the abdomen.

Distribution is quite general in more or less undisturbed areas, though it is not nearly as abundant as the garter snake. It frequents damp meadows and the grassy borders of brooks and might almost be noted as semi-aquatic. It is a member of a genus with several species as fully aquatic as the water snake. It seldom exceeds a yard in length.

Food consists of small fishes, tadpoles and frogs. It is viviparous, but the litters are small, there seldom being as many as a dozen young.

General range: Southeastern Canada and eastern United States to the Mississippi Valley; southward to Georgia and Alabama.

The Garter Snake or Striped Snake, *Thamnophis sirtalis* (Linne), (Figures 23, 24, 25), is the most commonly seen of the local serpents. Distribution is general and it is fairly abundant near reclaimed or improved areas, where other snakes have long since disappeared. It is common along the salt meadows immediately west of the lower Palisades of the Hudson, and in many of the suburban areas of New Jersey and New York. Large numbers inhabit the old reservoir site along Jerome Avenue, in the northerly part of New York City, and even occur on the northerly portion of Manhattan Island. It is found about everywhere in the rural districts where snakes occur.

The general color is dark brown or black, with three yellowish stripes extending lengthwise. The color beneath is greenish yellow. The skin along the sides, when distended, shows numerous white or pale greenish spots, which are often so arranged that a checkerboard or tessellated appearance is produced when the scales are widely separated after eating, or if the reptile is angry and greatly flattens the body. Coloration and pattern are quite variable. The stripes may be more or less distinct. When the side stripes are present, they are always on the *second and third rows of scales*, counting upward from the abdominal plates. With some specimens, the central stripe may be ragged or broken, and with others from the mountainous areas of New England, the stripe is usually very faint or absent. With these, the tessellated pattern of the skin invades the scale coloration, producing a checkered effect. The side stripes remain to assist in identification.

The Garter Snake feeds only upon cold-blooded prey, such as frogs, toads, tadpoles, salamanders and earthworms. The length of a large female adult is about a yard, while the males are seldom over two to two and one-half feet in length. This is a viviparous species, bringing forth as many as thirty young in a litter. The markings of the young are similar to the parent, although the tendency toward tessellated pattern may be more pronounced.

General range: Probably extending farther north in easterly Canada than any other species of serpent. According to Dr. Thomas Barbour, it ranges up to the 50th degree of latitude. Extends southward through Florida and westward to Minnesota.

Summary

The Local Non-Venomous Serpents

The largest of the local species, and approximately ranking in size in the order named, are the mountain blacksnake, pine snake, common blacksnake or racer, king snake, corn snake, water snake and milk snake.

The most diminutive species are the worm snake, De Kay's snake, Storer's snake and smooth brown snake. Differences of coloration may be defined as follows:*

*See descriptive key at beginning of article

Worm Snake	No pattern
Ring-Necked Snake (Has a smooth collar)	No pattern
Smooth Green Snake	No pattern
Keeled Green Snake	No pattern
Blacksnake	No pattern
De Kay's Snake (Occasionally a faint band on back and minute black dots)	No pattern
Storer's Snake	No pattern
Smooth Brown Snake (Minute black dots on back)	No pattern
Hog-nosed Snake (Occasional specimens are black)	Strongly blotched pattern
Corn Snake	Strongly blotched pattern
Pine Snake	Strongly blotched pattern
Milk Snake	Strongly blotched pattern
Water Snake	Transverse bands extending to sides
King Snake	Pale chain pattern
Mountain Blacksnake	Numerous scales narrowly edged with white
Ribbon Snake	Striped lengthwise
Garter Snake	Striped lengthwise
Striped Water Snake; Queen Snake	Striped lengthwise

Seven species have perfectly smooth scales, two have the scales faintly keeled, and with nine the scales are strongly keeled.

Eleven of the species are oviparous and seven are viviparous.

Two species, the banded water snake and the queen snake, are persistently aquatic. The ribbon snake also takes much to the water, or frequents margins of streams and damp meadows.

The hog-nosed snake prefers very dry, sandy areas. This species is the most dramatic in endeavoring to frighten an intruder. While most snakes will glide to safety when disturbed, this species widely flattens the neck and hisses. It will also feign death.

The preceding species and the pine snake are the only local species to loudly hiss when disturbed.

Several of the local non-venomous species will flatten the body and strike, if cornered. Their bites are entirely innocuous beyond the possibility of infection which may result from any small abrasion.

The two species of blacksnakes, the corn snake, pine snake, king snake and milk snake, vibrate the tail when angry, and produce a buzzing sound when the appendage is among dry leaves.

Twelve of the local species feed only upon cold-blooded prey, three upon both cold and warm-blooded prey, and three entirely upon warm-blooded prey. The common green snake appears to be the only species which is altogether insectivorous. While its near ally, the keeled green snake, feeds largely on insects, it also devours small lizards.

The garter snake, De Kay's snake and water snake are the most abundant species.

Fig. 28. A Copperhead Den. This typical formation of shelving rocks at the top of a ledge illustrates the character of place for picnic parties to avoid, and where care should be used in employing the hands when climbing, or if a person is walking about in low shoes, with ankles and legs unprotected. The rocks cover deep, sheltering crevices, in which numbers of snakes may be lurking.

Descriptions of the Species—(*Continued*)

Venomous

The three poisonous snakes coming within the scope of this article are members of the Family *Crotalidae*. In non-technical terms they are called pit vipers, owing to the presence on both sides of the head, between the eye and the nostril, of a deep pit, appearing more prominent than the nostril itself. Another external character renders them unique among the local species. This relates to the form of the pupil of the eye, which is elliptical. With the non-venomous species, the pupil is round. The arrangement of the plates or scales under the tail forms a third differentiation. They occur in a double row, from the vent to the tip of the tail, with the non-venomous species, while with the poisonous snakes, the plates from the vent to the tip of the tail are in a single row, except with the copperhead, where the scales separate into two rows near the tip of the tail.

The Crotaline serpents are provided with a pair of long, hollow teeth in the forward portion of the upper jaw. These are the fangs, which have an orifice at the tip, like a hypodermic needle, for the injection of poison when they are driven into an offending object by a combination strike and bite, or by a deliberate bite alone. A tubular connection from the base or top of each fang extends backward to a poison gland on each side of the head. When the serpent bites, a contraction of the masseter muscle against each gland vigorously squeezes it, forcing poison forward and out of the connected fang. The fangs are on movable bones, and fold back against the roof of the mouth when the jaws are closed. They are covered with a sheath of delicate flesh, which is forced back when the fangs are imbedded in any object.

These pit vipers do not spring or jump at an intruder. They strike from one-third to one-half their length, and almost invariably coil with the neck in an S-shaped, lateral loop, ready to strike from that position. They can as readily strike when crawling, for when disturbed, the neck is usually kept laterally looped for defence. They can also quickly turn and deliberately bite, without recourse of darting the head from a loop. These local species never wantonly attack a human.

All are viviparous, giving birth to living young to the number of about twelve.

The Copperhead Snake, *Agkistrodon mokasen* Beauvois, (Figs. 28, 29, 30). Coloration is vivid and rather characteristic, owing to the separation and fair symmetry of the blotches. The body hue is pale brown, pinkish, or light reddish brown, with a series of large blotches on the sides, somewhat like inverted Y's. These blotches are usually of a rich, chestnut brown. When examined from above, a number of the markings will be seen to unite across the back, producing a continuous pattern across the body, the central portion being narrow and broadening on each side, giving the outline of an hour-glass. The top of the head is without marking, and often slightly paler than the body hue. The undersurface is usually pale, pinkish brown, with a row of dark spots on each side. There is some pattern variation in intensity of the blotches, which may be paler in the central area and outwardly margined (very narrowly) with quite a pale tint, which accentuates their intensity.

Large specimens are about three feet long, but occasional four foot specimens are noted. Curiously enough, the largest specimens which ever came to the writer's attention were captured in the immediate vicinity of White Plains, Westchester County, New York, where an example measuring four feet and five inches, and approximately two inches in diameter, appears to form a record for the species.

The water snake and hog-nosed snake are sometimes mistaken for the Copperhead, owing to their proportionately thick bodies, and gross similarity of markings. The poisonous species, however, carries its points of marked differentiation in having elliptical pupils, prominent cavity or pit between the eye and nostril, and greater number of plates under the tail in a single row. The milk snake is also confused with the copperhead; but is more slender, while the blotches are irregularly rounded and narrowing as they approach the sides, instead of spreading widely, as with the copperhead.

While the bite of the copperhead is very dangerous, and there are records—although they

are rare—of fatalities from such injuries, it is not nearly so poisonous as the timber rattlesnake. Its fangs are proportionately shorter, its venom not so virulent, and the amount of poison injected into a bite of lesser quantity, owing to the serpent's smaller size. In habits, it is very quiet, preferring to lie perfectly still when an intruder enters its lair, and escape detection owing to its pattern and colors closely resembling the fallen leaves around it. Seldom will it make any attempt to strike, unless very definitely annoyed or attacked, or if it is stepped on. Most of the cases of copperhead bites which have come to our attention have resulted from the latter condition, and have related to persons wearing low shoes—many of the bites being on or near the ankles. If a copperhead fears it is about to be attacked, it will impart a rapid, vibrating movement to the tail, and if among dried leaves, produces a distinct, buzzing sound, readily heard for about fifteen feet. It will coil and fight bravely if cornered, but at the first opportunity, quickly turn and glide to safety in some crevice.

Distribution is more extensive than with the rattlesnake, owing to protective coloration and more secretive habits. Copperheads are still found along the top and at the base of the Palisades of the Hudson, while the rattlesnake appears to have been exterminated from that area for close to fifty years. Throughout Pennsylvania and New Jersey, the copperhead is rather generally distributed, except in regions of intensive cultivation. There are various areas of New York state where the species has not been recorded. It is common from the latitude of northern Westchester County, well up the Hudson and past the easterly border of the Catskill area, also in counties to the west. While showing a decided preference for mountain areas, as illustrated by its abundance in elevated regions of New Jersey, Pennsylvania and Connecticut, it does not occur in the Catskill Mountains proper, and in but few portions of the Berkshires; or in the general area of the Schwangunk Mountains, in Sullivan County, except on the easterly side of the Neversink River, although it is quite evident and increasing in abundance along the Delaware River. It is common in Connecticut, both along the shore and in elevated regions, also in the coastal area of Rhode Island. The species does not extend northward of central Massachusetts, hence may be eliminated from consideration in the states of Vermont, New Hampshire and Maine.

Ledgy, wooded hills, with a base of wild, damp meadows, form the favorite prowling grounds of this snake, as it searches for small rodents, birds and frogs. During the summer it is often seen along old stone walls, which might offer shelter and a congregating place for rodents. With the autumn, it returns to specific crevices among the rocks, to hibernate, and it is close to such locations that the young are born during August or early September. From six to nine young are produced in a litter, and the tails of the infant snakes are bright, sulphur yellow.

General range: Central Massachusetts to northern Florida; westward to Texas.

The Massasauga, *Sistrurus catenatus* (RAFINESQUE), (Figure 31), might be regarded as somewhat of an intruder among the local serpents, as it is essentially a western species, and is found only in a limited area in western New York. It is a small rattlesnake, which may be easily told from the widely distributed timber rattlesnake, by the large and symmetrically arranged plates on the top of its head—quite similar to the head plates of a harmless serpent. Its rattle, of course, provides a point for immediate identification. The ground color is brown, or grayish, with a series of chestnut-brown, symmetrical, oval blotches on the back, becoming darker toward the edge and narrowly outlined with a paler hue. There is a smaller row of rounded blotches on each side. The usual length of the Massasauga is from two to three feet.

Mr. Edward T. Whiffen, who has been much interested in the occurrence of this reptile in New York state, has written about it in the New York Zoological Society BULLETIN as follows:*

"The Massasauga, a species of dwarf rattlesnake, is still to be found in New York State, in and around Cicero Swamp, which, with some interruptions, stretches across the northern parts of Onondaga and Madison Counties, between Oneida and Onondaga Lakes. The main

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swamp is said to be fourteen miles long and seven miles wide in its greatest extent. It consists of the swamp proper, in which are numerous 'islands,' or higher areas of land. Next to the dry land is the 'shore,' a wet, marshy strip, from seventy-five to one hundred yards wide. Beyond the 'shore' is the swampy land proper, fairly dry in summer and covered by a dense growth of trees, bushes, ferns and moss. In some places this moss is knee-deep. Many of the bushes are of the huckleberry variety, and it is among these that the Massasauga is frequently seen in August and September, when berry-pickers go out into the swamp.

"The Massasauga seems to like the neighborhood of swamps, though it shuns the actually wet places. In the harvest season it is usually found either in the hay-fields or oat-lots, or it may be seen out on the moss among the bushes, or under the evergreen trees. However, it may occur almost anywhere. A gentleman told me that two years ago he found a large Massasauga in his wood-pile, about six feet from the house. Others reported having found the snakes in their cellars, or under the steps. There is an abundance of frogs and mice in the meadows, and frogs and birds in the swamp; and such conditions account for the presence of the reptiles in those places. In the hay-field the Massasaugas seem to select the damper spots, where the growth of vegetation is heaviest. There they are frequently cut in two by the knives of the mowing-machines. Newly cleared fields, where there are plenty of stumps and berry bushes, are also favorite lurking places of this reptile, which is sometimes seen sunning itself on a stump, or lying coiled among the bushes.

"Older residents assured me that the snake is much less common than formerly, when its range extended over the entire northern part of the county. Its disappearance is due probably to ceaseless slaughter and to the draining of the swamps. That it is still fairly common may be judged from the fact that the killing of a dozen snakes in an area of perhaps a hundred acres was reported within the space of two weeks' time. One of these snakes had sixteen rattles and two had ten. Six or eight was a common number. The whole region is abundantly supplied with reptile life, milk snakes, ribbon snakes, garter snakes, water snakes, etc., being of frequent occurrence. As much of the swamp has little value for tillage purposes, and as the timber is small and comparatively worthless, the massasauga, though in diminishing numbers, will probably continue to be found in the region for some time."

General range: Western New York to Nebraska; northward into Michigan and Ontario; southward to Texas and northern Mexico.

The Timber Rattlesnake; Banded Rattlesnake, *Crotalus horridus* LINNE, (Figures 34, 35). In pattern and colors, this species presents great variation. The most familiar phase is that of sulphur yellow or pale tan ground-color, with wide, dark brown or black cross bands, usually wavy, or pointed to the rear, and sometimes broken into three series of blotches, the central or larger ones being rather rhomb-like. The tail is black.

The blotches on some specimens are narrowly margined with a paler hue. The ground-color varies from yellow to brown and olive. Some specimens are so suffused with black that the bands are indicated only by their pale margins. Specimens of a uniform, velvety black, are not rare. Blackish and pale yellow specimens are usually associated in the same den. The greater number of the black specimens are males, although there are some melanistic females. We have never noted any pale yellow male examples. These large yellow or tan specimens thus appear to be invariably females.

The average length of the adult timber rattlesnake in the northeastern states is slightly under four feet. As with a number of species of serpents, however, a specimen may well exceed the usual run. The largest specimen I ever examined was two inches over six feet in length and nearly three inches in diameter. It was taken near Sheffield, in the Berkshires. A specimen nearly as large (slightly under six feet) was taken near the top of the great rock slide near Hartsville, Massachusetts, which shattered ledge is alleged to have inspired Oliver Wendell Holmes' description of "the mountain" in his classic novel, "Elsie Venner." Large specimens have been recorded from New Jersey and Pennsylvania.

Distribution of the rattlesnake in the northeastern states is associated with hills and mountains of moderate height, on which there are

broken ledges with large, loose fragments on the slopes and top. These flat fragments may be a foot or more in thickness and from a yard to six or eight feet in length, sloping back into a fissure the bottom of which may be covered with soil or leaves, and which provides a position of security during storms. It is the common habit of rattlesnakes to coil under the edge of these rock masses, protected from the too-hot summer sun, and ready to quickly retreat if disturbed. If the intruder goes on his way, the snake may lie in its motionless coil, without sounding the rattle, thus seeking to escape notice.

Near these natural homes, are specific crevices or "dens," where rattlers that have roamed over a considerable area during the summer, congregate each fall preparatory for deep penetration and hibernation, beyond the frost line. During the late summer the females return to such places and here the young are born, with a natural instinct to return to this specific spot each year for winter shelter. From the areas of the ledges, many rattlesnakes prowl through the forest areas for food, and often into the farmlands. Variations in weather conditions produce marked difference in numbers observed. During particularly dry summers, they may come into the low grounds for water, in considerable numbers. Their natural prey, small rodents and birds, sometimes shift their feeding grounds and this also affects the summer distribution of the rattlesnake. If a farm is infested with rats and mice, and a rattlesnake den is not far distant, it will not take the reptiles long to discover the favorable feeding ground. They may also be commonly noted during the haying season, due to the presence of large numbers of field mice.

While a very dangerous snake from the standpoint of its large fangs and the amount of venom it is able to inject at a bite, the northern rattlesnake is a rather inoffensive reptile as compared with its larger allies in the southern states. It almost invariably gives warning of its presence by sounding the rattle, if disturbed when out of immediate contact with a sheltering crevice. If closely approached, it will strike, but the full striking distance of the average specimen is barely eighteen inches—and usually shorter. There are records of fatalities from the bite of this species, but generally considered, in the northeastern portion of its range, there is a surprisingly small number reported, less than with the copperhead, which gives no warning of its presence. In an area of the southern Berkshires, where rattlesnakes are particularly frequent, the writer has records of but three bites during a period of about twenty years. One of these was fatal.

Distribution is general in the wilder, hilly country, with the exception of the Catskill and Adirondack Mountains. As far as we are aware, no rattlesnake has ever been recorded from the Adirondack Mountains proper, although the species is quite common on Tongue and Black Mountains, in the vicinity of Lake George. Likewise, the only recent Catskill records come from Tremper Mountain, at the edge of the Catskills, near Phoenecia, New York. The species is abundant in the Ramapos (where, however, accidents are extremely infrequent), the Kittatinnies of New Jersey and Pennsylvania, and the Swangunk range in New York. In central New Jersey it occurs in conditions rather curious for a mountain type. There is considerable flat, forested country back of the central coast, quite damp in spots and with large sections covered with heavy sphagnum moss. In these locations, the species attains a considerably larger average size than the mountain type and exhibits a slightly different coloration. It is grayish, with strongly contrasted black bands, and a faint, rusty, dorsal stripe, several scales wide. There is a resemblance to the southern race known as the canebreak rattlesnake, which, in the costal area of the Southeast and the lower Mississippi Valley attains a frequent length of close to eight feet and has a distinct reddish band along the back.

Rattlesnakes are extremely rare in the state of Maine, and that area is thus unique among all the states in the virtual absence of poisonous serpents. The Boston Society of Natural History has been unable to obtain a record specimen for its collection, from Maine. There appears to be a few records from New Hampshire, and specimens are reported on an island in Lake Winnepesaukee. Vermont seems to have few specimens, except along the westerly slopes of the Green Mountains and in the southern portion of the state. Both the cop-

perhead and rattlesnake appear to be extinct on Long Island, although that the latter was formerly found there is evident from skins and rattles among the trophies of old farm houses. We have been unable to verify the occurrence of a specimen of either species during the past thirty years.

General range: The central portion of the New England area, southward to northern Florida; westward to the Plains.

* * *

Precautions Against Accidents—A pair of stout, canvas leggings or leather puttees are positive protection to the legs against northern poisonous serpents. The leggings, however, should be worn with high shoes. If low-cut shoes are worn, there are usually several inches of the ankle left exposed—and this is the part of the limb most frequently bitten.

With the legs protected, it is well to bear in mind that the practise of using the hands in climbing rocky places or getting over a stone fence is dangerous, unless each hand-hold is investigated, with due thought of crevices or hollows that may secrete a coiled serpent. Any thick, brushy place, or pile of leaves, in the wilder country, should be considered a hazard, unless the eye is keen in noting where the hand is directed.

In establishing a summer camp, it is well to ascertain from local residents whether or not there is a particular prevalence of poisonous snakes. We have several times been consulted about camps which have unconsciously been located in the immediate vicinity of a den of rattlesnakes or copperheads, with the consequence that a number of city children, unfamiliar with woodcraft, have been turned loose in an area over-run with poisonous reptiles. There are many ideal locations for camps where poisonous serpents are seldom reported, and the finding of such areas is not difficult. There are also fine camping areas in most of the states under consideration, in which no poisonous snakes are ever to be found.

While the edification of young people in camps about the wild types of life found in the nearby country is highly desirable, instructional measures relating to poisonous snakes have been a bit overdone. This relates to the exhibition of numerous living specimens, and the handling of these in what is considered to be a safe way, to show the poison fangs, etc., the carrying of such specimens to lectures, and the like. Too much of such familiarity reduces respect for danger and it has been noted that a rather large following of boy students has been inclined to transport poisonous reptiles in anything but a thoroughly competent and cautious manner. Several accidents have resulted from this undue familiarity. Camp instructors should be cautioned not to go too far in this direction, to caution boys not to deliberately collect poisonous serpents, and not to harbor such creatures for observation. A captive poisonous snake, except in the care of a competent person, is a source of danger to the possessor and those around him.

* * *

Treatment of Snake Bite—Through the formation of the Antivenin Institute of America, and the guidance of Dr. Afranio do Amaral, Chief of the Brazilian government's Instituto Butantan, specific serum for the bites of the poisonous snakes is being regularly produced in the United States. This product should be located at all points of particular hazard.

It is made by injecting horses with small doses of snake venom, the process continuing through a number of months until the animals have developed a high degree of immunity. Blood is then obtained from them, in small quantities, and is subjected to a number of processes. The red is separated from the serous portion, and the latter is filtrated. Simply explained, the action of this serum, injected into the human victim who has been bitten by a dangerous snake, is to neutralize the poison of the reptile. Its effect is rapid and quite astonishing in relieving the dramatically alarming effects of snake bite.

Serum may be injected immediately after a bite, or up to the time the victim has approached a condition of collapse. It is then usually too late to be properly taken up by the circulation and thus neutralize the poison injected at the time of the bite.

The bite of a copperhead or massasauga is not ordinarily fatal, although it may be very serious. Serum may be injected as late as a day or even two days after the symptoms of great swelling have developed. It is far better,

however, to inject it as soon as possible after the bite, in order to quickly neutralize the poison and thus prevent great destruction of tissue and the red cells of the blood stream. This assures against an extensive necrosis of the bitten area.

A large specimen of the timber rattlesnake may inject enough poison to cause death within ten to twelve hours, and in a much shorter time if a vein is actually struck, which is a rare, but possible condition.

As the bite of a poisonous snake is no more or less than a simultaneously double injection by two hypodermic teeth (the fangs) the measures to meet the emergency should be quick and positive. A ligature of some type should be bound a moderate distance above the bitten part, to prevent the poison being absorbed into the upper limb. The ligature may consist of a strip of cloth, a large handkerchief, or even a piece of heavy cord. A rubber ligature is much the best. There is necessity of making the ligature sufficiently tight to indicate a stoppage of circulation. Even moderate pressure tends to localize the area of poisoning.

With the absorption of the poison retarded, the fang wounds should be opened by an incision across them to an estimated depth of three-eighths of an inch for a large rattlesnake, or a quarter of an inch for a Copperhead. The incision should be made with care not to injure the delicate skin covering a bone, or to cut into a blood vessel. If no cupping device is at hand, drainage should be induced by sucking the wound, there being practically no danger from this if the lips and mouth are free from sores.

After these immediate emergency measures for eliminating as much poison as possible from the vicinity of the wound, the serum should be administered. It is provided in tubes which are actually small hypodermic syringes, and it is only necessary to attach the needle and the handle. The serum is *not* injected in the vicinity of the bite, but under the skin between the shoulder blades or on the abdomen, by what is known as subcutaneous injection. In this way it is quickly taken up by the general circulation. The entire contents of a tube should be injected for a bite. If symptoms are particularly grave, two tubes may be necessary. Intravenous injection might be advisable if the poison fangs have punctured a blood vessel, but this should be done only under the direction of a doctor who has actually diagnosed the condition.

The ligature should be slacked off every ten minutes or so, to induce bleeding at the wound. If no serum is available, the treatment of suction and the frequent slackening of the ligature should be continued, and additional drainage incisions, upward from the injury, are necessary if the swelling greatly increases. If a good cupping device is at hand, the incisions should be rather short and cruciform, so as not to extend beyond the suction surface of the device and thus admit air. It is well to wash the incision with a *mild* solution of permanganate crystals in pure water (to produce a pale amethyst hue), as this fluid will neutralize by oxidation what venom it may reach. The use of strong solutions of permanganate of potassium, however, is not only unwise, but dangerous, as there is much tissue destruction by this chemical at a high strength. This caution also points to the utter rashness of rubbing pure crystals of permanganate into a wound. Moreover, such a wound should never be cauterized. Nothing should be more foreign to the treatment of snake bite than such practice, which actually seals the destructive poison within the tissue.

As not only the immediate area of the wound, but a considerable portion of the neighboring tissue is much weakened and subject to bacterial invasion, and the bite itself is sometimes attended by specific infection with germs from the snake's mouth, the wounds should be covered with a heavy layer of wet dressing, and kept saturated with a mild antiseptic solution. This not only retards or prevents infection, but induces copious drainage, through a discharge of quantities of serous fluids which always appear to be rushed to such a poisoned area.

There are but few spots in the whole northeastern area where poisonous snakes occur, which are not accessible, within a reasonable time, to the aid of a physician, and the snakebite victim should, if possible, make contact with skilled hands to carry through all but the preliminary measures of treatment.

A first-aid kit for the treatment of snake bite should contain the following articles: Several one-sided safety razor blades; a small bulb and cupping glass for flat surfaces, with additional attachment for "round" surfaces, like a finger; a roll of rubber ligature; a small roll of bandage; and two tubes of antivenomous serum. The serum will remain efficacious for several years. A few permanganate crystals may also be carried. Whiskey is useless as a cure, although a moderate dose of medicinal brandy does no harm and may greatly relieve the mind during a situation which may not be nearly so dangerous as it seems.

We have noted the bites of copperheads to produce great swelling which cleared up within a few days with no other treatment than a drainage incision across the fang wounds, and the covering of the area with a wet dressing. There are also cases of both copperhead and rattlesnake bites being treated with the serum and the patient going about his regular business the following day. Again, there are records of grave manifestations. Consequently, poisonous serpents warrant great respect, caution in investigating their lairs, and personal protection in going through the areas which they inhabit.

As many people are bitten by harmless snakes which may quickly glide away, leaving apprehension behind them, it is well to understand that the bite of a poisonous serpent is unmistakable. A harmless serpent may produce distinct wounds from its recurved teeth, and as but a few teeth may cause lacerations which bleed, the imagination of a nervous person may quickly classify two "fang" punctures. If nothing happens within ten minutes following a bite, the snake was harmless. A bite from a poisonous serpent develops rapid symptoms. A burning pain is apparent within three to five minutes, and within ten minutes there is a distinct swelling. This rapidly increases, and is usually followed, within half an hour or less, with profuse perspiration and there may be reflex vomiting. By this time, of course, emergency treatment should have been given, and if serum is at hand, its injection may prevent the more alarming symptoms.

Books of Reference on Serpents

The following list of books may be consulted for a more extensive study of serpents and other reptiles:

REPTILES AND AMPHIBIANS: THEIR HABITS AND ADAPTATIONS ..... *Thomas Barbour*
Houghton Mifflin Company, New York City.

CHECK LIST OF NORTH AMERICAN AMPHIBIANS AND REPTILES (Technical)
Leonhard Stejneger and Thomas Barbour
Harvard University Press, Cambridge, Massachusetts.

REPTILES AND BATRACHIANS ..... *E. G. Boulenger*
E. P. Dutton & Company, New York City.

THE CROCODILIANS, LIZARDS, AND SNAKES OF NORTH AMERICA (Technical) *Edward Drinker Cope*
United States National Academy of Sciences, Washington, D. C.

THE REPTILE BOOK (REPTILES OF NORTH AMERICA) ..... *Raymond L. Ditmars*
Doubleday, Doran & Company, Garden City, Long Island, New York.
(Temporarily out of print. On file in the larger libraries.)

REPTILES OF THE WORLD ..... *Raymond L. Ditmars*
The Macmillan Company, New York City.

AMPHIBIA AND REPTILES ..... *Hans Gadow*
The Macmillan Company, New York City.

THE POISONOUS SNAKES OF NORTH AMERICA ..... *Leonhard Stejneger*
United States National Museum, Washington, D. C.

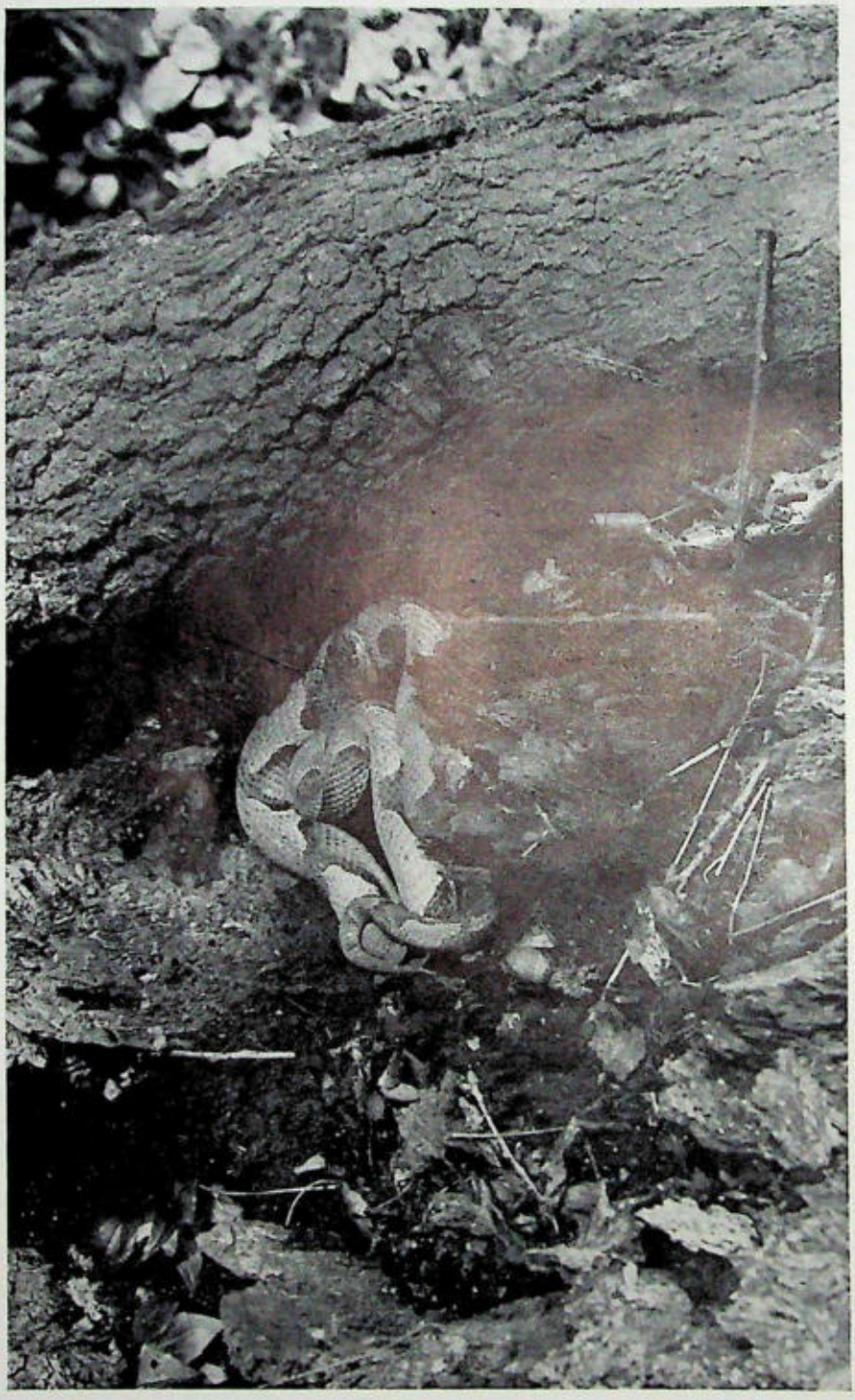

Fig. 29. A copperhead blended with the tints, tones and shadows of its lurking place. These dangerous snakes are extremely difficult to see when coiled among fallen leaves, which is a common habit. All of this goes to show the necessity of care in placing the hands in picking flowers or climbing, or in walking through brushy places with thin stockings and low shoes.

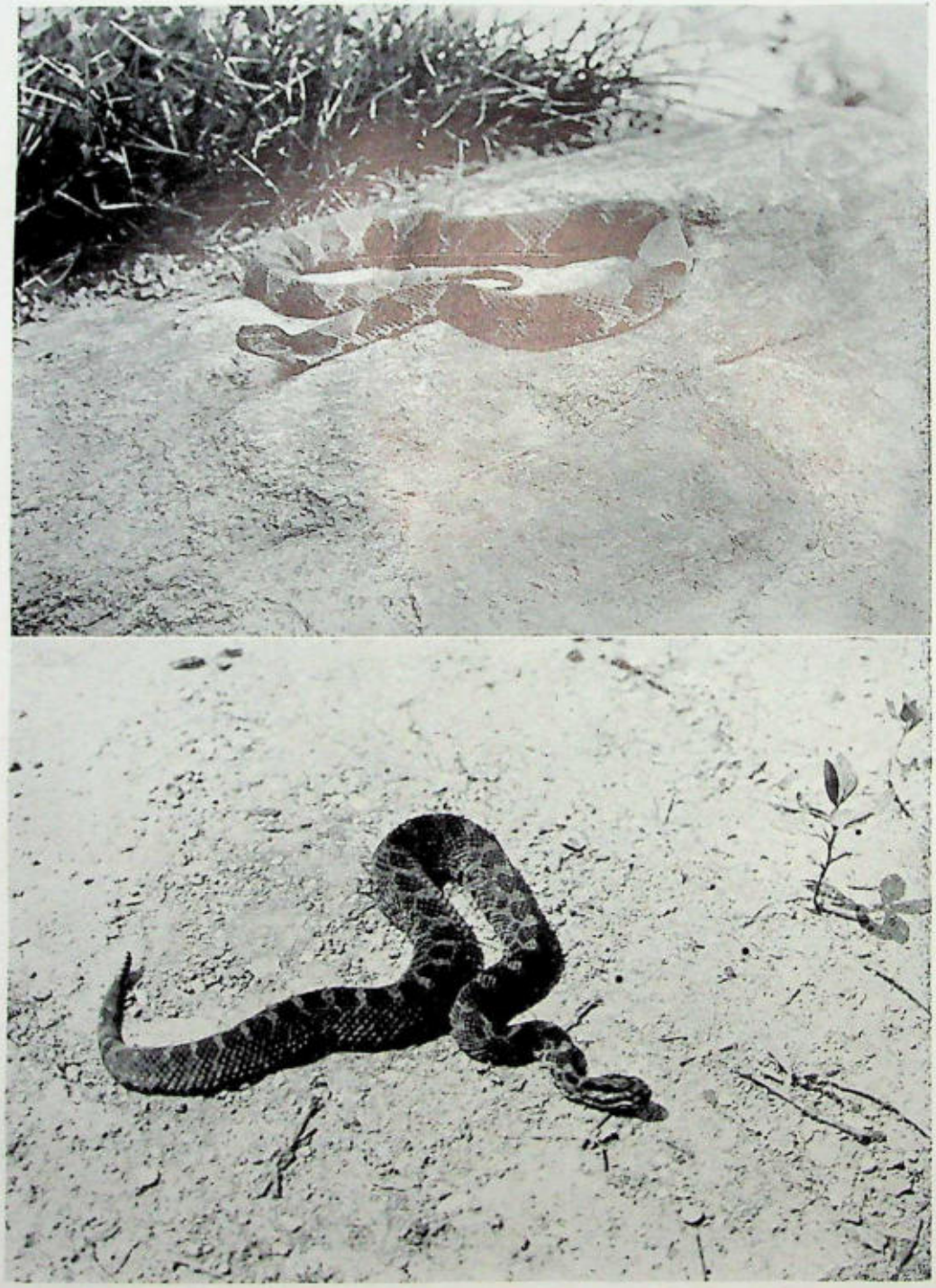

Fig. 29. Copperhead Snake, *Agkistrodon mokasen*. Coloration is vivid and rather characteristic. The body hue is pale brown or reddish brown, with large blotches on the sides like inverted "Y's." These are of rich, chestnut brown. Examined from above, a number of the markings will be seen to unite across the back, giving the outline of an hour glass.

Fig. 30. (*Lower*) Massasauga, *Sistrurus catenatus*. A small rattlesnake which ranges easterly into the local area in a limited portion of western New York. Its rattle is an immediate point for identification.

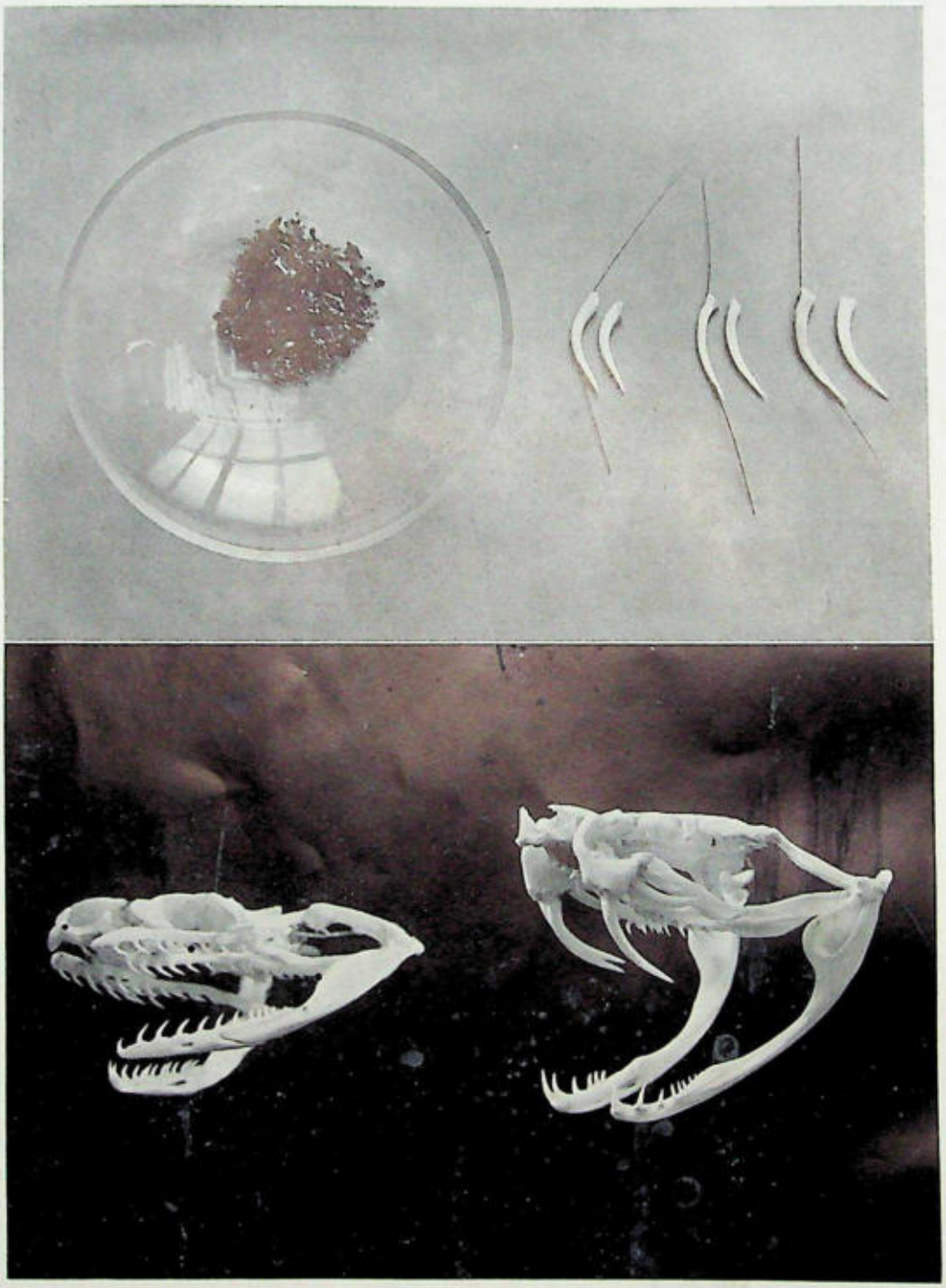

Fig. 26. Dried crystals of rattlesnake poison. It is dehydrated after extraction from the snake to prevent decomposition. When used for immunization in producing antivenomous serum, it is quickly soluble in distilled water. It retains its potency for months or years in a dried state. (*Right*) Fangs of Rattlesnake, Fer-de-lance and Bushmaster, with horsehair passed through the orifice which extends from tip to the base, to show the resemblance to the hypodermic needle of the surgeon.

