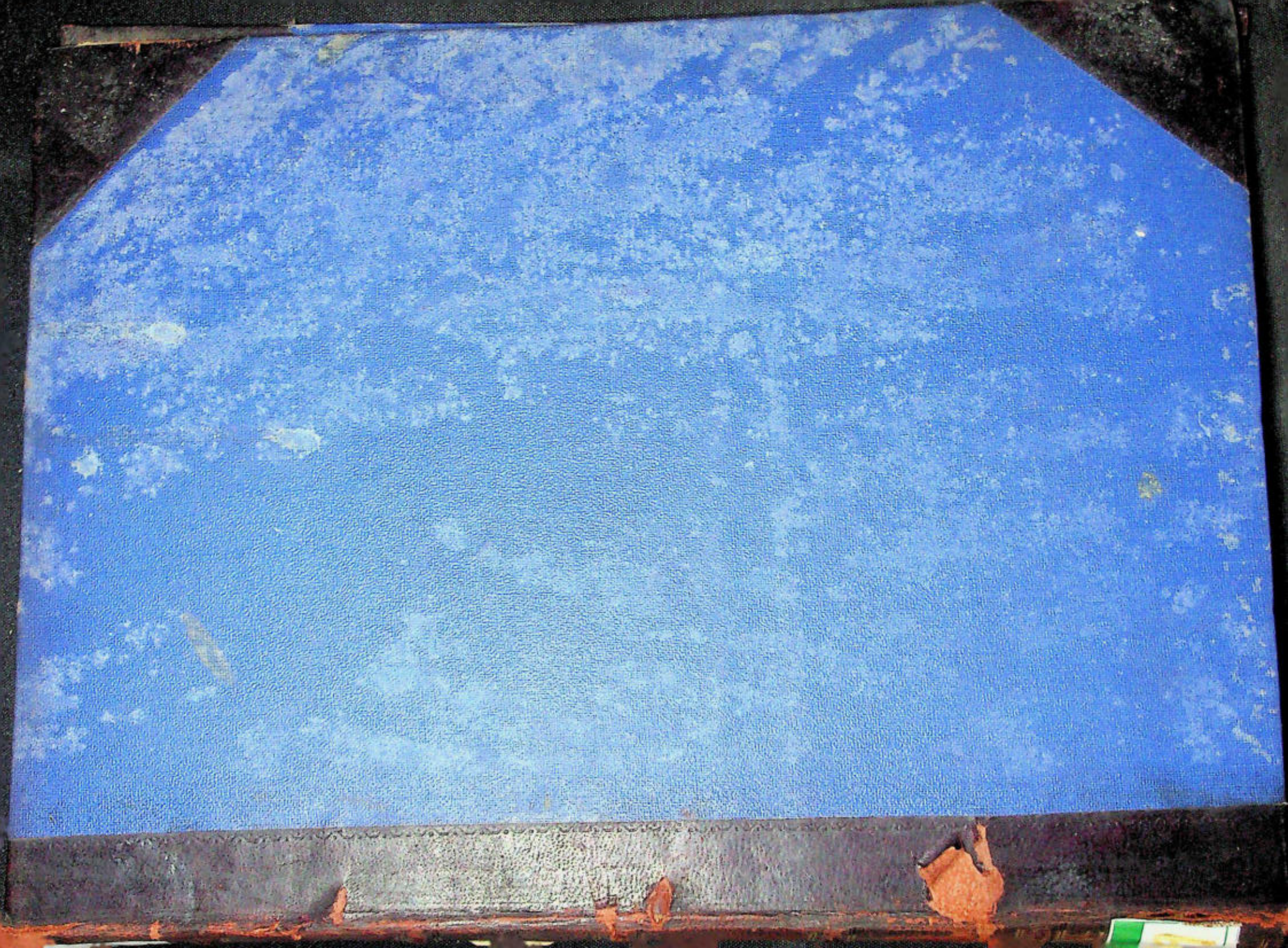


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Illustrations

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Great Gray Kangaroo
Giant Red Kangaroo
Island Kangaroo
Parry's Kangaroo
Black-faced Kangaroo
Woodward's Kangaroo
Wallaroo—Euro Kangaroo
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Agile Wallaby
Rufous-necked Wallaby
Bennett's Tree-kangaroo
Short-tailed Wallaby
West-Australian Rat Kangaroo

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Bennett's tree-kangaroo *D. bennettianus*, in a tree, about twenty-five feet from the ground.
From a photograph by the late W. H. D. Le Souef.

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BULLETIN
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Kangaroos and Their Kin*

Australia's National Animals in the Wilds and Captivity.

CHARLES BARRETT, C.M.Z.S.
President of the Field Naturalists' Club of Victoria

Illustrations from photographs by the author taken in Australia, and from the collections of the New York Zoological Society by Elwin R. Sanborn.

AUSTRALIA still is the "Land of the Kangaroo." Though many millions have been slain for their pelts and persecution is almost unceasing, kangaroos and wallabies occur abundantly over wide areas of our island-continent. In Victoria, smallest of the commonwealth states, excepting Tasmania, kangaroos are increasing, and only this year "drives" were carried out, to thin their ranks, in several districts. Protection proved to have definite "survival value": before the game laws guarded them, kangaroos were becoming fewer every year in Victoria.

Other states, much larger than Victoria, allow kangaroos to be hunted all through the year; but eventually will be compelled to protect them, at least to limit the hunting season—else lose our national animals as familiar objects of open forest country and the plains. At present, happily, none of the large species is in danger of extinction, though some of the smaller forms (wallabies), are becoming scarcer.

It is one hundred and sixty years since the first kangaroo was seen by white men. The record of a remarkable discovery is given in the original account of Captain Cook's voyage, during which he chartered the east coast of this country and made it a British possession. Cook was the real founder of Australia; and was it not fitting that our world-famous mammal should by him have been discovered?

Not the great navigator himself, but one of his men first sighted a kangaroo. It was on a winter's day—June 22nd, 1770. A party from the *Endeavor* had been sent into the bush to shoot pigeons, as delicate food for the sick on Captain Cook's staunch little vessel. They discovered many Indian (sic) houses, the narrative states, and a fine stream of fresh water—and the kangaroo! Returning, they reported having seen "an animal . . . as long as a greyhound, of a slender make, of a mouse color, and extremely swift." Soon afterwards the Captain himself, and several others, including (Sir) Joseph Banks, the botanist, had the good fortune to see the strange animal. Eventually a specimen was shot. Since then millions have fallen to the gun, or other weapons.

The destruction of these marsupials has been encouraged by Governments placing a price on their heads. In twenty-five years (1877 to 1902) the Queensland Government, it is recorded, paid for the scalps of nearly seven and a half million kangaroos and wallabies! The tally for six months only, on one station (ranch) was 60,000.

There has been no truce in later years. Vast numbers of kangaroos and wallabies are killed

* Scientific nomenclature has been left to the discretion of the Author.—Ed.



Gap leading through limestone cliffs two hundred feet or more in height, to the coastal plains in southwestern Australia. This is the habitat of kangaroos, *M. robustus woodwardi*, and the black-gloved wallaby *M. irma*. From a photograph by Charles Barrett.

annually by the pelt hunters. It is ruthless slaughter for gain, and, although conservation is urged by naturalists and nature lovers, it is justified, not on the score of commerce only, but for the reason that the grass-eating marsupials are competitors of sheep and cattle for natural food supplies, and they raid cultivation areas when the crops are young. Thus pastoralist and farmer have ever been leaders in the endless campaign against the kangaroos, and some of their smaller cousins, the wallabies. It has been, in all states, (Victoria excepted, in recent years) a war of extermination. Fortunately, some pastoralists give a measure of protection to the kangaroos on their wide holdings of the country. Besides, there are large reserves, sanctuary for all the Australian animals that frequent them. Conservationists do not despair of saving kangaroo and wallaby for posterity, though inevitably, as closer settlement spreads over the vast station areas, native animal life must steadily decrease.

Results of Destruction:—Those who hold a brief for the marsupials claim that wholesale destruction of kangaroos and wallabies has not achieved its main object. I quote from a standard work, "The Animals of Australia," by Dr. A. H. S. Lucas and the late W. H. D. Le Souef (former Director of Melbourne Zoological Gardens), the following:

"In many districts the slaughter of their natural prey has turned the attention of the dingo to the sheep, and when once a dingo has tasted sheep he is henceforth contemptuous of kangaroo. Another evil has been ascribed in Queensland to the destruction of kangaroos. They were wont in past times to crop down the grass which grew in and around the patches of scrub where the sheep had not as yet penetrated. Now the grass grows and withers, and thus affords tinder for serious bush fires."

Dingoes (*Canis dingo*), the wild dogs of Australia, hunt in packs, alone, or in pairs, and are notorious sheep-killers. They take heavy toll of the flocks, and have no human friends, excepting the aborigines, who domesticate these "warrigals." In the inland areas, where human habitations may be fifty miles apart, dingoes abound. So numerous are they, in parts of Western Australia, that trappers are "in clover." One man, whose camp I visited a few months ago, told me that his average earnings amount to £15 (75 dollars) weekly; while occasionally he made five times as much. The "bounty" paid is £2 (10 dollars) for each "kill." Scalps and tails are the proof required before payment. Dingoes still prey upon marsupials, where they cannot get sheep; but undoubtedly man's war against kangaroos has tended to make the wild dog a sheep-killer.

The aborigines, of course, for many centuries, were enemies of the kangaroos and their kin; and still are in the central and northern portions of Australia. But, from the greater part of the continent the native tribes have disappeared, or are represented by a few scores or hundreds of more or less civilized blacks, mostly on mission stations or in reserves for aborigines. Many of these people have never hunted the kangaroo; some know less of its ways than does the city-business man, who, with a taste for natural history, spends his holidays out in the wilds.

The aborigines, nowadays, hardly count, excepting in the unsettled and "undiscovered" region, as enemies of the kangaroo. And even when the land was solely theirs, before the white man came, the blacks were no great menace to marsupial life: they were not sufficiently numerous, with all their hunting, to check the increase that nature ordained. Kangaroos and wallabies swarmed on the grass-plains and in open forest regions and, according to their species, in other classes of country. True, certain kinds, now rare, may never have been very abundant; but those with which we are most familiar, doubtless existed in countless numbers long ago, where now there are a few thousands or hundreds only.

The records of the rocks show that from the "Dream Time," as Arunta natives term the era of their legendary ancestors, the kangaroo has been associated with aboriginal life. One of the many "totem" animals, the kangaroo is forbidden as food to those tribesmen whose totem it is. It is figured in primitive "art galleries," either painted in white (pipeclay) or red ochre, or carved in the living rock of caves and shelters. Many of these portraits of *Macropus* have I seen: some crude as a child's chalk drawing on the nursery floor; others, though only in outline, nearer to nature than are the kangaroos painted in our studios!



Aboriginal rock-carvings. *Upper.* This petroglyph at Mootwingee, New South Wales, is famous for its antiquity. It is supposed to have been executed several thousand years past. The two white forms in the lower left are boomerangs, an interesting aboriginal weapon of strange power. Photograph by Charles Barrett. *Lower left.* Another carving depicting a kangaroo with a spear in its back. Also a smaller kangaroo and a deity. Duffey's Forest, New South Wales. *Lower right.* Rock carving of a kangaroo depicting that it has been speared by an aborigine. The carvings have been chalked to aid photographic delineation. From photographs by B. L. Hornshaw.

Some of the rock-carvings are fine examples of "pecking," a very ancient craft, or art. The lonely, rugged Mootwingee Range, in northwestern New South Wales, was for centuries frequented by the blacks, maybe for ten thousand years. They have all gone now, and the gorge, where they feasted and carved figures and symbols on the rocks, is guarded by the white man's law as a reserve because of the art they expressed there.

When I was at Mootwingee, kangaroos often came near to the camp, just below the rock-holes that hold water even during a drought. These natural reservoirs, in an arid region, attracted both birds and marsupials; and the blacks could live at Mootwingee when, for miles around, the country was waterless and sere, and almost gameless. It was unsafe, in those far off days, for a kangaroo to appear "within cooee," as we say, of any camp-site! But then the animals were numerous; now they are few in the ranges.

There are innumerable pictures in that gallery, formed by nature, and decorated by primitive man. Flat and sloping rock-faces are covered in carvings; while a great high and shallow cave, which was used by the blacks as a shelter, has its walls flaked with "red hands" and other paintings, one being in the form of a huge serpent. On the rock by a pool are emu feet, thought to be the oldest petroglyphs in the romantic gorge. Their age has been estimated at from five to ten thousand years. Very ancient they certainly are.

In myth and legend the kangaroo has its place, but, strangely, one less prominent than that held by the emu, and some other birds, and by mammals less closely associated with aboriginal life than the kangaroo has ever been. Consider how many of the blacks' needs have been supplied by the kangaroo. Tribes that effected "dress," made their one-piece garments mainly of kangaroo skins. Universally, the flesh was native food; while use was made of leg bones for various purposes: needles were fashioned from them, for instance, and tendons off the hind-legs and the tail utilized as "thread." Some tribes wear kangaroo bone nose-ornaments. Necklaces were made out of the incisor teeth of kangaroos, attached to long strips of the animal's skin, dressed until pliant as a worn kid-glove. The tail-sinews were used to sew the teeth to the leather. Its importance as a totem animal should be remembered, too. One would expect a big crop of kangaroo legends and myths. Of course, there are many, but fewer than might have been invented by the "tellers of legendary tales."

The origin of the very word, kangaroo, is uncertain. You will not find it in vocabularies of aboriginal dialects, though "koongaroo" and "kungara" are native words. Captain Cook obtained it from the Endeavor River tribe; or some word of very similar sound. "Kangaroo" was a word unknown to the blacks in the "type" locality of the first kangaroo seen by white men, when an explorer visited it fifty years after Captain Cook. The term in use was "menua." The red kangaroo was known as "purra" by the members of one tribe; and the grey kangaroo, as "kaiimer." A list of kangaroo words from the vocabularies would be long. It has been suggested that the tribal name of the first-comers to Australia began with the sound "koo," and that, finding no human inhabitants, they "whimsically called the kangaroo, which they saw standing erect like themselves, by their own tribal name"!

How the kangaroo got its tail is the theme of one myth—of an extinct Victorian tribe. Mirram (the kangaroo) and Warreen (the wombat), once upon a time were men, and lived in the same place; the latter had a good camp; the former had none. After a great rainfall, Warreen was snug by the fire in his bark shelter, while Mirram shivered outside, his fire extinguished. The wombat would not allow his friend even a corner of the camp. Well, Mirram lost patience, flattened Warreen's head with a stone, and said "You shall live in dark-holes"—the wombat's dwelling is a burrow. One day, Warreen threw his spear and it stuck fast in the lower end of Mirram's backbone. "It will be a tail for you," said the wombat, and you shall have to use it when you run." And that's how the kangaroo got his tail.

He makes good use of it, too! But not in the manner believed by those who have never watched kangaroos closely, or are familiar with them only as captive animals. The broad-based, powerful organ is used as a third leg, a support when resting. When the kangaroo hops, with body inclining forward, its tail does not "beat"



Agile wallaby *M. agilis* in the Zoological Gardens, Melbourne, Australia.
From a photograph by Charles Barrett.

the ground, but acts as a balance: a tailless kangaroo would topple over "on the hop," instead of being nicely balanced on its hind legs.

Kangaroos are splendid jumpers, but when traveling at a leisurely pace, cover only about four or five feet in a hop. The faster they go the longer the hop, with return to short ones if the ground offers obstacles. Records vary, but, at its best, a fullgrown kangaroo might cover eight or nine yards with one hop. Often I have watched kangaroos in the wilds, and wished that I could measure their "steps," as they fled across the plain or through the timber. There is no more wonderful picture of wild life at home, in Australia, than a mob of kangaroos hopping from what may be danger. I have never hunted them. That is not sport, though kangarooing on horseback, with dogs trained to the hunt, is still described as "sport" by many Australians. Pursuit in motor-cars also is favored by some shooting men. Well, I am no sportsman for I hunt only with fieldglass and camera. A living animal to me is worth a hundred dead ones of its kind, whether it be furred or feathered.

Kangaroos and wallabies, generally speaking, thrive in captivity, if properly fed and given ample room to move about, in their own peculiar manner. It is cruel to keep them in small enclosures. Many I have seen, pets of the family, had the freedom of big yards, or even a paddock. Others were so content with a tame life, that they were allowed to go where they pleased. One old kangaroo, was a familiar figure in a little township or village. He visited the neighbors! Again, kangaroos may be kept in a wire-netted run, many yards in length and two or three hops wide. They do not appear to be unhappy in such quarters.

On some of the sheep stations, kangaroos are allowed to live in reasonable numbers; a "drive" being held occasionally to prevent over population. The animals are not necessarily killed, though the drive, in some cases, is, frankly, slaughter. Look at the pleasanter picture.

This year, two kangaroo drives were held in Western Victoria, by authority of the Fisheries & Game Department. The animals were shepherded into a high-fenced "corral," and captured without being injured. They were sent to the Zoological Garden, which needs kangaroos for exchange with Zoos in America and other countries. The demand is pretty constant; and

for our marsupials we receive bears and buffaloes, deer, birds, and other creatures—at current exchange rates.

During a drive, kangaroos may display their powers of leaping. They jump at the high fences, and sometimes get over. Hunted, a kangaroo has taken a fence nine feet in height, without touching the rail. This is exceptional, possibly a record; for many kangaroos, unfortunately, break their legs in attempting paddock fences on the stations. Six feet is a good jump for a kangaroo, and often enough a fence of that height baffles them. Those crippled in trying to jump wire-fences, die slowly of hunger, or are put out of their misery by the boundary rider, who has also to kill disabled emus. The fences claim many victims, and emus predominate.

Notable among the squatter friends of the kangaroo was the late Mr. H. L. White, of "Belltrees" Station, Scone, New South Wales. He was a rich and generous patron of natural history, and himself a fine naturalist, specializing in birds. His collection of Australian birds' eggs, the most valuable and complete in the world, was bequeathed to the National Museum, Melbourne. Mr. White, in a fifteen acre paddock, kept about thirty kangaroos and a few wallabies. He began, many years ago, by having tame kangaroos about the homestead, allowing them full liberty. But visiting dogs killed so many, that an acre was enclosed with wire-netting, for a grey kangaroo and some wallaroos. Finally, the big paddock adjoining the house-garden, was surrounded by a six-foot fence of netting and barbed wire. When Mr. White wrote the story of his pets (for the "Australian Zoologist") his stock consisted of fifteen wallaroos (*Macropus robustus*), ten grey kangaroos (*M. giganteus*), and five red kangaroos (*M. rufus*). All of them bred freely; wallaroos more than the other kinds, so that it was difficult to keep their numbers within reasonable limits. However, the population of the paddock was reduced by liberating some of the "captives." It was not easily done, for they declined to go through the open gate when driven, instead, in their excitement, dashing into the fence. They would "run or jump over both man and horse attempting to stop or to turn them."

The first grey kangaroo kept by Mr. White became famous. He was an immense animal,



Bennett's wallaby *M. bennettianus* in the Zoological Gardens, Melbourne, Australia.
From a photograph by Charles Barrett.



A scene on the Daintree River, North Queensland. In the mountains where this river has its source is the habitat of the tree kangaroos. From a photograph by Charles Barrett.

named "Ben," and a wonderful fighter. He had a very bad temper, and was dangerous. "Upon several occasions," his owner wrote," he broke the wire netting by kicking it when teased, and he half-killed a couple of men who ventured into his domain; he was eventually destroyed." "Ben" liked a bath; and, before he became savage, would approach when the gardener was watering. When the hose was played upon him, as he stood against the wire-netting, "Ben" would "turn round slowly, lifting his arms meanwhile, so that every portion of his body got a thorough wetting."

Zoo Director's Records:—No one has a wider knowledge of kangaroos in captivity than my friend, Mr. Andrew Wilkie, Director of Melbourne Zoological Gardens. He has completed over fifty years' service at the Zoo, having started as a youth. For many years he was foreman, succeeding to the directorship on the death of Mr. LeSouef.

Necrosis, Mr. Wilkie states, is the chief cause of mortality among captive kangaroos, but there is no evidence that it is at all prevalent in their wild state. Soon after they are captured, the complaint may develop; or it may not do so until months later. Healthy animals shipped to Great Britain, died soon after arrival, from necrosis.