Fig. 27. (*Lower*) Skulls of harmless and poisonous serpents. The latter shows reserve fangs and a double fang on right—one of these about to be shed.

Fig. 31. Albino Timber Rattlesnake, *Crotalus horridus*. Albinism among serpents is fairly frequent. This specimen was discovered at Black Rock, near Sheffield, Massachusetts. It was twenty-five inches long. A second specimen, apparently a year older, was found at the same den the following year.

Fig. 32. *(Lower)* Timber Rattlesnake, *Crotalus horridus*. Typical example of the species of rattlesnake broadly distributed over the northeastern area in the neighborhood of mountains and ridges. Yellow and blackish examples are equally common.

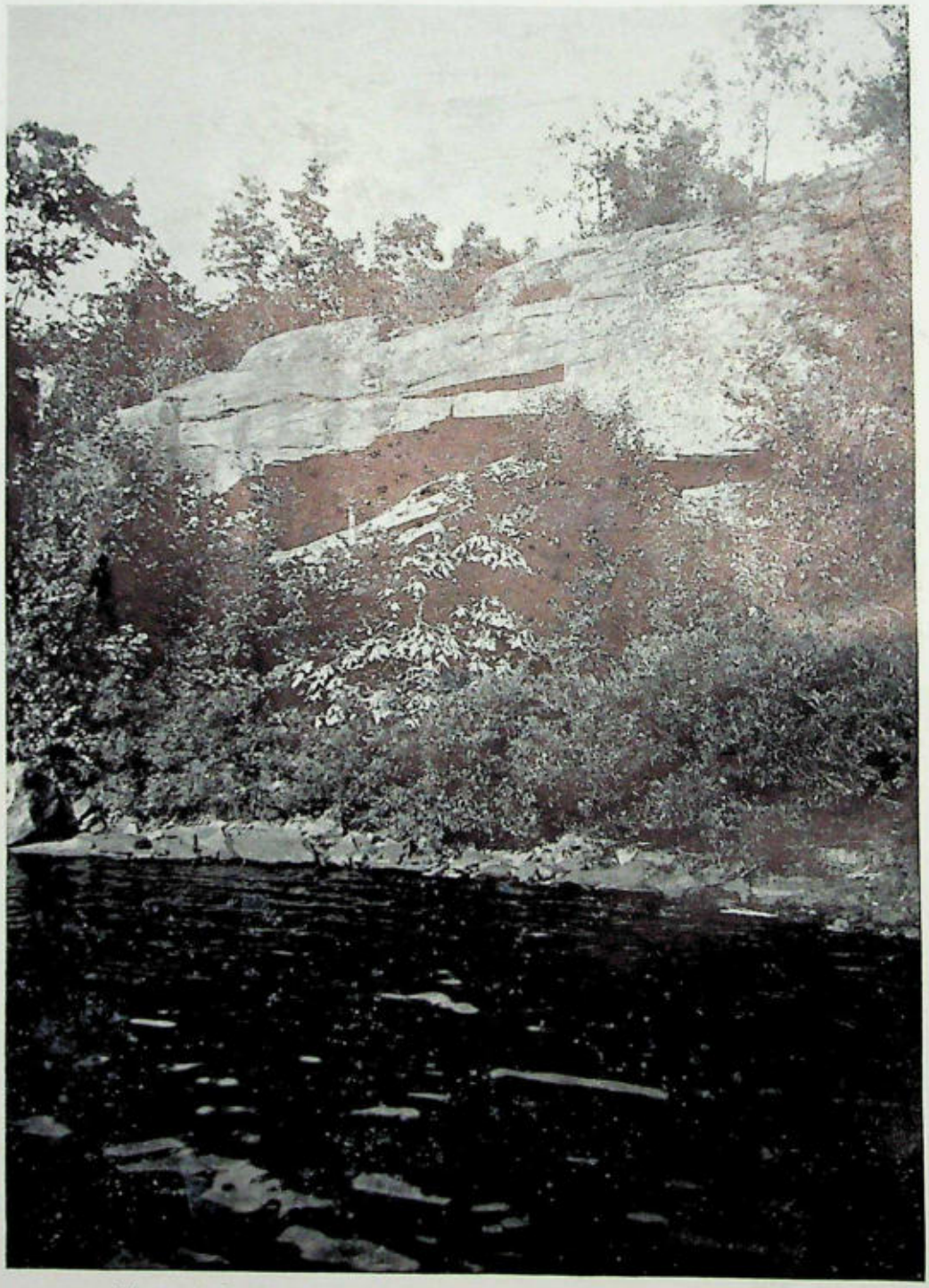

Fig. 33. A Rattlesnake Den. Portion of a ledge in Sullivan County, New York, which extends a distance of several hundred yards, with numerous lesser ledges behind it. The top is covered with loose, shelving rocks, many of them covering deep crevices. The great fissure in the center is about five feet high and extends in about twelve feet, when it narrows to a crevice of great depth. Numbers of rattlesnakes congregate at this den every autumn, to hibernate.

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Contents

BULLETIN

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The Hoatzin (*Opisthocomus hoazin*) or *cigana* as it is known locally, is quite common along most of the rivers and *igarapés* of Marajo. Many attempts have been made to bring this primitive bird to the zoos of the United States and Europe, but thus far it has not proved successful. The bird does not flourish in captivity. Further information concerning the Hoatzin may be found in Zoologica Vol. 1, Nos. 2 and 3, Tropical Wild Life, and Bulletin for September 1916: publications of the Society.

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Marajo, The Wonder Island of Amazonia

Part I. Description of the Island and Its Environs

Arthur H. Fisher

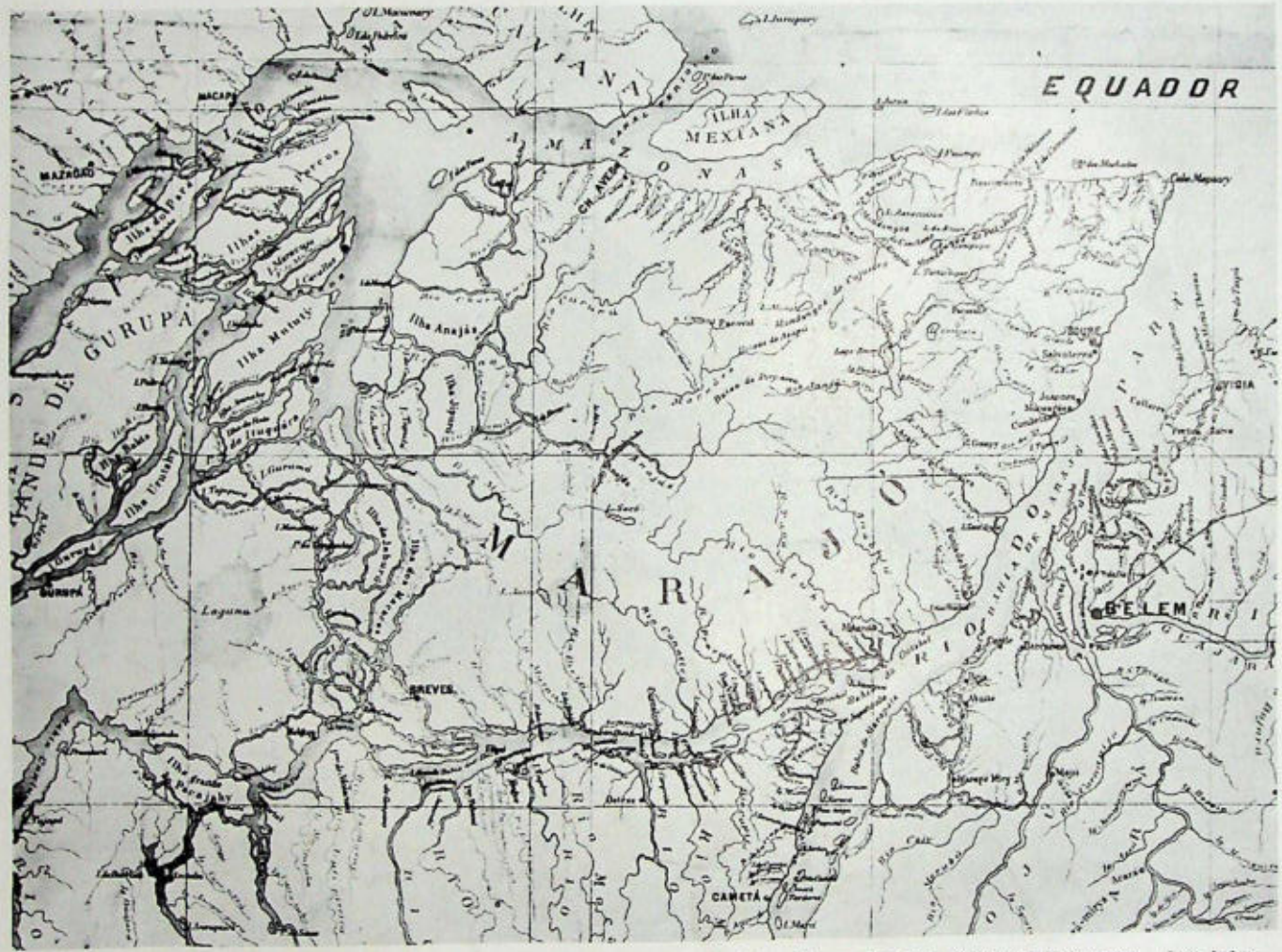
The illustrations are from photographs taken by the author unless otherwise noted.

THERE certainly must be few, even among the less-informed, who do not carry in their minds at least a vague conception of the Amazon, the mightiest of all the world's waterway systems. On the other hand, I venture to say that there are a far less number who know that within the very maw of this Titan of all rivers, lies the wonder island of Marajo, the terrestrial Noah's Ark of Amazonia, with an area comparable in size to the Kingdom of Denmark. Truly a wonder island, with more than a hundred miles of coastline caressed and cudgeled by the broad Atlantic, and where ships at sea can fill their casks with fresh water, a phenomenon unknown in any other spot in all Christendom.

If we are to consider the Rio Para—its only navigable gateway—as one of its true mouths, what constitutes the mouth of the Amazon is more than one hundred and eighty miles in width. Some hundred miles of this great expanse, however, is occupied by the north shore of Marajo. This only port of entry for sizable vessels, known as the Bahia do Marajo, the estuary of the Rio Para, stretches for thirty-five miles from Cape Magoary, the extreme northeast point of the island, to the town of Salinas on the mainland to the southward.

I shall never forget my first glimpse of the distant shore line of this remarkable island. To me, after nineteen days out from New York aboard a slow passenger carrying freighter, even land was a welcome sight, and behind those verdant barriers seemed to me a promised land where I should find a paradise for the field naturalist and hunter for archaeological treasures. Yes, and the ensuing months were to prove, for once at least, that realization can exceed even the most highly colored anticipation. As we lay at anchor in the open sea waiting for the pilot boat to come out to us from Salinas, I could see from the bridge through my glasses, many small fishing boats scudding along the coast of the island against a background of glistening strand and the greens of the forest. I could but wonder what adventures might await me behind this jungle fringe.

One of my fellow passengers, a Japanese scientist with a keen sporting instinct, offered to wager ten yen that the pilot would put his left foot over the rail first. I foolishly accepted, for somehow I never can win bets like that. I remember when going home one day from prep-school with another boy, he bet me a dollar he would see more dogs than I would see cats before reaching a certain street corner. Just as we approached the appointed spot, I was full of juvenile joy, for I had him three down and he was preparing to hand me the much coveted dollar. But alas, and without warning, the dog-



Marajo is the largest and by far the most important of all the islands that make up the vast delta of the Amazon. Just below the Equator, this island, in area almost the size of the Kingdom of Denmark, lies in the very mouth of the greatest of rivers, bounded on the west by the Amazon and on the east by the Rio do Para. This latter river is twenty miles wide opposite the city of Belem, as Para is more properly known. The island of Mexicana, just to the north of Marajo, is more than thirty miles in length, which gives a good idea of the size of the greater island and the extent of its shore line stretching along the Atlantic.

Map through courtesy of the American Geographic Society.

Against the glistening strand and greens of the forest, fishing boats scudded along. In one of these sturdy single masters we made the voyage from Para (Belem) to the Rio Cambu, which enters the Rio Para about twenty miles southwest of Cape Magoary, the extreme northeastern point of Marajo.

catcher's wagon turned the corner and swept by with a full load of unfortunate barking freight. It always has been that way with me. The pilot put his worst foot forward, and my five dollars winged its way eastward.

It was late in the afternoon when the pilot came aboard, and we weighed anchor. The atmosphere had become quite oppressive, and large cumulus clouds commenced forming to eastward, their edges fast darkening. Then without warning, the entire horizon became fringed with the hue of indigo, rapidly spreading upward to blot out all vestige of sun. Then came the wind. As it swept along the shore of Marajo, I could see through my powerful binoculars, the tall burity palms bending with its force. With their fronds waving they reminded me of fleeing humans, wildly tossing their arms in the frenzy of despair. Rapid flashes of lightning, crashes of thunder and then the rain—rain in deluges.

Almost as quickly as it had come upon us, the squall had passed, and as the sun again appeared, only distant rumbling and faint flashes reminding us of its visit. The tense, almost unsupportable atmosphere had also vanished with the storm, and in its place came a cool refreshing breeze. To the westward hung violet tinted clouds, draped like huge valances and curtains edged with burnished gold, slowly drawn aside to disclose a scape of phantom hills and valleys, fringed by lakes of lapis lazuli. Then the sun rapidly dropped beyond the deep emerald barriers of the island's shore, and the entire horizon from every compass point was a blaze of spectrum color.

Many carry in their minds the erroneous idea that there is no twilight at the Equator; that night comes like the pulling down of blinds, or the turning of an electric switch. It is true that you do not have the slowly lengthening shadows of our northern mid-summer evenings, and that these equatorial twilights last but for a few fleeting minutes—but what splendid, what gorgeous twilights they are—preceded by sunsets rarely equalled, and never surpassed by any in all the world. Such a sunset I saw that night, and even as the stars commenced to appear, the

From Cape Magoary, the coastline of Marajo stretches westward for more than one hundred miles, swept by the waters of the mighty Atlantic. It is off this coast, where the power of the Amazon's mighty flood is so great, that sailing vessels in need of fresh water may fill their casks at sea; a thing unknown elsewhere in all the world.

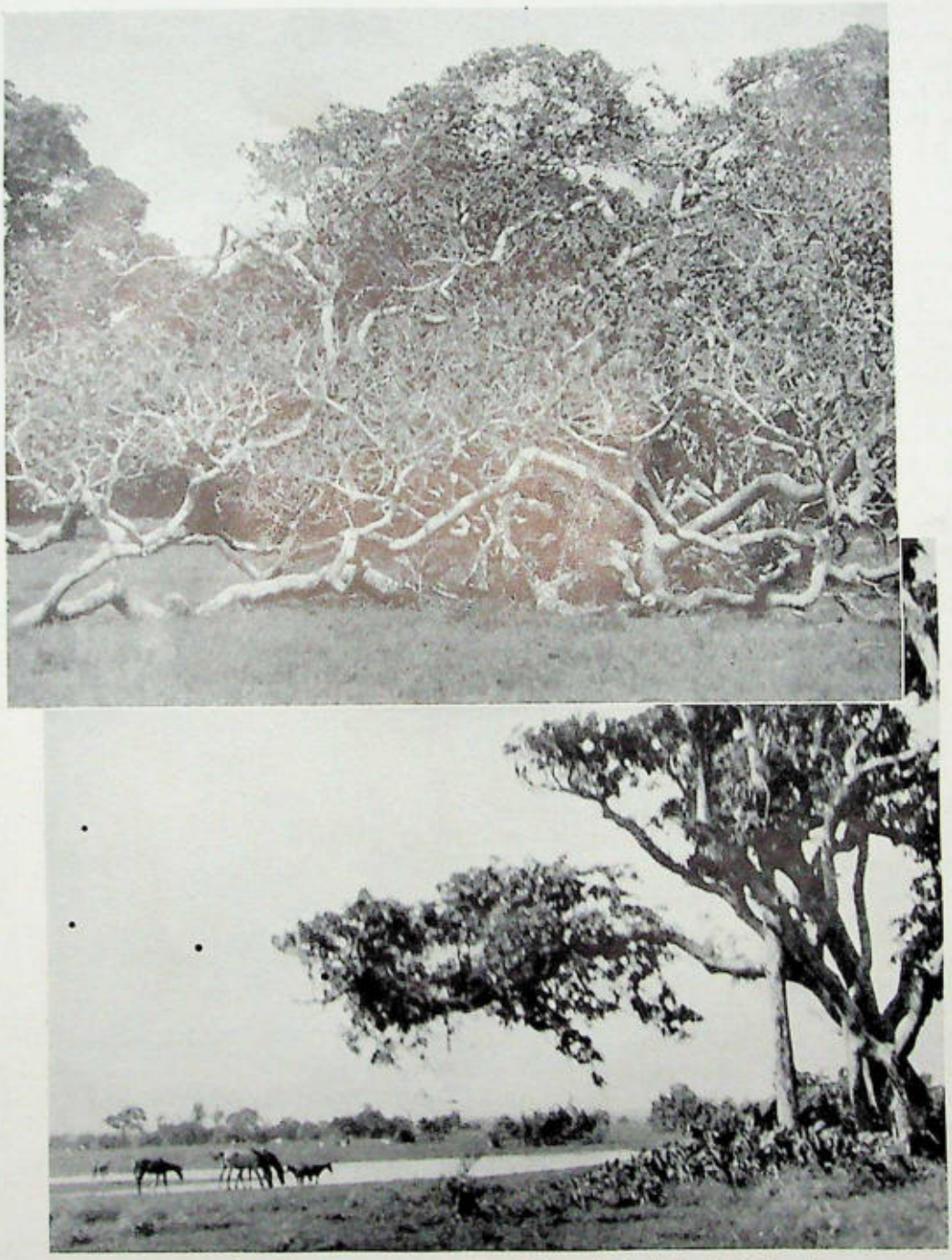
Just as the pilot came aboard in the late afternoon, the atmosphere became oppressive and large cumulous clouds formed to the eastward, spreading upward to blot out the sun. Then came the wind and the rain. When it had passed the violet tinted clouds slowly swept aside to disclose the phantom hills and the setting sun which slowly dropped behind the barrier of the shore.

beauty of its last glow seemed to linger like the aftertones of cymbals.

What constitutes the delta of the Amazon is made up of a great labyrinth of islands, grouped between Marajo and the northermost, or true mouth of the river, which pours its flood of yellow water into the Atlantic through many great channels. With four times the volume of the Mississippi, the great stream of this mighty flood discolors the green surface of the ocean for sometimes more than a hundred miles to seaward. These channels flow to the northwest and north of Marajo, and while they are the main arteries, they do not accommodate all of the Amazon's tremendous outpouring of turgid muddy water, a considerable volume seeking an outlet through a vast system of *furos* (smaller channels) to the west and south of the island. It is these furos that link the true Amazon with the Rio Para, all subject to the ebb and flow of the tides.

The largest of this vast delta is Marajo. Not only in size, but in many other respects, it stands forth in distinct contrast to all the other islands large and small; the wonder island of this delta group. Like Gurupa and the many even less important islands in this maze, the western side of Marajo is the result of countless centuries of alluvial deposits, and represents Amazonia in its most pestilential and defying aspect. It is here covered by dense insect infested and fever ridden jungles, subject to inundation annually during the flood time of the great river. Along the borders of this dismal wilderness, timber, rubber and oilseeds are worked to a certain extent, but here certainly, living conditions appear at their very worst. A less healthful region could not support human life. On the other hand, the eastern side of the island is a vast, and for the most part, a healthful expanse of practically all open *campos*, stretching to the Atlantic coastline on the north. Over this section roam more than half a million wild and semi-wild cattle and horses. It seems unquestionable, but that this eastern half of Marajo is a remnant of the original *terra firme*,* or main land, and not a more recent alluvial accretion as is true of the western portion. If

* Portugese.



Upper—Low-lying Marajo is in the path of the constant trade-winds from the Atlantic, and in many places over the open *campos*, the wind-swept trees have been changed into curious and grotesque shapes by the resistless force of these steady winds. *Lower*—A typical *teso*, or sparsely timbered oasis in the *campos*. At such points, the ground is sufficiently high to be above the inundations during and following the rainy seasons. Here also may be seen the effects of the trade-winds in the gnarled and twisted tree-trunk.

I remember correctly, Agassiz took samples of the soil at Souré, on this eastern side, and found them to correspond with similar tests made of the formations on the mainland directly across the Bahia do Marajo.

This eastern shore of the island rises well above sea level, gradually sloping westward over miles and miles of campos, to at last drop into the Mondogas, as the dismal swamps on the eastern fringe of its westward jungles are called. Although this vast campos region is flooded for about eight months of the year, this inundation is entirely due to the long rainy season, as this eastern section is in no way affected either by the river's annual flood or by the tides.

In Para, only seventy miles distant from the town of Souré, the most important settlement on the island, rain occurs every month throughout the year, while in Marajo, the months of October, November and December are absolutely rainless. This unusual phenomenon causes this campos country to go through a sort of Jekyl and Hyde metamorphosis as the year progresses. There are, for example, large stretches of country where during the month of June one can travel in a shallow draft sailboat. Returning in December to the same locality, it would be hard to realize, as you galloped on horseback over the parched prairie, that you had ever visited this same region before.

Scattered over this vast campos are many small islands or chains of "islands," sparsely timbered, and sufficiently high not to be under water during the long rainy season. It is on these "islands," or *tesos*, as they are locally called, that the cattle congregate during the height of the inundations. On many of the more suitable of these tesos, are erected ranch houses, corrals and outposts. During the intermediate season, the pastureage over the campos is lush and ample, but later on when the campos is dry and parched by the equatorial sun, there is great suffering and mortality among the herds. On the other hand, during the flood time, there is also considerable loss of cattle, through mutilation by those bloodthirsty little man-eating fish, the *piranhas*, and by the thousands of *jacaré* (crocodile) with which the island fairly swarms.

This enormous eastern area of prairie lands is divided up into large tracts, or *fazendas* (ranches), chiefly owned by the more wealthy residents of Para. On one fazenda alone there are more than fifty thousand head of cattle, and it is upon these ranches that this important city of more than two hundred thousand inhabitants depends for its fresh meat supply. It might rightly be said, that these *fazendeiros* of Marajo, who own these huge tracts of wilderness, are the landed gentry of Para. And truly a wilderness it is, for one who enters the interior of this island without experienced guides, is certainly flirting with calamity, for he can become almost as helplessly lost as in the great forests that border the Amazon and its tributaries.

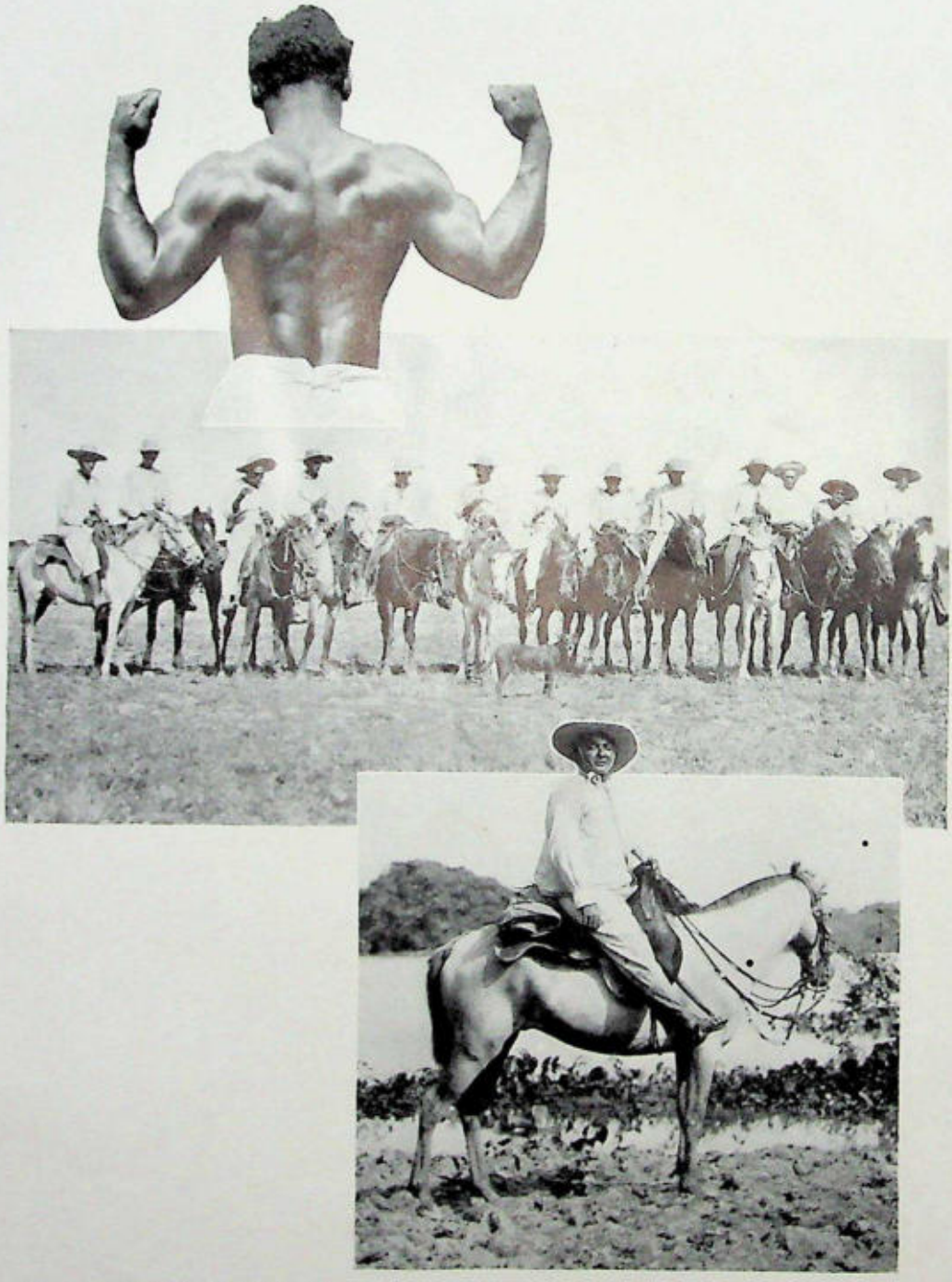
The cattle industry is carried on in Marajo on even more primitive lines than prevailed on our own western frontiers when the late Colonel Roosevelt spent his younger days on his ranch on the Little Missouri. Six-shooters, silver mounted saddles, dance-halls and horse rustling do not enter into the life of these island cowboys. Furthermore, the fact that for eight months of the year they are for much of the time mounted in canoes instead of in the saddles, deprives the picture of much of this former wildwest glamor. Their stirrups, on the other hand, add a unique interest, for they are but tiny rings only large enough to accommodate the great and perhaps the second toe. Their saddles are also peculiar sloping affairs, compared with which our army saddles are as soft and comfortable as a feather bed. Nevertheless, these cowboys of Marajo are able horsemen, skilled in all the arts of roping, bronco busting, steer riding and the rest. I attended more than one of their rodeos and roundups, and they were accompanied by a goodly quota of thrills and spills. If ordered to walk a couple of miles on foot their boss is a tyrant, but if dispatched on a fifty mile journey, they are in the saddle and off, to ride through the day and night through crocodile infested and insect swarming swamps as cheerfully and with less fear than our bank-runners making their appointed rounds.

Long before the discovery of America, the Island of Marajo was inhabited by tribes of

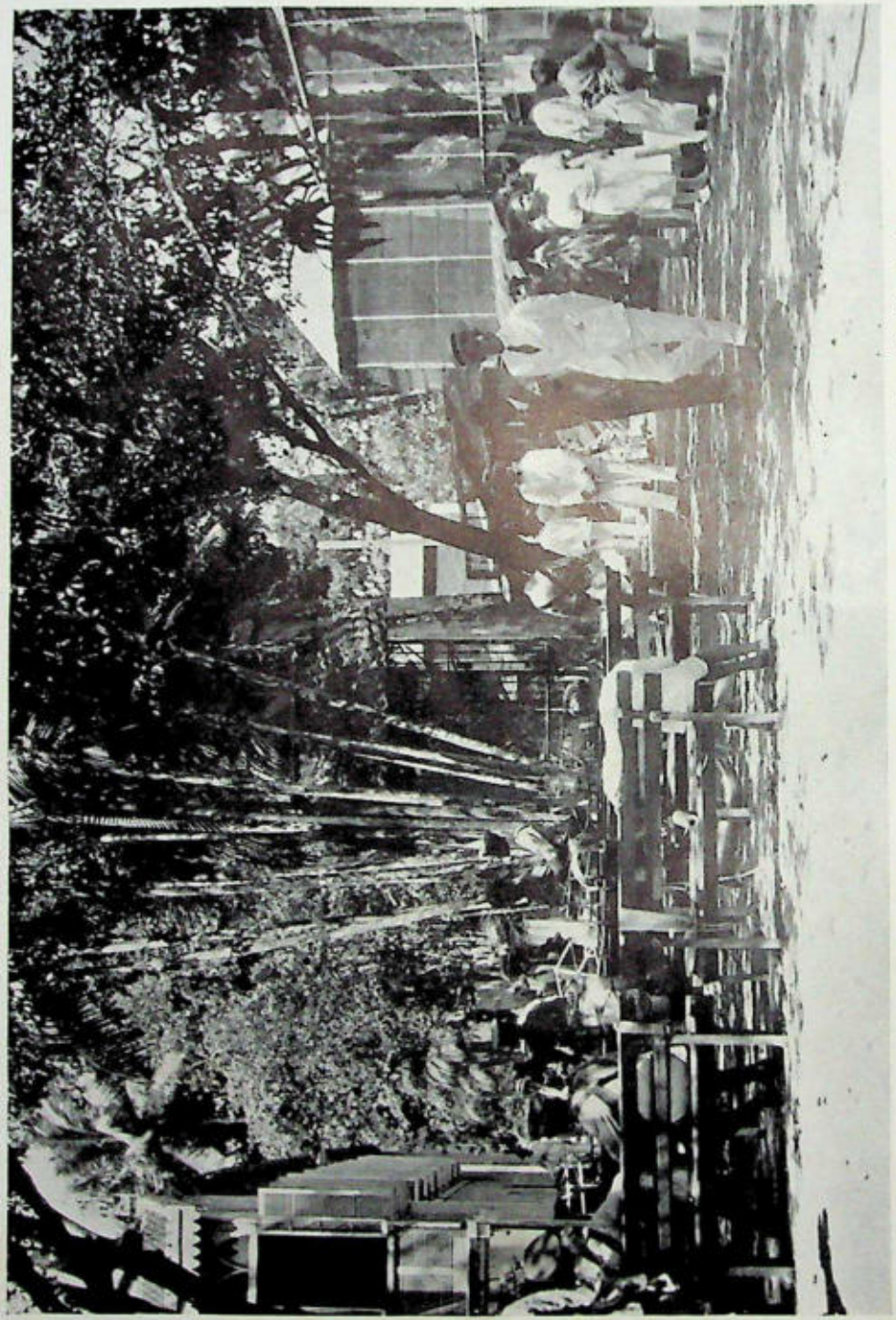
Dotted over the wide expanses of the open prairies are many small areas of higher ground, which are not subject to the annual inundations of the rainy season. Many of these areas or *tesos* as they are properly called, are thickly timbered, bordered by long sedgy grass, affording excellent cover for the jaguar. These powerful cats, including the rare black variety (simply a color phase) are found on Marajo in great numbers. The majority of jaguars that reach the zoos and menageries of the world are captured on this island.

aborigines whose origin and disappearance still remains but a mild speculation. Yes, before any white man had put foot on the soil of the Americas, these tribes had developed a high state of culture and then vanished from the face of the earth. All the evidence of their existence that is left to us are the mounds where they paid their last respects to their dead. Buried

The northeastern section of Marajo is practically open *campos*, ideal for grazing, and over this region roam more than a half-million wild and semi-wild cattle. Indian zebu bulls have been introduced among these herds and the infusion of this stock is quite noticeable in the character of the cattle bred from the alliance. It is upon these wild herds that the city of Para depends entirely for its supply of fresh meat.



The Marajo cowboys are most able horsemen, skilled in all the tricks of roping, bronco-busting and the rest of the arts which contribute to the thrills of a rodeo. For the most part they are descendants of former African slaves, and with few exceptions they are men of the most remarkable endurance and the perfection of physical development. The peculiar stirrups add unique interest, for they are small iron rings fastened to the stirrup strap, large enough to accommodate only the great toe and perhaps the second.



The municipality of Para maintains a small but interesting zoological garden. The authorities in charge have wisely limited the specimens to the more interesting examples of the fauna of the Amazon Basin. There is a very creditable synoptic collection of the more well known birds, mammals and reptiles of this rich faunal region.

Spider monkey, prehensile-tailed porcupine, and two-toed sloth in the market place, Para. Para is a clearing house for every imaginable thing rare and commonplace peculiar to this land of river and jungle. Anything from the smallest parakeet, the savage jaguar, boas, anacondas, ocelots and huge turtles await the customer. Often these animals are shipped to Germany and then resold and shipped back to the United States. The jaguar Senor Lopez for many years in the collections of the Park was acquired by the Society in this manner.

Toucan is the native Brazilian name for this tropical American bird noted for its immense beak which gives it a rather grotesque appearance. By its size one might imagine that the bird would be burdened by so large an object, but the structure is a thin shell covering a spongy cellular mass within, and altogether of scarcely no weight at all. The plumages of the different species are combinations of delicate shades of blue, yellow, red and black, and the beaks of many are most fantastic in their color patterns. Besides soft pulpy fruits, the toucan is not averse to a regimen of eggs, fish, reptiles and small birds which are devoured entire; the bird giving the object a toss into the air whence it drops into his capacious maw. Here are two species, a young sulphur and white breasted toucan, (*Rhamphastos vitellinus*), and the red-billed (*R. monilis*).

in these mounds, archaeologists have found, in the form of most extraordinary ceramics, a clue, another link in a much broken chain, but the solution of whence they came, or the tragedy of their final extinction still remains a mystery.

There are but few collections of this remarkable pottery of varying forms, colors and design, in existence, and it was not only to study and photograph the bird and animal life of this island that lured me, but also to excavate for these archaeological treasures.

After a short stay in Para, I was able to organize an expedition to Marajo, and my party included a prominent Brazilian gentleman, who, together with other members of his family, owns several of the more important fazendas on the island.

During these early days in Para, I spent considerable time rambling about the city looking for the unusual. Such ramblings naturally often led me to the Zoological Gardens, which though small in size, and also in collections considering the possibilities of securing specimens, comprises quite a creditable synoptic collection of the well known birds and animals of Amazonia. And while this collection is wisely limited to local material, I was particularly attracted by one exception, an adult female chimpanzee (*Pan niger*). This anthropoid had been confined there for many years, and was apparently enjoying unusual health and vigor. She was formerly the property of an American physician residing in Manaos, that remarkable isolated city one thousand miles up the Amazon. Her former owner, a specialist in tropical diseases, had imported two of these apes to Brazil from Africa, during an alarming outbreak of yellow fever, with the object of innoculating them with the germs of the disease, and then making exhaustive autopsies after death. One of the chimpanzees rapidly succumbed to yellow fever, but Olga, as she is called, not only refused to be laid low with this disease, but she showed equal resistence to other innoculations including many of the worst. After running the gamut of these injections, she was finally presented to the zoo at Para. I have had an opportunity to observe many chimpanzees, and I found Olga to exhibit a high degree of intelligence. One trait in her character was to me particularly interesting: If she got an object in her possession which interested her, its recovery was impossible except by offering her something in exchange which she regarded as more desirable. With one hand extended to receive the new treasure, the other hand containing the object already in her possession was kept out of reach. When the new treasure proffered was safely within her grasp, she never failed to fulfill her end of the bargain. Her keeper told me that before she had been deceived, "double-crossed" as it were, she had always been willing to pay in advance. However, after one lesson in the chicanery of mankind, she put everything on a strictly *C. O. D.* basis.

As is true in most far off places, I found Para's municipal market a spot of great and ever changing interest. It is the clearing house for every imaginable thing rare and commonplace peculiar to this land of river and jungles. Everything from the smallest parakeet to a snarling jaguar is offered for sale. One section is a diminutive menagerie. Boa constrictors and anacondas large and small; rare monkeys, parrots, toucans, and other smaller birds, to say nothing of giant ant-eaters, kinkajous, ocelots, huge turtles, and other strange jungle folk await the customer. Today many of these creatures are in this market, and tomorrow on their way to Germany to be shipped back over the broad Atlantic to be sold to zoos in the United States.

Flanking this market is the *Ver-o-pesa*, or municipal basin, the landing quay for most of the sailing craft trading at Para. The world traveler carries with him the memory of many unusual waterfront scenes. The canals of Venice, the dhows in the harbor of Mombasa, the junks on the Yang-tse, are lasting impressions. If his peregrinations lead him to the Amazon, this strangely fascinating scene of river life should certainly further enrich his retrospective archives. Into this basin, deeply indented in the city's wall, come with the early morning tide, picturesque craft and floating homes from the far and near interior. Laden with birds and animals and products of the wilderness, in they crowd beam to beam. With their colored sails of different hues, the flood of brilliant sunlight

The Municipal Market in Para is typical of similar places throughout Central and Tropical South America. It is the place of exchange and barter for everything indigenous to this rich and fertile land. These markets are open daily, but there are special days for the sales of fresh meats, vegetables and fruits and articles of wearing apparel and various textiles. Here may be found an exchange for the fauna and flora of the region both for domestic purposes and for delivery to the markets of foreign countries. It affords an ever changing scene of interest for tourist and scientist alike.

Oil nuts—*Upper left*—have created an important industry in Amazonia. Among the many oil nut bearing palms is the Babassu which is found in certain parts of Marajo; this is the land of the ant, there are hundreds of species, and their nests are both curious and interesting in structure. This species—*upper right*—has a home about the size of a peach which it skilfully conceals in the dense foliage of a tree. Frequently one finds such examples of bee architecture—*lower left*—cleverly attached to a leaf and so placed that it lies on the under side completely hidden. The nest is about the size of a quarter-dollar and makes a safe harboring place for its small stingless owners. This ant—*lower right*—is more ambitious and more powerful. The nest is about four feet long and is attached to a tree trunk about fifteen feet from the ground. The holes in the sides of the nest are the results of the onslaughts of arboreal ant-eaters and many species of ant-eating birds.

Close by the Municipal Market is the Ver-o-pesa, the municipal basin, the landing place for most of the craft which trade at Para. Into the basin, deeply indented in the city's wall, on the early morning tide, come picturesque river craft from far and near interior, with gaily colored sails of varied hues. Laden with the products of the wilderness, they crowd into the quay, beam to beam. Out of this labyrinth we hired a sturdy single-master—a rugged sloop, and when the evening brought the returning tide we slowly untangled from this Gordian maze of spars and sails, and got underway; a fair wind behind and hope of adventure ahead.

over it all, the effect might be compared to the tail of a giant peacock draped over a seemingly hopeless maze of hulls, spars and rigging. As the morning advances and the sun mounts in its daily midway course across the sky, the tide recedes rapidly and here in an ill-smelling, vulture-explored, black jelly-like ooze they lay through the long torrid day, a helpless tangled flotilla. As evening approaches, comes the returning tide. Then one may see them slowly untangle, and as the sun drops behind the Island of the Jaguars, silently they make their way, one by one disappearing like shadowy phantoms into the deepening blues of the brief twilight.

It was from this labyrinth, we were able to hire a sturdy single-master to make the voyage to Marajo. And so one August evening, shortly after sundown, with a native skipper and crew we were underway, a fair wind behind us and the hope of adventure ahead. There was an almost full moon, and the heavens were fairly alive with "shooting stars," which now and again cut pathways like tiny rockets among their neighbors. I soon swung my hammock between the stays, and lay enjoying the glories of the night. Astern rose the Southern Cross, lying obliquely like a mammoth diamond brooch, worn on a robe of purple mid countless distinguished gems. As I lay there enjoying the cool breeze, I could not but wonder whether my family at home pictured me sweltering in humid jungles, when as a matter of fact, within about one degree of the Equator I was covered with a warm blanket.

Such ponderings and dozings were soon to be rudely interrupted. Toward midnight, dark clouds driving across the moon, rumblings and flashes, followed by equally squally symptoms brought me out of my hammock and back from reveries. Our skipper, well versed in the treacheries of the Bay of Marajo, and these quickly formed storms, had shortened sail, and before the squall broke upon us in full force, we headed for and reached the shelter of a cove in the lee of a small island. Here we anchored, and then came the wind and rain, rain and more rain from which the cabin was the one refuge.

Now when ten men seek shelter in a cabin evidently designed to offer discomfort to about five, at the same time harboring odors of which bilge and forgotten fish are the mildest—well, I will leave my thoughts unrecorded. Fortunately the storm was soon over, but I shall always feel that I got a fair idea of what floated upward from the between-decks of the olden-day slave ships loaded with their human cargo.

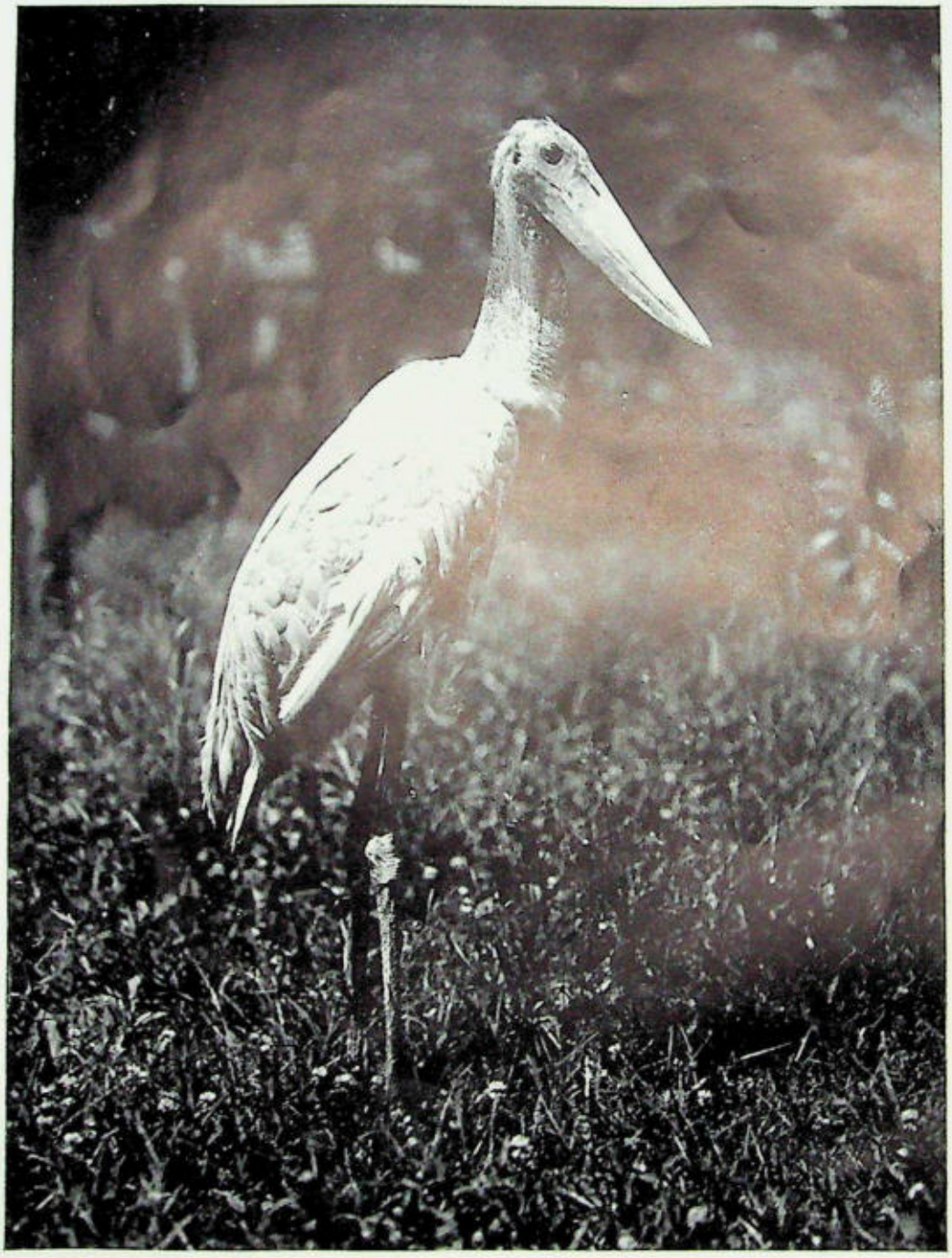
With the passing of the storm we were again under way, and about two hours before daybreak we came to anchor off the mouth of the Rio Cambu, our point of entry to the island. Owing to the flat shelving beach, we were compelled to wait outside for the morning tide. With the dawn came one of the most marvelous pictures of bird life I have ever seen. Literally thousands and thousands of feathered fishermen came winging their way from the interior of Marajo to their feeding grounds along its coast. Long undulating lines of scarlet ibis (*Eudocimus ruber*) flying in "V" formations streaked like crimson streamers across the gray-blue sky, followed by countless hundreds of white herons (*Herodias egretta*) and *magoarys* (*Ardea cocoi*). Long wedge upon wedge of cormorants, (*Phalocrocorax vigua*) passed so low above my head that I could see their eyes, and the noise of their wings was like the wind whistling through the halyards of a ship. For nearly half an hour the air was alive with these different birds, while high above it all seven jabiru storks or *tuyuyus* (*Jabiru americanus*) to me the most inspiring of aviators, spiraled in wide circles. As I watched them through my binoculars, manipulating their ailerons, I was summoned back to earth by the voice of the skipper.

"*Atire as guara, Senhor,*" he pleaded. "*Sao tao bons como gallinha.*" (Shoot some scarlet-ibis. They are as good as chicken.)

I thought he was exaggerating when he made this claim for them, but keen appetites are never absent aboard ship, and while I expected them to be fishy in taste, to please the skipper and crew, I successfully dropped seven into the bay, and one of the men waded out and got them. I was surprised to find them quite good in flavor, and so we all enjoyed a hearty breakfast of roasted ibis. By seven o'clock there was ample water and we again dropped anchor a short distance inside the mouth of the Rio Cambu, and about a half mile from an outpost of one

We came to anchor off the mouth of the Rio Cambu a short time before daybreak. No more beautiful stream than this *igarapé* could be imagined. For miles it winds its silvery way through the *campos* of the island, but for the greater part it is hemmed in on either side by swamp and jungle. Lofty trees projected a graceful canopy of foliage over head, hosts of gaily colored flowers peeped through the luscious greenery and from the trees swept a maze of graceful tendrils like the streamers of a bridal wreath. Neither artisan nor artist could hope to achieve a glory of design to compare with this picture by the hand of the Creator.

Magoary, cocoi heron (*Ardea cocoi*) is found practically throughout South America. It resembles our great blue heron but the gray of the head and neck closely approaches white, forming a striking contrast with the darker portions of the plumage. From a photograph made in the Zoological Park.



The *jabiru* (*Jabiru mycteria*) is the largest of the three species of storks found in South America. The name is of native origin and is said to refer to the bird's habit of distending the loose skin of the neck. From a photograph made in the Zoological Park.

The pileated heron (*Pilerodius pileata*) is one of the most beautiful of its family. The body is pure white, set off by a crown of black, from which several pendent white plumes descend along the neck. The skin of the face is bare of feathers and bright blue in color. From a photograph made in the Zoological Park.

In the more open spaces, masses of bamboo and burity palms fringed the banks to the water's edge. I saw no fairies, but they must have been there, perhaps dancing behind the screen of trailing vines and feathery bamboos, to the lilting notes of the Sabias, whose plaintive, flute-like tones were so mindful of our northern woodthrush. On the high bank of the igarape was a nesting colony of *japims* (*Cassicus icteronotus*). These beautiful orange and black cassiques colonize near the habitations of man. Their curious gourd-like nests swinging from the branches shelter many birds, the females greatly out-numbering the males.

of the important fazendas, known as Camburupy. Here was a very comfortable two-roomed shack, which we could use as our headquarters at this point.

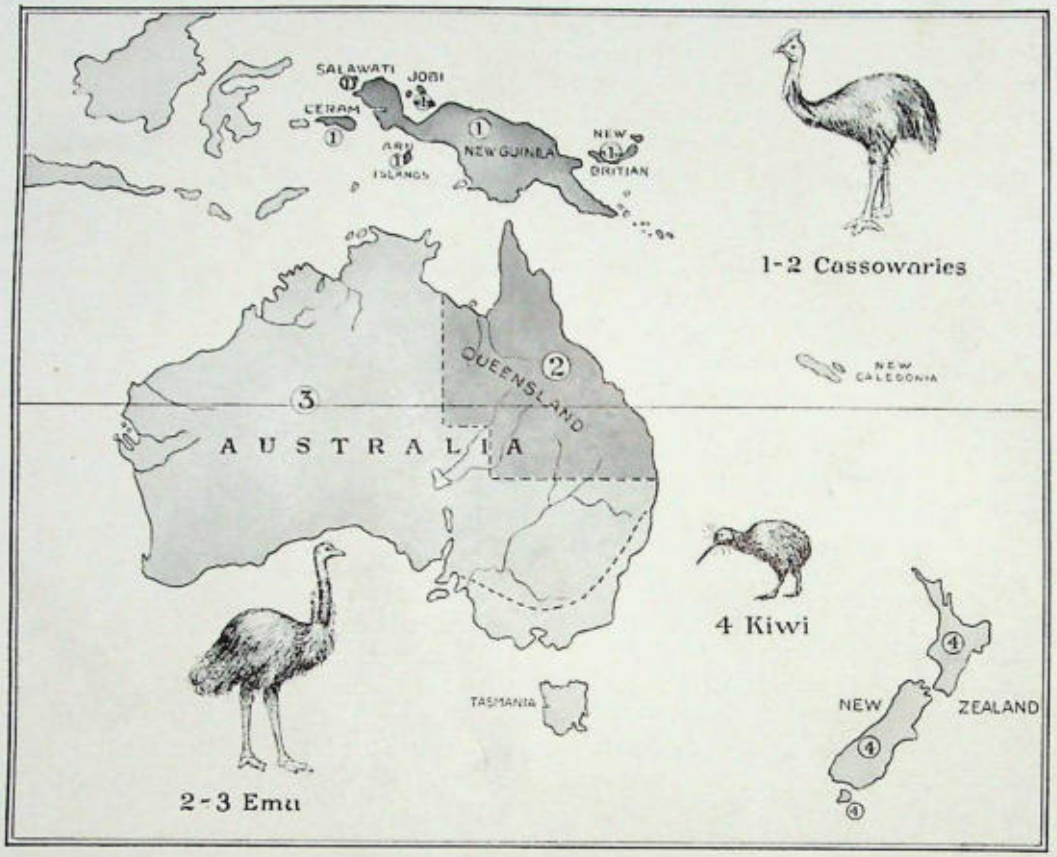
From a photographic standpoint, I was favored from the start. Only a short distance from the outpost and directly opposite a high bank of the *igarapé* (Tupi indian for canoe path) as these smaller rivers and streams are called, I discovered a large colony of *japims*. These beautiful orange and black cassiques (*Cassicus icteronotus*) seem to like to build their colonies near the habitations of man. They are most interesting and intelligent birds, and seem to be in full accord with the philosophy of Brigham Young, since they practice polygamy on a liberal scale, the females of these colonies always far outnumbering the males. They build long hanging nests, with a small entrance near the top, grouping their aerial apartments like a collection of well filled Christmas stockings. I set up my Akeley camera, and slipping in a telephoto lens, proceeded without shame to pry into their most intimate affairs. At first they seemed to view my actions with suspicion, scolding and apparently discussing the white man and his strange ways. In a short time, however, normalcy was restored and they settled down to their morning routine. The gregarious nature of these birds is shown in all their actions, particularly in feeding their young. The whole colony would leave the nests in a body, flying off into the nearby *matto* (jungle). Then everything would be quiet for a few minutes. Suddenly they would all return bringing jungle titbits for their young hopefuls, keeping up an incessant chatter and hubbub of strident calls. From early dawn until bedtime they carry on their garrulous gossiping, like so many housewives in a crowded tenement.

That same afternoon, I took a canoe and a boy to paddle, and made by first exploration of the Rio Cambu. I cannot imagine a more beautiful stream than this *igarapé* which winds its way through miles of this campos section of the island, but for the greater part, like most of the island's streams and rivers, hemmed in on either side by a wide fringe of swamp and jungle. In many of the reaches of the Cambu, lofty trees projected their branches in a bower overhead, festooned with air-roots, which in turn formed trellises for garlands of climbing plants. Interspersed among the lovely greens, burst forth the gaily painted blooms of the trumpet vines (*bignonidae*), while now and again a lovely orchid caught my eager eye. In many places both banks were lined with *mangue* and *ciri-uba* trees, their stilt like roots radiating in all directions. In the more open spaces, masses of bamboo and burity palms dominated the lower barriers of the stream. No man-designed effort of florist or artist could hope to approach the beauty and harmony of it all, and with almost every stroke of the paddle came something new to delight the eye.

Large crimson dragon-flies poised for a moment stationary against the blue, only the next instant to dart into some equally charming setting. Morphos, those vagrant princes of butterflies and bluer than any sky, languidly fluttered into the picture, and then vanished on their careless, aimless way. Now and again from the depths of the matta came the flute-like notes of the *sabias* (*Planesticus albiventris*) similar to the tones of their cousins, our northern woodthrush, while atop a high dead tree a solitary *cara-cara-y*, (*Polyborus tharus*) sounded his melancholy whistle. As we rounded one bend in the stream, five brilliant scarlet ibis had arranged themselves on a projecting limb in a framework of delicate foliage, the effect reminding me of a certain lovely Japanese screen I knew at home. Everywhere there were birds. Ibis, roseate spoonbills, boatbills, (*Cochlearius cochlearius*) white herons, magoarys, snowy egrets (*Leucophoyx candidissima*) and many varieties of kingfishers greeted us at every turn. They seemed but little disturbed by our invasion, only rising when we were almost upon them, while overhead flocks of parrots, (*Amazona amazonica*) made their noisy way through the tree tops. I saw no fairies, but I feel sure they must have been there, peeping out from the draperies of vines and bamboo, for in such a fairyland, surely there must be fairies.

Concluded, September-October Bulletin

The boat-billed heron (*Cochlearius cochlearius*) derives its name from the extreme breadth and thickness of its beak. The eyes are very large, doubtless an adaptation to the bird's nocturnal habits.



Sketch-map showing the distribution of the Cassowaries, Emus and Kiwis. It is intended to give a general idea, only, of the lands where these birds live.

The Struthious Birds

Part I. The Emus, Cassowaries and Kiwis

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Curator of Birds, Zoological Park

The illustrations are from photographs made in the Zoological Park unless otherwise noted.

BECAUSE of their great size, and a common inability to fly, the ostriches, rheas, cassowaries and emus fall into a natural group, which, until within recent years, has received scientific sanction. Extended study has now caused most investigators to feel that the superficial resemblances between these birds are, for the most part, examples of parallel development, rather than expressions of actual close relationship. They are usually assigned to four Orders: Rheiformes, or Rheas; Struthioniformes, or Ostriches; and Casuariiformes, which includes both the Cassowaries and the Emus. A fourth species of Apteryx, or Kiwi, of New Zealand. These four Orders come under the Sub-class Ratitae, collectively known as the struthious or ostrich-like birds.

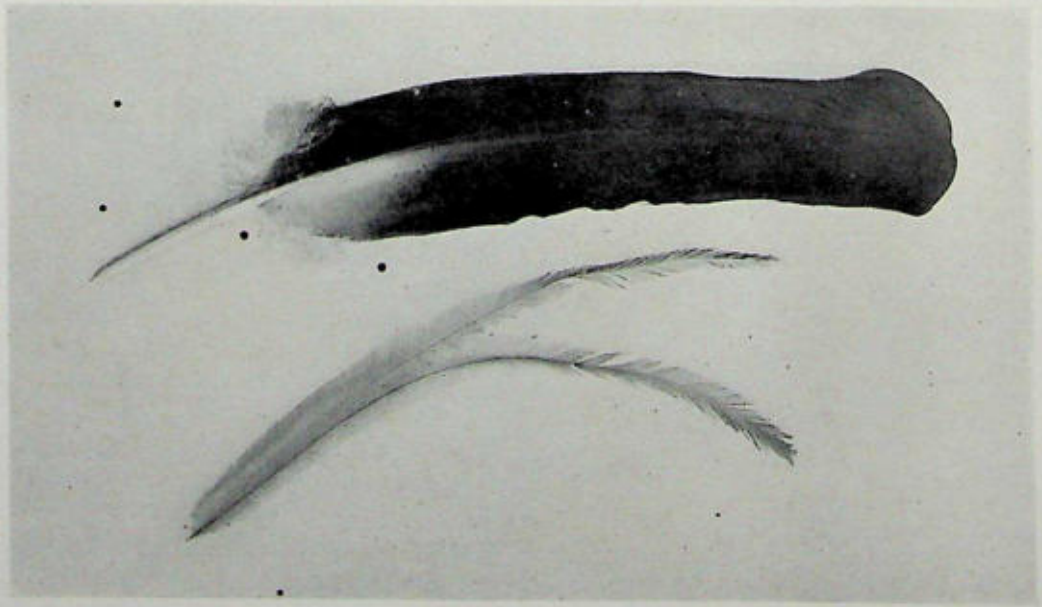
The ancestors of these great birds must have sprung from far down on the avian stem, for the forms of the present day still retain certain reptilian characters. The most prominent of these are the claws which persist on the digits of the wings—three in the Ostrich, two in the Rhea and one in the Cassowary, Emu and Kiwi. These and various other primitive left-overs, coupled with the reduced size and functionless Order, Apterygiiformes, is formed by the various

condition of the wings, led early observers to consider the struthious birds as little better than feathered reptiles, which had failed to progress to the flying stage. At the present time, they are looked upon rather as the descendants of forebears capable of flight—fallen angels, in fact, that have renounced the freedom of the skies to live on earth.

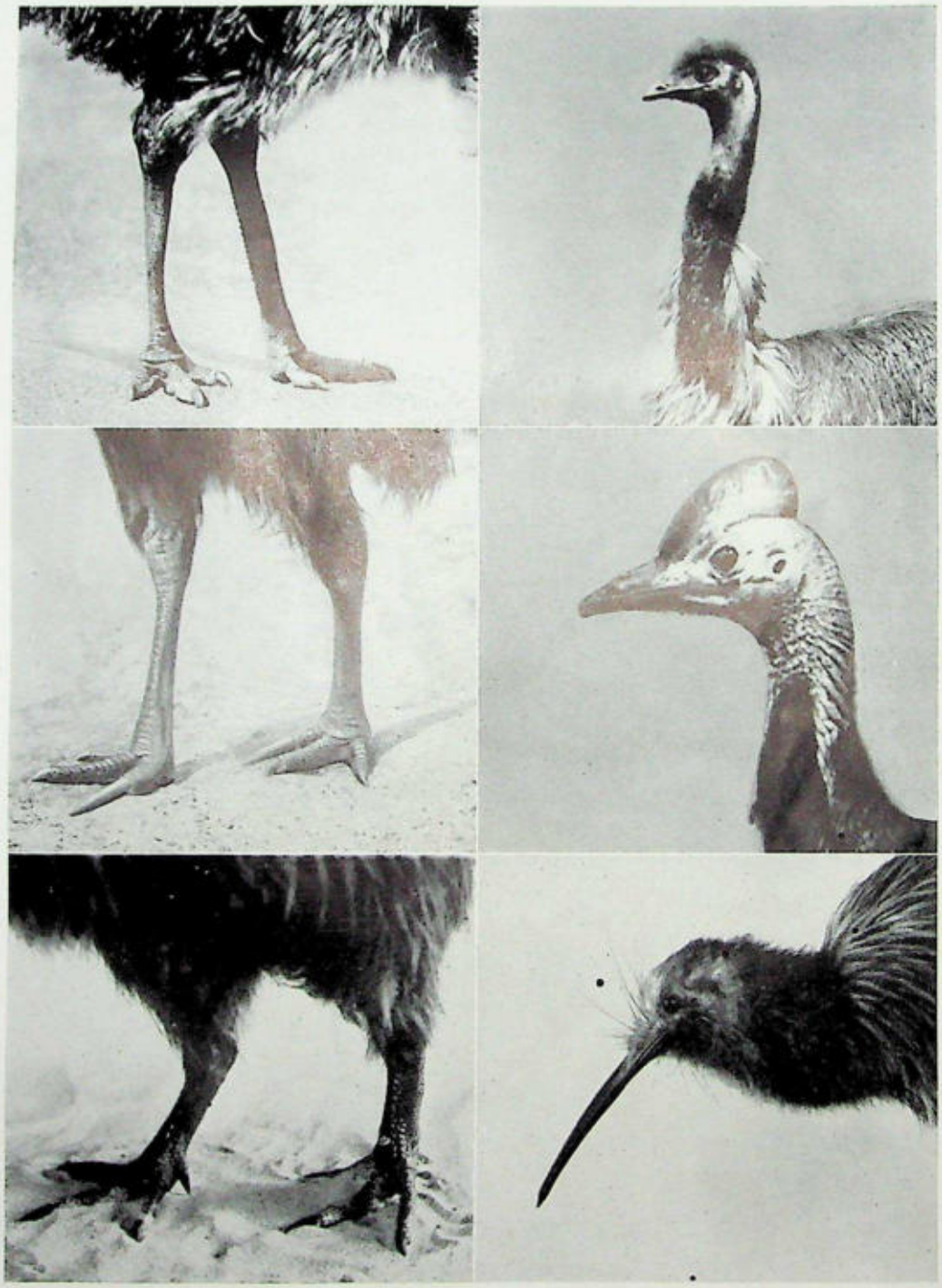
The degeneration of the wing has been balanced by adaptation of the legs to running at great speed, at least in those species which rely on them chiefly in escaping their enemies. The Ostrich, Rhea and Emu are dwellers on open or lightly wooded plains, and all are swift of foot. The toes of the Ostrich have been reduced to two on each foot, while the Rhea and Emu have three. The Cassowary, evidently somewhat closely related to the Emu, has the same number of toes, but its legs are short and thick, and it relies on the protection of the thick bush and a powerful kick, rather than on high speed. The little Kiwi possesses the normal four toes of birds in general, and seeks to avoid discovery by skulking, nocturnal habits.

The Emus are open country birds, and range over practically the whole of Australia. Several forms, apparently of doubtful value, have been described. In common with the Cassowaries, they differ from the Ostriches and Rheas in the character of the plumage, the feathers being long, narrow and almost hair-like. They also have the appearance of being double, the after-shaft being so developed that it nearly equals the main feather in size.

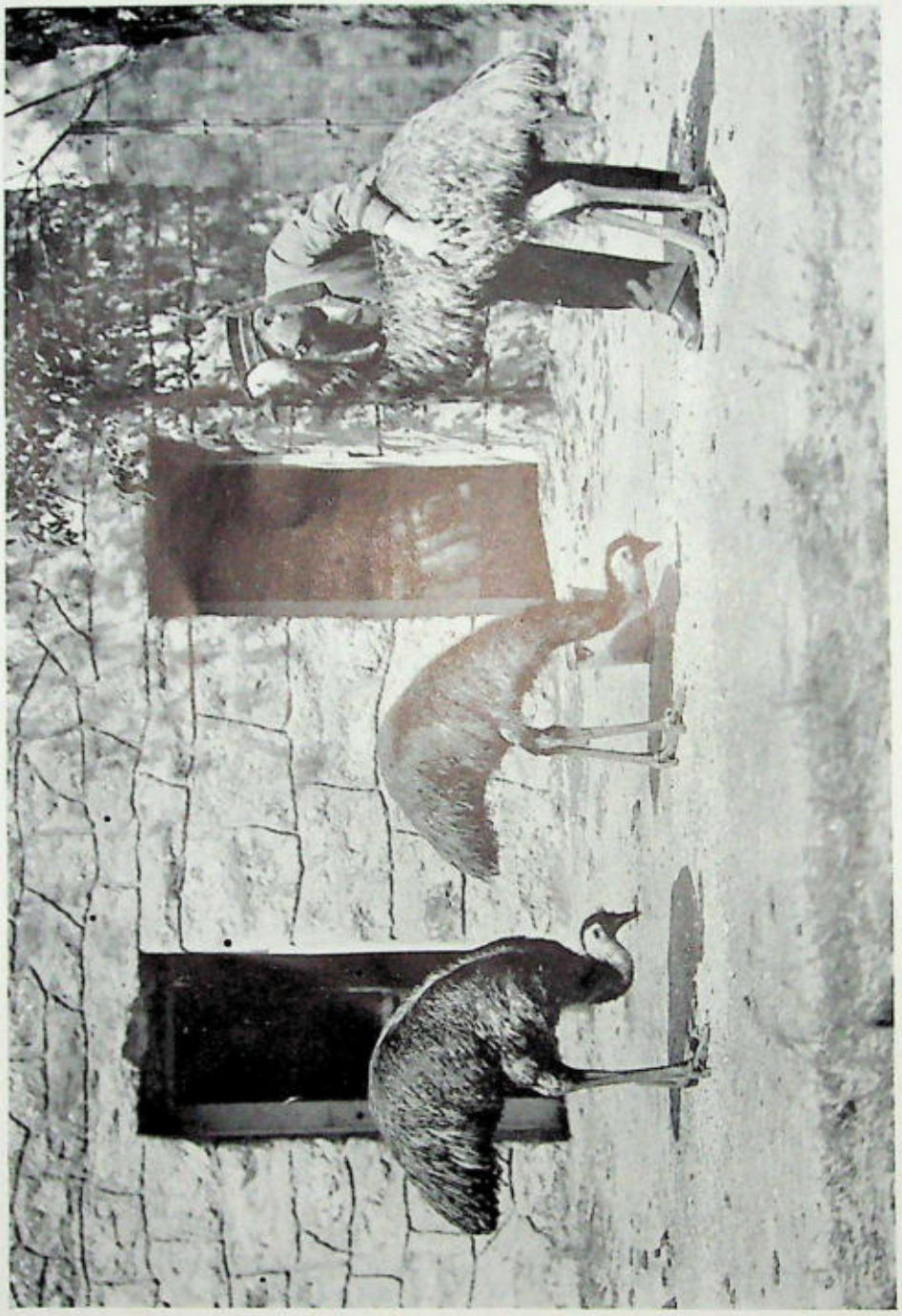
The curious nesting habits of the Emus are well known and accounts of their breeding in the Zoological Park have appeared at various times in our Bulletin. Incubation of the eggs and rearing of the young are accomplished by the male alone, the female bearing no part once the eggs have been laid. This reversion of the parental instinct is also found in the Rhea and Kiwi, and probably in the Cassowary as well, although in the latter case, the facts are not well known.



Secondary feather—*upper*—from the wing of the South American Condor. The units that compose the structure of the wing are perfectly joined, giving the necessary air resistance when the bird is in flight. Body feather—*lower*—of the Emu. In all of the struthious birds, the tiny booklets or barbicels that join to make the firm surface of the feathers of birds of flight, are degenerate or altogether lacking. The result is a soft, delicate plume, with no resisting surface. The double effect in the Emus and Cassowaries is caused by the unusual development of the after-shaft



Left—*upper*—feet of Emu; *middle*—feet of Cassowary; *lower*—feet of Kiwi. The Emu has three toes only, the hind toe having been abandoned as detrimental to speed. The Cassowary also has but three toes, with the inner digit of each foot armed with a greatly elongated claw. The Kiwi still retains the hind toe or hallux, since it depends on skulking habits rather than on speed to escape its enemies. Right—*upper*—Head of Emu; *middle*—head of Cassowary; *lower*—head of Kiwi. The head and neck of the Emu are fully, though thinly, feathered, with a curly tuft on the crown. The Cassowary wears a bony helmet as a protection against the branches and thorns amongst which it is constantly barging its way. The head and much of the neck are bare, the skin being brilliantly colored. In the Kiwi, the base of the beak is surrounded by a number of highly specialized, hairlike feathers which act as feelers.



A flock of sub-adult Emus, from which one of our breeding pairs was derived. The late Keeper George Snyder, who was mainly responsible for our success with this species is seen fondling one of the birds.

Feathers of the Cassowary and Emu photographed to show the similarity of form and the differences in the textures of the barbules. *a*, feathers of Emu. *b*, feathers of Cassowary.

In the more settled districts of Australia, particularly along the eastern and southern coasts, the Emus have been nearly exterminated but in the wild, undeveloped interior of the country, they continue to thrive and undoubtedly will do so for many years to come.

The Cassowaries are the only members of the group of struthious birds that have become adapted to life in the jungle. Their heads are protected from thorns by a heavy casque, and their short, powerful legs are fitted for crashing through tangled bush, rather than for dashing at high speed over open plains. The bare portions of the face, as well as a long, narrow space on each side of the neck, are brightly colored, in blue, red and yellow, the variations in shading being an important factor in the separation of forms. About twenty have been described, ranging from northeastern Australia to New Guinea and small adjacent islands.

The plumage of the Cassowary is much like that of the Emu, having the same well-developed aftershaft. In structure, however, the wing is quite different from those of other struthious birds, the flight feathers being represented by five or six hard, stiff quills. The function of these appendages is not understood, but I have seen an enraged Cassowary scrape his wing quills along a fence, making a loud, rattling sound, which may be the key to the mystery.

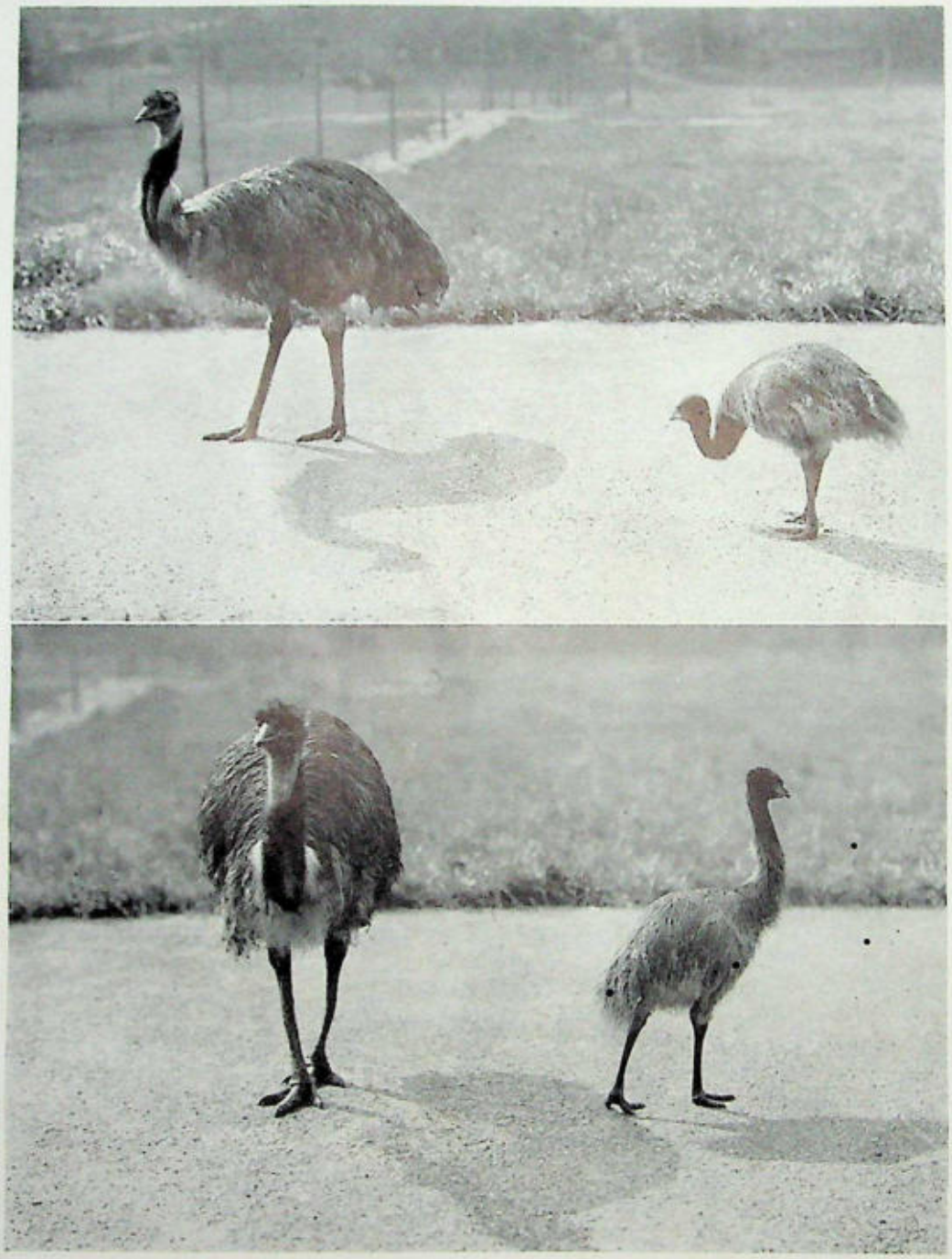
Although wild Emus never see snow even in the most southerly parts of their range, our birds enjoy it immensely, leaping and kicking to show their pleasure. This is our original breeding pair. The female was secured in 1911, the male in 1913. Both are still living.

In the Emu, incubation of the eggs and care of the young are left to the male alone. The eggs are laid in midwinter, and since the incubation period is eight weeks, the chicks are hatched in March or early April. This brood of five is enjoying an outing in the first chilly sunshine of spring.

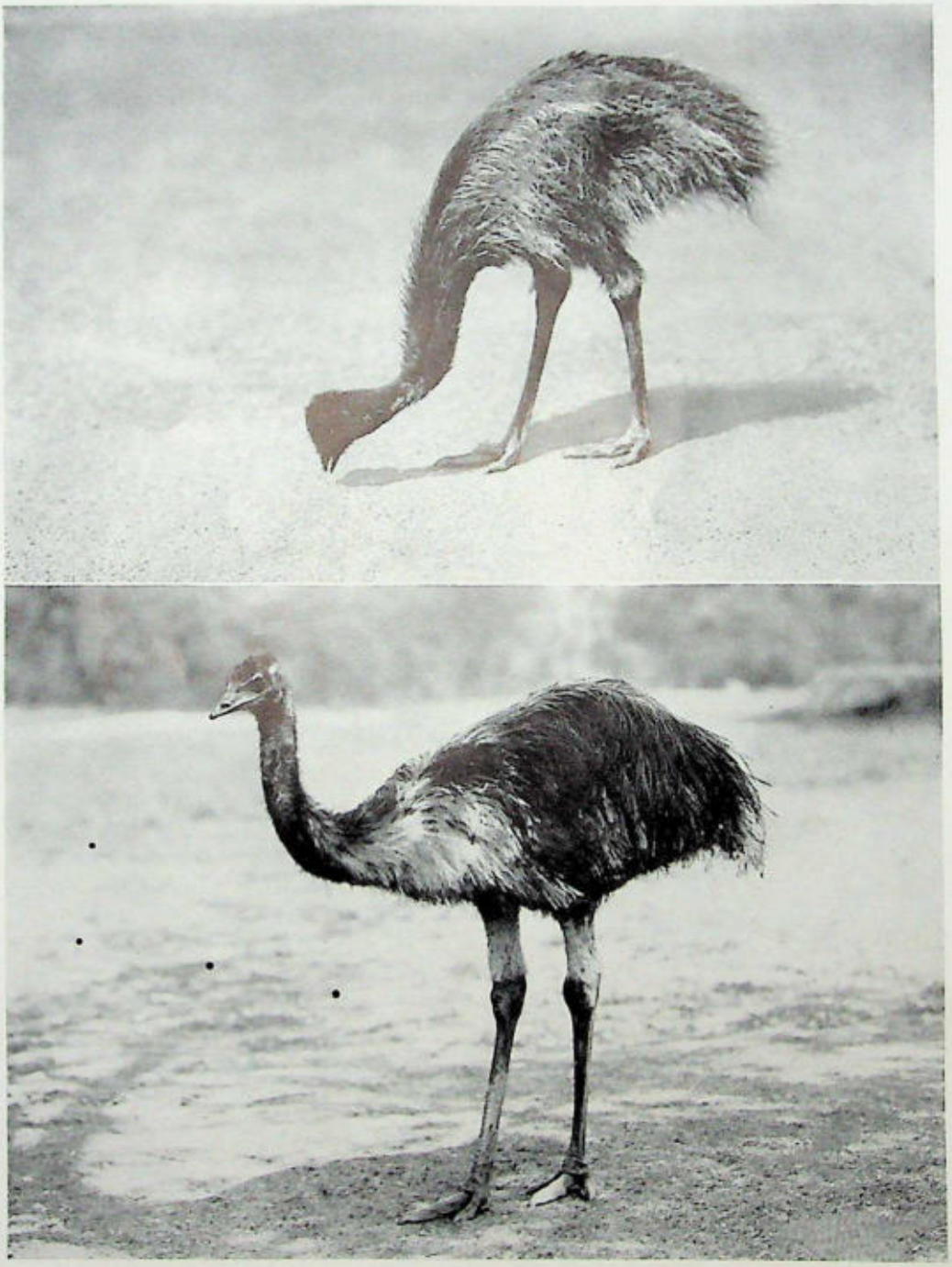
The same brood in midsummer, with the male bird still in charge. The young birds are between three and four months old.