Again, from no apparent cause, other than fretting for freedom, death may occur. Thus, more than a score of kangaroos captured in a drive, died within a few months. Post mortems revealed neither disease nor ill-nourishment—the victims had fed normally. But, many of the marsupials, happily, escape disease and do not suffer from longing for the wilds. They settle down in the paddock, and become quite friendly. These contented and healthy captives are general favorites.

Some of the kangaroos have lived at Melbourne Zoological Gardens for fifteen years, and still are in good condition. They are familiar friends of mine. But I venture into their enclosures with caution. When the old males become "playful," they are apt to be rather dangerous, unless one is watchful. A foolish visitor, who worried a kangaroo he had lured to the wire fence of its paddock, received a cuff from a paw which sent him spinning. He deserved the punishment.

"Boxing" is a natural habit, even a pastime of the kangaroo. The males often have stand-up fights, lasting for half an hour, or even longer. They cuff one another vigorously. Fights are fierce in the pairing season; at other times kangaroos are generally peaceful.

Training boxing kangaroos is not so difficult, since, in their natural way of "fighting," they nearly reproduce many movements of the human boxer. At Melbourne Zoo, once, a professional boxer did some sparring with a grey kangaroo, which won on points!

An irate male kangaroo literally drove a man from the paddock. Two of the animals, on another occasion, got a man down and thumped him with their hind-legs. He was fortunate to escape with only a broken collar-bone and several fractured ribs.

Mr. Wilkie has frequently measured the hops of kangaroos going at high speed, and finds the average distance covered to be about sixteen feet. He has seen a "flying doe" clear a nine-foot fence, and a male scramble over one the same height.

The biggest kangaroo (one of the "red" species) Mr. Wilkie has had in his care, measured seven feet when standing on "tip toe"—that characteristic attitude, especially when the animals are fighting, or at bay after fleeing from dogs.

Many kangaroo-dogs have been killed by the hunted marsupials, which may face the pack, with back to a big gum tree (Eucalyptus), or standing in the water. If it has the chance, a hard-pressed kangaroo will hop into a stream, a lake, or a lagoon, even a waterhole, and await its pursuers. It is formidable, even against odds, and often the dogs, without aid from human allies, would get the worst of the encounter.

I have seen hunting dogs deeply scarred—kangaroo-claw wounds; and some ripped so terribly that they died. I have known dogs to be saved only by the hunter rushing in to brain the kangaroo with a stock-whip or a stirrup, or to shoot at close range. It's not sport; it's butchery: a term applicable to kangaroo shooting from motor cars, which is practised in some places.

Hunting on horse-back is the old colonial method, still favored, though public opinion is gradually turning against this sport, also. It

is exciting and has the spice of danger, since at full gallop in rough country, the hunter may be thrown when his horse fails to clear a log or puts its hoof in a burrow or a hole. An "old man" kangaroo, having wonderful powers of endurance, may get clear away when hunted, outpacing both horses and dogs. Brought to bay, he will put up a brave fight. Two dogs might easily fail to bring him down. Three or more, as a rule, form the pack. Then tactics, quite unfair, may end the fight. One dog holds the kangaroo's attention, attacking fiercely in front; giving its companions the opportunity to leap on the marsupial and kill or disable it. Often victory is paid for, a dog being killed and others wounded.

The kangaroo boxes with its fore-feet, and uses the hind ones when fighting for its life. Should the chance offer, it seizes a dog with its fore-paws, and dashes it violently to the ground; or, hugging the enemy, rips it open with a powerful upward blow: the big conical claw on the central toe of the hind foot is a killing-weapon. When the blow is given, the animal's body weight is supported wholly by the tail.

At bay in the water, a kangaroo, when it seizes a dog, always tries to drown it, and often succeeds. But it will not, despite the camp-fire stories one hears, carry a dog to water for this purpose. Rarely, a kangaroo may rush a man. I've never seen such an attack made, but there are records of kangaroos leaping at hunters.

Snaring is one method of getting kangaroos, in vogue more in the past than at present. A thick snare of wire is attached to a post or a log, which is set in a "run" in the bushland or in a paddock fence. This often involves cruelty, for if the snares are not visited night and morning a kangaroo may remain for many hours, struggling for freedom, and suffering horribly.

Aboriginal modes of hunting the kangaroo are many. It may be run down by one man, who follows recent tracks until he sights his quarry. He advances openly and, when the animal goes hopping away, runs after it. Again and again this may happen, until the hunter wins the long race of endurance. Often the end does not come until the second day, the aboriginal sleeping on the track, which guides



A view of the coastal country of Victoria. The habitat of the large wallabies.
From a photograph by Charles Barrett.



The "Cave of Red Hands," Mootwingee Gorge, New South Wales. These caves were frequented by the aborigines, where they cooked and ate the kangaroos that they had killed. From a photograph by Charles Barrett.

him next morning to the kangaroo, perhaps many miles from the little camp-fire.

Drives are carried out, the hunters advancing from several directions on a mob of marsupials. Another method is firing the bush, so that the flames will force the kangaroos towards the natives, who are ready with their weapons, to kill. Stalking, with the long-handled spear, is practiced by many of the tribes.

Netting is a usual method, in some districts, of taking kangaroos. Three-sides of a square often are "walled" with nets, and many noisy, naked beaters drive in the kangaroos, which are speared or killed with waddies (clubs). Emus also are taken in this manner.

While kangaroos nowadays are rarely seen near large towns, small parties appear in the vicinity of outback homesteads and farmhouses. They come into the crops. I have seen them often in the Mallee country of north-western Victoria; have come quietly along a lonely road between cultivation paddocks, to surprise the raiders. They stand and gaze for a few moments, heads and shoulders only showing above the wheat or other crop. Then off they go with long hops, clearing the fence at a bound, or scouring through the crowded plant stems. Sometimes they hop across the road in front of a car.

During my motor journey along the Darling River, in New South Wales, last year, I counted nearly 500 kangaroos. Mostly the mobs were small, but occasionally a score or more of kangaroos were sighted, feeding on a green patch among the gum trees. They were frightened of the car, bounding away as soon as they saw it. It was surprising the ease with which they travelled through the forest, avoiding trees and clearing the logs, at high speed. Halting in a patch of timber—old, grey-boled gum trees—they were camouflaged. Their coloration harmonizes with such an environment, though the kangaroos are noticeable enough at a long distance, out on a grassy plain.

When a mob is frightened from the feeding-ground, the does, which are fleeter than the males, and the young are away first. The old males bring up the rear. They are graceful when travelling at any pace, but I like best to watch them going at full speed. A "flying doe"



Rain-forest or "brush." In North Queensland. Small wallabies frequent this class of country, where timber cutters lead lonely lives. Cassowaries were seen in this spot where the tree has been felled.
From a photograph by Charles Barrett.

would make a splendid cinema film, if only we could get more than a few feet of such a subject!

Once, a "boomer," as the huge old males are termed, went bounding down the main street of a gold-mining township. There were dozens of men about, but surprise held them still for a while. Then, some with shovels, others with pickaxes or sticks, they began the hue and cry. It was too late: the boomer was already beyond range of their weapons.

Drought, which takes such heavy toll of our wild animals, drives kangaroos and emus, in some localities, close to settlement, in quest of green feed and water. But these animals are able to go for days without drinking and, in a prolonged rainless period, die of starvation rather than thirst.

In poor condition they become an easy prey of the great wedge-tail eagle (*Uroaetus audax*), or eaglehawk, as it is generally termed, and of the wild dog or dingo; natural enemies of large and small marsupials. Hunting in pairs or in packs, dingoes will out-run a kangaroo, which, once down, is quickly killed and eaten. The introduced fox, also, preys upon these marsupials; but full-sized kangaroos are seldom victims of either foxes or the dingo.

Eaglehawks most often take young kangaroos, and will hunt, craftily, in pairs. But the rabbit (introduced into Australia from England, years ago, and now a great pest), has become their usual prey where it abounds.

On some of our country's postage stamps, a kangaroo is depicted, on an outline map of Australia. He spreads over the continent, in this popular design; and in nature, also, the kangaroo—collectively—occupies all Australia. We are considering them as a sub-family (*Macropodinae*), which contains all the kangaroos and the wallabies, varying in size from animals little bigger than a bandicoot to the great red kangaroo, largest of living marsupials.

All classes of country are occupied by these marsupials. Different species have become adapted, through the ages, to different environments. So that kangaroos and wallabies are the most typical Australian animals; and the continent deserves its nickname of Kangaroo Land. As John Bull represents the English, so does a big kangaroo stand for Australia and, with the emu, figures in the coat of arms of the Commonwealth.

In that admirable work, "The Wild Animals of Australasia," A. S. LeSouef and Harry Burrell, give the best general account of the genus *Macropus* I have read; of the genus that includes the typical kangaroos and wallabies, which are divided, roughly, into three groups: the larger kangaroos, the large wallabies, and the smaller wallabies. Concerning environment, the authors say:

"Thus we have the grey kangaroo living in the open forest to which its brown-grey coat is well suited; the black-faced kangaroo inhabits the denser thickets, in the shade of which its brown fur is almost indistinguishable; on the plains of the interior, more often than not on red soil, the red kangaroo has its home; while the powerful wallaroo is perfectly at home on the rough hillsides. The wallabies keep close to cover, hiding during the day among the scrub and undergrowth and coming out in the evening to feed at the edge of the thickets."

It has been my fortune to travel widely in the wilder parts of Australia, and to visit some of the remotest unsettled areas. Thus, I have become familiar with all the various kinds of country inhabited by kangaroos and wallabies. I have followed the tracks which these animals make, through scrub and in timbered country, and in rocky regions; tracks leading often from one favorite feeding place to another.

During the daytime, kangaroos, as a rule, prefer rest to activity. One finds them lying at ease in the shade of a tree; in a natural forest clearing; or—the wallaroos—in a rock-shelter or a cave, frequently a sheltered place in the sun. Many a sign of their presence have I noticed, when riding through their haunts, without sighting kangaroos. They form shallow holes in the ground, which serve both as dust-baths and "beds."

Feeding-time, usually, begins towards the evening; and at sunrise you may come upon mobs "going home." Often, when boiling the "billy" (the tin can in which we brew tea), at my camp in the evening, I have thought, "The kangaroos are going to their feeding-grounds now." The old males are last when a mob is pursued, as already mentioned; but, moving out to dinner, they go first, according



Desert and "sown" in the Mallee. The figure of the man is standing in the midst of young wheat near the edge of the uncleared country. In the evening these fields of wheat are raided by the kangaroos coming from the thick scrub which adjoins the "sown." Mallee is a dwarf species of eucalyptus which grows in dense masses, forming an admirable cover for game. It is called mallee-scrub. From a photograph by Charles Barrett.

to careful observers of kangaroo ways in the wild.

Of their intimate home life we know little, beyond what has been learned from the study of captive kangaroos. No one yet has written a full-length biography of any species of kangaroo, though pages, even chapters, by various hands are plentiful enough. It is a book that we need; on the lines of Burrell's platypus monograph.

Naturalists are trying to save the marsupials, but Governments are slow to recognize the need for conservation. Thus, in Victoria, this year, despite the advice of scientists and field naturalists, and much public disapproval, an open season for opossums (phalangers) was declared. More than 500,000 pelts were taken. The result is, opossums have disappeared from some districts, and become rare in others. The toll has been too heavy. Efforts now are being made to save the marsupials; to gain for them closer protection. At a recent "Marsupial Night," organized by the Field Naturalist' Club of Victoria, opinions expressed were strongly in favor of the movement.

Professor F. Wood-Jones, F.R.S., the distinguished anatomist and leading authority on the marsupials, in a letter read before the meeting, said: "That an effort is being made to awaken public conscience in the matter of preservation of the marsupials is, to my mind, an extremely good and necessary thing. . . . . I do not think most people realize how very ignorant we still are concerning the more intimate life details of these animals for which we must consider ourselves as trustees. There are enormous gaps in our knowledge of life histories, physiology, anatomy and development of the marsupials . . . . . The marsupials must be preserved for humanitarian and aesthetic reasons—but they must also be preserved because they are capable of yielding up so many biological secrets that may yet be solved to the possible benefit of humanity."

There is no longer a mystery about the birth of kangaroos, though many stubborn, if not



Distribution of Kangaroos and Wallabies*

Compiled by James A. Kershaw, Director, The National Museum, Melbourne

Kangaroos

Macropus giganteus—Australia, except centre and extreme north.
M. giganteus fuliginosus—Tasmania.
M. isabellinus—North West Australia.
M. rufus—New South Wales; Victoria; South Australia; Central Australia; West Australia.
M. robustus—Queensland; New South Wales; South Australia; Northern Territory; North West Australia.
M. bernardus—Northern Territory.

Wallabies

Macropusualabatus—New South Wales; Victoria.
M. ruficollis—New South Wales; Victoria; Southeastern South Australia; Islands in Bass Strait.
M. ruficollis bennetti—Tasmania; Islands, Bass Strait.
M. greyi—South Australia.
M. dorsalis—Queensland; New South Wales (interior).
M. billardieri—Victoria; Tasmania; South Australia (Southeast); Islands in Bass Strait.
M. brachyurus—West Australia.
M. parryi—Queensland; Northern New South Wales (coastal ranges).
M. irma—West Australia (southern districts).
M. agilis—Southern New Guinea.
M. wilcoxi—South Queensland; New South Wales.
M. thetidis—South Queensland; New South Wales.
M. coxeni—North Queensland.
M. stigmaticus—Northeastern Queensland.
M. brunii—Aru Island.
M. browni—Duke of York Island; East and Southeastern New Guinea; New Britain.
M. eugenii—West Australia; Islands off coasts of West and South Australia.
M. parma—Eastern New South Wales.
Lagostrophus fasciatus—West Australia.
Onychogale unguifera—North and North West Australia.
O. frenata—Queensland to Victoria.
O. lunata—Western Australia; South Australia; Central Australia.

Rock Wallabies

Petrogale xanthopus—South Australia (northern) and into Central Australia to New South Wales border.
P. penicillata—East Coast—Queensland to Victoria.
P. lateralis—West Australia; Central Australia.
P. brachyotis—North West Australia.
P. concinna—North West Australia.

Hare Wallabies

Lagorchestes hirsutus—West Australia.
L. leporoides—New South Wales; Victoria; South Australia.
L. conspicillatus—North and Northwest coasts of Australia.

Tree Kangaroos

Dendrolagus lumholtzi—Northern Queensland (Herbert River district).
D. bennetti—Northern Queensland (Bloomfield River district).
D. ursinus—Northwest New Guinea.
D. dorianus—Southeastern New Guinea.
D. inustus—Northwestern and eastern New Guinea.
Dorcopsis muelleri—Northwestern New Guinea and adjoining islands.
D. luctuosa—East and Southeast New Guinea.
D. macleayi—South coast, New Guinea.

Rat Kangaroos

Aepyprymnus rufescens—New South Wales; Victoria.
Bettongia cuniculus—Tasmania; Victoria.
B. gaimardi—New South Wales.
B. penicillata—New South Wales; Victoria; South Australia; West Australia (southern districts).
B. lesueuri—South Australia; West Australia (southern districts).
Caloprymnus campestris—South Australia (probably extinct).
Potorous tridactylus—New South Wales; Victoria; South Australia; Tasmania.
P. gilberti—West Australia (southern districts).
P. platyops—West Australia (southern districts).

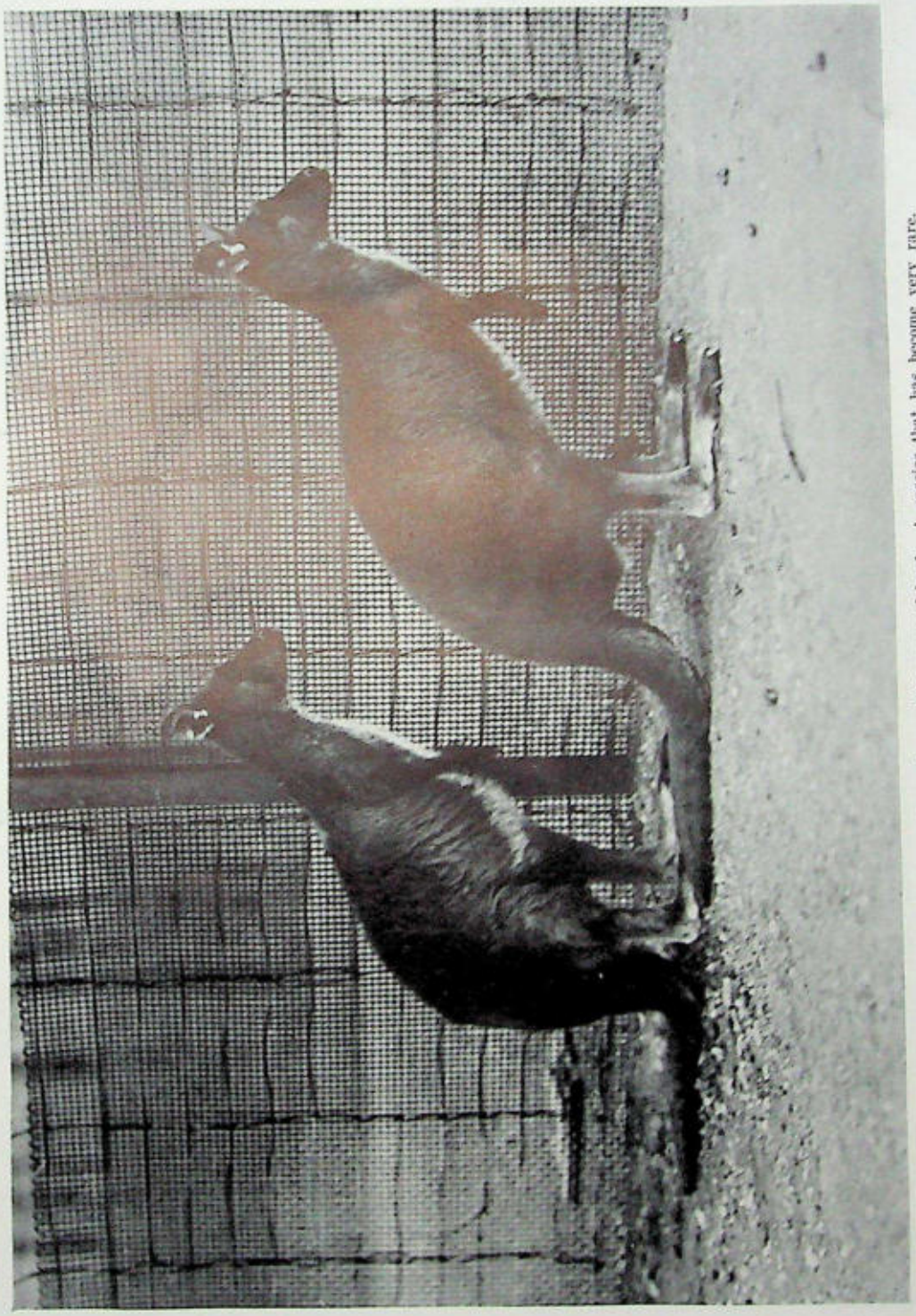
* Doubtful species not included.



Gray Kangaroo. A species common throughout the greater part of Australia except the central and extreme northern areas. Photographed in the New York Zoological Park.



Giant Red Kangaroo. This species is the largest of the kangaroos. When standing erect it is over six feet in height. Photographed in the New York Zoological Park.



Island Kangaroos. Found in Tasmania and Kangaroo Island. A species that has become very rare. Photographed in the New York Zoological Park.