Upper-left—An Emu egg, showing the shell chipped by the imprisoned chick. *Upper-right*—Newly hatched Emu chick. *Lower*—Emu, male parent, with a week-old chick.

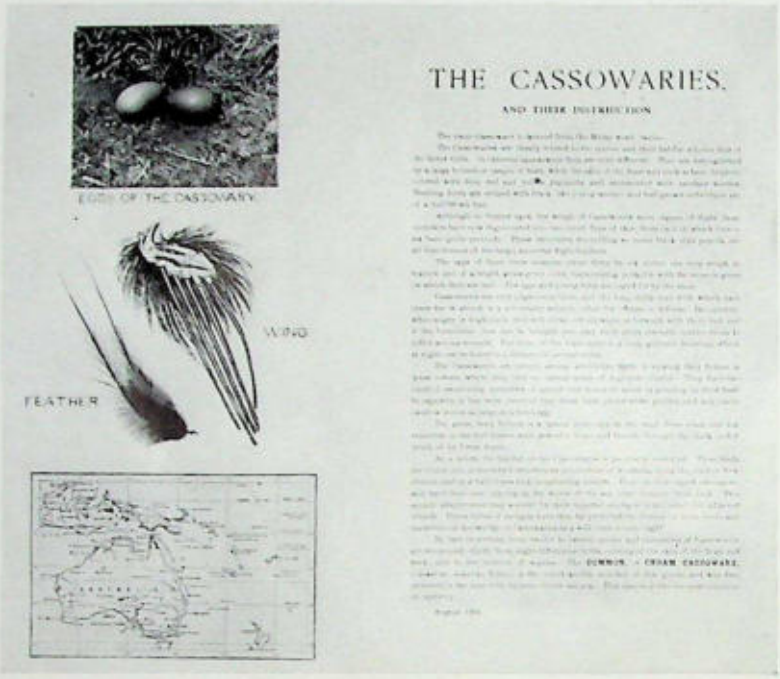
Upper—Emu chick, about three weeks old. *Lower*—Emu chick, about four weeks old.



Upper—Emu chick, three months old. *Lower*—Emu chick, about four months old.



Upper—Emu chick, about six months old. *Lower*—Emu chick, about eight months old, fully feathered but still slim of body.



Cassowaries are fierce, pugnacious creatures, able and ever willing to deliver stunning blows with their powerful feet. Wounded birds are treated with respect by natives in the bush and captive specimens receive watchful consideration from their keepers.

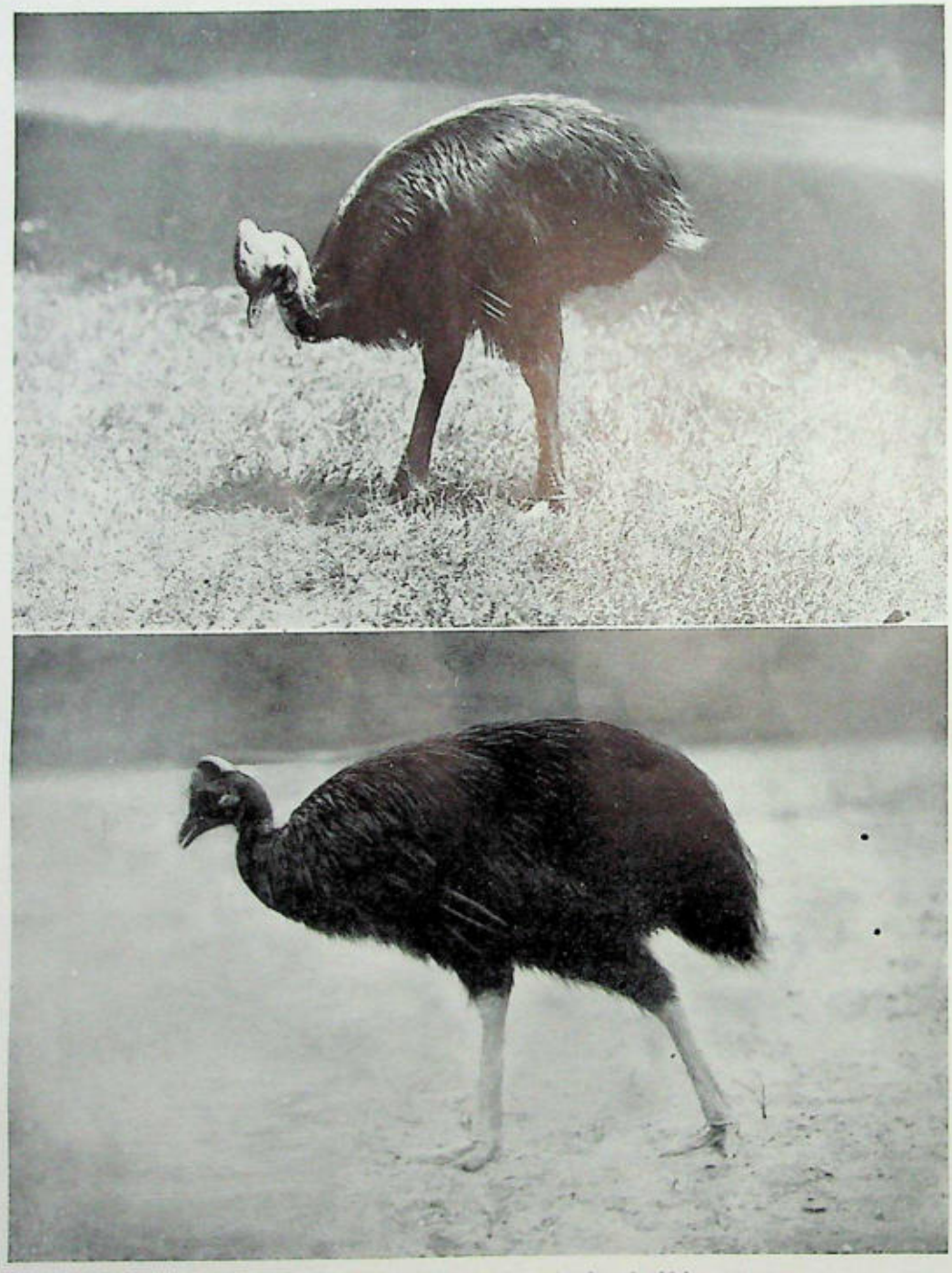
The Kiwis are by far the smallest of the struthious birds, most of the species being about the size of a large domestic fowl. They are further characterized by a long, slender beak and wings so tiny that they are hidden by the hair-like body plumage. The Kiwis are largely nocturnal, and frequent tangled bush and grass country, where they use their sensitive beaks in probing for the earth worms that form the bulk of their food. Their legs are very stout in proportion to the size of their bodies, and are able

Upper—Typical descriptive label, as used in the Ostrich House in the Zoological Park. *Lower*—Wing of Cassowary, showing the curious quills that represent the flight feathers.

The Ceram Cassowary (*Casuarius casuarius*) inhabits the island of Ceram, which lies to the west of New Guinea. It is well known in captivity, so much so, in fact, that it is sometimes known as the "common" Cassowary.

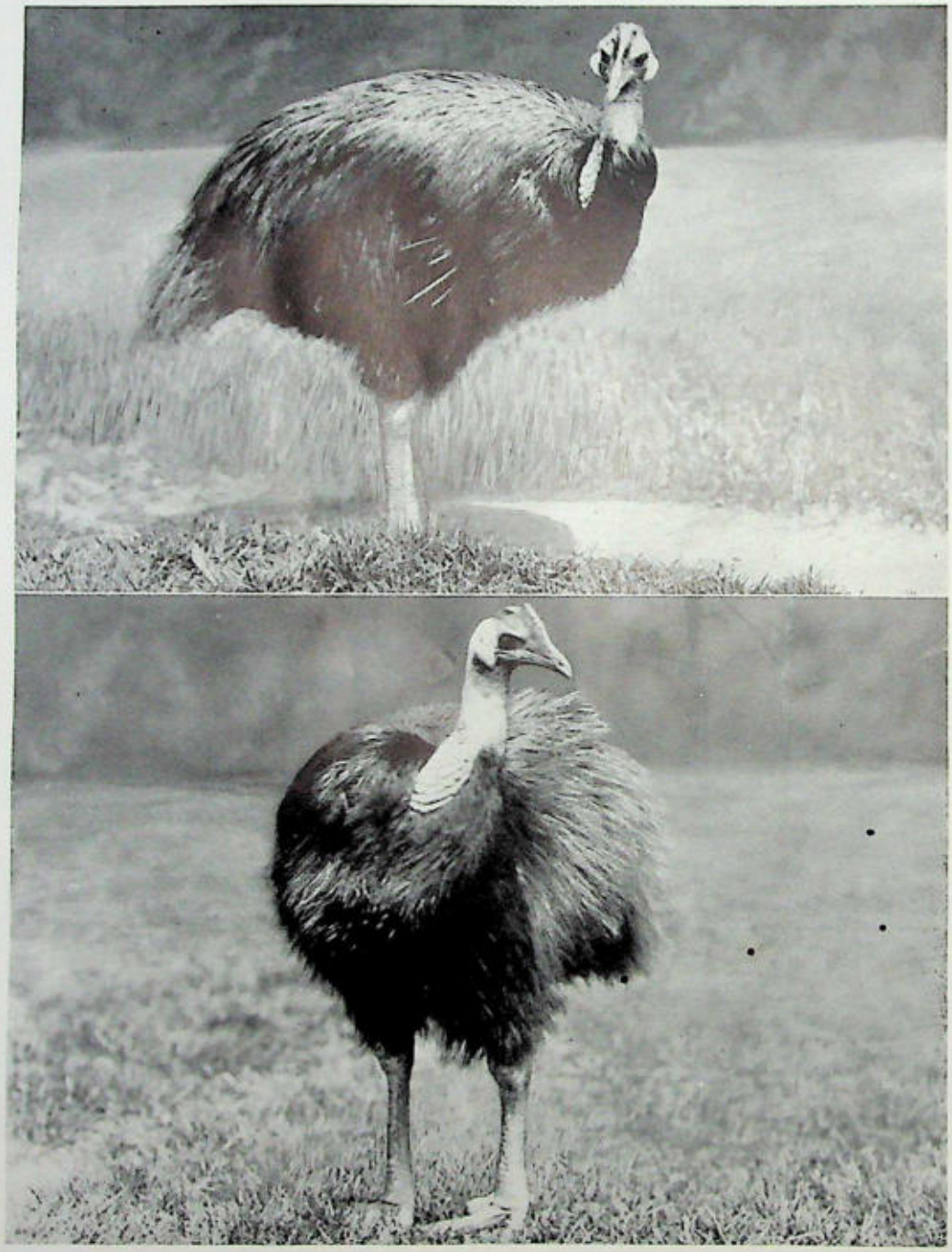
This plate, showing the head of the Ceram Cassowary, has been reproduced from Lord Rothschild's "Monograph of the Genus Casuarius." It shows clearly the characteristic form of the casque, in this species, the bare tracts of the head and neck and the two pendant wattles on the throat, which are highly colored in the living bird. *Lower*—An immature One-wattled Cassowary (*Casarius unappendiculatus unappendiculatus*). In the adult, the casque is three-cornered.

Immature Jobi One-wattled Cassowary (*Casuarius unappendiculatus occipitalis*) from the little island of Jobi, which lies just north of New Guinea.



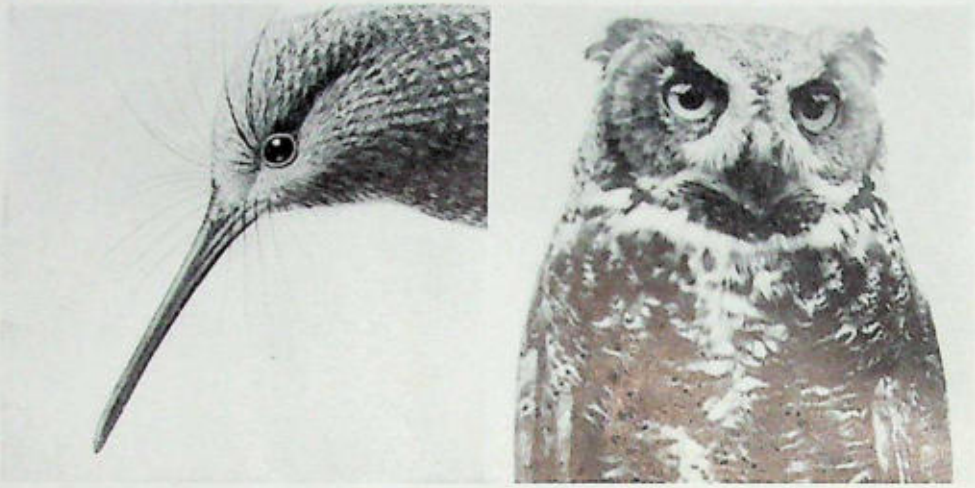
Upper—Fully adult Jobi One-wattled Cassowary, showing the high, narrow casque characteristic of this form. *Lower*—Bennett Cassowary (*Casuarius bennetti*), from New Britain, where it is known as the "Mooruk." The head coloring is dull and there are no wattles on the fore neck.

Two young specimens of the D'Albertis Cassowary (*Casuarius casuarius sclateri*). This is the common cassowary of the coastal regions of southeastern New Guinea.



Two poses of the Papuan Cassowary (*Casuarius papuanus*), from northwestern New Guinea. This is one of the smallest species. It is further characterized by having the nape pure white and the neck wattle represented by a mere button.

The Kiwi (*Apteryx*) is much the smallest of the struthious birds. It is found only in the islands of New Zealand, where it is represented by six species, none much larger than a domestic fowl. Unlike the larger members of the group, the Kiwi depends for protection almost entirely upon thick undergrowth. It usually remains hidden during the hours of daylight, coming forth at evening to probe with its long beak for earthworms. Photograph of a mounted specimen in the American Museum.



Left—Head of Kiwi; *right*—Head of Great Horned Owl. Striking examples of adaptation to nocturnal habits, each bird attaining its object in its own way. In the owl, the eyes are very large, and make the most of the faintest rays of light. They are further assisted by well developed ears. The eyes of the Kiwi are very small, hardly more than beads, but the loss is amply balanced by the hair-like feathers which extend from the face near the base of the beak, and by the delicate, highly sensitive beak.

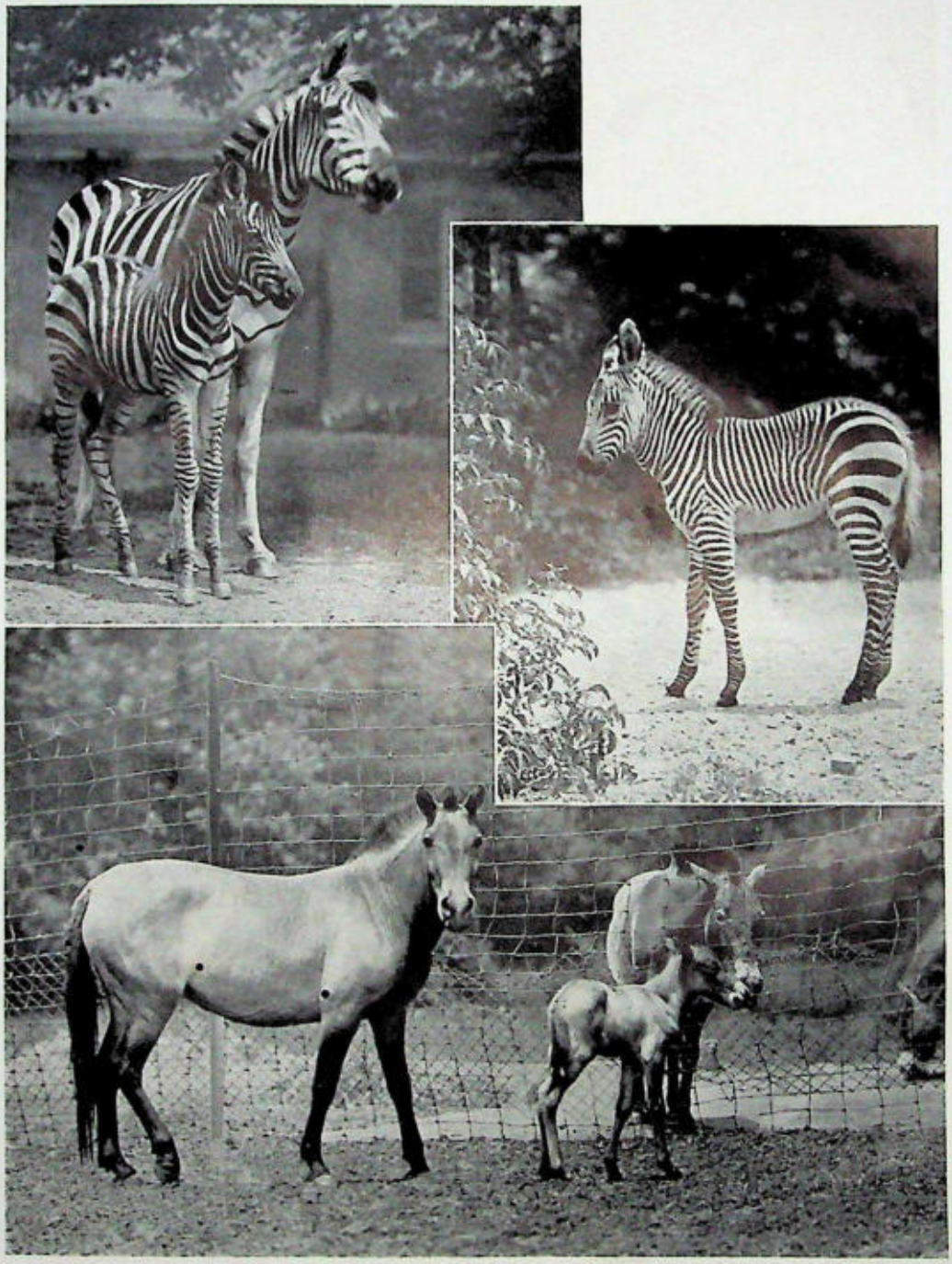
to deliver the vigorous kicks for which the entire group is noted.

The breeding habits of the Kiwis are peculiar, the female excavating a burrow, in which she lays two white eggs and apparently leaves them in the care of her mate.

Dogs and men have reduced the Kiwis practically to extinction, although efforts have been made to preserve them in Government sanctuaries. Six species are recognized, all confined to the various islands of New Zealand.

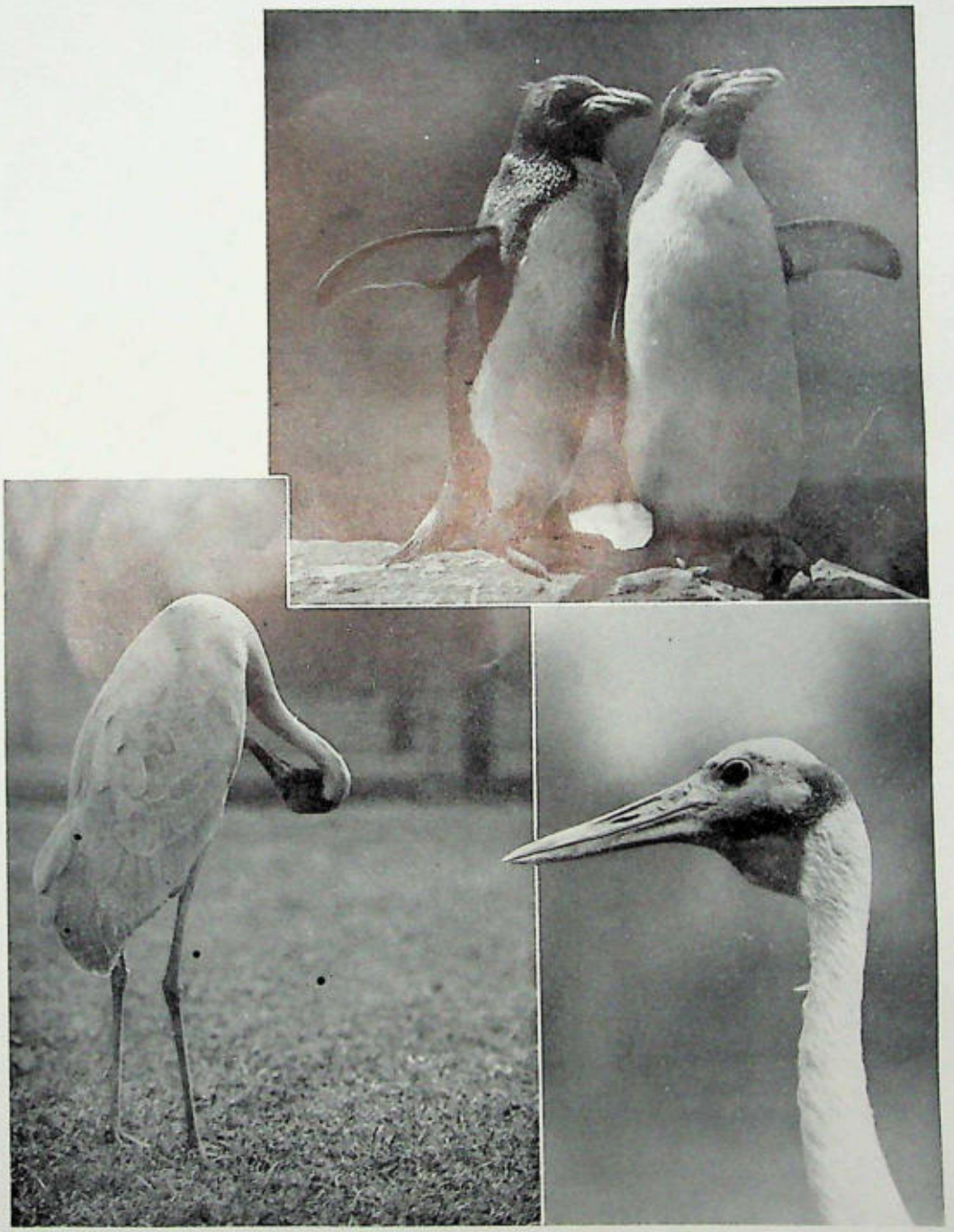
Concluded, September-October Bulletin.

North Island Kiwi, from an old lithograph.

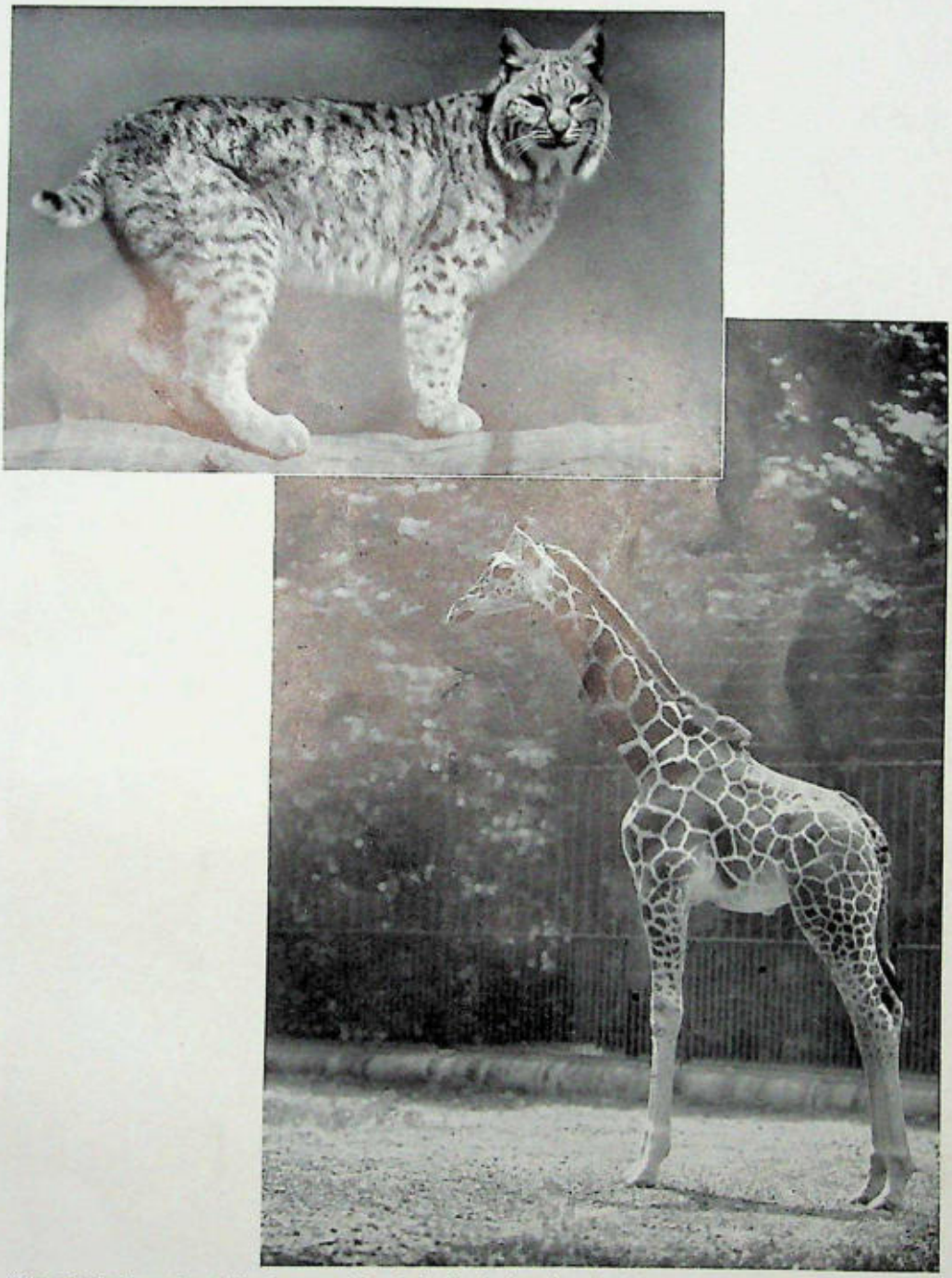


The collections of the Zebra House have been increased this year by the births of a Chapman Zebra, (*Equus chapmani*), May 5, 1929, and a Mountain Zebra, (*Equus zebra*), May 26, 1929. Both of these species have proved good breeders. The pair of Prjevalsky horses (*Equus prjevalskii*), originally acquired through an expedition financed by the Society and carried out through the Hagenbecks have prospered and their progeny still flourish. This young colt was born in 1929. Further information concerning the zebras may be found in the Bulletin for July-August, 1926.

The Greater Kudu (*Strepsiceros strepsiceros*)—*upper*—is a young male specimen recently acquired by the Society. This interesting antelope of the Family *Bovidae*, sub-family *Antilopinae* when fully grown bears long spirally twisted horns and it is marked by narrow white stripes on the sides of the body descending from a similar stripe along the back. The female kudu is distinguished by the absence of horns. The generic name *Strepsiceros* is from two Greek words meaning "twisting horns." The head of the common Iguana (*Iguana tuberculata*) would serve admirably as a model for legendary dragons.

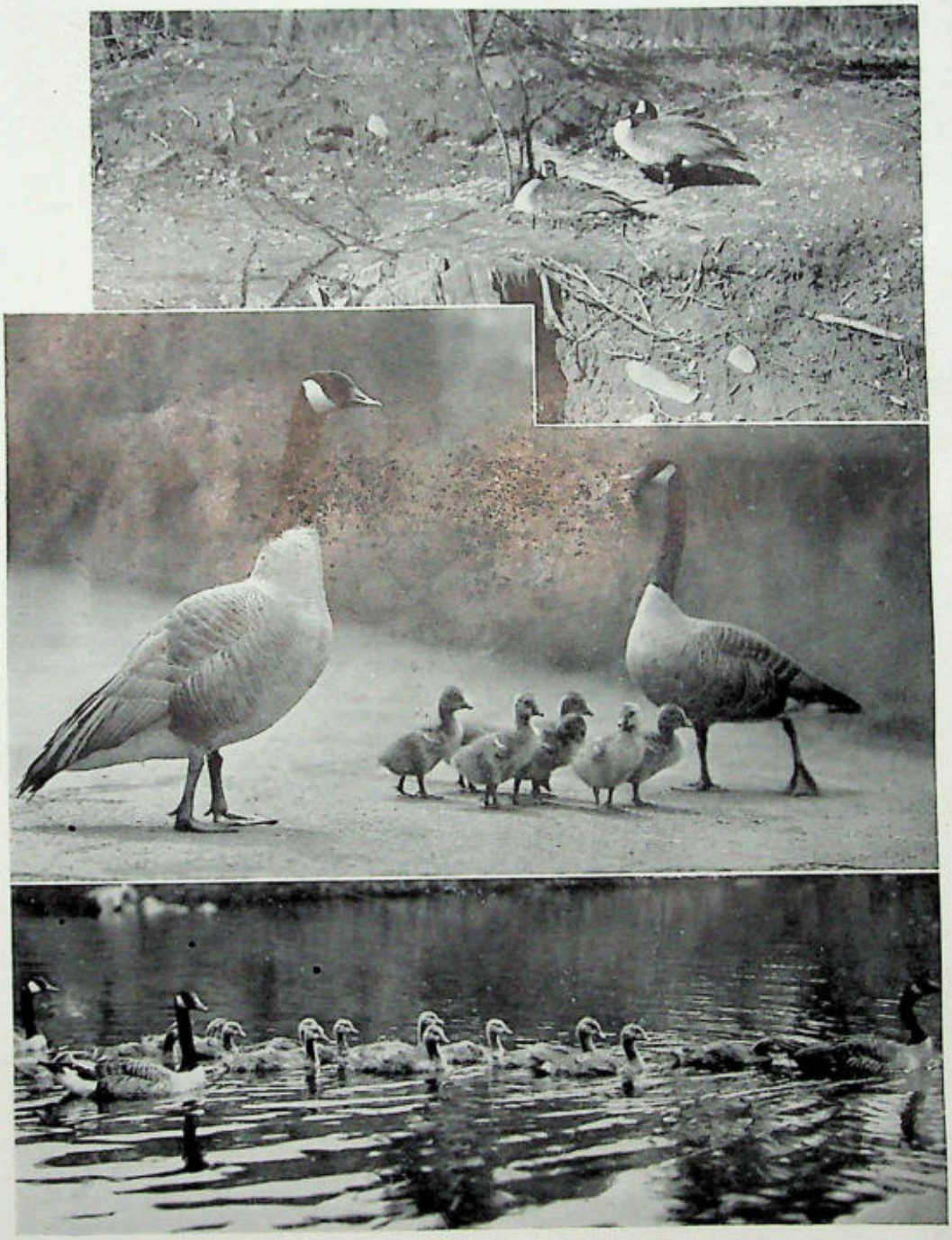


The penguin is a bird to excite the imagination of the most casual observer. Web-footed, flightless with flipper-like wings, legs placed far back, plantigrade feet to enable the bird to sit firmly erect, without quills in the wings and feathers like scales, the penguin is neither fish nor fowl. On the land he is awkward and clumsy; in the sea he is transformed. His anatomical make-up is designed to offer as trifling resistance to the water as the smooth sides of a submarine. He is a living torpedo of graceful speed, flying under the sea as swiftly as a bird in the air. The two penguins shown here are the Golden-crested (*Eudyptes chrysolophus*) called by sailors rock-hoppers and maccaroni. The Australian Crane (*Mathewsia rubicunda*) —*lower*—is found on the great plains of the interior Australia. Its erect, almost human posture, makes it a favorite with lonely sheep-herders who know it as the "native companion."



Two principal species of the lynx are found in North America, the Canada Lynx (*Lynx canadensis*) and the Bay Lynx (*Lynx rufus*), also called Red Lynx, Wild Cat or Bob Cat in different localities. This specimen is the Bay Lynx. The lynx is not regarded as a dangerous animal except when brought to a stand. It is heavily furred and distinguished by a short, stumpy tail. A strictly carnivorous animal feeding chiefly on small ground-dwelling game and occasionally birds.

The Giraffe of the Family (*Giraffidaei*) is an African mammal of the Order *Ungulata*, and the tallest of living mammals; a full grown male attaining a height of sixteen feet. It is characterized by horn-like appendages on the heads of both sexes which are developed before birth. It is a timid animal depending on its highly developed vision to detect enemies and speed to distance them. This young specimen, is a Nubian Giraffe (*Giraffa camelopardalis*) born in the Park in January 1929.



Of the several interesting species of wild geese indigenous to the continent of North America, none is so well known as the Canada goose (*Branta canadensis*). Of its mating habits, there is a pretty legend of the fidelity of the pair, the bond being severed by death only—a constancy unquestionably more common among animals than man. But of its protection and care of the young fledglings there can be no doubt; it is an example of tenderness and devotion that might well be adopted by most humans. When the signal for the southland flight comes upon the wings of approaching winter, and the great flocks rise to the trumpet note of the leader, what manner of man is he who is not thrilled by the majesty of this mysterious call of the wild.

Vol. XXXII. No. 5 September-October 1929

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BULLETIN

NEW YORK ZOOLOGICAL SOCIETY

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1857—1929

PERCY RIVINGTON PYNE was one of that small but distinguished group of men who organized and made possible the New York Zoological Park and later the development of the New York Aquarium.

Mr. Pyne had been a member of the Board of Managers and the Executive Committee since the organization of the Society. He was devoted to the best interests of the Zoological Park and gave freely of his time and money in order that it should come to occupy a worthy place among the many notable scientific, educational and recreational institutions of this City.

He was a man of excellent judgment, extreme modesty, perfect poise and unselfish generosity. His passing is a great loss, not only to the Zoological Society, but to numerous other institutions to which he gave such devoted and distinguished services. W. R. B.

BULLETIN
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Vol. XXXII September-October, 1929 No. 5

Marajo, Wonder Island of Amazonia

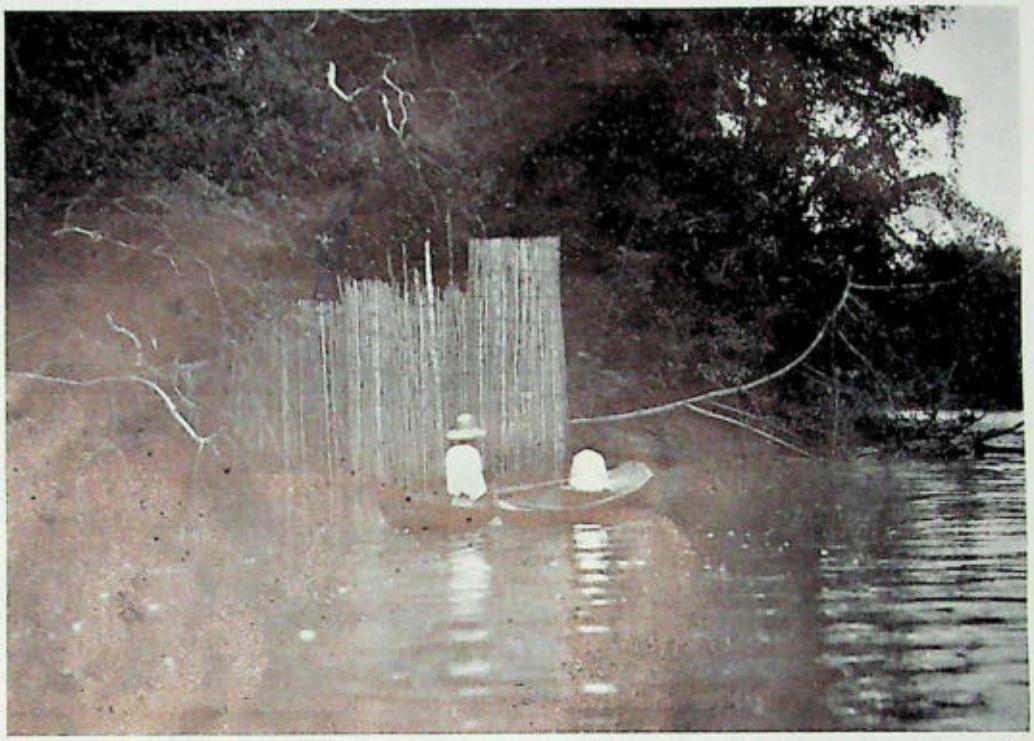
Part II. Review of the fauna, modes of travel and quest for archaeological treasures.

Arthur H. Fisher

Illustrated from photographs by the author unless otherwise noted.

A FEW days after my first reconnaissance of this charming little river, I worked my way farther up stream, and came upon what may possibly be the largest colony of white herons, (*Herodias egretta*) in Brazil. Before I was within half a mile of this colony, I could hear the uproar of the *garças* (their local name) at their nests. When we came abreast of the colony, the tremendous din of their raucous voices was really amazing. Their breeding grounds covered an area of several acres, while the number of nests and birds almost defied anything but a rough approximation. So numerous were the adult birds, that the tall trees looked as though they were in full bloom with huge white flowers, and hundreds that had not yet developed their flight feathers, awkwardly stalked about on the ground. Constantly I would hear the dull thud of some unfortunate fledgling that had fallen or been crowded out of its nest. I saw dozens of these youngsters killed in this way during a few hours, yet it seemed as though they could not possibly be missed in the confusion and bedlam of the mob overhead. Several *urubus*, (black vultures) were in constant attendance on the colony, and no sooner was the sound of such an unfortunate's fall heard, than one of these horrid looking birds would be on hand to seize the victim. They always reminded me of a lot of ghoulish imps of darkness, perched about in hopes that tragedy would bring them fortune. While undoubtedly this type of raptore has its place in the scheme of the cosmos, I must admit to wantonly burning up many a shell on these hideous flying mortuaries, nor have I ever regretted the cost of the cartridges. Anyone who has ever watched them in the streets of South American cities and about the abattoirs, I think will share my feelings toward them.

At this colony I was quick to notice the absence of undergrowth beneath the giant mangue and ciri-uba trees that made up the grove. Upon inquiry I found that the ground under the nests was kept clear in order that the aigrettes shed by the birds during the breeding season could readily be gathered up for market. This heronry is kept protected by the owners of the land, and a watchman is always present during this period to guard against plume poachers. It is only during the breeding season that the egrets develop the plumes so eagerly sought for millinery purposes. At this and one other colony in Marajo, none of the garças is killed for the aigrettes—only the shed plumes being taken. These are



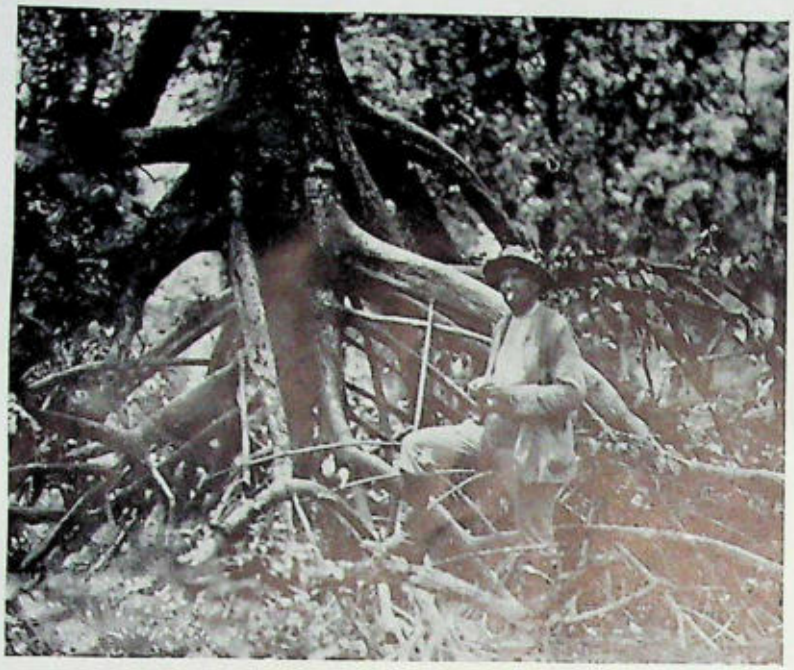
The rivers and streams of Marajo have no real sources, and therefore no downward current. They fill and empty with the tides. The fish-trap shown in the foreground is covered at high tide, which shows how great is this rise and fall, some fifteen to eighteen feet.

sent to Para where they are cleaned and sold in Brazil and those countries where so far there is no taboo on trading commercially in the feathers of plumage birds. It is hoped that Brazil will soon join the list of the countries so wisely allied in the movement for bird conservation.

I spent many days in photographing and studying this wonderful city of herons. Just adjoining this heronry was a large colony of cormorants where I was also able to get a fine series of motion picture studies. Under a small dead tree in this latter bird community, I was quite surprised to find a considerable pile of snail shells of the genus *Ampullaria*. I had frequently noticed these shells on the open campos, in fact had collected several specimens for Dr. Pilbry of the Philadelphia Academy, but the one under this tree had evidently been dropped from above. While I was speculating whence they came, the solution of the problem alighted in a nearby tree—a *gavião de urua*, (*Rosthramus leucopygus*). These interesting hawks are quite plentiful in the Lower Amazon, and have an elongated hook on the upper mandible, something after the order of the Kea, the sheep-killing parrot of New Zealand. I had heard that these hawks fed on snails, using their hooked beaks to tear *Ampullaria* from his portable fortress, and now the evidence was before me.

These smaller rivers or igarapés, such as the Rio Cambu, have no real sources, and therefore no real downward current. This is true of all the streams that lead into the estuary of the Rio Para. They depend entirely on the ebb and flow of the tide, emptying rapidly with a swift current and a drop of perhaps fifteen or more feet. In one of the illustrations will be seen a typical bamboo fish trap, and the great rise and fall of these streams can readily be imagined by the fact that these traps are but a few inches above water at high tide.

After a few pleasant days on the Cambu,



Under the ciri-ubu trees that made up the grove of the rookery there was an entire absence of undergrowth. The space is kept cleared so that the shed plumes could be gathered.

word came from the main fazenda of Camburupy, that a large jaguar (*Felis onça*) had killed a colt the night before, and had been tracked to a teso not far distant. This news seemed to me to spell promise of good sport, and at my request a man was dispatched to get word to the *caçador*, (hunter) to delay the pursuit of the jaguar until we arrived. Jaguars, including many of the black phase, are quite numerous in certain sections of Marajo, and some of the fazendas have one or more experienced hunters. Few of these *onças* are killed with firearms, in fact, there are few rifles owned on the island suitable for such dangerous game. The native method of killing them is both primitive and attended with considerable skill and bravery. These hunters go armed with long spears, on the ends of which are attached double-pointed irons something like a diminutive pitchfork. When one of these big cats is brought to bay, usually with the aid of trained mongrel dogs, the hunter or hunters approach within a few yards of the quarry, which usually trees. They then await the charge. As a rule this wait is of short duration, for once the onça realizes that his retreat is cut off, he hurls himself at the nearest adversary with all the fury and determination of his kind, only to become a dying, snarling mass spitted on a spear. Luck is not always with the hunters, however, and many bad maulings and serious casualties have resulted from encounters with these powerful brutes, far sturdier

This is the largest nesting colony of white egrets in South America. This rookery is protected by the owner of the land and a watchman is always present during the breeding season to prevent poaching.

American egret (*Casmerodius albus egretta*). This is the larger of the two species of white egret found in the New World. It extends from our own southern states southward through Mexico and Central America, to the Straits of Magellan. In the days when trade in egret plumes was permitted, in the United States, the beautiful straight feathers of this species were known as "long whites" as distinguished from the smaller, curved ones of the Snowy Egret.

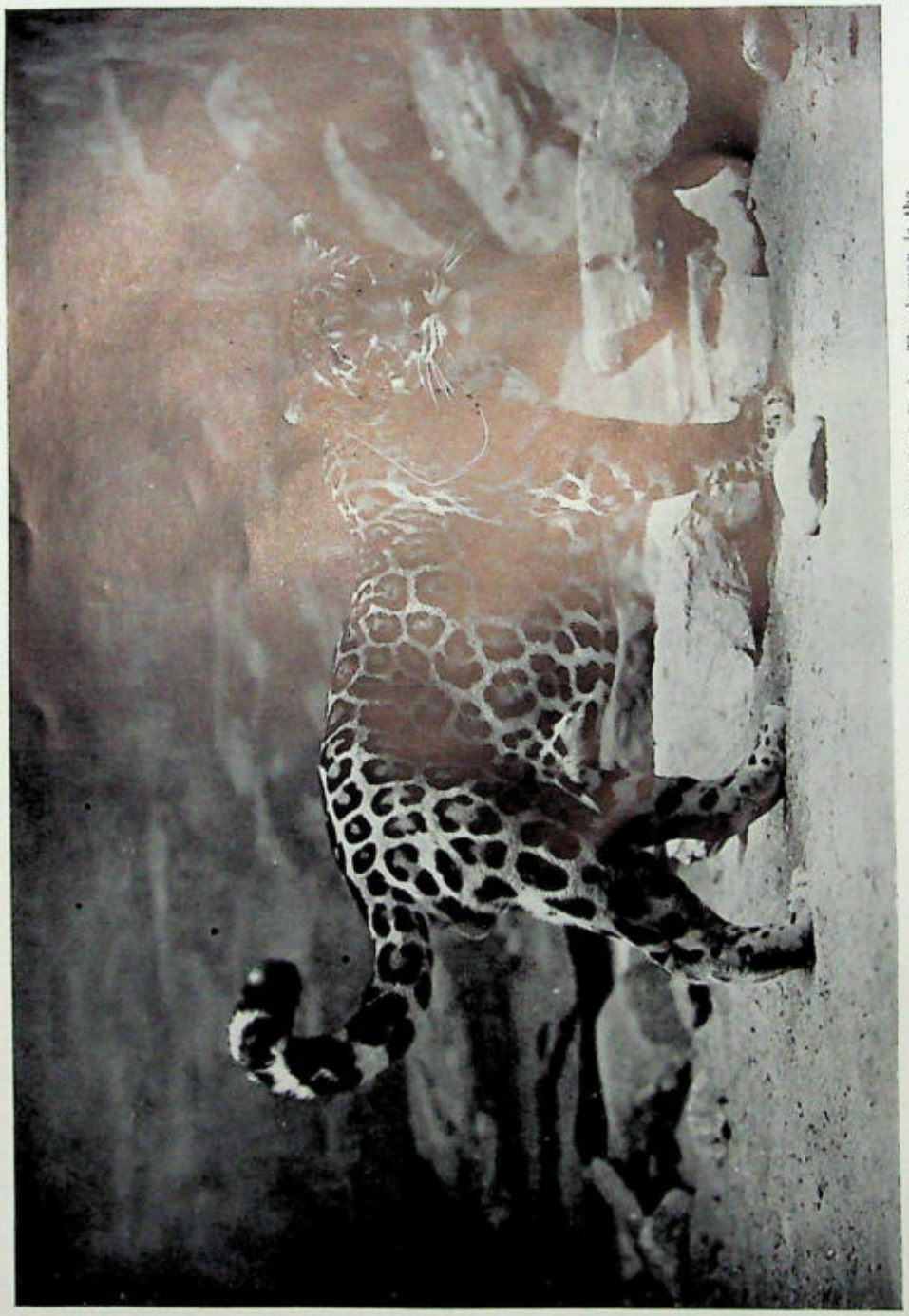
A typical outpost of one of several fazendas which compose the 76,000 acres of land controlled by the Pennas.

and heavier than the largest Indian or African leopards.

We were soon in the saddle, having first loaded the cameras and heavy baggage on a cart pulled by a yoke of oxen, and sent over a more circuitous route to avoid the lower ground. It was slow and hard going, for much of the campos was still under water, and in many places we had to swim our horses. For the greater part of the distance our ponies had to pick their way over wide boggy stretches, often floundering up to their bellies. They never failed to extricate themselves, however, even in the tightest places, and with a knowingness I feel sure only a Marajo cow-pony could show. On the other hand, they undoubtedly would be correspondingly helpless if called upon to do the work of our western ponies in the rocky Bad Lands.

As we rode across the campos, I had visions of making a cinema record with a mild approach at least, to the thrills of lion spearing by the Nandi or the Masai in British East Africa. No such luck awaited me, however, for as we rode up to the main ranch house such thoughts went the way of most day-dreams — a fresh jaguar skin was pegged out in the sun. Our messenger had arrived too late. The onça, a large female, had been shot out of a tree without much excitement. Her cub, a cute little unweaned kitten, had been captured alive. The youngster was presented to me, together with the skull and pelt of the mother. I left it with one of the cowboys

A jaguar trap made of bamboo to capture adult males. It is about fifteen by twenty feet with a small opening just large enough to admit a full grown animal. The males are lured to this trap by the presence of a female jaguar confined in a cage.



The jaguar—*Felis onca*—from a specimen once exhibited in the Zoological Park. The jaguar is the largest of the American cats, and this specimen was nearly the size of the Asiatic tiger. He was a powerful animal and in every way justified the reputed disposition attributed to these great cats. Jaguars are very active swimmers and take to the water readily. They are among the most adept of tree climbers and when the lands of their habitat are inundated, they are perforce compelled to live among the branches of the trees for indefinite periods. Both the jaguar and the tiger seem to relish a bath which is as abhorrent to the lion as to the domestic cat.

The hut of a cowboy in the interior. A strange combination of the primeval—with a touch of tropic climes—and the modern dwelling plucked from a ready-to-erect catalog.

who volunteered to become its foster mother by the bottle route. When I passed through here a few weeks later, I found that my pet had not long survived, which was another disappointment, as many of the jaguars that reach our zoos are reared in Marajo in this manner. Many are taken fairly young, and confined in large cages in which they mature and never leave until they reach the hands of some animal dealer in Para. Quite a number are shipped to Europe in the very cages in which they are trapped as adults.

On another fazenda on the island I was shown the method used to capture adult males. On a thickly wooded teso a tall strong bamboo stockade had been constructed. It was about fifteen by twenty feet in size, and with the exception of a removable section in the rear, the only entrance was a small opening just large enough to admit a full grown jaguar in a crouching position. Within this stockade, a female jaguar was confined, regularly fed by a man detailed as her keeper. Naturally enough, under such conditions she was as savage and morose a feline as I ever expect to see. She was confined in a large wooden cage, and alongside of this was another empty one of about the same size. This female charmer, through no design of her own, was nightly an unwilling siren, luring unsuspecting suitors to possible execution, or at best, imprisonment for life. Once an ambitious swain crossed the threshhold of that small inviting door, the lovelight was to vanish from his eyes, and his wheezy purr of courtship to turn to snarls of fury and then despair. No warning would come to him; only the dull thud of a heavy door that had dropped behind him. With the coming of day, comes his arch enemy, man, to either snuff out his life or drag him away from freedom forever. In the very cage that has trapped him, before another moon has come he may be on his way to menagerie or zoological park. And so among jaguars, as among men, some are fortunate, while many fail hopelessly, tragically in their struggle with "the way of all flesh."

On the fazenda Camburupy, there was quite a herd of wild Indian buffalo, (*Bubalis bubalis*) the caraboa of the Philippines, using the swampy bottoms of the Rio Cajuuna, which flows through the campos at this point. These buffalo were introduced into Marajo more than a century ago, and in certain parts of the island

A herd of wild Indian buffalo on the fazenda Camburupy. They were introduced into Marajo more than a century ago. In certain places on the Island they are wild and aggressive.

they are dangerous and belligerent, particularly toward the whites, as is the case with these animals in their native habitat in the Far East. As a matter of scientific interest, I brought back to the United States a fine skull and horns of this introduced feral stock.

The island of Marajo literally swarms with *jacaré*, (the crocodiles of Amazonia) and every year when the waters recede they are slaughtered in thousands by the natives. It is mostly in the lakes and the igarapés that the larger ones are to be found. I was told that there were some very large ones in the Cajuuna, and I was anxious to try my luck at night - hunting these ugly saurians by flashing their eyes with an electric torch.

Among the cowboys at Camburupy was a husky negro, who I was informed was a "mighty jacaré hunter before the Lord." I was also told that he could imitate the love call of these saurians in a manner that would increase the blood pressure of the most confirmed jacaré bachelor on the island. I asked him to give me a sample of his art, and at once this dusky nimrod let loose an awe-inspiring bellow that seemed to start at his feet and struggle upwards painfully to at last find freedom from out an ivory studded cavity of huge dimension. It might be likened to the grunt of a huge porker, elongated and amplified to the volume of a lion's roar. I was convinced. I failed to see how any upstanding crocodile could ignore such a challenge. I organized a jacaré hunt then and there.

I had in my outfit a very powerful electric torch, capable of considerable throw. Armed with this and an eight millimeter Mauser, I started out about midnight to disturb the tranquility of the Rio Cajuuna. About this hour it was low tide, and the uncovered mud banks offered better opportunity for this kind of hunting. Except for the weird call of the goat-suckers, the stillness of the igarapé was almost unbroken save for the soft swish of the paddle

Among the cowboys at Camburupy, one, Jose, was a mighty jacare hunter. He could imitate with close accuracy the bellow of these great crocodiles.

The piranhas or man-eating fish of Amazonia. This fish, while only from six to nine inches in length, can bite off a finger in a flash. They go in large schools, and a man unfortunate enough to be attacked is sure to be seriously mutilated, and if he cannot quickly escape will be reduced to a skeleton in short order.

strokes, or the sudden splash of an iguana, capivari or other nocturnal creature dropping or diving into the stream as we approached. I sat in the bow, and the negro José with the jacaré voice sat behind me with the torch. In the stern was another boy to paddle. We had worked slowly down the igarapé for a few minutes, when José let loose his God-given gift of crocodilian oratory, but with far less force than during the tryout audition. Then all was quiet. It had sounded quite realistic to me, but then I was not a jacaré, and I wondered whether José had slipped in a false quarter-note somewhere. I am always mildly suspicious of self confessed experts. In a few minutes he gave the call again. This time, a little to my surprise, there came a deep throated reply like an echo out of the darkness, perhaps a hundred yards ahead. José muttered to the "boy" astern and he brought the canoe quietly to rest against the soft bank. Another rumbling grunt, then another came past my ear, and this time the answer was much closer.

"Jacaré grande." whispered José.

"Usa a luz," (put on the light) I whispered back, and the long widening beam of light pierced the darkness ahead.

Just beyond the range of its greatest power, under the shadows of some low hanging branches, two burning red balls loomed up like smoldering embers. The space between them told me that no small "croc" stretched behind these tell tale luminous eyes. José knew his flashlights, directing the beam of light carefully over my shoulder. The jacaré had left the water, and crawled up the bank about three feet from the edge. Carefully lining up the sights, I aimed a trifle below the center of the two fiery bulleyes and pulled. Instantly there was a thrashing of mud and branches and then utter stillness.

"Jacaré morte," snorted José.

Keeping the light ahead, we paddled to where those eyes had vanished. José was right; the jacaré was certainly dead. I had used a soft

brazilian hawk-headed parrot (*Deroptyus accipitrinus fuscifrons*). Among the many species of parrot found in South America, this bird is distinguished by the decorative, erectile ruff of feathers borne on the neck. It is a favorite with the Indians, who frequently rear young birds from the nest, to keep as pets.

nosed bullet, and it had done its work far too well. I found the entire scalp had been ripped off the brute, and the head and shoulders reduced to a mass of bloody pulp, buried in the sticky ooze of the bank.

We pulled the carcass down to the water's edge and it was a fair sized crocodile, as near as I could judge about twelve feet in length. I regretted that I had not used a steel jacketed bullet, for the creature was far too mutilated to make it worth while to take the hide.

Hardly was the bloody carcass at the edge of the stream, and the taint of blood floating on the water, than the body of the jacaré was fairly stormed by hundreds of *piranhas* (*Pygocentries piraya*) churning up the surface of the

Blue-and-yellow macaw (*Ara ararauna*). There are nineteen species and subspecies of macaws, all found in tropical or subtropical America. They range in size from the great Hyacinthine, largest of living parrots, to the tiny Hahn Macaw, smaller than many parrakeets. Many are characterized by brilliant, even gaudy coloration. The present species is one of the finest, being blue above and bright yellow on the lower surface. It is found from Panama to Bolivia and Paraguay.

water, as they ripped at the exposed flesh like a pack of starved wolves. I shuddered to think what these little blood-mad demons of fish might do to a human being, unfortunate enough to fall overboard among them at such a time. I was also careful not to dangle my fingers over the side of the canoe again that night.

After many pleasant days in this part of the island, I started for the north coast and Cape Magoary. Returning by much the same route, I crossed the Rio Cambu onto the fazendas Magoary, one of the largest and most important of all the fazendas in Marajo. These great tracts, stretching from the Rio Cambu to

From an outpost north of the Cambu, we traveled in a large batalao drawn by five oxen. Along an igarape which flowed through the campos, the oxen swam the entire distance.

the cape, are owned by a wealthy Brazilian, Dr. Penna. When I made the purpose of my mission known to him, I was invited to be his guest, and horses, canoes, and men were put at my disposal during my long stay on these lands. Never have I experienced such wholehearted and graceful hospitality as was extended to me by the men in control of this wilderness country.

I made the trip to the coast by easy relays, staying at the various ranch houses and outposts distributed over this enormous fazenda, embracing more than seventy-five thousand acres. With much regret, I had parted with my companions on my return to the Rio Cambu, and with only the guides provided me by Dr. Penna I continued my explorations on the island. For the most of the way to Cape Magoary, I travelled in a large *batalao* (bateau) drawn by five oxen. Leaving a small outpost not far north of the Cambu, we traveled for the first three miles along an igarapé which flowed through an open stretch of campos, the oxen swimming the entire distance. Then we turned north into the vast *aruma-rana* marsh, following certain tracks known only to my chief guide. If you can imagine being towed through the great corn fields of Iowa, with the ground beneath you under about two feet of water, and with about what seemed a million mosquitoes to the square foot, then you may get some idea of this means of travel in these great aruma-rana marshes of Marajo. In many places, and for considerable distances, the oxen dragged the heavy batalao across practically waterless sections of the campos. At other times we were compelled to stop when one or more of the oxen became enmired. Several times it looked as though these patient beasts were hopelessly stuck in the deep ooze. Somehow, however, they always struggled free with the help of the other oxen and urged to greater effort by the shouts of the riders and wicked jabs in their rumps by the long pointed poles carried by the men as persuaders. To me it was wonderful how the men guided these awkward beasts through this wilderness; even more wonderful

In many places the campos was under water and for the greater part of the way our ponies had to pick their way over wide, boggy stretches. They never failed to extricate themselves, however, in the tightest places.

how our guide could find his way through the twisting, winding paths, the towering arumarana shutting out the view in all directions. Later on we came out of this high growth, and passed over long stretches of more open campos, but still following winding paths, made by small igarapés which wormed their way across the prairie.

Although we were traveling almost under the equator, and my only head covering a light felt hat, I did not experience the slightest discomfort from the sun. There was a constant breeze in the afternoons, and with so many things to hold a field naturalist's attention and interest, I was hardly conscious that I was fast acquiring a heavy coat of tan. Strange as it may seem, Brazil is the only place on the Equator where heat prostration, or so-called sun-stroke is a thing unknown.

Large flights of duck, *marrecas*, were constantly rising as we approached, sometimes in such numbers as to almost blot out the sun. They would make but short flights, however, and then settle in long regular rows with almost the same precision as the famous West Point line. Here and there large jabiru storks dotted the landscape, and as we slowly made our way through the narrow channels, hundreds and hundreds of wild cattle would gallop off across the campos, then wheeling about in groups, stand and gaze stupidly as we passed. Often we would see considerable numbers of *capivari*, those giants of the rodent family, feeding over the open country in the early morning and late afternoon. Always there was a wealth of bird life in great variety, while overhead long flights of scarlet ibis and egrets were nearly always in view.

For quite a while I made my headquarters at Jilva, the main fazenda of these Penna estates, and from here made many excursions in canoe and on horse back, collecting natural history material. My first trip to the seaboard of the island was to one of the Penna outposts at the mouth of the Rio Pacoval. It was about two hours canoe trip from Jilva by way of this

The baggage was sent across Lake Guara in dugouts. Instead of by yoke, the oxen were attached to the canoes by means of a rope fastened to their tails.

large igarapé, and in many respects even exceeded the Rio Cambu in beauty and wealth of aquatic bird life. As we made our way along its course, we were literally surrounded with jacaré large and small. Never in a single stream have I seen so many of these ugly saurians. I put well placed bullets in two very large ones, but both sank in deep water beyond recovery at the time. The following day I found one of these, about thirteen feet in length, washed ashore near the mouth of the igarapé. It was worthless as far as taking the skin, however, for the black vultures had made their usual feast and devoured the entire tail.

When we reached the seacoast outpost, Santa Ignez, at the mouth of the Pacoval, instead of being greeted with the bracing air of the broad Atlantic, an almost overpowering stench of fish hammered my olfactory nerves. It was not difficult, however, to locate the reason for these offending and far reaching aromas. They rose heavenward from thousands and thousands of fish, drying on long narrow platforms under the burning rays of the sun. From here and similar stations along the coast, countless tons of these dried fish are shipped annually for native consumption. Dried fish and *mandioc* (*farinha*) are the staple foodstuffs of the natives throughout the entire Amazon Valley, where the rivers and streams fairly swarm with a supply of fresh edible fish.

The unromantic odors of this important industry were somewhat leavened by the marine picture that stretched before my eye, as more than a hundred of the fishing fleet from far distant Vigia on the southern mainland, were operating off shore. Walking up wind along the beach, I was soon away from the smell of drying *Gurijuba*, *Purimutaba* and *Bagre*, and experienced the truly novel sensation of a fresh-water bath in the Atlantic Ocean. I was also much surprised at the utter absence of marine shells always to be encountered in more or less degree along a similar strand. Then I realized that here, the mighty sweep of the Amazon's waters was denying such mollusks their necessary saline environment.

On arrival at Lake Guara, we were obliged to swim our horses for nearly a mile. The lake received its name from the great nesting colony of scarlet ibis, locally known as guara.

On my excursions out from Jilva, I saw many types of the island's wealth of animal life, including giant anteaters, small arboreal prehensile tailed ant-eaters and porcupines, howler monkeys and marmosets, ocelots, coati-mundis, the South American cousins of our raccoons, and many other interesting mammals, and a wealth of reptile life, but I was not fortunate enough to run across an adult anaconda, though Marajo is famed for the number of these giant snakes taken there. Somehow, I feel that the granddaddy of this reptile is hiding somewhere on this island, and on my next trip I expect to make a strong effort to bring him back to the Bronx.

After considerable stay in and about Jilva, I was unsuccessful in my search for archaeological material, and so headed farther inland to a point called Macacao, where I was to spend many most uncomfortable but happy days, for it was here I took from the ground one of the four important collections now existing in museums, of the wonderful pottery left by the prehistoric races mentioned earlier in this account.

On my way to Macacao, we crossed a fair sized lake known as Lago Guara, which received its name from the fact that here is located the greatest nesting colony of scarlet ibis, (locally known as *guara,*) known to exist in the North of Brazil. In the evening I have seen strings of these beautiful birds more than two miles long, returning to their nests from their feeding grounds on the coast. Any attempt to estimate the number of these birds using this locality seemed to me hopeless. The small trees and growth that lined the shores of the lake seemed to be constantly in full bloom with brilliant scarlet splashes, and the effect of it all under the blue of the tropical sky made a picture never to be forgotten.

In the midst of a great aruma-rana swamp, some three miles from the lake was the teso of about two acres in extent, known as Macacao. In order to reach this lonely spot, I was compelled to secure riding oxen from a fazenda a

Along the shores of Lake Guara, the trees and bushes fairly bloom with countless numbers of scarlet ibis. This is the largest rookery in North Brazil.

few miles distant, since these are the only animals that can make their way through many of these marshy places. They do not lose their heads when enmired, and their splayed hoofs spread, and then contract when withdrawn from the gripping ooze. On this little "island" in the swamp lived a negro, named Seabra, his wife and three small children, the eldest about ten. Only Seabra and this boy, knew the way into Macacao. With the tow-lines of two canoes attached to the tails of two of the patient bovines* I had secured, we made our way to this teso, and I was given the guest chamber in a tiny three roomed, mud-walled, and dirt floored hut. This I shared with a native assistant. Here for many days I lived on a meagre diet of fish and farinha, leavened occasionally with a duck or scarlet ibis, or marreca eggs brought in from the marsh by the boy. The last clutch of these eggs I passed up when I discovered they contained well developed embryo ducks, but Seabra and his tribe ate them with great relish.

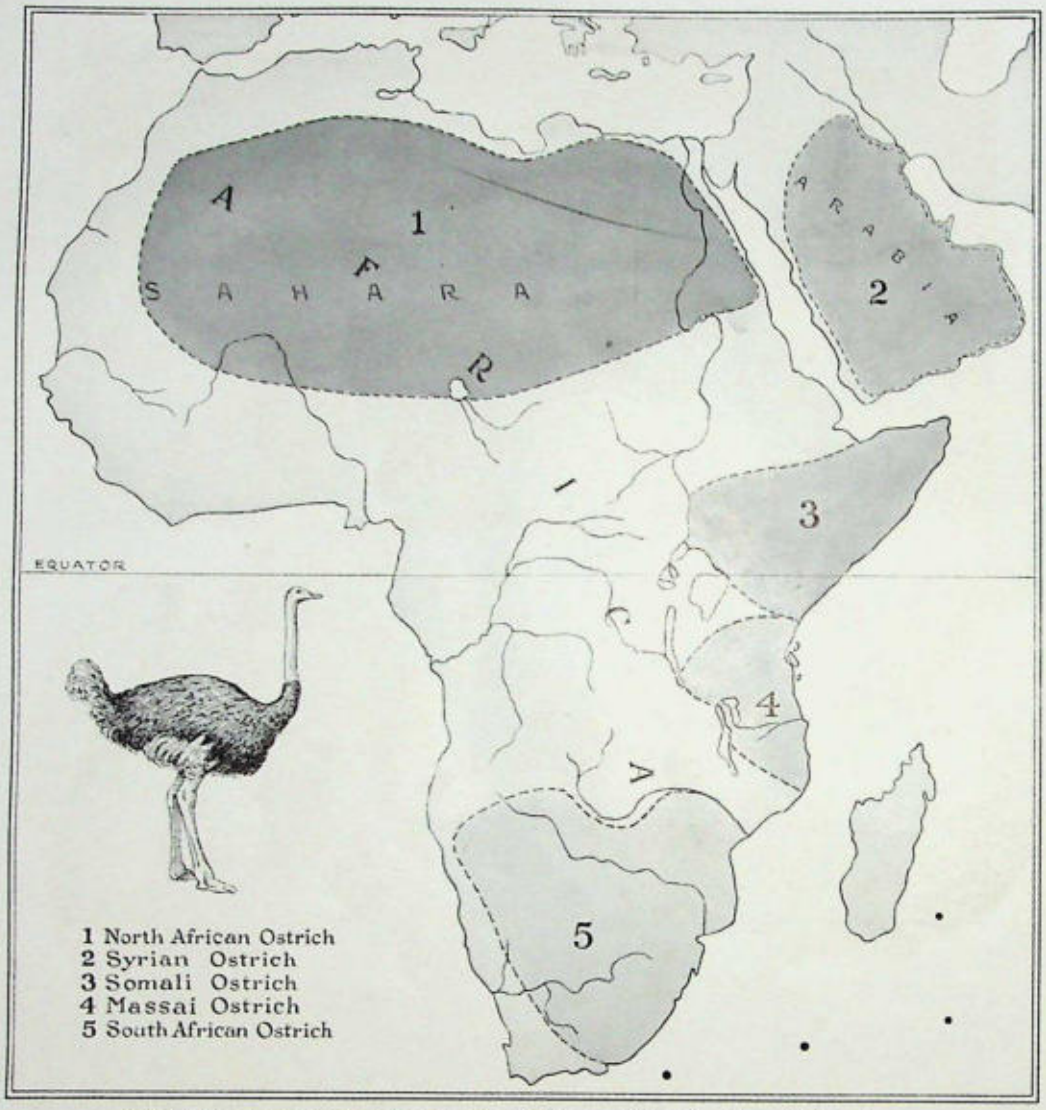
Strange to say, there were no mosquitoes here between sunrise and sunset, but at 6:10 P. M. they invariably arrived on schedule and in such numbers that one's hammock and *mosqueteiro* (mosquito-bar) was the only recourse. I shall never forget the nights at Macacao. Several pigs were given sanctuary in a hut at night, for if they were left without, they would be devoured by the jacaré that nightly paraded across the teso. Three mangy mongrels were also nocturnal tenants. No taxis were available, so the oxen, our only means of escape, were well secured in a corral. And so each night with the setting sun I sought early repose, while the children cried with colic, the pigs fought for desirable space on the floor, the dogs whined or barked, the oxen bellowed

* I had previously found that this is a common practice and means of transportation in Marajo. It usually works quite well, but it would certainly never get the approval of our S. P. C. A., for not infrequently an ox loses his caudal adornment unless the line breaks under an overstrain.

The beautiful and brilliant Scarlet Ibis (*Eudocimus rubra*) is no longer found in the United States except possibly for solitary individuals. In color it is one of the most beautiful of the scarlet plumaged birds. On Marajo Island it breeds in hundreds and it is found also along the mouth of the Orinoco and on the coast of Northern South America. In captivity the color fades gradually, which probably is due to the lack of certain foods obtainable only in the habitat of the birds.

in the corral, and above it all the continual zoom of the *caripana* (mosquitoes) swarming about my hammock with hypodermic intent. Yet with all these discomforts, I was happy indeed, for each day brought new treasures of the past from the black soil of the teso. Yes, these were the last and happiest of my days at Marajo, for here I met with success far beyond my dreams. And now I wish again to return to this wonder island of the Amazon, where in a short while Noah could have loaded his Ark below her summer marks.

Upper—Cleaning pottery taken from the ground at Macacao, Marajo. *Center left*—Bird-shaped redware jar with human face in relief and red painted decoration. *Center right*—Large bowl with fluted rim, black and red painted decoration. *Lower*—Oxen attached to a batalao hauling the pottery through the aruma-rana swamps, Macacao.



Sketch-map showing the habitat of the Ostriches. It is intended solely to give a general idea of the distribution of these birds.

The Struthious Birds

Part II. The Ostriches and Rheas

LEE S. CRANDALL

Illustrations are from photographs made in the Zoological Park unless otherwise noted.

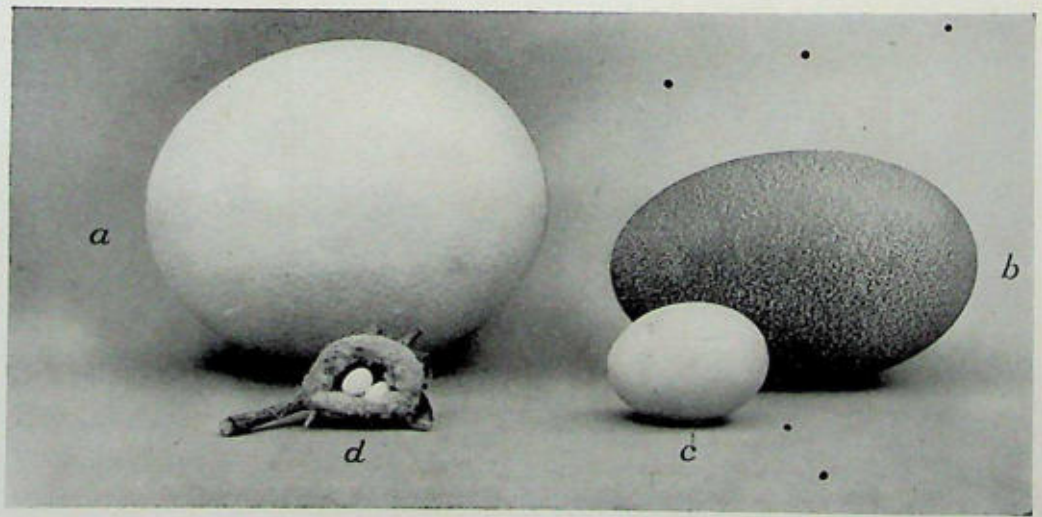
The Ostriches, of course, are the largest of living birds, a fully adult male often reaching a height of eight feet or more and a weight of three hundred pounds. Five forms are generally recognized, extending from the deserts of Syria and Arabia, over the open country of northern and eastern Africa, almost to the Cape. The differences are slight, chiefly those of size, and variation in the color of the neck and legs. The adult males of all are black, with white wings and tail, while the females are uniform gray.

In the soft, loose plumage of the Ostrich, the tiny hooklets or barbicels, which cause cohesion

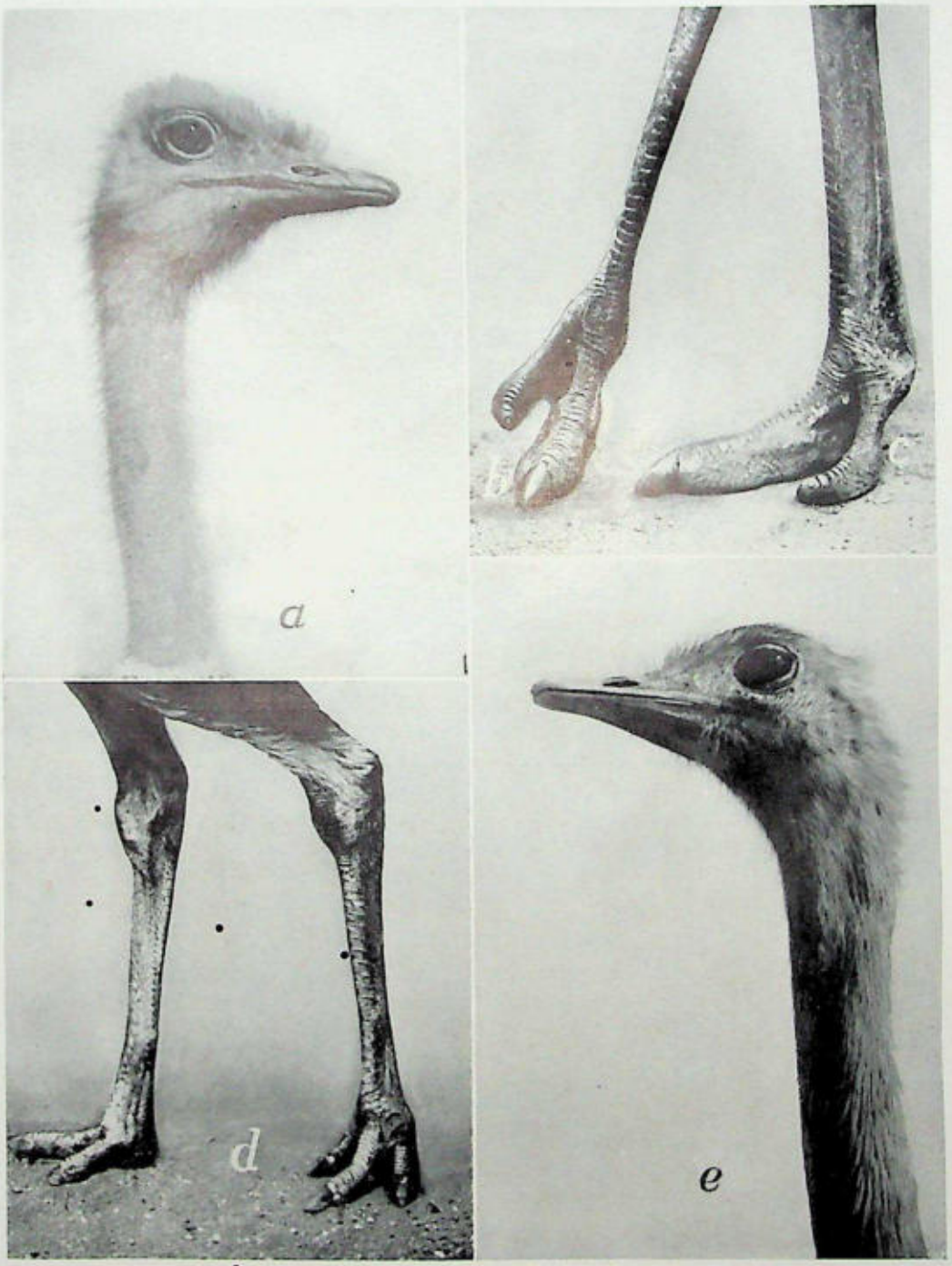
Flock of North African Ostriches (*Struthio camelus*) on their range in the Zoological Park. The male, a splendid bird, came from one of the California farms in 1918, the year that marked the final breaking up of commercial plume-growing in America. The females were secured in 1919, from the ill-fated ostrich farm at Bloomsburg, Pennsylvania.

Development and growth of an ostrich feather.