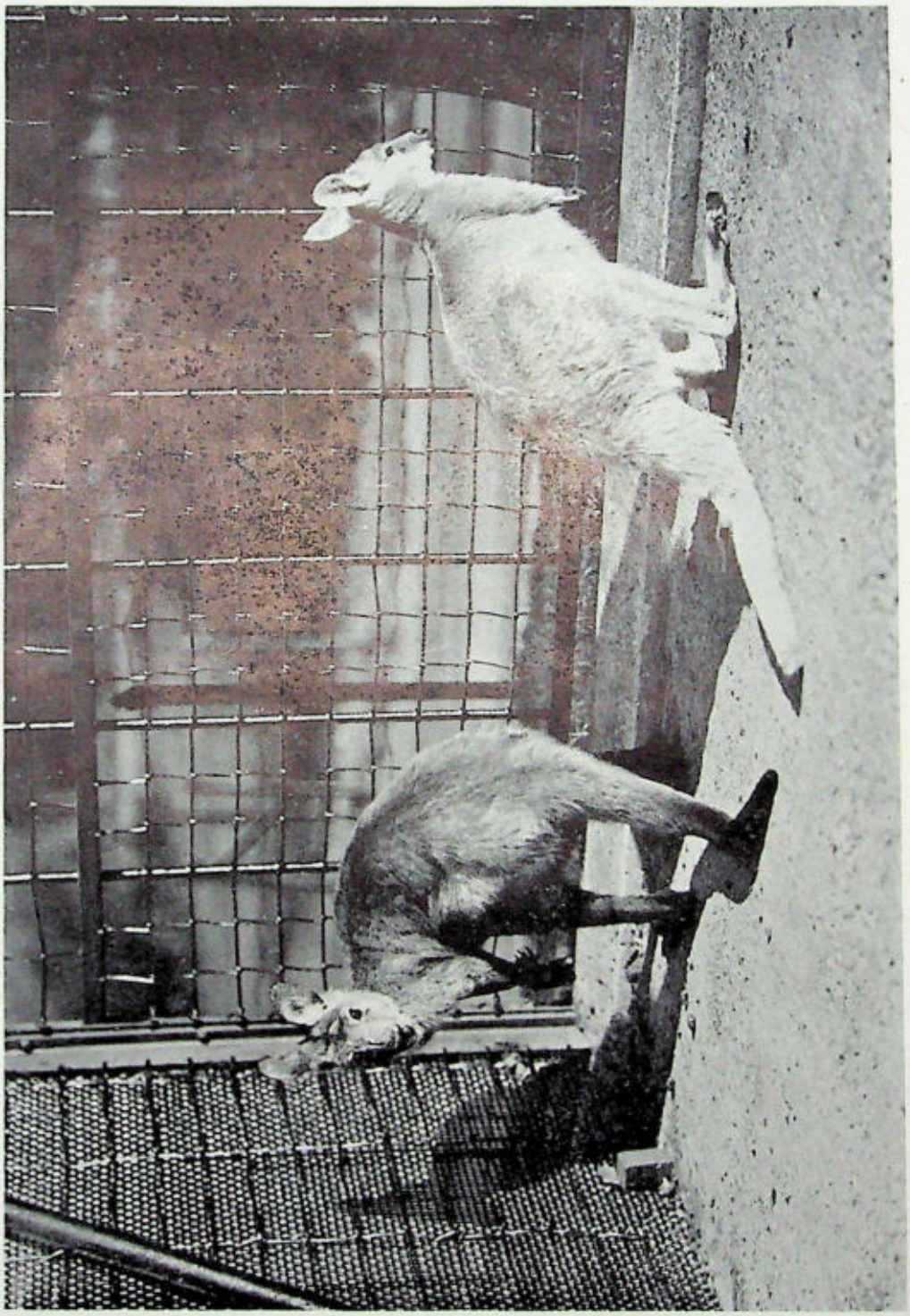
Parry's Kangaroo is a small and slender species frequenting the hilly coastal districts of Queensland and northern New South Wales. Photographed in the New York Zoological Park.



The Black-faced Kangaroo lives in the dry and sandy districts of southern Australia where the mallee eucalyptus grows. Since its habitat is in a good wheat producing locality, it is becoming scarcer as the land is cleared. Photographed in the New York Zoological Park.



Woodward's Kangaroo is confined to northwest Australia. The color of the male is a bright red and that of the female, fawn. Photographed in the New York Zoological Park.

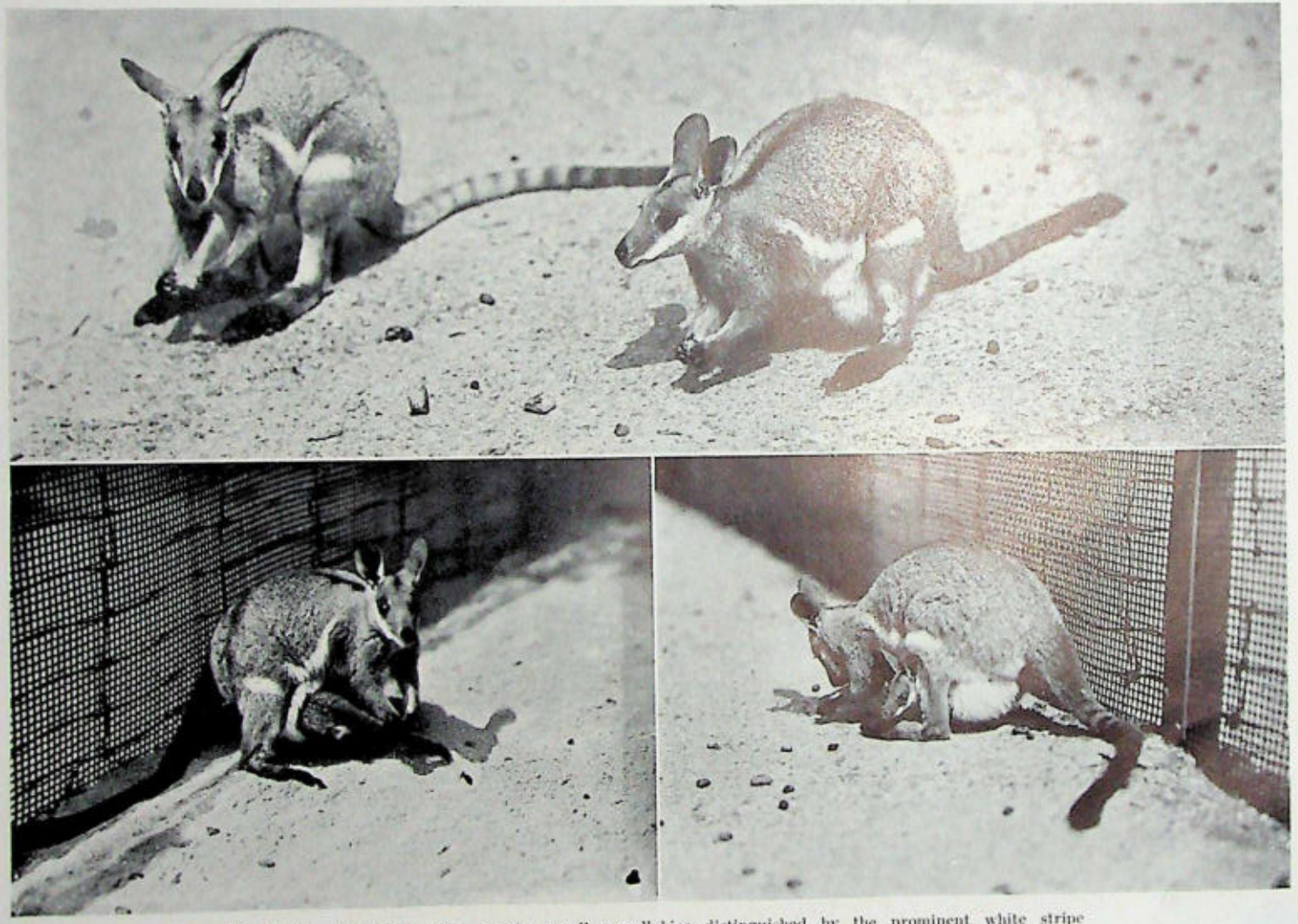


Wallaroo or Euro Kangaroo. The color of the male is a dark gray, tinged with red; the female a blue-gray shade and much lighter in tone. They are well set up and thoroughly adapted to the rough, rocky country in which they live. Photographed in the New York Zoological Park.





Bernard's Kangaroo, *Macropus bernardus*, is found in the Northern Territory of Australia. It is distinguished by its thick and very dark pelage. Photographed in the New York Zoological Park.



Ring-tailed Wallabies. One of the smaller wallabies distinguished by the prominent white stripe extending along the side to its hip and the ringed tail with black brush-like tip. In the lower picture, a young animal may be seen in the "pouch." Photographed in the New York Zoological Park.



Black Swamp-Wallaby. One of the larger of the wallabies, with very dark, long and coarse fur. The young animal in the mother's pouch has nearly outgrown its haven of safety. Photographed in the New York Zoological Park.



Black-tailed Wallabies. This animal is rather heavy in structure and not so active as many of the smaller wallabies. It lives in scrub or bush country. The male is dark brown in striking contrast to the very pale gray of the female. Photographed in the New York Zoological Park.



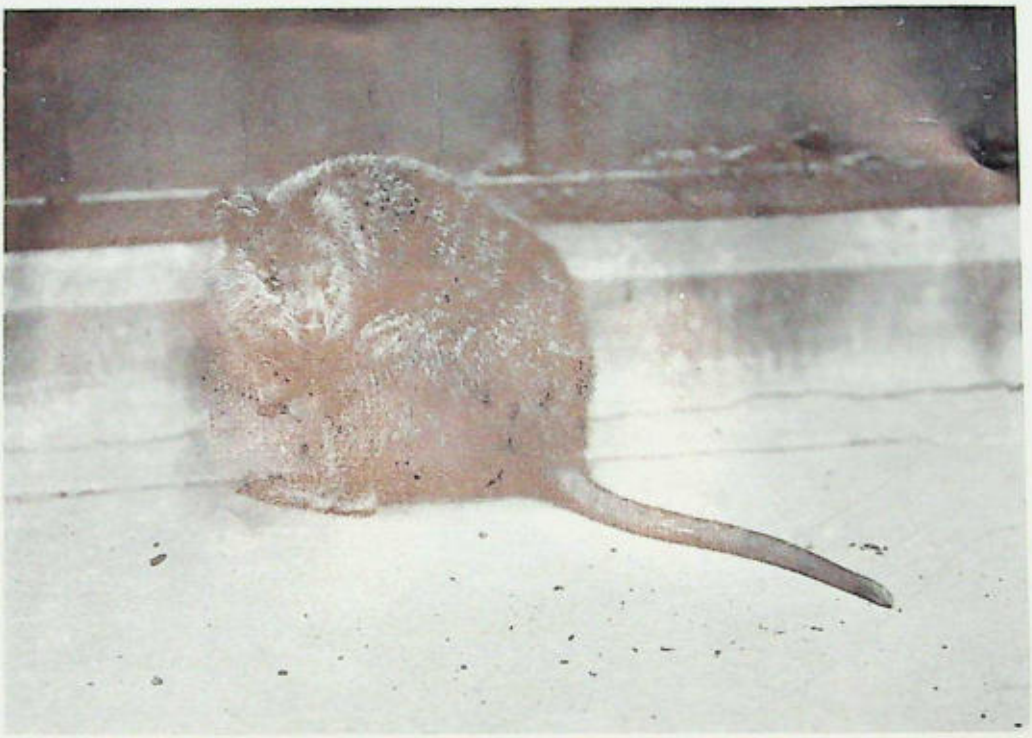
The Nail-tailed Wallaby (*top*) derives its common name from the spur at the end of its tail. Among mammals, the lion is the only one similarly equipped. The Agile Wallaby (*lower*) is a slender species distinguished by the long, slim tail. Photographed in the New York Zoological Park.