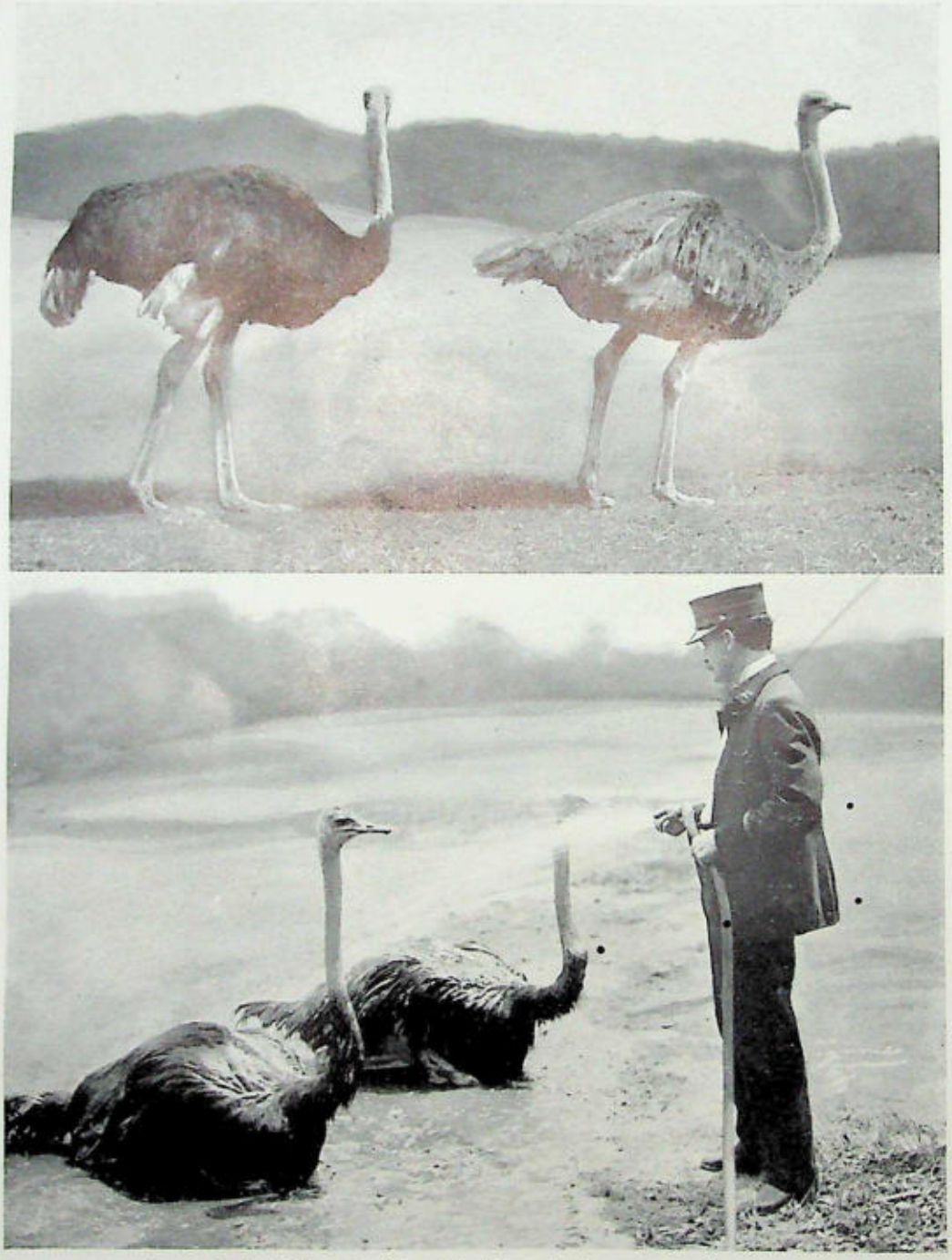
in normal feathers, are degenerate or altogether lacking. However, there has been a gain in the direction of beauty, for few things in the world are more lovely than an ostrich plume. The finest feathers are those borne in the wings and tail of cocks, and they have been sought as ornaments from the very earliest times. In the latter part of the past century, this demand resulted in the development of farms devoted to domesticated ostriches, chiefly in South Africa. The new industry grew with great rapidity and at its peak earned an income of many thousands of pounds annually. However, the resulting abundance of ostrich plumes eventually defeated its own purpose, for fashion finds no delight in things that are common. The graceful, drooping feathers soon became unsaleable and the great birds that bore them were slaughtered by the thousand. Their owners pocketed their loss and turned their paddocks into sheep runs. Already the natural reaction is taking place; small ostrich feathers are appearing on hats in the exclusive shops of Paris and New York. No doubt the curious race between fashion and industry will be run again, with the victor never in question.



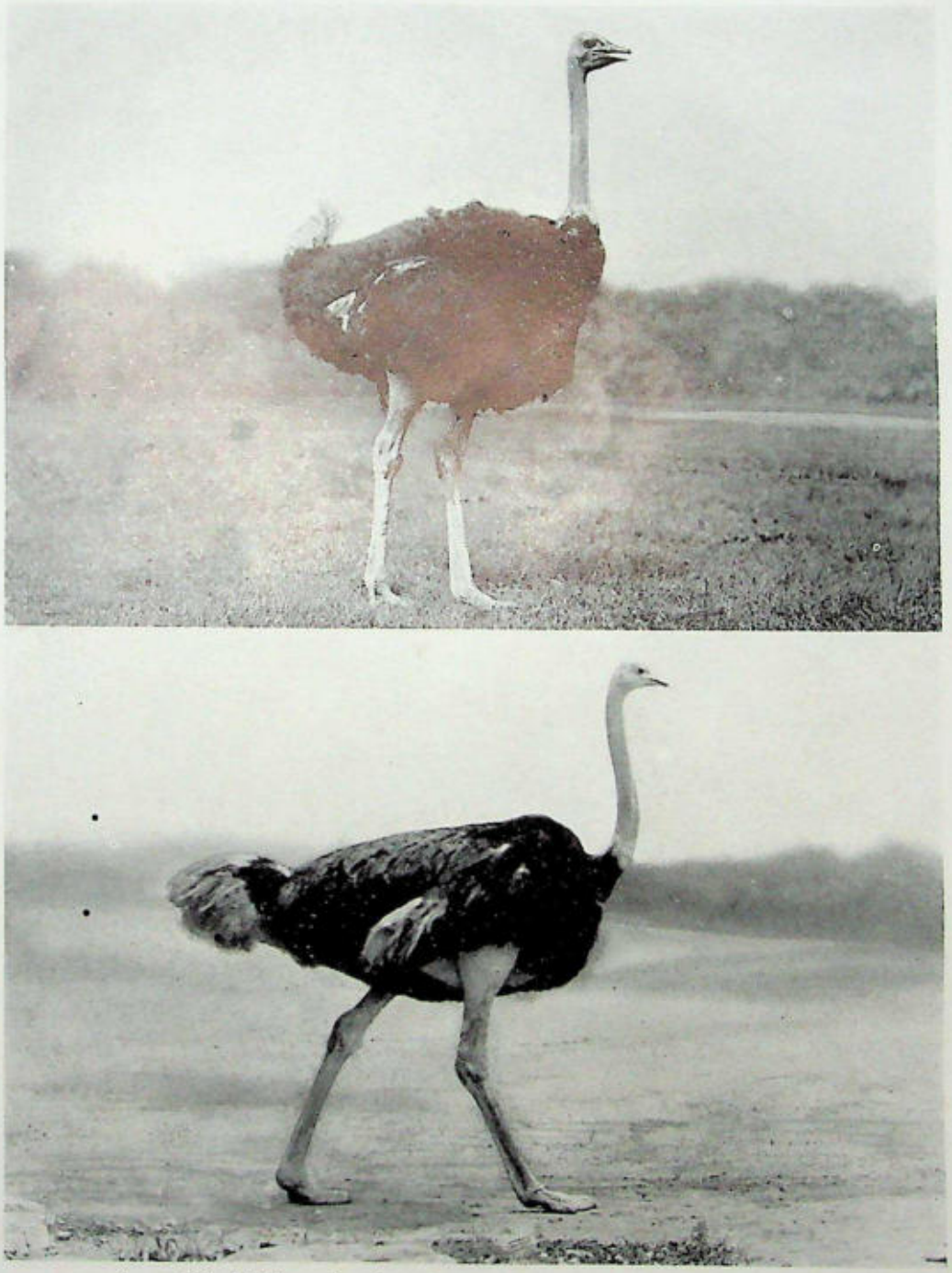
Comparative size of eggs of *a*, ostrich; *b*, cassowary; *c*, domestic fowl; *d*, hummingbird. The egg of the ostrich weighs from three to four pounds and its capacity is equal to about twenty fowl eggs.



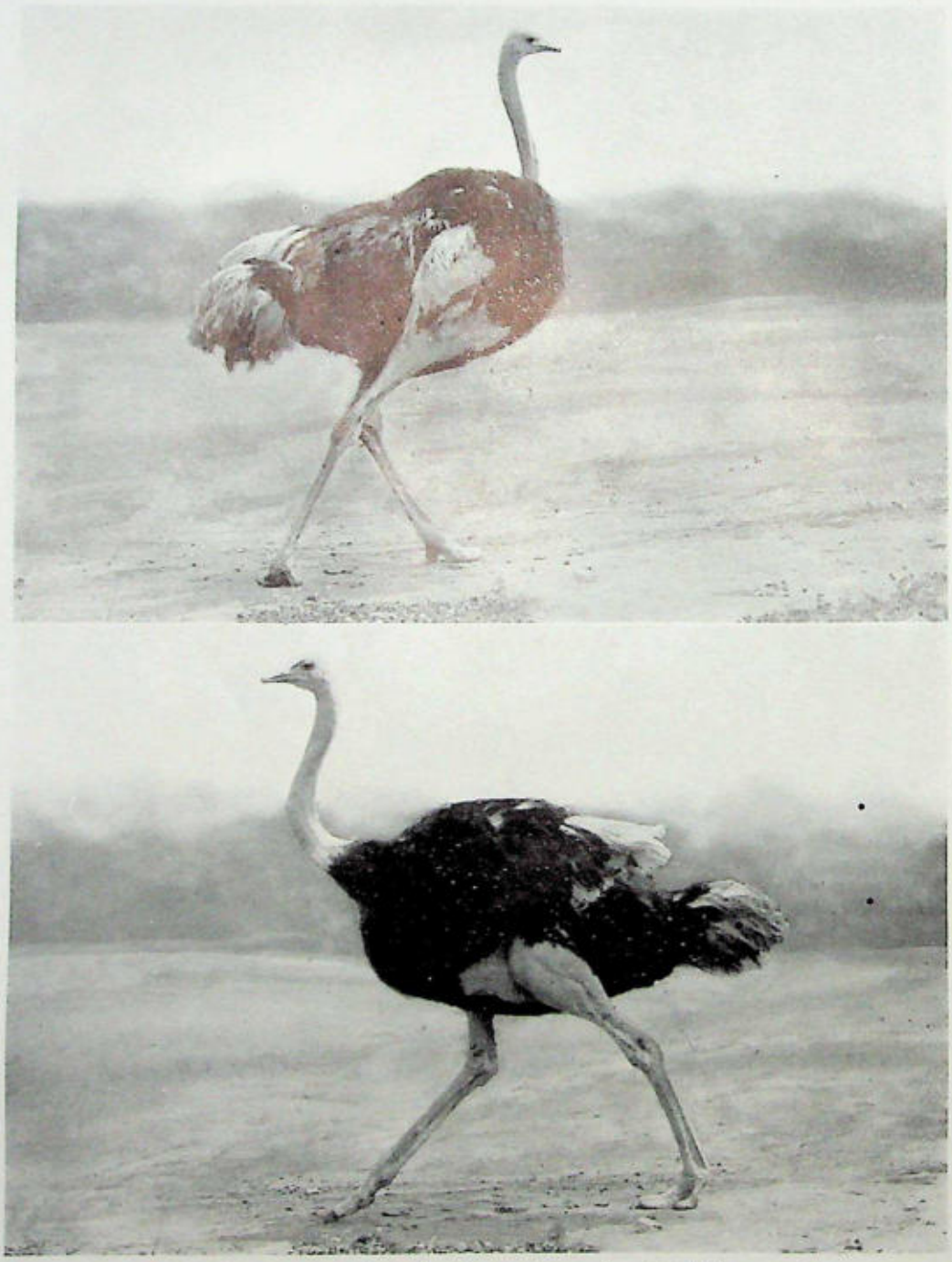
a, Head of ostrich; *c*, Head of Rhea. The small brain capacity and well developed eyes are striking characters. *b*, position of ostrich's foot in running, the weight being carried chiefly by the middle toe. *c*, standing position, in which a portion of the weight is supported by the outer toe. *d*, feet of rhea. While three toes are still present, the middle one is of greatest importance.



Upper—South African Ostriches (*Struthio australis*). The male—*left*—is distinguished from his mate by the black body plumage, with white wing and tail plumes. The adult female is a uniform dark gray. *Lower*—South African ostriches enjoying a shower bath. Because of the soft, loose character of the plumage, it offers no resistance to water and the birds quickly become thoroughly soaked.

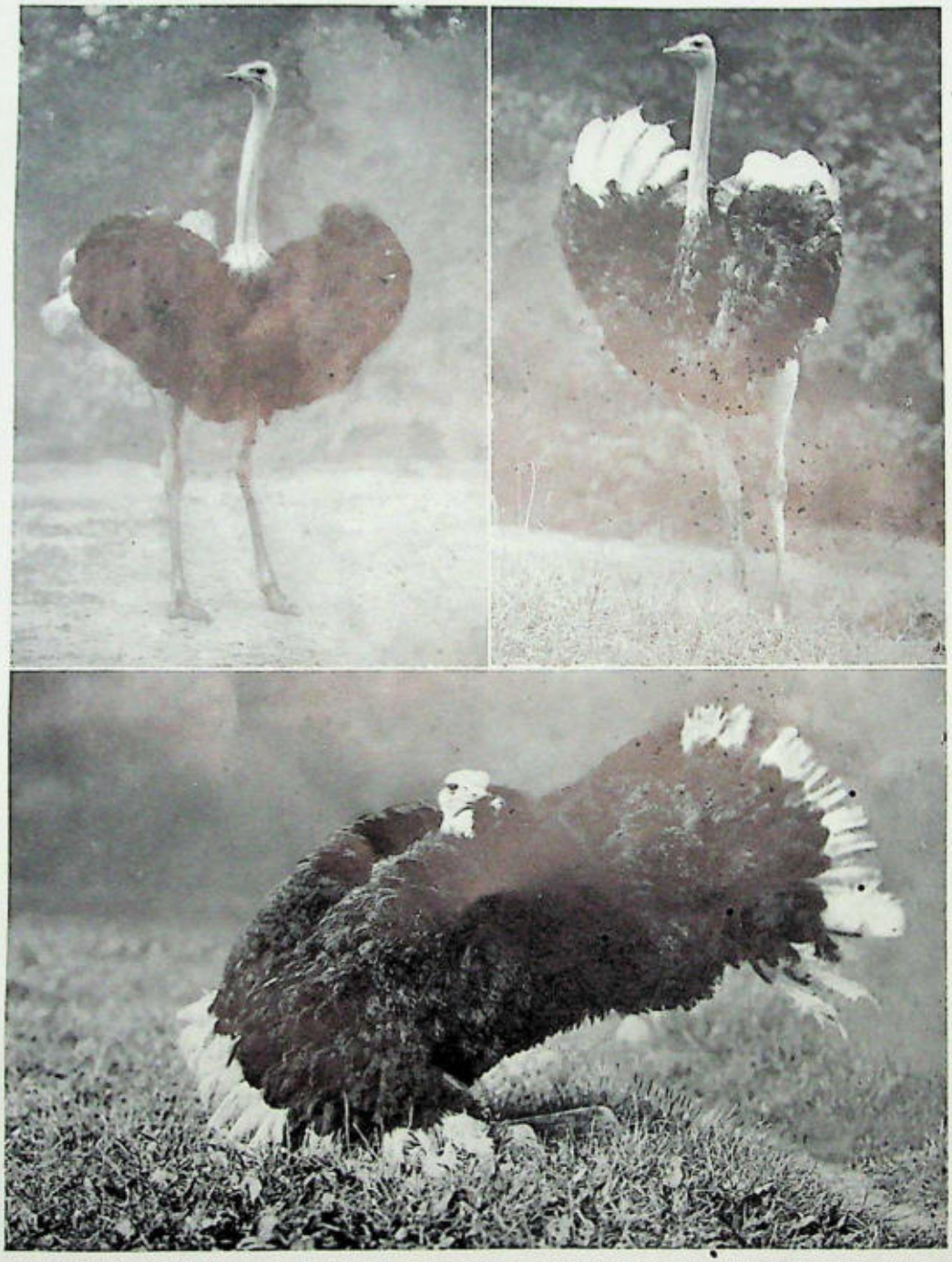


Upper—Male ostrich on the alert. In the wild state, no creature is more difficult to approach or stalk. *Lower*—Although a dangerous antagonist when cornered, the ostrich prefers to escape his enemies by running. Even when walking, as shown above, the stride is long and graceful.

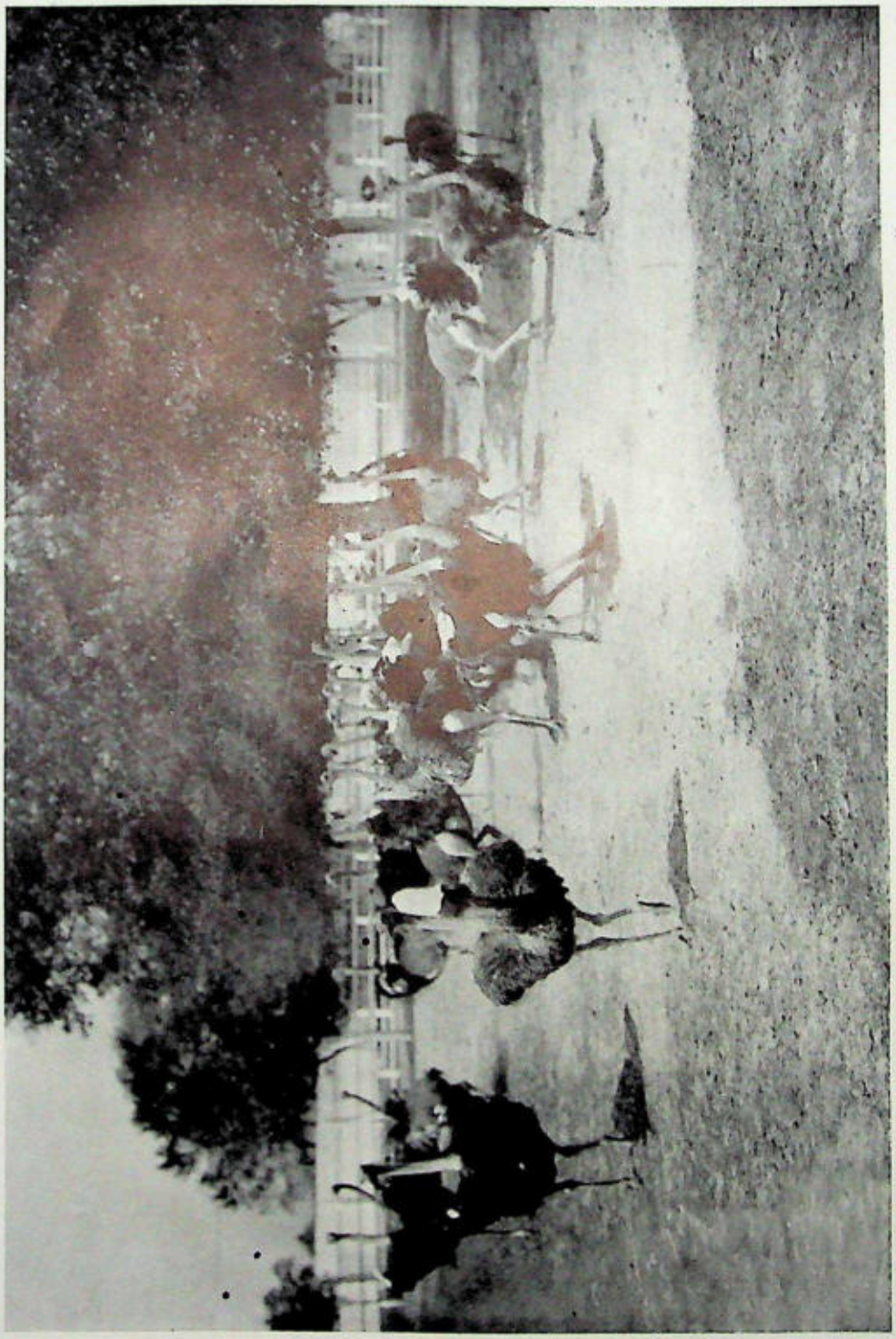


Upper—A sharp turn at full speed, with one wing partly extended as a counterbalance. In spite of its great weight, the ostrich is surprisingly agile as well as swift. *Lower*—In full stride—a picture of grace and muscular force. An ostrich is said to be capable of a speed of sixty miles an hour. At any rate, he can easily outdistance the swiftest horse.

Upper left—North African ostrich in the snow. In spite of the apparent inadequacy of the plumage as a protection against cold, we have found that our ostriches thrive best when kept out of doors the year 'round. *Upper right*—The roar of the male ostrich is a series of loud booming sounds, not unlike the roar of a lion. The neck is widely distended with air during the process. *Lower left*—South African Ostrich. The slenderness of this species as distinguished from the North African bird, is well illustrated. *Lower right*—South African ostrich. In this species, the bare portions of the neck and the legs are blue, while in the North African bird, these parts are red.



Upper right—The courtship display and dance of the male ostrich is a sight of unusual beauty. This is the first phase, in which the wings are alternately raised and lowered. *Upper left*—Both wings are then extended, while the bird moves in small circles. *Lower*—In the final stage, the bird drops to the ground, moving body and wings from side to side, the head and neck following in graceful, serpentine movement. The lovely wing plumes are now seen to the best advantage.



Ostriches at the Ostrich Farm in Jacksonville, Florida. This was one of the attractions at a small resort on the outskirts of the city. It was developed also in a commercial way. The pictures were made about twenty years ago, and at that time the dock was in a very prosperous state. The feathers were sold as single plumes, made into scarfs and the smaller ones were used for fans. The feathers were taken from the birds at their most perfect state of development by cutting. This left the end of the quill imbedded in the skin and the bird suffered in no way by the operation. When the quill dried it was easily drawn out and the new feather then commenced to grow.

The breeding birds were given the freedom of large yards where the warm sand provided admirable means for the rude nests which the birds hollowed out. Both male and females assumed the responsibility of incubation. The two pictures at the top show the male and female on the nest. They were quite fearless and proceeded with their duty heedless of any crowd that might gather at the fences.

The Jacksonville climate was admirable for the breeding of these great birds, and one of the interesting features was this old colored man and his fledgling birds which he seemed particularly gifted in rearing. He was very patient and kindly brought out this young brood for photographing.

Some of the large male birds were used for riding and driving. The riding being done without saddle, the rider simply slipping his legs under the wings, the bird then ran around an enclosed track with great speed. The weight of the rider seemingly offering no inconvenience. Catching the birds for this purpose was anything but sport; none of them required pursuing. If the boy's chance was good he grasped the bird's neck and pulled it down. The ostrich was then practically helpless. If he missed getting a hold his only salvation was to fall flat to the ground. In the case of a catch, the bird was immediately hooded, when he could be led around with ease.

A white rhea, with billowy plumes raised, is a sight of rare beauty. This is an unusually fine specimen. When the bird ruffles its feathers they form a perfect cascade of billowy plumage, so light and graceful as to seem like a halo rather than a material structure.

Sketch-map showing the habitat of the Rheas. It is intended to give a general idea of the distribution of these birds. The range of the Common Rhea probably extends into Patagonia.

Part II. The Struthious Birds—Rheas

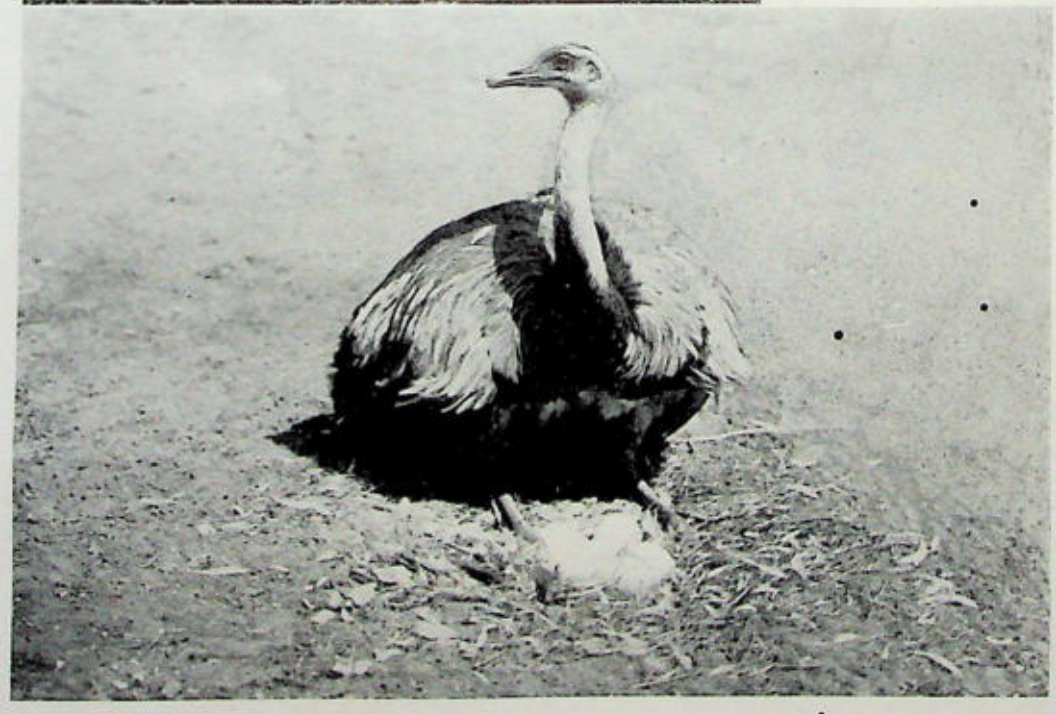
The Rheas are the only representatives of the struthious birds found in the Western Hemisphere. Hardly more than half the size of the Ostrich, they bear a superficial resemblance to the larger bird. The feathers are similarly soft and loose, though they lack the ornamental value of the African plume. Unfortunately, they are curiously well adapted for use as feather dusters, and so many thousands of the birds have been slaughtered for this utilitarian purpose, that their numbers have become dangerously reduced.

There are three species of Rhea, ranging over the plains of northeastern Brazil, Argentina, and Patagonia, as well as the higher plateaus of Chile, Peru and Bolivia.

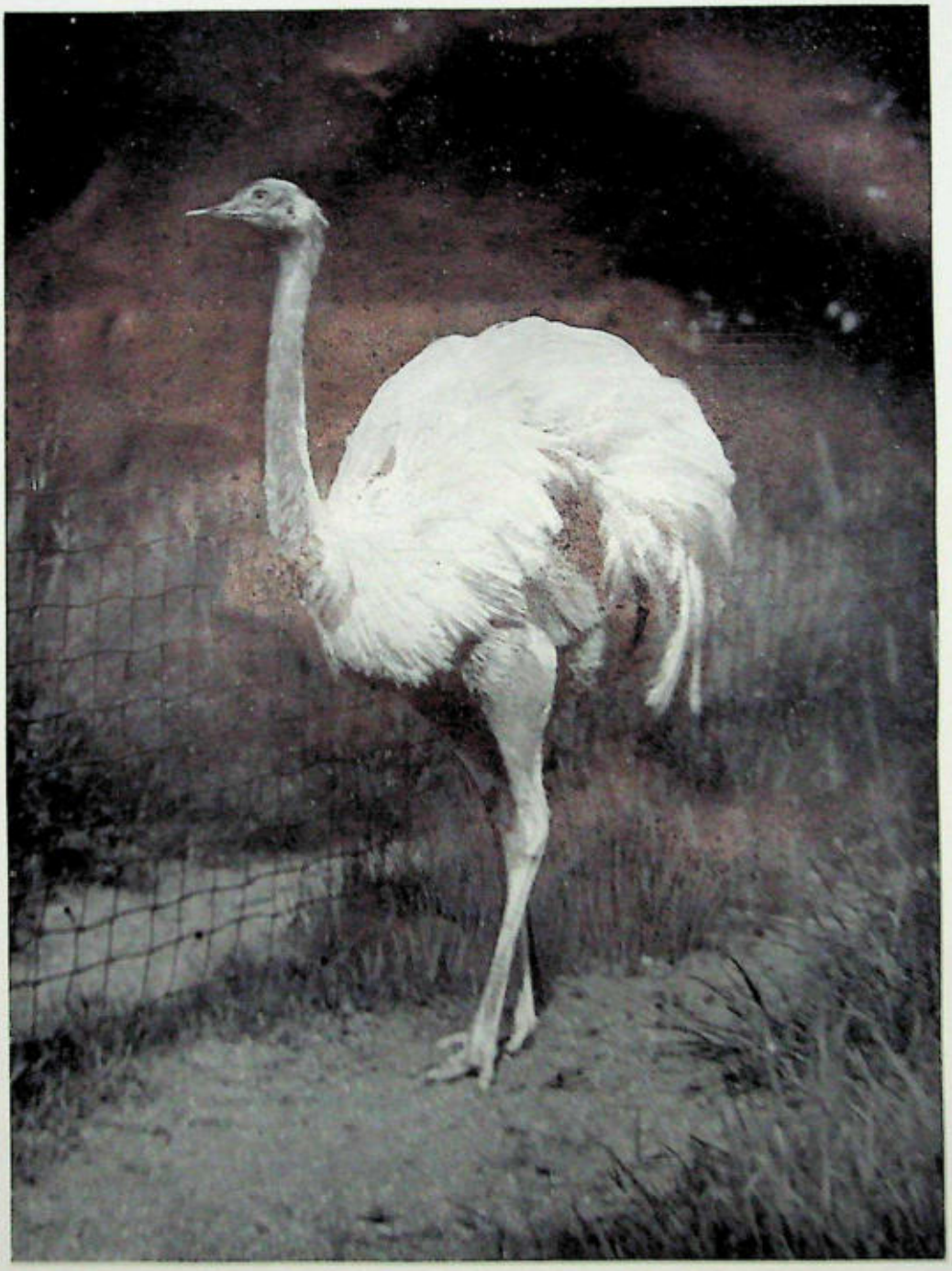
Common rheas (*Rhea rothschildi*) in the Zoological Park. The plumage of the rhea, while soft and loose, lacks the beauty of that of the ostrich. However, it has been in great demand for making dusters, and until within recent years, great quantities were imported for this purpose.

Common Rhea (*Rhea rothschildi*) in the Zoological Park. The rheas, in habit and appearance, have a general resemblance to the ostriches, although this likeness appears to be one of parallelism rather than of close relationship.

A pair of great-billed rheas (*Rhea americana*) in the Zoological Park. The male is incubating, while his mate looks on with indifference. The care of the eggs and young, like the emu, is solely the task of the male bird. There is a slight growth of feathers on the thighs, differing in this respect from the ostrich.



In the rheas, as in the emus, incubation of the eggs and care of the young are left to the male alone. Above, father common rhea with chick. *Below*—male great-billed rhea incubating in the Zoological Park.



White rheas, sometimes pure in color but often with a trace of gray on neck and thighs, are frequently seen. These albinistic sports have been cultivated in captivity, so that they are now well established.

Volume XXXII, No. 6 November-December, 1929

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The design reproduced on the cover of this number of the Bulletin was made from a water color drawing by Paul Branson. It was drawn expresely for this purpose and presented by the artist to the New York Zoological Society as a gift of appreciation.

BULLETIN

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Long-tailed Bird of Paradise. *Epimachus fastosus meyeri* Finsch.
Immature Male.

BULLETIN
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The New York Zoological Society's Expedition to New Guinea

LEE S. CRANDALL
Curator of Birds, Zoological Park

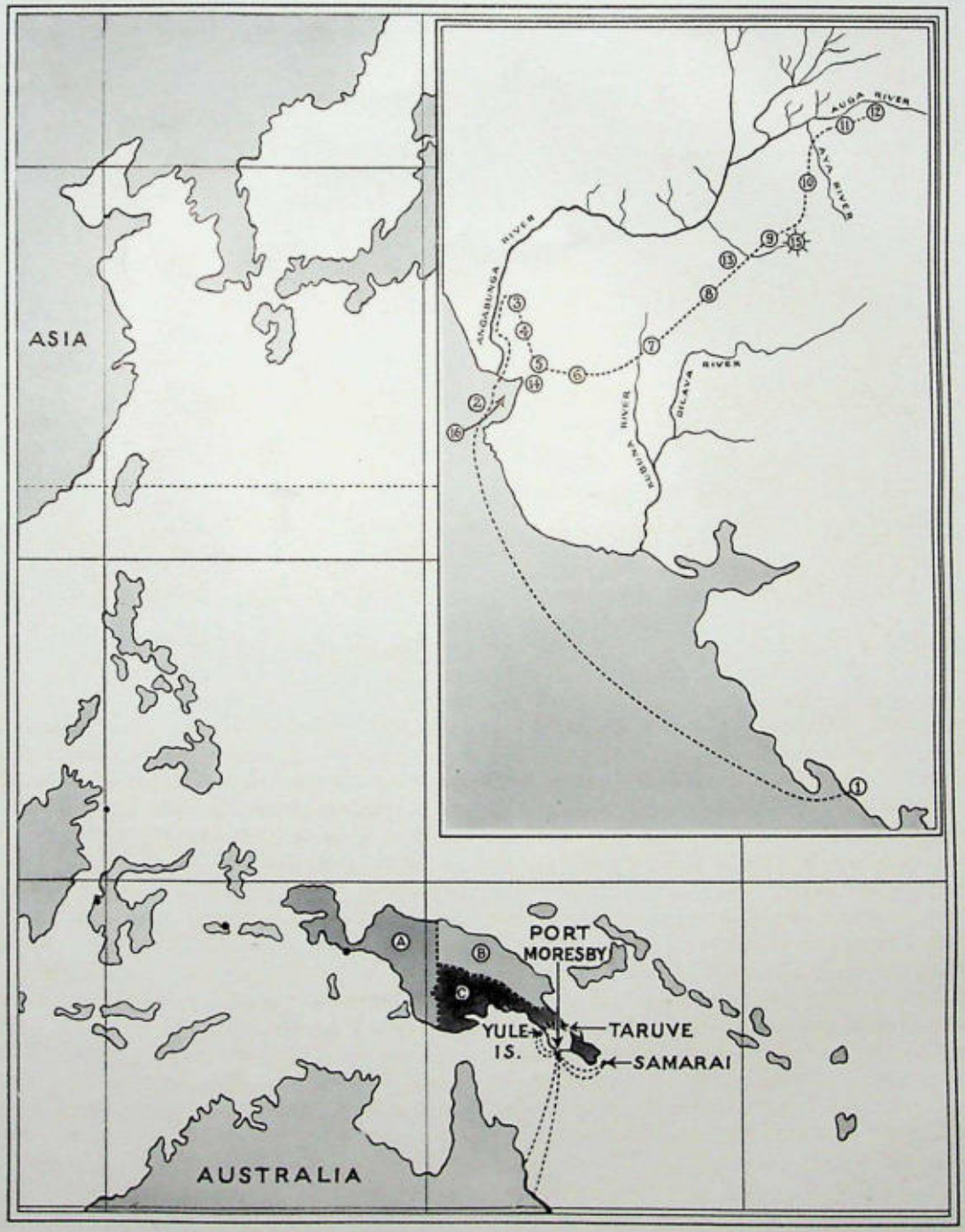
Illustrations by the Author from photographs made in New Guinea, and from the living birds in the Zoological Park by the Author and Edward R. Osterndorff.

TWO things were of primary importance in making plans for the Zoological Society's expedition to New Guinea. It was necessary to find a point of entry, from which the habitats of the greatest number of species of birds of paradise could be reached, in the shortest possible time. It was also essential to secure the services of someone with actual field experience in New Guinea. The solution of both problems was found when Mr. J. E. Ward, of Sydney, Australia, replied favorably to a cabled inquiry. Not only was he willing to undertake the project but he suggested the Central Division of the Territory of Papua, as the district most likely to yield success. While naturally we were pleased at Mr. Ward's acquiescence, we did not, at the time, fully realize our good fortune. Without his knowledge, enthusiasm and powers of endurance, the expedition probably would have had a very different outcome, for to an utter stranger, no land is more cruel and difficult than New Guinea.

Sailing from San Francisco, August 9, 1928, I arrived in Sydney on September 4. No sooner had I been installed in the hotel where Mr. Ward had made reservation for me, than he informed me that His Excellency, Sir Hubert Murray, Lieutenant-Governor of the Territory of Papua, was a fellow-guest. This was an unexpected stroke of good fortune and I lost no time in taking advantage of it. The birds of paradise are rigidly protected in British territory and permits to collect them for any purpose are difficult to procure. A brief cable message from His Excellency had assured us that a license for a very limited number of birds would be issued on personal application. We had proceeded in the hope that some extension of the privilege might be granted.

Soon I was in the presence of the man whose explorations, firm ideals and unfailing sympathy with the natives, have so ably upheld British colonial policy for more than twenty-five years. He graciously received me at breakfast and allowed his grilled kidneys and bacon to cool while I pleaded my case. Before the interview ended, he gave me a pencilled note requesting the Government Secretary at Port Moresby to use his discretion in the issuance of a license. Typically British in reticence, to be sure, but I knew it was all I required and I was duly grateful. My happiness was not lessened when His Excellency informed me that he was off for six months' holiday in England. Had I arrived in Port Moresby without that hastily scribbled note, I should surely have met with difficulty.

The Burns-Philp steamer *Morinda* is the



Sketch map of New Guinea in its relative position to the adjacent islands. Section in upper right represents the area northeast of Yule Island covered by the expedition. A. Dutch New Guinea; B. Territory of New Guinea; C. Territory of Papua; *Upper right section*, 1. Port Moresby; 2. Yule Island; 3. Jesubaiboa; 4. Inawaia; 5. Inawaibui; 6. Aropokena; 7. Kubuna; 8. Diene; 9. Matsika; 10. Deva-deva; 11. Popole; 12. Taruve; 13. Kekefi; 14. Bioto; 15. Mt. Kebea; 16. Hall Sound.

Port Moresby from the eastern or seaward side. The town lies in the hollow between the two hills in the foreground. During the dry season, it is a hot and dusty place.

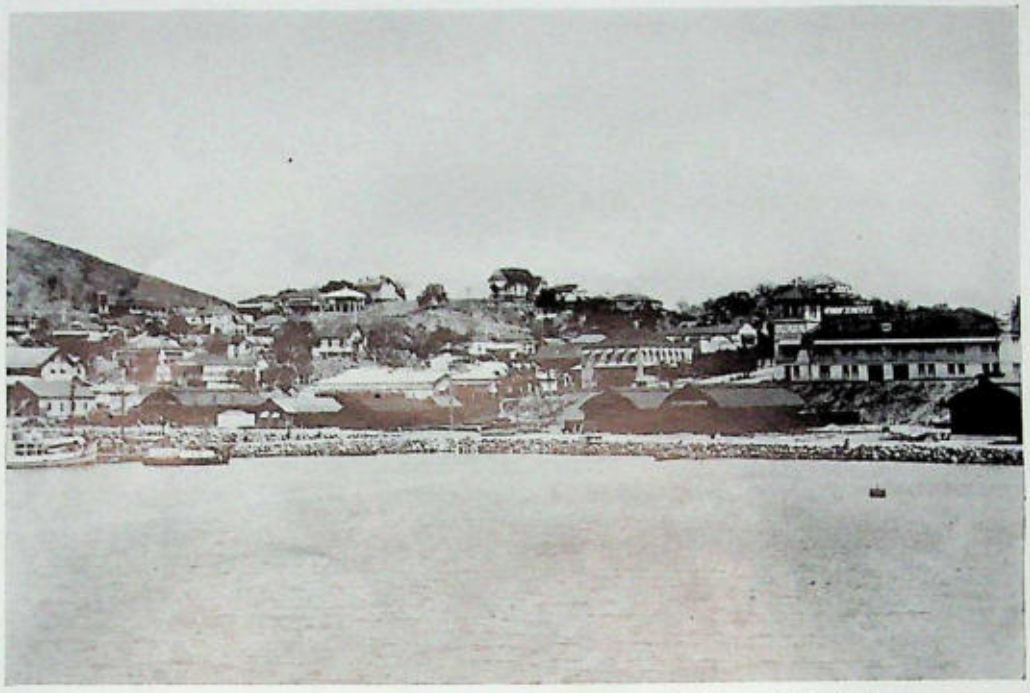
connecting link between Sydney and Port Moresby, making the 3,600 mile round trip once monthly. She was to have sailed about September 15th, but she had to wait for a cargo of rice to relieve a shortage in Papua, so that she did not arrive in Port Moresby until the early morning of October 4th.