Rufous-necked Wallaby, or Red-necked Wallaby is found in the open forest country of the Eastern parts of Australia from Southern Queensland to Victoria. Photographed in the New York Zoological Park.



Bennett's Tree-kangaroo. This interesting kangaroo, termed wallaby by the late W. H. D. Le Soeuf, is an agile climber, feeding almost entirely in tree tops. The tail forms an effective balance. It is not prehensile nor is it used in the manner of its terrestrial relations. Photographed in the New York Zoological Park.





The Short-tailed Wallaby (*top*) is the smallest of this group. Its body is about twenty inches when erect and the tail a trifle over one-half that length. The West Australia Rat-kangaroo, locally kangaroo rat, is a small animal about eighteen inches long, with tail one-half that length. Photographed in the New York Zoological Park.

stupid, bush "naturalists" and city folks quite untaught in biology, cling to the old belief. "The young are born in the pouch," these wiseacres declare; some even assert that the embryo grows from its mother's nipple! You cannot convince them that these are "vulgar errors." I receive, occasionally, almost abusive letters on the subject, from men who sign themselves "Old Bushman," "Station Hand," etc. It is rather amusing.

Newly-born kangaroos are unlovely objects, but of the deepest interest. They are naked and barely an inch in length, tiny, but not quite helpless things. Born, of course, in the normal manner among mammals, the infant kangaroo climbs up to the pouch through its mother's fur. So slowly does it move, however, that its first "journey" occupied perhaps half an hour. The mother often does not help her offspring; indeed, appears to ignore its existence. Sometimes she may aid it with her lips. It may become lost for a while, in its wandering through a "forest" of fur, from the ground to its future nursery. Once safely inside the pouch, it fastens on the nipple, which pointed before and firm enough for the infant mouth easily to seize, becomes enlarged while it also softens—a kind of bulb. The young one appears to have grown from it, so close is the nipple's alliance with the mouth! It can be removed only by main force, causing rupture, as a rule.

Several months are required for the young kangaroo to develop its fur covering and grow into a miniature image of its parents. It is charming to see one, when between three and four months old, looking out on the world from the pouch.

The young animal, for some time after it has learned to venture "abroad," and nibble at the grass when hungry, keeps near its mother. Frightened, it hops at once to the parent, and seeks safety in her pouch.

Giants of the Past:—None of the existing kangaroos approaches in size the giant extinct forms, whose fossil remains are found in many parts of Australia. During the Pleistocene period, *Macropus titan* flourished. It was allied to the gray kangaroo (*M. giganteus*), most familiar of all the living species, and the one usually seen in Zoological Gardens, both in Australia and overseas. A full-grown male grey



Typical Mallee country in northwestern Victoria. This type of country is the habitat of kangaroos and scrub wallabies. From a photograph by Charles Barrett.

kangaroo will weigh about 200 lbs.; and from nose to base of the tail, measure over five feet; the tail itself being about four feet four inches in length. *M. titan* was of much larger size, a veritable monster of the past.

Giant wallabies, also, flourished during the Pleistocene period. Some species had skulls twelve inches in length. The remains of several extinct genera have been discovered. Such fossils are plentiful in superficial deposits, as well as in caves, deep and shallow.

At Puralka, in western Victoria, a "find" of fossils was made in a shallow limestone cavern. I went down to examine the site, and collect material. Remains of *M. titan* and other gigantic kangaroos were obtained. But more exciting was an artefact, a small stone implement, discovered by the pastoralist who first delved in the cave. This "Puralka Flint," as it is generally called, was associated with the fossil marsupial bones, and is one of the most ancient relics of the kind hitherto discovered in our country. Thousands of years ago, when the monster kangaroos roamed the western plains or lived in the open forest areas, they had "Stone Age" men to hunt them.

We are on the trail of ancient man in Australia. Did he hasten the end of *M. titan*, *M. atlas*, and other huge marsupials, as the *Diprotodon*, which had a skull three feet in length and was the size of a rhinoceros?

Reports are occasionally received of "boomers" in wild places remote from settlement. Quite recently I heard of one "about 8 feet in height"! It was sighted at a distance; but the observer was sure that his estimate was near the mark! It is certain that both grey and red kangaroos of exceptional size do exist; for growth, in the males, continues even in old age. The "boomers" are animals that for years have escaped all enemies and lived to become giants among the largest younger members of the herd or mob. The females are smaller than the males. This applies to the larger species of wallabies, as well as the kangaroos. Sex difference in size is so marked, that one familiar with the animals, can easily pick out the males in a mob when some distance away. It is usually guess-work, however, where the lesser wallabies are concerned.

The great red kangaroo (*M. rufus*), now becoming scarcer, in parts of its range, but for-



Red-necked wallaby *M. ruficollis* in the Zoological Gardens, Melbourne, Australia.
From a photograph by Charles Barrett.



Black-tailed wallaby *M. valabatus* in the Zoological Gardens, Melbourne, Australia.
From a photograph by Charles Barrett.

merly very abundant, is the largest and one of the most beautiful species. Its realm is a wide one, on the open inland plains; it does not occur within several hundred miles of the sea, unless exceptionally. I have met with it in mobs of up to a dozen, though often only about half that number associate. Lying at their ease, in the shade of a tree, the reds form a charming group of "Australian natives." The females especially are shapely and slender, and aesthetically colored, the white legs and under-surface contrasting finely with the blue-grey of the back and sides of the body.

In Central Australia, motoring through country traversed afoot and on camels by the Horn Expedition long ago, I saw occasionally small mobs of the red kangaroo. It was a dry season, and much depends upon the rains on the Central plains. In a good season, kangaroos are fairly numerous, where I met with only a few—north of the Macdonnell Range, out towards Central Mount Stuart, practically the centre of Australia.

Three sub-species of *M. rufus* have been described; while the grey kangaroo in Tasmania has been regarded as a race of *M. giganteus*. Other sub-species of kangaroos and wallabies have been recognized by systematists; but the field naturalist may not agree with such "splitting."

The grey species, more often termed "forester," because of its preference for the open forest lands, unlike the red kangaroo, is chiefly a coastal form. It is, however, to be found a long way from the sea—two or three hundred miles. The most of its territory, years ago, was claimed for sheep-runs and farmers, but it still lives in fair numbers in certain parts of its range—the eastern and southern portions of Australia. Gregarious, at least when feeding, it forms both small and large mobs. I have seen nearly 50 together; also five or six; and have observed, now and then, a lonely grey kangaroo—always a male.

Smaller, darker, and of slighter build than *M. giganteus*, is the black-faced kangaroo (*M. melanops*). It frequents scrubland and bush, and is common in the Mallee country—that remarkable dry region, with its covering of dwarf Eucalyptus trees, its pine-ridges and sand drifts, and wonderful fauna and flora. It is in the Mallee that the mound-nest building



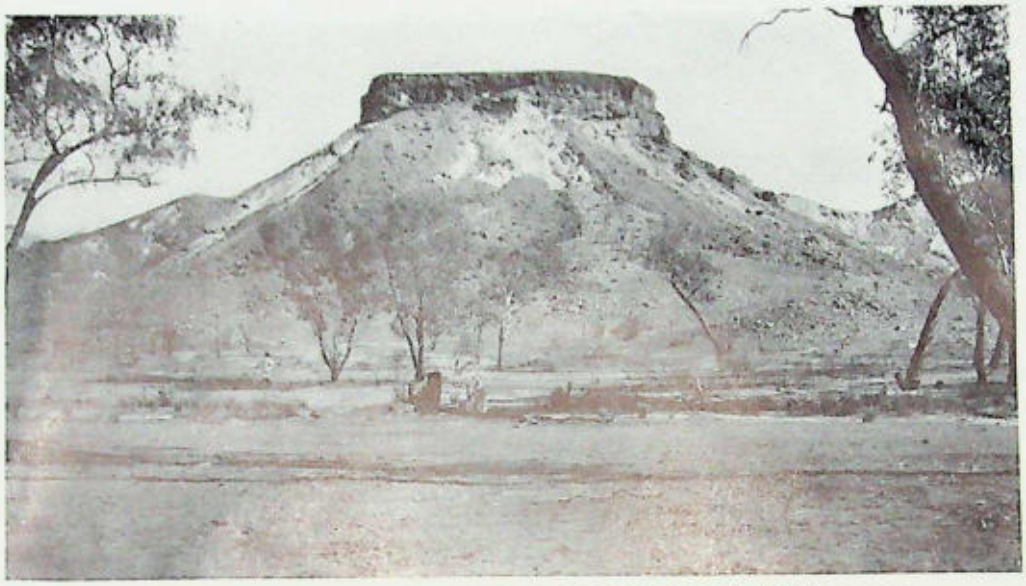
Rock-wallabies are animals that live in the rocky ranges. Some species frequent caverns, spending the daytime in such retreats. This is the typical habitat of the brush-tailed rock wallaby *Petrogale penicillata*.
From a photograph by Charles Barrett.



Nullarbor Plain. A blow hole on the Nullarbor. These holes are a notable feature of the treeless plain and present a problem to geologists. Some are shallow and blocked; others deep, leading to mysterious caverns, with galleries opening from them. They are the doorways to a vast, unexplored underworld. Kangaroos frequent these great treeless and scarcely explored areas. From a photograph by Charles Barrett.



The Dingo Donga Cave on the Nullarbor Plain, known to only a few people, is the haunt of small bats. It has been their refuge for thousands of years, judging by the pyramids of guano on the floor of the main chamber, which is over 100 feet high. The cave opens off a great and deep circular "donga" with rugged walls which are unscalable except at one spot where boulders are piled in a natural stairway. Kangaroos often frequent these "dongas" in search of water which collects in rock-holes. From a photograph by Charles Barrett.



Crown Point, a famous landmark in the heart of Central Australia. Red kangaroos live on the plains of this vast inland region. From a photograph by Charles Barrett.

birds, *Leipoa ocellata*, have their ever-narrowing territory. The wilderness of little gums, of "spinifex" (*Troidia*) and sand, is rapidly being converted into wheat-fields.

Kangaroo Island, off the coast of South Australia, has its own special kangaroo (*M. fuliginosus*). Flinders, the famous navigator, and the French explorers, found the island so well stocked with the marsupials, over a century ago, that it deserved the name bestowed upon it by the English captain. It still has a population of kangaroos; they live in dense scrub, and are numerous in many places. There is a big national reserve for wild life on Kangaroo Island.

Arnhem Land, in the far north of Australia, where a great area has been reserved for the aborigines, is the realm of the antilopine kangaroo (*M. antilopinus*), a short-furred, stoutly built and heavy species. They are not numerous, and, being very shy, are difficult to observe. We know little of their ways in the wild.

The wallaroo or euro (*M. robustus*), is a mountain species; it keeps to the rocky hills and is rarely, if ever, seen on the plains. But it inhabits both coastal and inland areas, is wide-ranging, and variable in coloration. There is a rufous form, a very dark, almost black form, and a light-hued, sandy variety. Eight or nine sub-species have been described, but some are very doubtfully entitled to such rank. The systematist has been too generous.

Wallaroos are sturdy mountaineers, being thickset animals adapted to their mode of living, often in steep and rugged hills. They are more formidable than the grey kangaroo, as many dogs have found to their cost. "The wallaroos," write LeSouef and Burrell, "are determined fighters; they use their teeth more than other kangaroos, and one has to be careful in approaching old males; when hunted they make for the rocks."

When searching for aboriginal rock paintings and carvings in a wild and lonely range of hills, recently, I saw wallaroos "at home." Early one morning an old male appeared on the ridge above my camp, beside a water-hole in the rock. It gazed down for a minute, then hopped leisurely away, silhouetted against the brightening sky.

In the old days, when the blacks camped at Mottwingee rock-holes, a kangaroo venturing within range would surely have been speared. The flesh of these marsupials is not to the taste of most white men, without the sauce of hunger. But it has been praised for its flavor! Thus when John Gould, the pioneer of Australian ornithology, and his party were making a forced march, their provisions being ex-

hausted, a red kangaroo was killed, and its flesh lasted the wanderers for four days. It was excellent food, is Gould's testimony. The animals weighed over 200 lbs. Kangaroo-tail soup is not to be despised, though perhaps one must learn to like it.

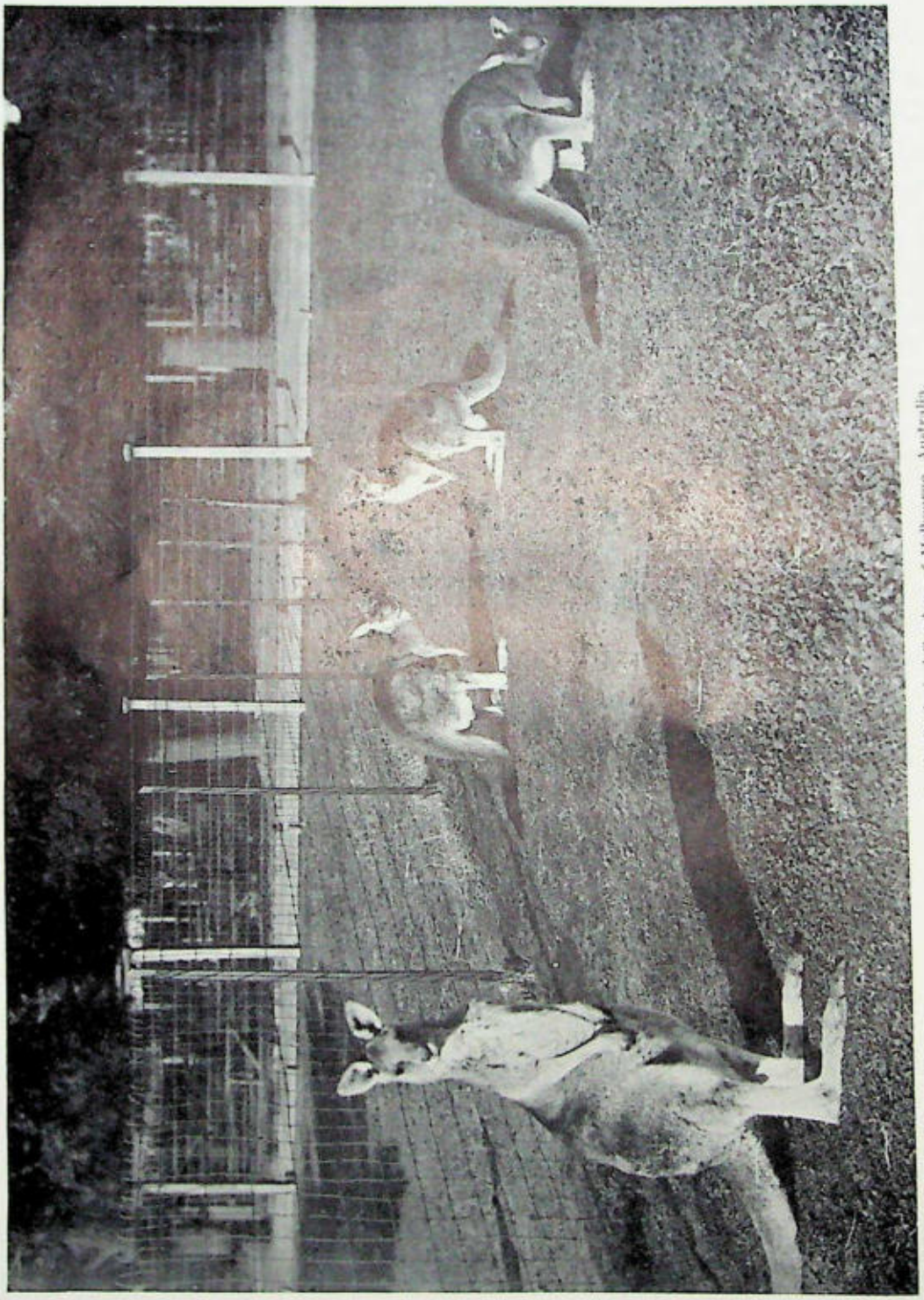
The Wallabies: — Wallabies are merely smaller kangaroos and are not markedly distinguished from their big near-relations, despite minor external and structural differences. There are numerous species, and to deal with them all would be wearisome. They are not, as a rule, gregarious, although often one finds many of a species congregated. On an island in Bass Strait, in a small patch of scrub, remaining very still, I was surrounded by wallabies. When I moved, suddenly, dozens of the animals went pounding away through the bushes. It is usual to see wallabies in pairs, or singly. They avoid being out in the open, because of the danger from their enemies. The dingo and the fox prey upon wallabies; so does our great eagle, the second largest eagle in the world, powerful enough to bear aloft a small wallaby in its talons.

Wallabies frequent the Mallee scrub, lightly and heavily timbered country, scrubby hills, and the sub-tropical and tropical "brushes" where palms grow tall and orchids tuft the branches and trunks of splendid "rain-forest" trees. You may follow wallaby tracks through scrub and jungle. In the glades, towards evening, it is pleasant to see wallabies feeding, or standing at gaze in their own charming manner. Delightful creatures, even at the Zoo; in their natural haunts, they are still more engaging.

In wide-ranging species, there is considerable color variation. The black-tailed wallaby (*M. ualabatus*) is lighter colored in its northern habitat than in the south—it ranges from my own state, Victoria, to northern parts of Queensland. It exists in large numbers in the south, where it is regarded as fair game by the sportsman and is hunted for the sake of its pelt. Big bundles of skins are commonly seen in the skin stores, and the export trade is extensive.



Victoria's Mallee Park. An area of over 30,000 acres has been set aside as a sanctuary for gray kangaroos and other native animals. From a photograph by Charles Barrett.



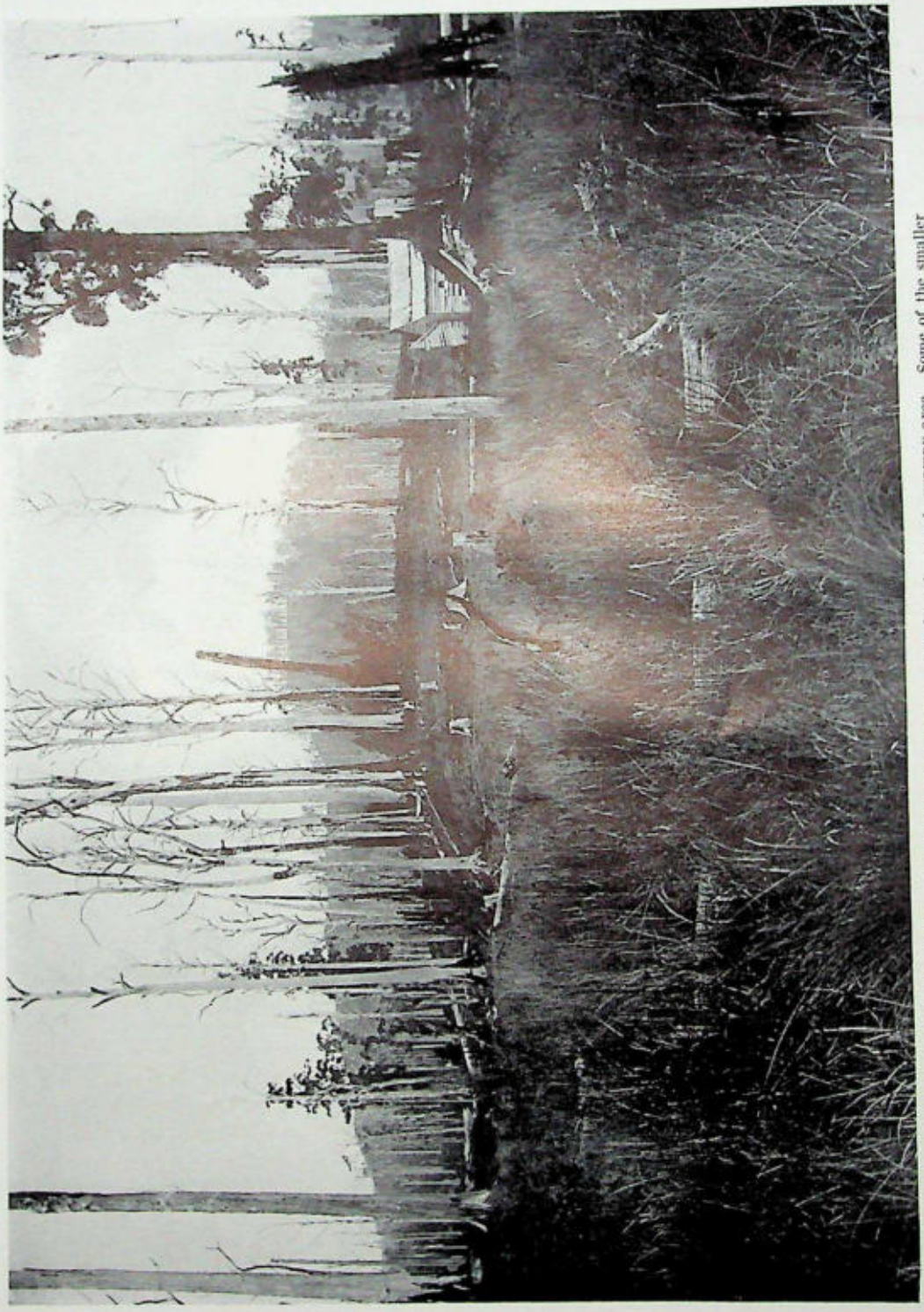
Grey kangaroos in the Zoological Gardens of Melbourne, Australia.
From a photograph by Charles Barrett.