We were on deck at dawn, to see the sun rise behind the eastern hill of the promontory on which Port Moresby lies. The end of the dry season was drawing near and the low, bare hills were scorched and brown. The town itself, nestling between them, looked dusty and desolate. Yet I thrilled at my first sight of the land that had haunted my mind for so many years—the land that attracts the naturalist as a magnet draws a needle.

Long before the official hours of business, I found my way to Government offices. When Mr. H. W. Champion, the Government Secretary, arrived, he received me at once and proved both kindly and sympathetic. Relieved from any official restriction by the note from Sir Hubert Murray, Mr. Champion granted my request for permission to collect a number of birds of paradise sufficient to make the trip worth while —if we could get them! An hour later, I was the proud holder of a collector's license, duly issued by Mr. Baldie, Resident Magistrate, as well as a receipt for £25, the established fee.

In the meantime, Mr. Ward had been doing wonders at Burns-Philp's store, purchasing supplies and trade goods, to supplement those brought from Sydney. When the *Morinda* sailed that night for Yule Island, which she visits every other month, we were safely aboard, everything in order.

A word on geography, at this point, will help clear the situation. The island of New Guinea is about 1,400 miles long and has a surface area of approximately 300,000 square miles; amongst the islands of the world, it is exceeded in size only by Greenland. Geographically, it is known also as Papua, a term which has resulted in great confusion. The western half of the island belongs to Netherlands and is known as Dutch New Guinea. The eastern half is divided into two portions, the southern division of which, once known as British New Guinea, passed into Australian control in 1906



Port Moresby from the harbor. At the right, are the buildings of the business section of the town. Beyond, are the offices and residences of various government and other officials.

and was promptly renamed as the Territory of Papua, commonly abbreviated to Papua. The northern section of the eastern half of the island, formerly known as German New Guinea, is now governed by Australia under mandate from the League of Nations and is officially known as the Territory of New Guinea. Consequently, the names New Guinea and Papua, apply not only to the entire island but, locally, to its divisions.

Yule Island lies about sixty-five miles west of Port Moresby, and is separated from the mainland, two miles away, by the waters of Hall Sound. Early on the next morning after leaving Port Moresby, the *Morinda* anchored off the dock of the Mission of the Sacred Heart, at the eastern end of the island. As soon as our rather bulky outfit had been placed in the Mission store-house, we were greeted by Mr. Speedie, a young Patrol Officer attached to the staff of Mr. Grist, Assistant Resident Magistrate of the Central Division. We spent the night as the guests of Mr. Speedie, who occupied a little thatched house at the Government headquarters, on the north shore of the island, adjoining the Mission grounds.

As there were no canoes available, we were in a quandary as to how to reach the mainland, but after long and involved bargaining, we were able, next day, to arrange for transport in a trader's launch. The Angabunga or St. Joseph River empties into Hall Sound opposite Yule Island, and is navigable for some distance by small craft. However, the entrance to the river is obstructed by a barrier of mud and sand, which can be crossed only at high tide by boats of very shallow draught. In order to make certain that we should cross the bar, it was necessary to avoid overloading the launch and my heavy motion picture films, which later proved a constant worry and encumbrance, had to be reduced to 2,000 feet. About two o'clock that afternoon, we managed to get into the river and made fair progress in spite of a swift current.

For several miles, the river is bordered by a heavy growth of mangroves and nipa palms. There were many birds here and we had our first view of a considerable number of species,

particularly white egrets, ibises, white cockatoos[1], a single great black cockatoo[2] and flocks of pink and green Geoffroy parrots[3].

After we had passed through this swampy coastal area, the current became swifter and our progress was so slow that eventually we were overtaken by darkness. We tied up at the bank and passed a most uncomfortable night in a heavy downpour of rain, the prey of hordes of greedy mosquitos. At dawn next morning, we were again under way and a few hours later, arrived at the landing place of Jesubaiboa, commonly called Ishibaibo, one of the Mekeo villages.

A great crowd of natives, by some mysterious means aware of our coming, had gathered, and had brought a large quantity of copra, of their own making, in the hope of selling it to the launch owner. In the heat of barter, they took little notice of us, so that I had a few moments in which to recover from the shock of my first contact with these wild looking, nearly naked savages. It seemed to me then that I could never feel comfortable amongst them. Later, I made many friends and found them, for the most part, a laughter-loving, loyal and kindly people.

Having disposed of a good part of their copra, the people were in holiday mood and not inclined to trouble about us, though a few who remembered Ward, came forward and shook hands, white man fashion. Finally, with the help of one of Ward's old bird boys, named Opu Kaki, now become village constable, we managed to persuade them to carry our duffle through their own village to Inawaia, about four miles from the landing. Here the usual uproar about payment ensued, resulting in dissatisfaction which later had its effect when we tried to get carriers for the trip to the mountains.

As in most of the Mekeo villages, there is a small but comfortable rest house in Inawaia, built of native materials, for the accommodation of occasional visiting patrol officers. Here we were soon installed, with our bulky cages stored in a rickety police boys' house, across the way.

Mekeo is a district of considerable extent,

[1] *Kakatoe galerita triton.*
[2] *Probosciger aterrimus goliath.*
[3] *Geoffroyus geoffroyi aruensis.*

Mountains of the Main Range, as seen from Yule Island. At the left, is Mount Yule, more than 10,000 feet high. The sharp peaks in the center are known as The Needles. The arrow at the right points to The Gap, which separates Mafulu from the Ambo country. These mountains are at least fifty miles distant from Yule Island, and after seven o'clock in the morning are usually obscured by mists.

Hall Sound, from Yule Island. The mainland, which is no more than two miles away, is barely visible and the distant mountains are entirely hidden by mist and cloud.

practically flat and not much higher than sea level. The soil is fertile and stoneless, and supports a number of large and powerful native villages. It is traversed by excellent native tracks, so that walking is not only easy but pleasant in the dry season. During the period of rains, which extends from December to March or April, or when occasional floods occur, much of the country is inundated and travel difficult or impossible. In most sections, the primeval bush has been cut down, by generations of native gardeners, and has been replaced by an almost impenetrable tangle of second growth, or by coarse saw grass, ten to twelve feet high.

There are many birds here, of course, but only one bird of paradise. This is the green manucode,[1] which is abundant from Yule Island, through Mekeo at least to Kubuna, at about 200 feet elevation, where I noted the last specimen, as we climbed into the mountains. The thin, piping note of this species is a striking feature of the early morning bird chorus in the lowlands.

Another most interesting bird of Mekeo is the fawn-breasted bower bird.[2] We examined a number of the bowers of this species, which are usually placed close to villages or near the native tracks. We measured one, which was built on a mound of twigs, four feet long, two feet wide and fourteen inches high. The true bower, built of slender twigs set in two parallel rows at the center of this heap, was fourteen inches long, eleven inches high and ten inches wide, over all. The "front" of the bower, and the tips of the twigs, were handsomely decorated with small pale green fruits of three distinct sorts. These bowers, of course, are used entirely as playhouses, and not for nesting purposes.

After a day or two in Inawaia, devoted to the sorting of luggage, much of which had to be stored until our return, we had no difficulty in getting the local people to carry our outfit the eight miles to Inawaibui, the next village. Here, however, we met with a distinct reverse, as only nine boys were willing to proceed and we

[1] *Manucodia ater alter.*

[2] *Alphachlamydera cerviniventris recondita.*

needed at least thirty. We overcame this obstacle only by dispatching runners to Yule Island, asking for help from the police. The Government ordinarily does not undertake to secure carriers for expeditions other than its own, but the next day a native sergeant appeared, accompanied by a private and a carrier, who, thanks to Mr. Speedie, brought three more tins of my precious film. By means best known to himself, the sergeant persuaded a sufficient number of boys to "volunteer," so that we were able to proceed. We promised him a present on our return and when we reached Yule Island, two months later, this efficient gentleman appeared and was pleased to express his satisfaction with four sticks of trade tobacco, which Ward gave him from our diminished stores.

Soon after leaving Inawaibui, we encountered low foothills and here we heard the first clear, ringing calls of Count Raggi's bird of paradise.[1] Thereafter, during our entire stay in the mountains, we were seldom out of the sound of these stirring notes, so characteristic of New Guinea. For five days we continued our march on a track frequently almost impassable, ever up and down precipitous razor-backed ridges. Fortunately, Mekeo's mosquito hordes had been left behind but we were constantly attacked by the land leeches that swarmed wherever there was a trace of moisture. After leaving Mekeo, there are no villages on the track until one has penetrated far into the mountains, but at intervals of from ten to fifteen miles, there are small rest houses for the benefit of patrol officers. By good fortune, we managed, at each stage, to reach shelter before the heavy rain which fell every afternoon, although the boys, who are invariably dilatory when going away from home, were not always so fortunate. We ate only two meals daily while on the march, since, to avoid the rain, it was necessary to push on as rapidly as possible.

Finally, we reached a point in the southwestern extension of the Owen Stanley range, known as Deva-deva. The elevation is about 4,000 feet, and the airline distance from Yule Island approximately forty-five miles. There had once been a village here, from which we

[1] *Paradisaea raggiana.*

Motumotu canoe at Yule Island. This unwieldy vessel has come from a point about fifty miles west, to bring native-made copra to the trading post. These are dangerous waters to navigate.

Motumotu canoe. It is really composed of two large heavy canoes, hewn from tremendous trunks, and decked over. It is propelled by means of sails and oars. A most seaworthy craft, and the islanders are expert mariners.

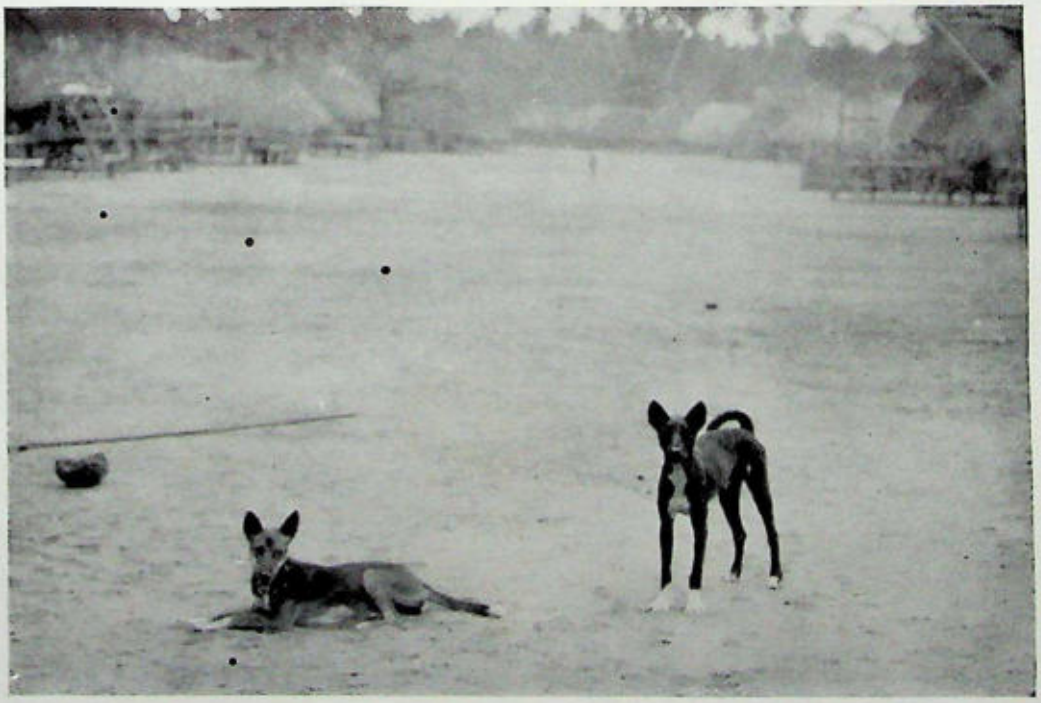
had expected to procure native food to replenish our scanty stores. Unfortunately, we found that this site had been abandoned. Its former inhabitants had scattered up and down the steep slopes of the valley of the Aya River, which flows northward into the Aduella, one of the upper tributaries of the Angabunga. With an immediate food shortage in sight, most of our boys promptly deserted. They were a mixed lot, gathered from several villages, suspicious of each other and constantly malingering. Really unwilling to undertake the journey in the first place, they had made us continual trouble and we were not sorry to see the last of them. At the same time, we were left in an awkward position, since we had neither carriers for the return trip, nor sufficient food to remain very long where we were.

Eleven boys remained faithful. On the day following the desertion, one, a very intelligent fellow, came forward and volunteered to return to Inawaia, with five others whom he would select, and bring to us one hundred and sixty pounds of rice we had left there. It seemed to us unlikely that the delegation ever would return or that we ever should see our rice. On the other hand, we could lose little and there was always the chance, however slim, that the thing might come off. After some consideration, we consented and the party set out, each boy carrying his blanket, a small packet of rice and two ship's biscuits—supplies for the trip!

As we now had only ourselves and five boys to feed, the strain on the commissary was somewhat relieved. Perhaps because of the reduced size of our party, the local natives began to drift in, shyly at first, soon with increased confidence and in greater numbers. We explained that we had come to get living birds of paradise, for which we were prepared to offer trade goods in exchange. Ward and Koi knew the words that represented most of the species we wanted, so that we had no difficulty on this score, though the natives showed little enthusiasm. But when we added that we also were in need of food, and offered them salt, trade tobacco and red calico, there was an immediate response. From that time on, we had a fairly constant, though small, supply of native sweet potatoes and squash-like pumpkins, which al-

Upper. A track in Mekeo. The country here is flat and stoneless, and during the dry season, the native paths are kept in excellent condition. This section lies between Inawaia and Inawaibui, and for miles is bordered by native garden land. *Lower.* A native dance in Mekeo. This was a social affair of importance, to which the village of Eboa invited the residents of ten neighboring communities. Such dances are continued, without interruption, for three or four days and nights.

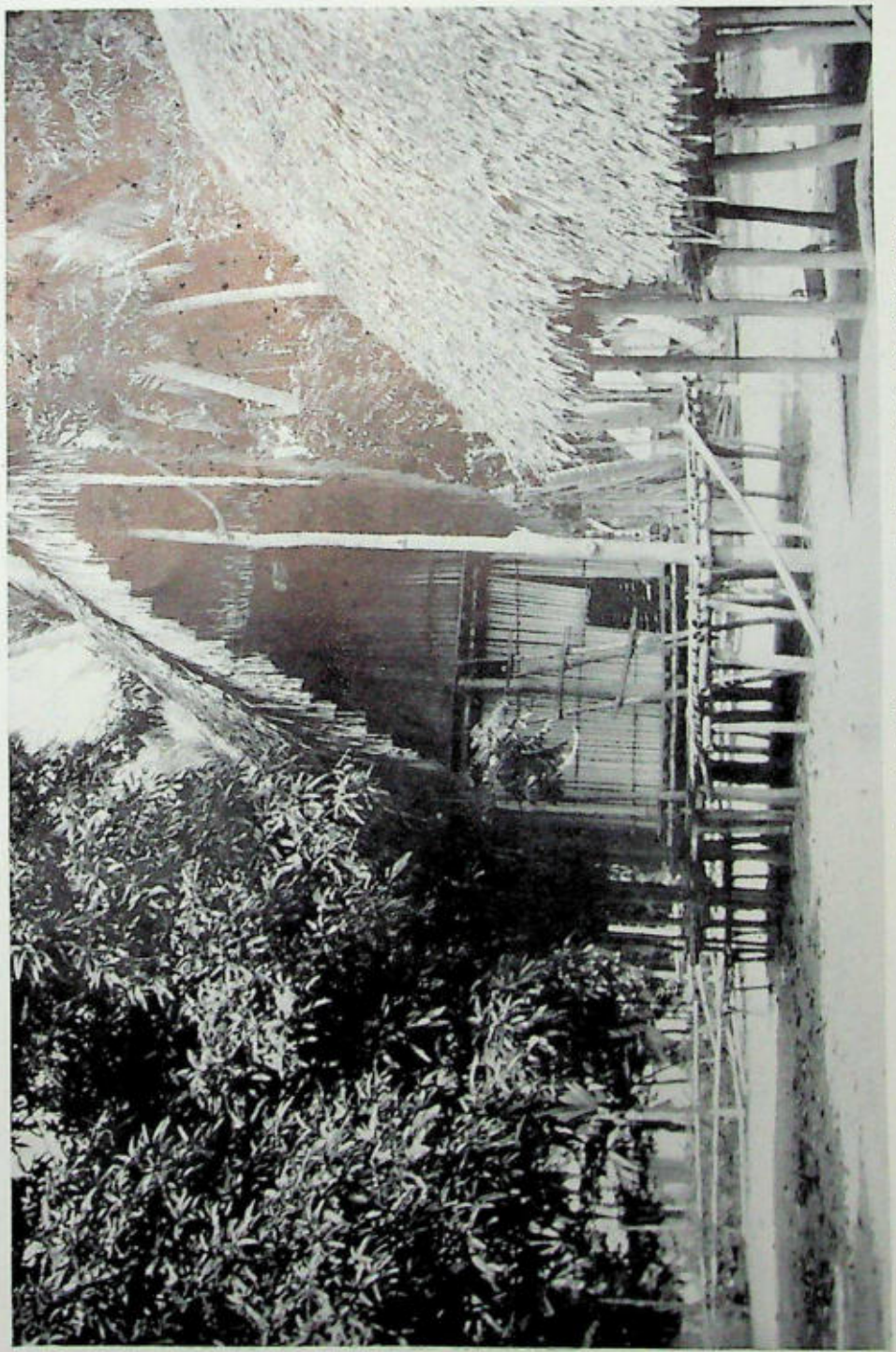
The expedition's Mekeo headquarters, at Inawaia. Rest houses of this type are present in most Papuan villages, at least in the lowlands, for the convenience of passing patrol officers. In the adjoining cook house, a neat pile of earth serves as a stove.



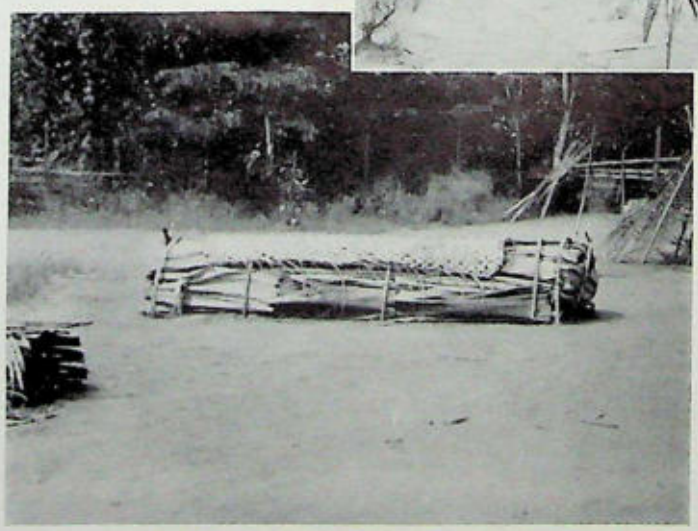
The native dogs of New Guinea are of great interest. Although slender in build, they are of undoubted dingo type. The usual color is the yellow of the dingo, as in the dog at the left, although black ones are not uncommon. Most of the animals are pointed with white.

Papuan village pigs. These creatures are among the most treasured possessions of the natives. They are killed only on the most important occasions, usually at dances, when the meat is eaten by guests alone. Wild pigs abound in the bush and young ones are often captured and reared by the women. The species is distinguished as *Sus papuanus*.

This dilapidated police boys' house faced the rest house in Inawaia. It proved a most convenient shelter for our large collection of birds. Mr. Ward is seen engaged in the endless round of attention necessary to keep them in good condition.

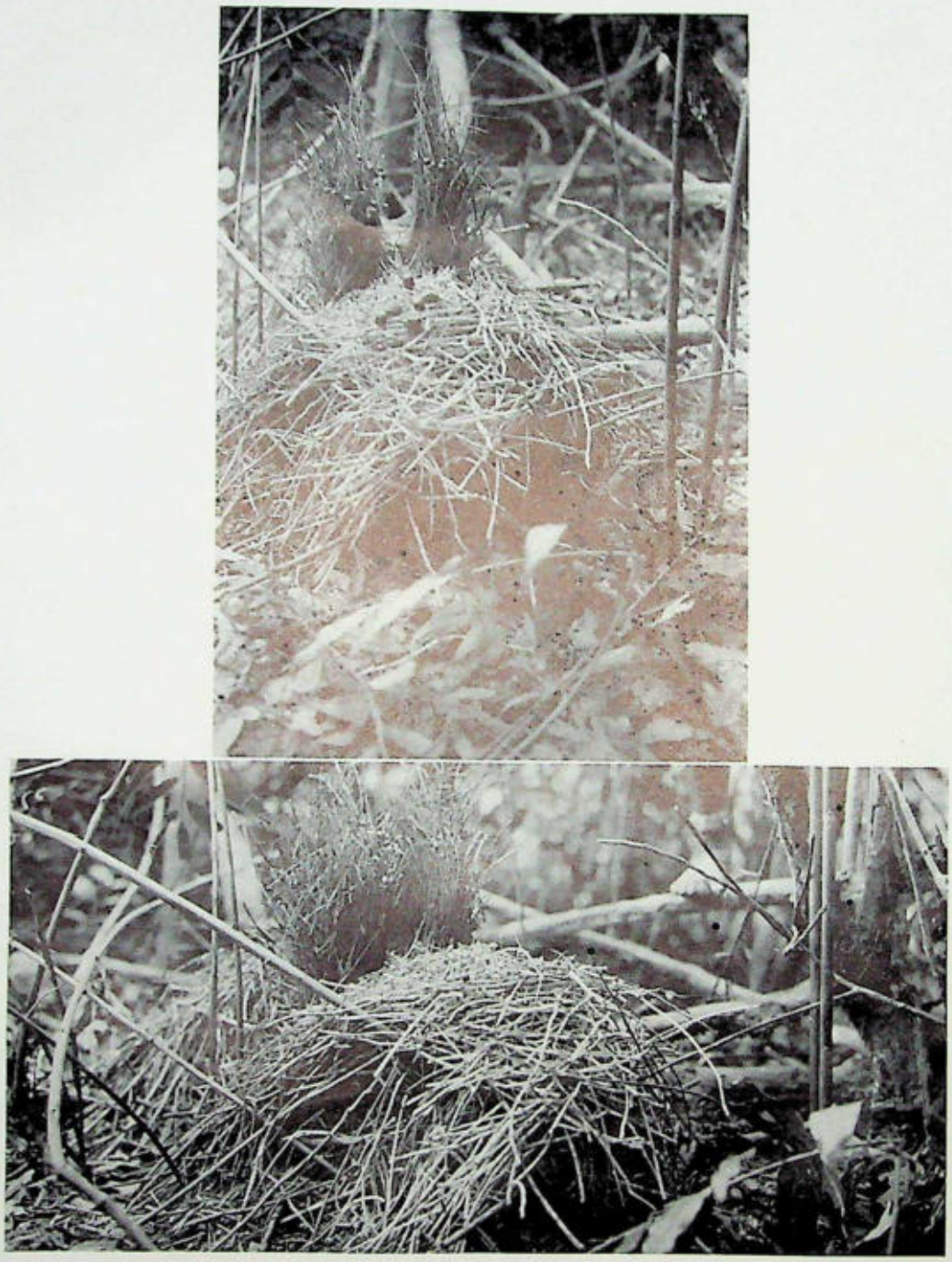


Deserted boys' house or dubu, in Inawaia. While we were stopping in the village, one of the young men who lived in this house, was bitten by a snake. In spite of all we could do for him, including the injection of serum, he died. According to custom, the dubu was immediately deserted and left to fall into ruin.



Upper. A Mekeo burial. A bower of green palm leaves, about fifteen feet high, is erected and kept in place during the period of mourning. *Center.* In Mekeo, a great variety of lovely Croton and delicately scented Coleus plants, are cultivated with care, in little fenced gardens, close to the houses of the owners. The leaves are used for personal adornment. The patch of onion plants in the center of this garden is an ironic comment on the savage's reception of plants strange to him. *Lower.* A Mekeo grave, after the removal of the palm shelter. The body is carefully wrapped in bark and staked to the ground, the whole being covered with a mat of palm leaves.

Upper. A village constable of Mekeo. In each village of Papua that is under governmental control, an influential native is appointed constable or policeman, a policy that has greatly aided pacification. This individual is Opu Kaki, a character well known throughout Mekeo. *Lower.* The Mekeo village of Inawaia. Like most Mekeo communities, it is large and powerful. There are about twenty houses at each side of the street and the population was estimated at three hundred. The house in which the expedition made its headquarters is seen at the far end.



Upper. Bower of the fawn-breasted bower-bird (*Alphachlamydera cerviniventris recondita*). The bower proper is built on a mound of twigs, approximately four feet long, two feet wide and fourteen inches high. *Lower.* Another view of the bower-bird's play-house. The true bower is built near the middle of the mound, of finer twigs. It is about fourteen inches long, eleven inches high and ten inches wide. This bower was decorated with three varieties of small green fruits.

Fawn-breasted Bower-bird. *Alphachlamydera cerviniventris recondita* (Meyer).
Adult Male.

Upper—Twelve-wired Bird of Paradise. *Seleucides ignotus* (Forst). Adult Male.

Lower—Lawes' Six-plumed Bird of Paradise. *Parotia lawesi lawesi* Ramsay. Adult Male.

Lesser Superb Bird of Paradise. *Lophorina superba minor* Ramsay.
Adult Male.

Lesser Superb Bird of Paradise. *Lophorina superba minor* Ramsay.
Adult Male.

lowed us to reduce consumption of our own scanty supplies.

For some days, there was no action as far as birds were concerned. Then, early one morning, a small boy brought us a large white-throated pigeon,[1] which is now happily dwelling in the Zoological Park. He received in exchange a beautiful trade knife with shiny brass rings in the handle, which caused his eyes to pop with admiration. The glad news must have spread, for just after noon, we received our first bird of paradise, a female six-plumed.[2] Soon afterward, a female lesser superb[3] was brought in. We duly rewarded the captors with the coveted knives but explained that we wanted males.

Koi, cook-boy and interpreter.

By the next day, the whole region was astir and a constant stream of natives came and went, bringing us birds of paradise and carrying away their booty. Beyond doubt, they considered us quite mad and certainly they never had the slightest glimmer of the reason for our seeming insanity. In no time, our eight box cages were crowded with lovely six-plumes, the deep velvet black of their plumage set off by the brilliant blue of their eyes and the silver patches at the bases of their beaks; shimmering little lesser superbs, with great shining green crescents on their breasts and heavy black capes over their backs; brilliant magnificents, with bright green breasts, and backs of yellow and maroon, that always seemed to be just out of pattern. Soon we could take no more of these but when natives brought them long distances, as they continued to do, we bought the birds and let them go. They always were overcome with chagrin when the captives seemed to slip from our fingers and escape into the bush.

We now concentrated on Prince Rudolph's blue bird of paradise,[4] which we knew was found here and was one of the main objects of the expedition. The natives showed a curious reluctance to catch this species, either from some superstitious fear, or simply because the birds live far up the sides of steep-sloped mountains. To reinforce our arguments, we displayed the shining trade axes, which until now we had held in reserve. We had expected to get Count Raggi's bird of paradise, with its fine red plumes, without much trouble, but it appeared to be difficult and none had been brought in. We therefore increased its value to that of an ax, and included, as a forlorn hope, the long-tailed bird of paradise,[5] the largest and finest of all the family, which we had no real expectation of getting.

Whatever may have been the cause for hesitation, the offer of real steel axes quickly overcame it and soon we had word that "All boy he go bush!" A day or two later, the first blue came in, borne by a diminutive messenger, who stated that the captor was remaining in the field, in hope of getting another. It was a magnificent creature, finer and more brilliant by far than any living specimen or skin I had

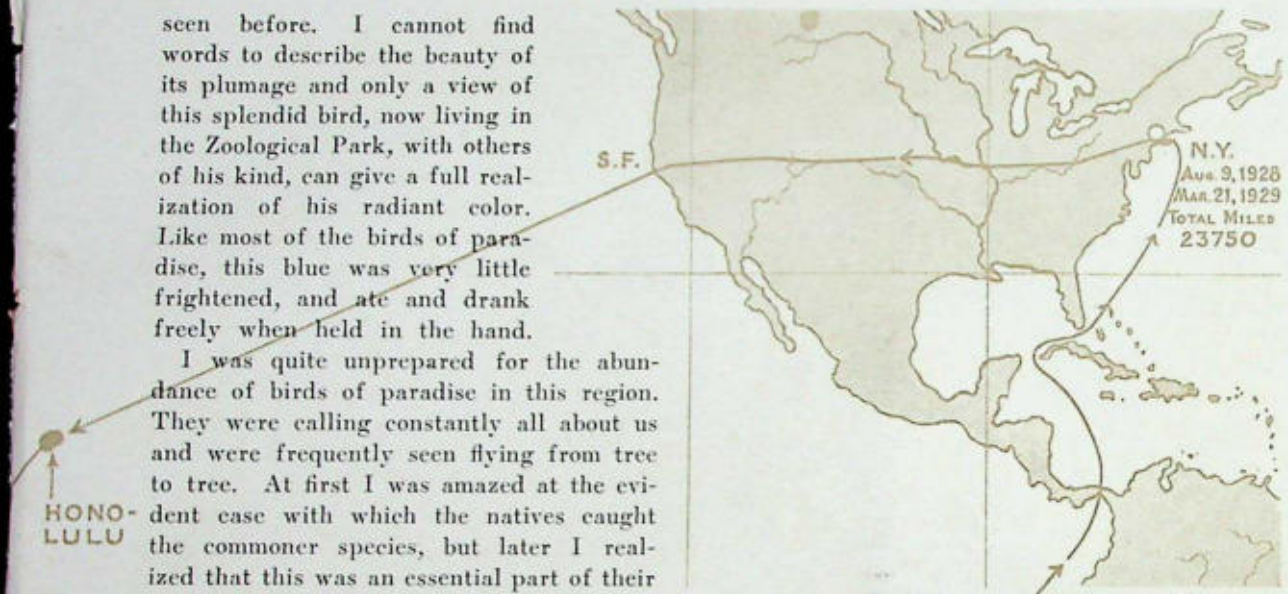
[1] *Columba vitiensis halmaheira.*
[2] *Parotia lawesi lawesi.*
[3] *Lophorina superba minor.*

[4] *Paradisornis rudolfi.*
[5] *Epimachus fastosus meyeri.*

seen before. I cannot find words to describe the beauty of its plumage and only a view of this splendid bird, now living in the Zoological Park, with others of his kind, can give a full realization of his radiant color. Like most of the birds of paradise, this blue was very little frightened, and ate and drank freely when held in the hand.

I was quite unprepared for the abundance of birds of paradise in this region. They were calling constantly all about us and were frequently seen flying from tree to tree. At first I was amazed at the evident ease with which the natives caught the commoner species, but later I realized that this was an essential part of their lives. In the bush, a native is as keen and sensitive as a hunting animal, to sound and smell. Nothing escapes his notice. In a given territory, he knows where each bird has its home—where it sleeps, where it feeds, where it displays. Except at certain seasons, when the birds are irregular in habits, he can catch them almost at will.

Mountain people, throughout New Guinea, do an extensive trade in paradise plumes, with the coastal tribes, receiving in exchange pots, shell ornaments, lime, cocoanuts, and other valuables. Many tribes, skilled in the use of bow and arrow, secure the birds by this means. But in those parts of the Central Division with which I am acquainted, the bow and arrow are unfamiliar weapons and the native does his catching with snare and net, usually taking the birds uninjured. He may set a snare in a feeding tree or over a bait of fruit, holding the free end perhaps for hours, waiting for the moment when a quick jerk will secure the bird he wants. Or he may use a net, skilfully woven of excellent cord made from the inner bark of a tree, placed in such a manner that the bird will fly into it and be seized before it can escape. No white man could hope to equal a native, working in his own district, at such a task. Catchers taken from one section to another are too much frightened to work well, so that the collecting of living birds of paradise in a bow and arrow district is a difficult matter.



After the first blue, there was a cessation in arrivals and in order to attempt to enlarge our field of operations, it was decided that I should take two boys and proceed to the Mafulu country, which lies higher in the mountains, to the northeast. It was impossible for Ward to spare Koi, as his services as interpreter were necessary. Consequently, I was compelled to choose two whose loyalty had been demonstrated chiefly by their actions, since they had only a word or two of English and Motu between them. As we were unable to exchange ideas, I could not understand the care with which they guarded me on the trip—two hens with one chick could not have been more solicitous. Later, I learned from Ward that he had warned them, before we started, that if any harm should come to me, he would give them both a hiding!

Aya, one of the bird-boys.

We followed the track from Deva-deva, straight down the mountain to the Aya River, followed by a heart-breaking climb up the other side, broken by sharp elbow turns, numbering close to twenty. New Guinea boys never stop on the track until they come to the

Count Raggi's Bird of Paradise. *Paradisaea apoda raggiana* Sclater.
Adult Male.

Count Raggi's Bird of Paradise. *Paradisaea apoda raggiana* Sclater.
Adult Male.

Prince Rudolph's Blue Bird of Paradise. *Paradisornis rudolfi* Finsch.
Adult Male.

Prince Rudolph's Blue Bird of Paradise. *Paradisornis rudolfi* Finsch.
Adult Male.

Mountain panorama from Dilava. Because of the density of the forest, it is seldom possible to obtain an unobstructed view. Even then, this is possible only very early on clear mornings, before the mists begin to rise. The large mountain at the right is Virjus Dome.

top, no matter how steep. In order to avoid the loss of prestige which must result from any show of weakness, I had to struggle on, though I would gladly have given any lesser price for a moment's breathing space. We finally reached the summit and could look down into the great valley of the Aduella River or, as it is called by the Mafulu people, the Auga. There were large patches of open grass country visible, though I took this to be saw grass, similar to that of Mekeo. If so, it would be far more difficult to traverse than any bush country. Perched high above, on a jutting spur, stood the outlying Mission station of Popole.

I judged the distance from Deva-deva to Popole to be no more than ten miles, but it took us three and one-half hours to cover it and I, for one, was not sorry when we reached the station. I was kindly received by Father Dontenwill, the resident missionary, who had occupied his solitary post for twenty years or more. After a hearty and more than welcome lunch, we went on about four miles to Taruve, the nearest village to the Mission. We had a rather embarrassing time here, as neither the boys nor myself could speak a word of Mafulu and we had no interpreter. To make things worse, both boys were badly frightened, as the Mafulu people have an unsavory reputation. However, we found that a dance was just ending and that among the guests was a native who could speak Motu. Through him, we managed to explain the reasons for our coming and to urge that birds be brought or sent to us. I received full assurance of cooperation but realized that nothing would come of it, since there were pigs to be killed and I knew no one would leave the village as long as a scrap remained. Moreover, in the light of present knowledge, I am quite sure that no Mafulu native would have ventured into the Deva-deva country for any such purpose.

I assuaged my feeling of disappointment by exposing all of the motion picture film I had brought, bought at least a bushel of sweet potatoes for the boys for a few sticks of tobacco and some matches, and departed. After another excellent meal at Popole, I was glad to seek the

cot assigned to me for the night. I was very tired after my eighteen miles of rough going and the cot was a pleasing change from the knotty poles of Deva-deva.

Next morning, while enjoying my third nearly civilized meal, I felt very sorry for Ward, forced to subsist on the thin fare of Deva-deva. This feeling grew naturally into the thought that my two boys should take with them the remains of the bushel of potatoes, in case of a not improbable shortage at our camp. I found, however, that they had consumed the lot, a feat of which they were quite capable.

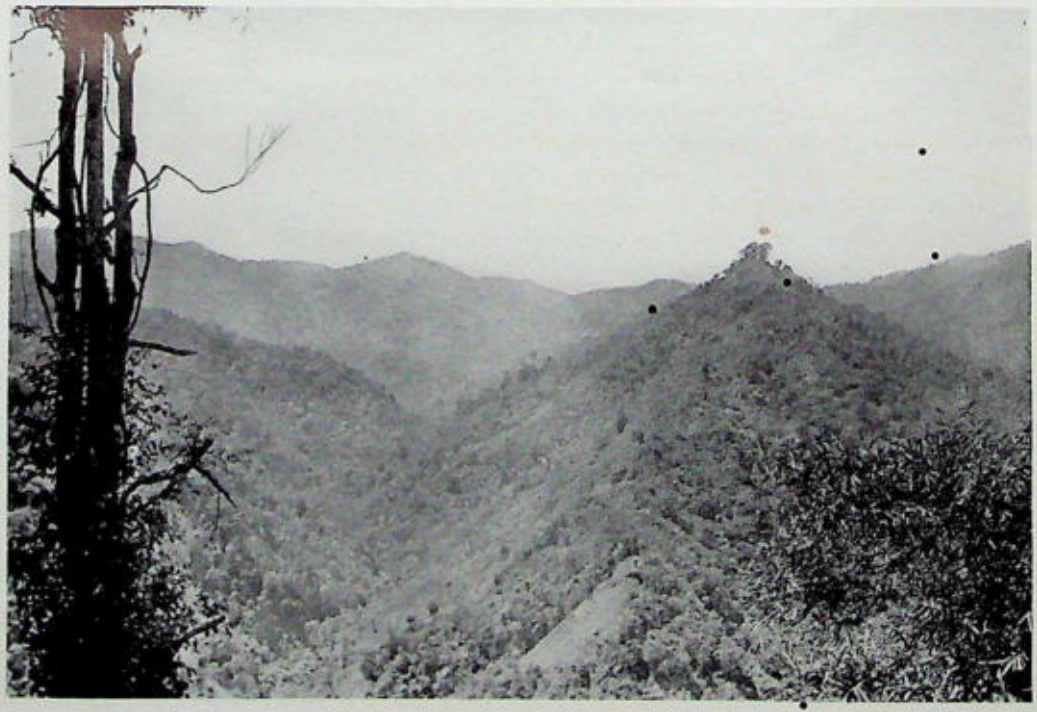
After expressing thanks for the hospitality of Father Dontenwill, we set out for Deva-deva, arriving well before noon. I found that Ward had received another blue bird of paradise, a pair of Count Raggi's and a beautiful black-headed catbird.[1] During the afternoon three more blues came in, as well as a female long-tail, a great prize.

[1] *Ailuroedus melanotus melanocephalus.*

We now had more birds than we really had room for and devoted the next few days to making reed cages, which the boys skilfully tied together with strips of bark. More blue birds came in, and at the last moment, a grinning native brought us another long-tail, which proved to be an immature male.

One day about noon, loud shouts were heard from down the track and a procession appeared, which turned out to be our rice carriers, who had exceeded out expectations by actually returning. Moreover, they had eaten only ten pounds of rice on the journey, had brought us two bunches of bananas, which they knew we needed for our birds, and had recruited four new carriers. Each boy received double pay for the eight days' journey and the venture was voted a complete success.

With our new supply of rice, it was evident that we had a chance to get through in a dash for Mekeo. However, it was three days before we could get the thirteen mountain boys needed



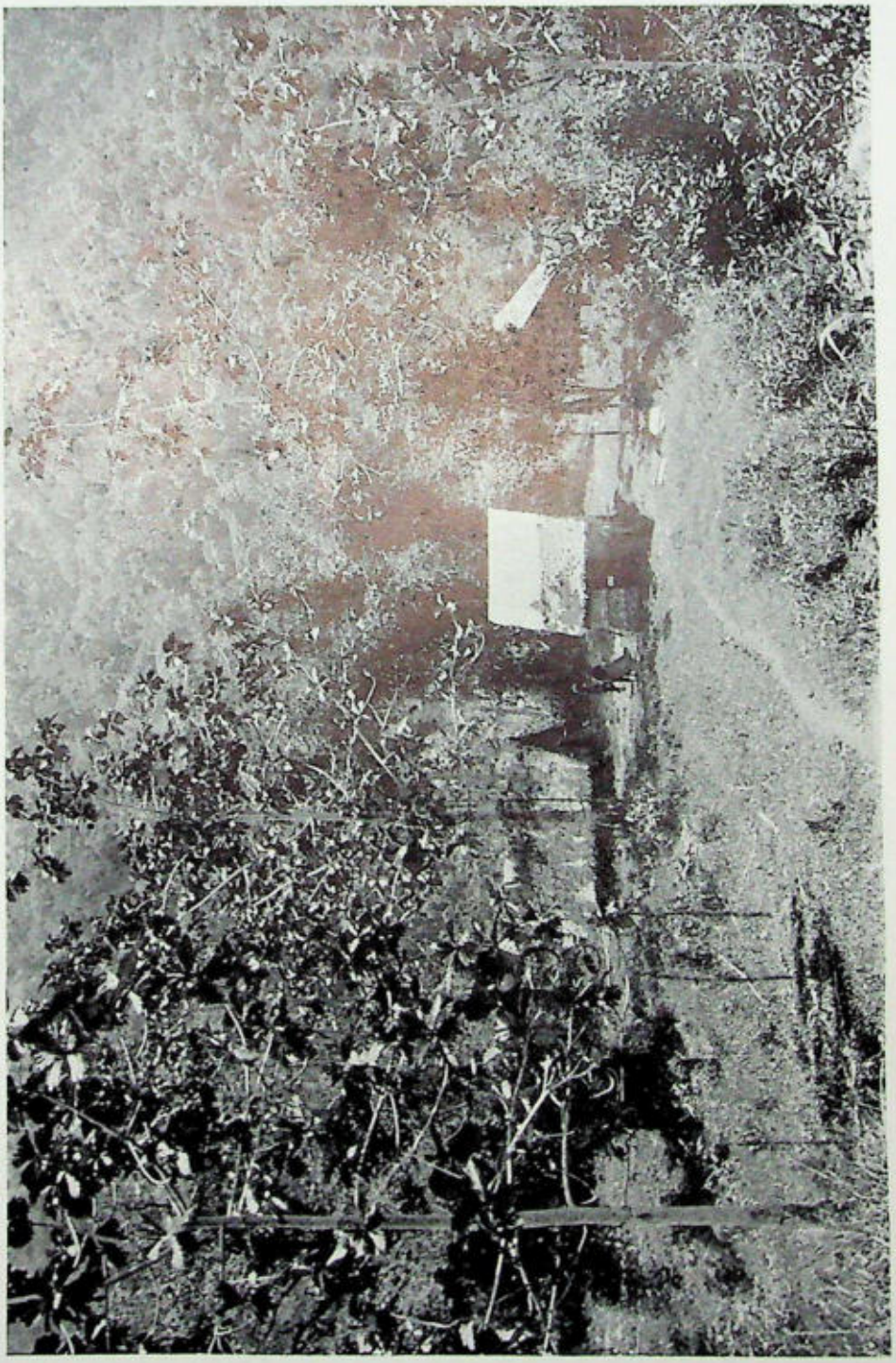
Mount Iola, as seen from Deva-deva. There are two peaks, one directly behind the other, bearing twin villages, also known as Iola. A large garden patch is seen on the lower slope. Iola is within shouting distance of Deva-deva, but visiting natives had a long walk to get to our camp.

A native garden at Deva-deva. Mountain natives seem invariably to live on the higher spurs, making their gardens on the slopes below their homes. The constant heavy rains and steep inclines make the soil difficult to hold. The cross barriers in this garden seem to indicate a primitive idea of terracing.

to complete our team of carriers, which meant a serious drain on our rice. After two days on the track, when we had reached a point known as Dieni, we found that food for both men and birds was practically exhausted. We were three days' proper march from Inawaibui, the nearest village, and there seemed nothing to do but try to get through in one day. We estimated the distance at about thirty-five miles, which seemed to me impossible to cover. However, we were astir before dawn next morning, divided the last of our rice and hard biscuits between ourselves, the birds and the boys, and set out in the first gray light. We made good time in the early coolness, but later, in the full heat of the day, we began to lose pace. Late in the afternoon, the boys began talking about the "big water," to which the little-used bush track we were following would soon bring us. They evidently looked forward to it without pleasure and I soon found their feeling was justified. The "big water" was an opening through the reeds of the great Bioto swamp, half a mile long, which was crossed on single three-inch poles, laid end to end, three feet under water. They were supported in forks formed by sticks thrust into the roots of the reeds on either side, and hand-poles were provided at long intervals in a similar manner. How the boys managed to get over with their loads I never knew, for they made the crossing before us. Two stopped behind to help Ward and me, and their assistance was needed.

Half an hour later, we came out on the Bioto track, two miles from Inawaibui. Here we found our party, sprawled among the bird boxes, devouring bananas. We rushed to our birds and found them gorging, as well. The explanation of this miracle was had from Koi. One of our boys, who lived in Inawaibui, had gone to his garden nearby and found a bunch of fruit ripened on a tree, carefully wrapped in leaves to protect it from birds and flying foxes. In New Guinea, one hears much of the laziness and uselessness of natives but the events of this day had put them in an entirely different light to me.

Mount Kebea. This lovely mountain, which has an altitude of about 6,000 feet, lies between Matsika or Valya, and Deva-deva. The track zigzags along the side of the mountain and it was here that we saw the first six-plumed bird of paradise. Kebea appears to represent the southwestern limit of the blue bird of paradise.



The headquarters of the expedition at Deva-deva. The shelter in the center is the patrol officers' house; the one at the left is for carriers; that at the right for native police. It was here that we gathered most of our birds of paradise. The tall trees with palmate leaves are bread-fruits.

Having refreshed ourselves, we made the short distance to the village with flying colors, and soon were established in the local rest-house, our birds slung underneath. There were plenty of bananas, pawpaws, taro and sweet potatoes to be had, and all joined in a tremendous meal. Next morning, we took stock of our birds, now somewhat recovered from their ordeal. We found that, for the most part, they had come through wonderfully well.

Rested after our night's sleep, we set out on the eight miles to our base in Inawaia, our feet flying over the flat Mekeo track, which was like a city pavement after what we had been through. Just outside the village, the boys stopped to comb their hair and decorate themselves with what leaves and flowers the bush offered, for they were too proud to be seen at the end of a long march in dishevelled condition. I took advantage of the opportunity to run ahead of them and set up my little motion picture camera, so that I could film them as they entered the village, bearing their heavy burdens with a lightness and grace I knew was largely bravado.

After two weeks of hard work in Inawaia, getting our birds back into condition and adding to our collection of lowland species, it was decided that I should go back into the middle mountains to try my luck. I was to take Koi and recruit ten boys for carriers, and Ward was to remain in Inawaia and look after the collection. This time, there was no difficulty in getting volunteers and I chose ten of the crowd that was willing to go. I knew all of these boys well and we were soon on a basis of comradeship ordinarily difficult to maintain with natives. They were constantly on the alert for my safety and comfort but never attempted to take undue advantage. Travelling light, we easily covered, the first day, a distance that usually requires three. Early morning of the third day found us established in a tiny mountain hamlet of four houses, called Kekefi. It was perched on a sharp spur facing almost due north. Across the valley, I could see the granite sides of Virjus Dome, with the Needles just beyond and the great crest of Mt. Yule, more than 10,000 feet high, rearing itself from the mists in the distance.

I sent back four carriers, so that we would not be too much of a drain on the local sweet potato gardens and settled down to await the birds I was sure we should get. Koi and I shared a tiny dubu with a hospitable native, who suffered from double cataract, and the six boys made a rude shelter for themselves.

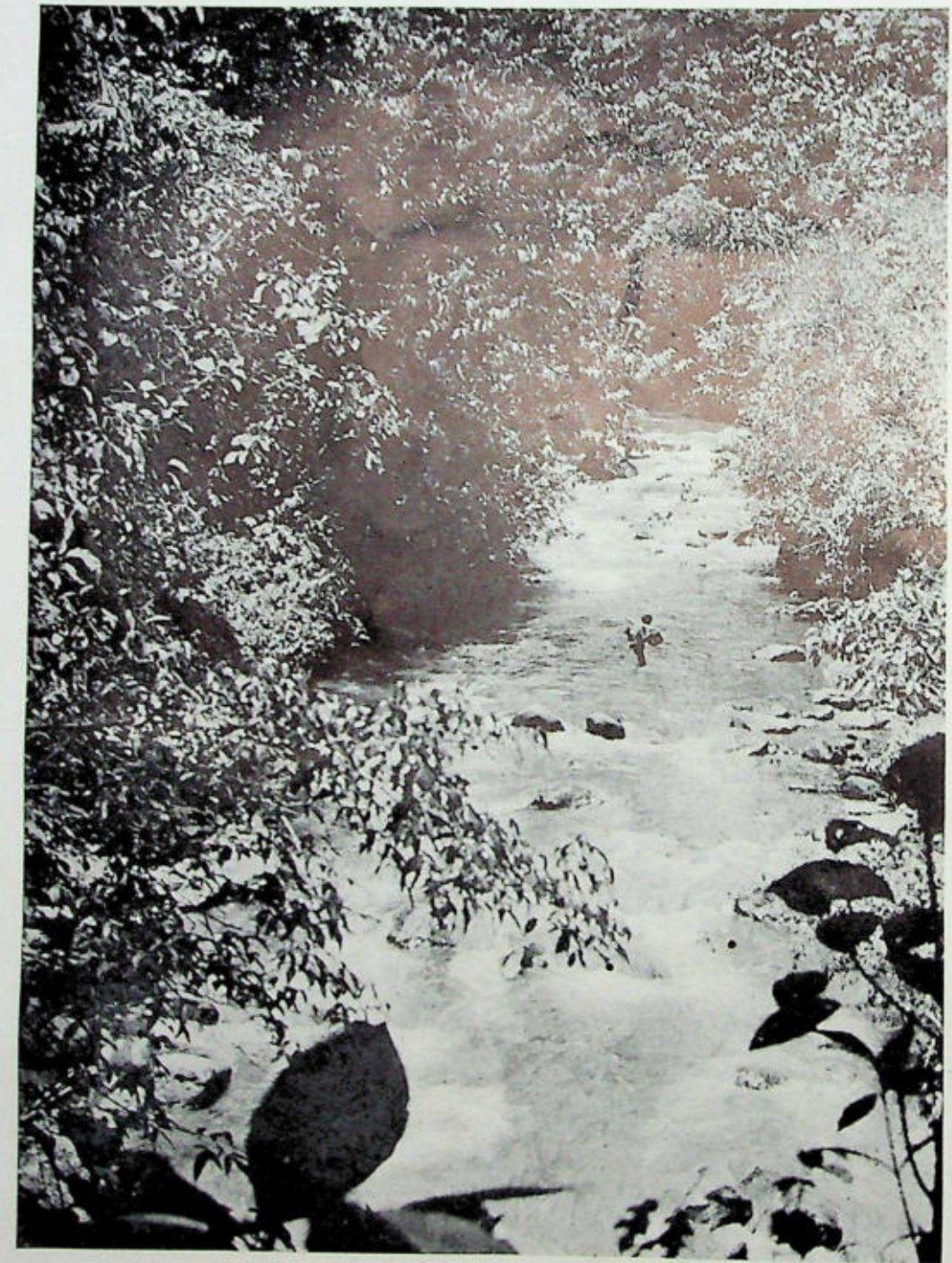
My aneroid showed the elevation to be 2,350 feet. Count Raggi's and magnificent birds of paradise, as well as the magnificent rifle bird, were abundant. The people assured me that there were plenty of king birds of paradise on the lower slopes of the mountains and that they would have no difficulty in getting them. However, several days passed, and while I had some lovely little fruit pigeons and black and chestnut shrike-thrushes, I received no birds of paradise. The would-be catchers finally admitted what I believed to be the truth—the birds were not dancing at that season and the only fruit at which they could be caught had just finished.

Realizing that further waiting was useless, we settled accounts with our friendly hosts and set out for Inawaia with what birds we had. We covered the distance this time in two days but not without some discomfort to myself, as I strained a knee-ligament early in the march and walked with difficulty. I found Ward well and happy, with numerous additions to the collection.

The time for the Morinda's bi-monthly call at Yule Island was drawing near, and we must leave with her or be caught by the impending rains. Angabunga Plantation, Mekeo's only commercial enterprise, lies about six miles from Inawaia, west of the river. Mr. N. G. Ducker, the manager, was planning to transport his copra to Arure, his station on Yule Island, for shipment on the Morinda. In spite of great inconvenience to himself, he agreed to allow us to fill a half-empty punt with our bird boxes. This was no small favor, for it saved us a walk of twenty-five miles or more, a march for which we should never have secured sufficient carriers. As it was, we had to muster most of the male population of two villages, well over eighty being required to carry our now formidable accumulation of boxes to the landing.

Running with the swift current, we made excellent time, and except for the usual excitement in passing snags and sand bars, the trip was uneventful. We reached the mouth of the

Upper left. Deva-deva native holding a gardener bower bird. This species is frequently caught for its decorative golden crest. *Upper right.* A six-plumed bird of paradise is brought in. This man's companion was severely injured in a fall from a tree, which accounts for his carrying two axes. *Lower.* Our first blue bird of paradise. While all of the species ate readily when held in the hands, the blue were particularly docile and took to their new lives without making the least trouble.



The Aya River. This river runs almost directly north, through the deep valley which bears its name. It must be crossed in going from Deva-deva to Mafulu. The carrier who is in the water, lost his footing and dropped a camera in the swift current. Fortunately, it was recovered without damage.

View from Popole, in the Mafulu district. The mountains shown are in the Ambo country, which lies to the north, across the Auga. The natives are not under control and in recent years have attacked several patrol parties.

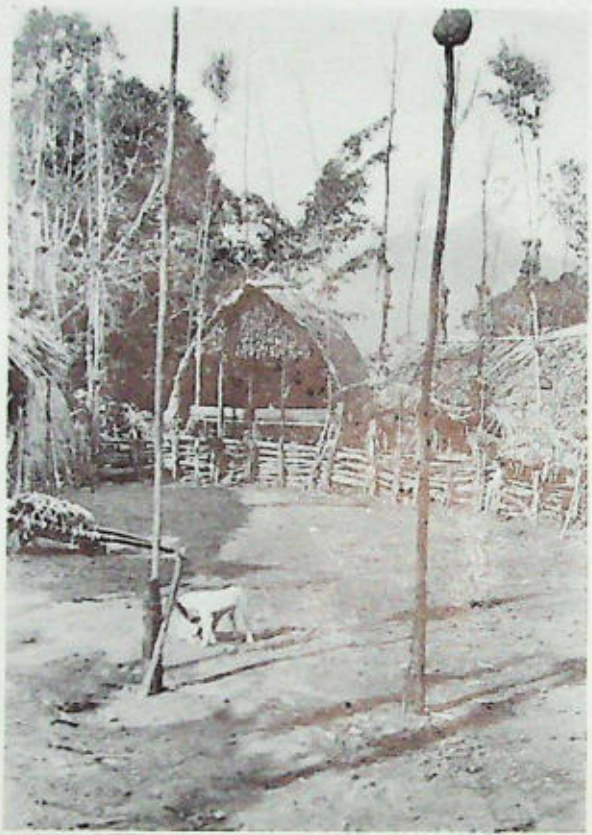
river at high tide, managed to scrape across the barrier into Hall Sound and soon were safely at Arure. For five days, we enjoyed the hospitality of Mr. and Mrs. Ducker, our birds comfortably stowed beneath the kitchen of their boys' house.

On December 9, for the first time in seven years, the *Morinda* entered Hall Sound far enough to anchor off Arure. Between punt loads of copra, we got our boxes of birds aboard and safely stacked under a shelter on the tiny poop-deck. Ward and I experienced a feeling of great relief and congratulated ourselves on the end of our troubles. We had only to sit tight, look after our birds and presently we should arrive, quite comfortably, in Sydney.

We spent the next day in Port Moresby, making official adieus and exhibiting our fine collection with pride. The *Morinda* sailed that night for Samarai, the second town of the Territory, situated at the extreme eastern end of the Island. About seven the next morning, as we were working on our birds, the ship gave a slight shudder and her engines stopped. We rushed to the rail and found that she was fast on a coral reef, which could be seen distinctly through the clear water. The engines were reversed, in an attempt to back the ship out as she had come in but this proved to be of no avail. We were about five miles off shore, at a point known as Dedele and did not feel that we were in any particular danger. However, the southeast trade wind stiffened, and as we were outside the barrier reef, we took the heavy seas full on our beam. The ship soon began to pound heavily on the reef, with the result that our cages could hardly be kept in position and their occupants were being badly shaken up. Two days later, the schooner *Matona* arrived from Samarai and removed a few tons of freight and our thirty passengers. For our birds there was no room, so we were unable to go.

On December 16, five days after the *Morinda* had struck, the steamer *Montoro*, called from Rabaul, arrived on the scene. After a

This beautifully symmetrical peak is just opposite the Mafulu village called Taruve, the most distant point to which the expedition penetrated.



Upper. The village of Taruve, in the Mafulu district. The plan of construction is quite different from that of Mekeo villages. All of the houses are small, and set closely together, forming an oval. The village can be entered only by climbing the bars at the left of the house shown in the center. *Lower.* A dance had just ended in Taruve and the invariable feast was about to take place. The houses are decorated with viands, including various fruits, yams and bark-wrapped bundles of smoked wallaby meat.

Upper. Our carrier train leaving Deva-deva for the long march to the lowlands. The boxes of birds made bulky and cumbersome loads. The usual method of carrying in Papua is well shown. *Lower.* A rest on the track. The expedition is safely back in Mekeo, after a strenuous and successful effort to save our collection of birds from loss through lack of food.

The *Morinda* fast on Dedele reef. Early on the first morning out from Port Moresby, on the return journey, the *Morinda* struck on the unyielding coral and was unable to free herself.

futile attempt to haul the *Morinda* into deep water, she took off the remainder of the freight and finally, ourselves. It was agonizing to see our bird boxes go over the side in slings, dropped helter-skelter into punts. Finally, they were landed, in the same manner, on the deck of the *Montoro*—cages upside down, slides smashed, food and water tins flying. When we had got them below and into some semblance of order, we were amazed and relieved to find that no harm had been done.

We proceeded to Samarai, back to Port Moresby and finally to Sydney, arriving on December 26. In spite of the unexpected delay and hardship, from Yule Island to Sydney we had lost nothing and our birds were landed in perfect condition.

Mr. Ward, at a considerable sacrifice to himself, placed his spacious Balmain aviaries at my disposal. Here our birds enjoyed rest and freedom for nearly six weeks, as there was no suitable ship leaving for New York. We passed the time in preparation for the long voyage, I over-hauling box cages, while Mr. Ward constructed a number of new ones, which proved excellent in practise.

One morning, our finest blue bird of paradise, the first one we had obtained at Deva-deva, escaped from a small cage in which he had been placed temporarily. We were able to follow him for a time, as he flew strongly from tree to tree, but we soon lost track of him. In spite of offered rewards, we could learn nothing of him and finally gave him up as definitely lost. Five days later, while working in the aviary, I was amazed to see our beautiful blue hanging on the outside of the wire, evidently looking for an entrance. I ran for Ward and presently we had baited a parrot cage with fruit, a string on the open door. In no time the delinquent was in his box, glad to be back where food and water were plentiful.

On February 6, I sailed for New York on the freighter *Canadian Cruiser*, sturdy flag-ship of the Pacific fleet of the Canadian National Steamship Line. Ernest Ward, Mr. Ward's

Soon after the *Morinda* had struck, the southeast trades sprung up. As she lay on the seaward side of the reef, she was fully exposed to the heavy seas and was subjected to a severe pounding.

Two days later, the 100-ton schooner *Matoua* came up from Samarai. Our passengers and some valuable freight were taken off but there was no room on the overloaded schooner for our birds.

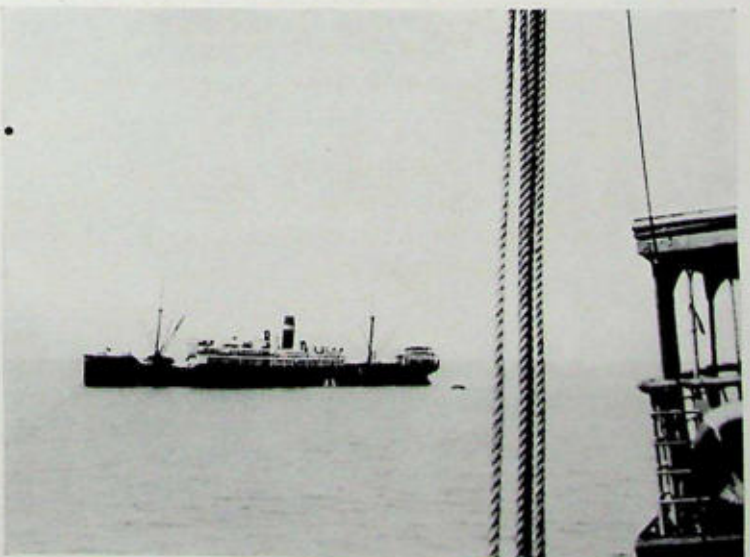
son, had managed to get leave from his government position, to accompany me. Our collection had been considerably enlarged by Australian specimens. Many of these were acquired by purchase, but Mr. Ward, by means of much hard work, managed to gather an excellent lot of the smaller species, not otherwise obtainable. Through the courtesy of the steamship officials in Sydney, we had secured a disused smoking room on the ship for our birds, with comfortable quarters for ourselves adjoining.

The voyage to New York, stopping only at Panama, required forty-four days, a long haul for our birds. However, we had started from Sydney with forty birds of paradise and when, on the warmest March 21 in many years, the *Canadian Cruiser* nosed her way to her berth in Gowanus Creek, South Brooklyn, the forty remained alive and well.

* * *

Since their arrival at the Zoological Park, the birds of paradise have continued to thrive, completing the molt that was then in progress. All of the adult males are now in full, brilliant plumage. The collection occupies the entire tier of cages along the north side of the Main Hall of the Large Bird House, where, throughout the summer and autumn, they were admired by great crowds of visitors. Of Prince Rudolph's blue bird of paradise, we have retained only two pairs, the three others, with several six-plumes, having been presented to the Zoological Gardens of Philadelphia, Washington and Milwaukee. The two remaining male blues are in almost constant display during the hours of daylight, hanging heads down from their perches, spreading their gorgeous colors without the slightest show of fear.[1] The deep red plumes of Count Raggi's bird of paradise may be compared with the golden yellow ones of the greater, a specimen of which we have had since 1926. The shining green breast plates and spreading hood of the lesser superb may be seen to ex-

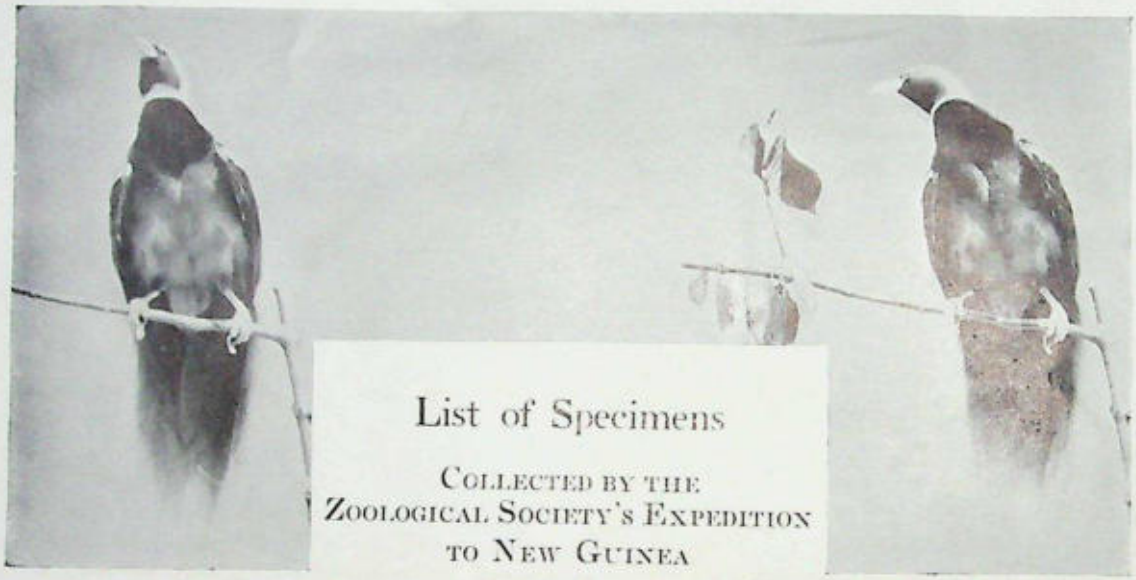
[1] A full description of the display of the blue bird of paradise, with a colored plate, was published in the Bulletin for September, 1921.



After five days of real hardship for our birds, the steamer *Montoro*, called from Rabaul, arrived on the scene. Our collection was transferred without mishap and finally reached Sydney without loss.

cellent advantage and a six-plumed may be detected at his curious dance, body plumage extended like a feathered umbrella, head plumes waving. That this display of beauty is appreciated by our visitors is evidenced by the numbers who enjoy it daily.

To cover the cost of the Expedition, the sum of $12,000, from the funds of the Zoological Society, was allotted by the Executive Committee. The total expenditure, including the final preparation of five reels of motion picture film, was within this amount.



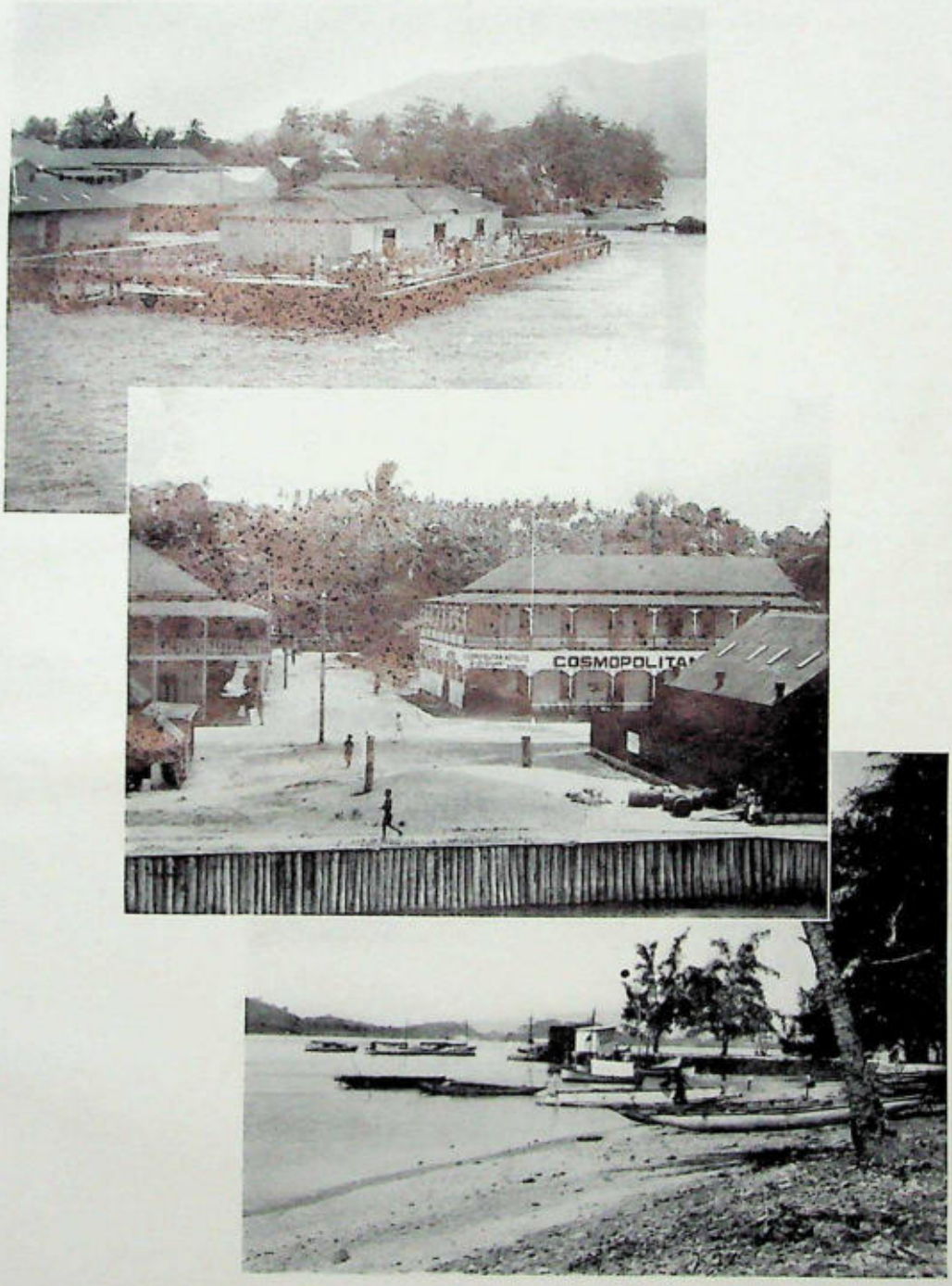
List of Specimens

Collected by the Zoological Society's Expedition to New Guinea

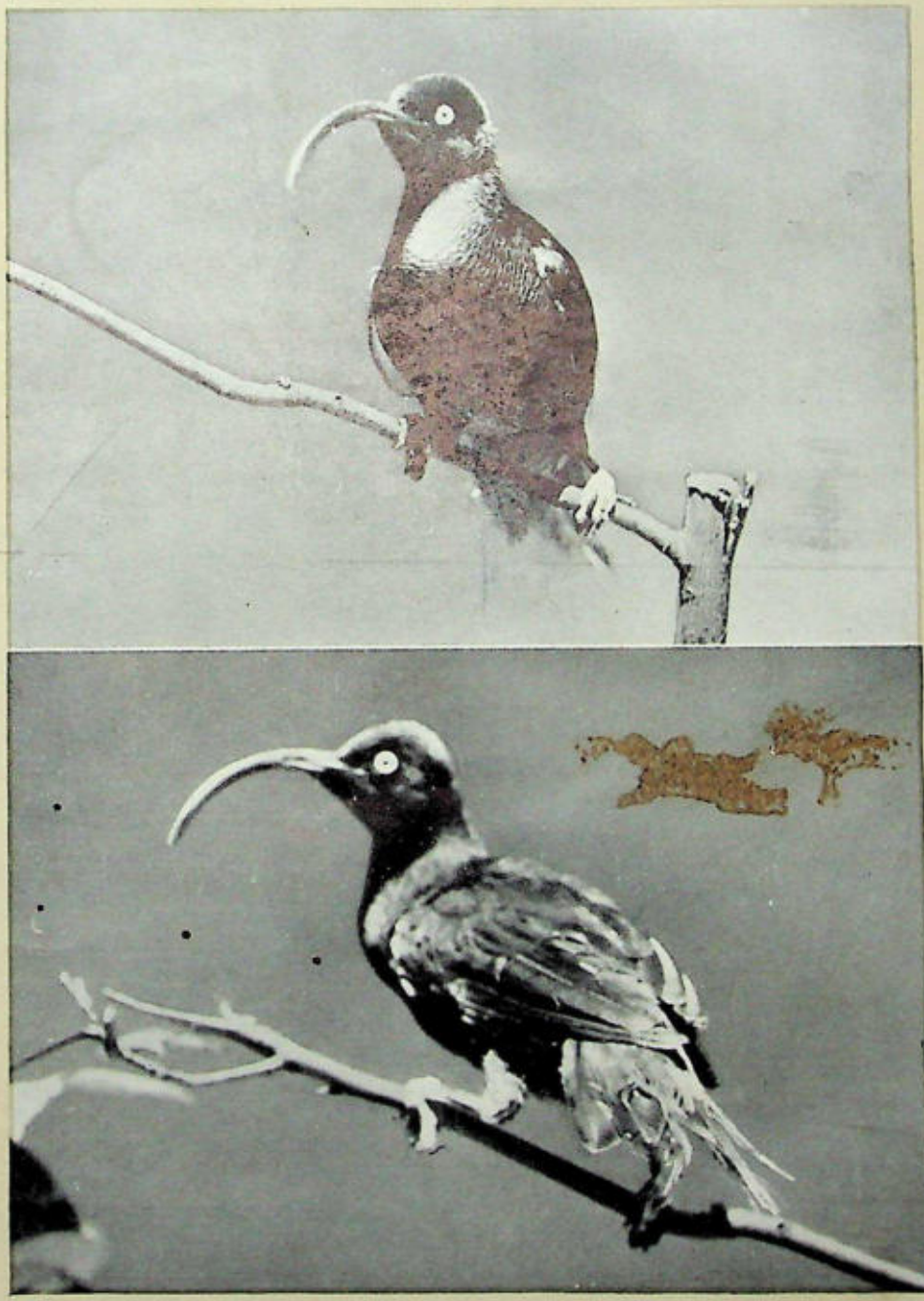
The Expedition left New York on August 9, 1928, and returned March 21, 1929, with forty birds of paradise, of nine species, about 200 other birds and several mammals. The list includes a number of rare Australian species secured on the return of the Expedition to Sydney.

16	Lawes' Six-plumed Birds of Paradise	*Parotia lawesi lawesi*
2	Long-tailed Birds of Paradise	*Epimachus fastosus meyeri*
6	Lesser Superb Birds of Paradise	*Lophorina superba minor*
1	Hunstein's Magnificent Birds of Paradise	*Dyphyllodes magnificus hunsteini*
2	Count Raggi's Birds of Paradise	*Paradisaea apoda raggiana*
7	Prince Rudolph's Blue Birds of Paradise	*Paradisornis rudolfi*
3	Horned Manucodes	*Phonygammus keraudrenii jamesi*
2	Black Manucodes	*Manucodia ater alter*
1	Blue Manucode	*Manucodia chalybata orientalis*
1	Black-headed Catbird	*Ailuroedus melanotus melanocephalus*
1	Fawn-breasted Bower-bird	*Alphachlamydera subalaris recondita*
1	New Guinea Friar-bird	*Philemon novaeguineae brevipennis*
2	Dumont Mynas	*Mino dumontii dumontii*
10	Purple Glossy Starlings	*Aplonis metallicus metallicus*

2 Green Glossy Starlings.....*Aplonis cantoroides cantoroides*
2 Gray-headed Mannikins .....*Munia caniceps*
8 Parrot Finches .....*Erythrura psittacea*
2 Gouldian Finches .....*Poephila gouldiae*
8 Chestnut-breasted Mannikins .....*Munia castaneithorax*
6 Diamond Finches .....*Steganopleura guttata*
3 Cherry Finches .....*Aidemosyne modesta*
2 Bicheno Finches .....*Stizoptera bichenovii bichenvoii*
4 Sydney Waxbills .....*Aegintha temporalis*
4 New Guinea Pittas.....*Pitta atricapilla*
1 Chestnut Shrike-thrush .....*Pitohui dichrous monticola*
4 White-rumped Wood Swallows.....*Artamus leucorhynchus leucopygialis*
6 Yellow-breasted Robins .....*Eopsaltria australis australis*
6 Superb Blue Wrens.....*Malurus cyaneus australis*
6 Australian White-eyes .....*Zosterops lateralis lateralis*
6 Black-and-white Fantail Flycatchers.....*Leucocirca tricolor tricolor*
2 Wonga-Wonga Pigeons .....*Leucosarcia melanoleuca*
1 Reinwardt Pigeon .....*Reinwardtoena reinwardtsi griseotincta*
1 White-throated Pigeon .....*Columba vitiensis halmaheira*
6 Brown Pheasant-pigeons .....*Macropygia amboinensis cinereiceps*
2 Blue-billed Pheasant-pigeons .....*Macropygia nigrirostris*
7 Golden-headed Fruit Pigeons.....*Sylphitreron ornatus gestroi*
4 Painted Fruit Pigeons.....*Ptilopodiscus coronulatus coronulatus*
1 Superb Fruit Pigeon.....*Ptilinopus superbus superbus*
1 Lilac-shouldered Fruit Pigeon.....*Chlorotreron iozona iozona*
2 Red-crowned Fruit Pigeons.....*Ptilinopus pulchellus pulchellus*
8 Yellow-heart Pigeons .....*Gallicolumba rufigula rufigula*
1 Black-fronted Amethyst Pigeon.....*Gallicolumba jobiensis*
1 Bustard-Pigeon .....*Otidiphaps nobilis cervicalis*
8 Stephanie's Pigeons .....*Chalcophaps stephani*
3 New Guinea Green-winged Pigeons .....*Chalcophaps indica chrysochlora*
7 Red-necked Rails .....*Tomirdus tricolor grayi*
2 Australian Stone Plovers.....*Burhinus magnirostris magnirostris*
2 Giant Laughing Kingfishers.....*Dacelo gigas gigas*
4 Blue Grass Parrakeets .....*Melopsittacus undulatus var.*
2 Cobalt Grass Parrakeets.....*Melopsittacus undulatus var.*
4 Barraband Parrakeets .....*Polytelis swainsonii*
4 Yellow-rumped Parrakeets .....*Platycercus flaveolus flaveolus*
2 Mealy Rosella Parrakeets.....*Platycercus adscitus palliceps*
2 Barnard Parrakeets .....*Barnardius barnardi*
4 King Parrakeets .....*Alisterus cyanopygius*
1 Blue Bonnet Parrakeet.....*Northiella haematogaster xanthorrhoa*
4 Crimson-winged Parrakeets .....*Aprosmictus erythropterus*
2 Blue Mountain Lorikeets.....*Trichoglossus novaehollandiae*
2 Echidnas .....*Echidna hystrix*
2 Great Red Kangaroos .....*Macropus rufus*
1 Agile Wallaby .....*Macropus agilis papuanus*



Upper. Leaving the wharf at Samarai. Situated at the extreme southeastern end of Papua, Samarai is the second town of the Territory. It is a lovely spot, set in delightfully tropical surroundings. *Center.* In spite of its secondary importance from a governmental point of view, Samarai enjoys far better shipping facilities than does Port Moresby. On steamer days, at least, it presents an air of business-like activity. *Lower.* The harbor at Samarai is particularly beautiful. This is a native section, where the outrigger canoes are drawn up on the beach.



Long-tailed Bird of Paradise. *Epimachus fastosus meyeri* Finsch.
Immature Male.