In the Federal Territory. A view near Canberra, the capital of the Commonwealth. Kangaroos inhabit the distant lowlands and wallabies live in the far distant ranges. From a photograph by Charles Barrett.



The entrance to a shallow limestone cave in western Victoria. Many fossils of giant extinct kangaroos were found in this cavern. From a photograph by Charles Barrett.



A scene in Tasmania. The home of a pioneer on the edge of a great, swampy area. Some of the smaller wallabies frequent these marshy areas, the tall water-loving grasses and ferns providing a safe shelter for these timid animals. From a photograph by Charles Barrett.

In size and shape the members of this group, the large wallabies, are much alike. With hind feet relatively large, they are more powerful jumpers than the smaller wallabies. Compared with kangaroos, they are brightly colored animals.

Brush wallaby is the popular name for the red-necked species (*M. ruficollis*) which, especially for this article, I photographed, in a paddock at the Melbourne Zoo, while its near ally, Bennett's wallaby (*M.r. bennettii*) came hopping up, inquisitively. The latter belongs to Tasmania.

For grace and beauty, Parry's wallaby (*M. parryi*), of northern New South Wales and Queensland, ranks first perhaps, in the "large" group. It sometimes is called "pretty face," because of white and grey markings on the face. Its tail is exceptionally long, and it has a slender body. A dweller on the highlands, it is to be looked for in fairly open country. You may gain long distance views of Parry's wallaby, but to approach it closely is not easy. It has a remarkable turn of speed, and is away in a moment when startled.

Another species with conspicuous markings, but on the thighs, not the face, is the black-striped wallaby (*M. dorsalis*), of the interior of New South Wales and Queensland. The black-gloved wallaby (*M. irma*), of south-western Australia, is dark bluish-grey above, with yellowish grey underparts. Its fingers and toes are black "gloved," and the tail is crested with stiff hairs, black, like the paws. This is an abundant form, found chiefly in the open forest lands.

The beautiful, short-eared agile wallaby (*M. agilis*), belongs to the tropical north, occurring also on certain of the islands and in Papua. I have seen it only once, at large, and was charmed by its delicate coloring—light fawn—and graceful appearance. It frequents country where the grass grows tall, and is conspicuous, with its uniform light coloration. This is the only member of the large wallabies group inhabiting Papua.

About a dozen species comprise the small wallabies group. They are much persecuted by the trappers, their fur being beautifully soft and of fine texture. They range far into the tropics, one species occurring on the Aru Islands; another in New Guinea and the New Britain group. They are mostly shy in disposition, being dwellers in dense scrub, or some class of "cover" where they are much more often heard than seen. Some kinds, towards sundown, or later, appear on the edge of the jungle or the forest. It is feeding time for wallabies when the shadows are long.

The Cape York wallaby (*M. coxeni*) is short-furred and sandy-colored or grizzled, with white under-surface. It is similar in coloration to the agile wallaby, also a northern form, and it has been suggested that this similarity may be the result of adaptation to environment. Other members of the "small" group are the banded wallaby (*M. stigmaticus*), the red-legged wallaby (*M. wilcoxi*), the Aru Island wallaby (*M. brunii*), the sombre wallaby (*M. browni*), the Parma wallaby (*M. parma*), and the rufous-bellied wallaby (*M. billardieri*), the last named being the common species of Victoria and Tasmania: it is abundant.

The non-naturalist generally terms any small wallaby a "pademelon." The name belongs rightly to *M. thetidis*, of south-eastern Australia. It is numerous in scrub-covered country. Many a pademelon have I startled on my bush rambles; and sometimes myself have been surprised by one, suddenly thumping off through the scrub, its presence the minute before unsuspected.

Rock Wallabies:—There are twelve species of rock-wallabies, forming the genus *Petrogale*. They are wonderfully agile, and live in rocky ranges, throughout the continent, but are absent from Tasmania. Some are cave-dwellers, and among the most interesting of marsupials. They form paths among the rocks, trails which they follow at high speed, though to the human eye not clearly defined, at least in places. Their toes are adapted for rock-climbing, being rough with small tubercles, which give a grip even on surfaces worn smooth by the feet of many generations of rock-wallabies.

Their foe is the fox, in parts of their range; in many localities, toll is taken of rock-wallabies by the Australian python (*Morelia variegata Gray*), known as the carpet-snake. This reptile is plentiful in *Petrogale* haunts, lurking in the caves. It attains a length of fourteen feet, but the average specimen is much shorter.



Central Mount Stuart. This peak is practically the center of Australia. On the plains about this region is the habitat of the great red kangaroo *M. rufus*. It is met with in small "mobs" and is the characteristic kangaroo of the central country. From a photograph by Charles Barrett.

The rock-wallaby is noted for its agility and boldness, and accuracy in jumping. It climbs leaning tree-trunks, and leaps from rock to rock as nimbly as a chamois of the Alps. Among the species are the brush-tailed rock-wallaby (*P. penicillata*), the yellow-footed rock-wallaby (*P. xanthopus*), and the short-eared rock-wallaby (*P. brachyotis*), which inhabits the north-western coast of the continent.

Nail-tailed Wallabies:—The genus *Onychogale* contains the three species of nail-tailed wallabies, characterized by the small horny spur at the tip of the tail, and also the form of their incisor teeth. What the use of the nail-like appendage is, we can only conjecture. The best-known species is the bridled nail-tailed wallaby (*O. frenata*), of eastern Australia, where it frequents ranges of low hills and long-grass country. It is seldom met with nowadays, owing to the advance of settlement and ravages of that introduced "curse," as we often term, justly, the European fox.

Other Wallabies:—The banded wallaby (*Lagostrophus fasciatus*) is an inhabitant of Western Australia, dry areas on the mainland, and some of the islands.

The little hare-wallabies deserve their descriptive name, for their speed, when pursued, is amazing; while they also possess remarkable powers of leaping. Both in size and form, these very active marsupials recall the common hare of Europe. The common hare-wallaby (*L. leporiodes*) inhabits the interior of New South Wales and South Australia.

The *Dorcopsis* wallabies are small and dull-colored animals, confined to New Guinea. There are eight or nine species.

Tree-Kangaroos:—Romance might have a chapter in any book dealing with the tree-kangaroos. They need a volume to themselves, if only a small one could be written. The discovery of each species, the quests for specimens for Zoological gardens, descriptions of tree-kangaroo country—would form subjects for descriptive writing by a literary naturalist.

I have been in the haunts of the two Australian species of *Dendrolagus*, and have what probably are unique photographs of a New Guinea form. Ambition may take me again on the trail of *Dendrolagus*, in our tropical wilds.

No fewer than fourteen species of *Dendrolagus* have been described, all but two being found in New Guinea. Some are very attractive, and make delightful pets; others are coarse-furred and have, in captivity, sleepy-looking faces. All are dwellers on the mountains, or at least

in high places; their haunts are remote from settlement, and in the wildest class of country. They choose the most inaccessible places, usually near the mountain summit.

Tree-kangaroos are not wholly arboreal in their habits; on the contrary, they spend much time on the ground, climbing trees when in danger from dogs or other enemies, and for the purpose of feeding. These notes refer to the Australia species, of which we have the most knowledge—it is scanty enough! But doubtless, the habits of the New Guinea tree-kangaroo are much the same as those of their Australian allies.

All the species are well adapted to the arboreal mode of life. Their foot-pads are much roughened; their claws are thick and strong and sharpened; those of the two outer toes are as much curved on the hind- as in the fore-foot. The tail, which serves well as a balancer among the boughs, is very long, with hair thick and even. The fore-limbs are nearly as long as the hinder ones and remarkably stout and strong.

These members of an essentially terrestrial sub-family, apparently have acquired larger and more powerful fore-limbs than any other kangaroos, as a result of arboreal habits. Or it may be, as Lydekker mentions, a primitive feature. That great naturalist, however, was inclined to favor the former view.

Tree-kangaroos are at ease among high and fairly slender boughs, but often climb low trees. They leap to the ground, often from a great height, alighting on their feet, as safely as a cat does after jumping, and running rapidly away. Leaps from about twenty feet up are not unusual, while one may be made even from a height of sixty feet!

The Lumholtz tree-kangaroo (*D. lumholtzi*), whose realm is among the ranges of north-eastern Queensland, with its black face and chin, black toes, fine grizzled-grey general color, white chest and pale yellowish-white under-surface, is one of the most beautiful Australian animals—a pleasure to the eyes of any naturalist. Its discoverer, the late Carl Lumholtz, was overjoyed when his long search for the



A view in the mountainous country in northeastern New South Wales. The pademelon *M. thetidis* and other species of the small wallabies are found in this type of country. From a photograph by Charles Barrett.



Left. The New Guinea species of tree-kangaroo *D. matschiei*. From a photograph by Charles Barrett.
Right. Bennett's tree-kangaroo. The picture gives an admirable idea of the use of the tail as a balance.
From a photograph by the late D. Le Souef.

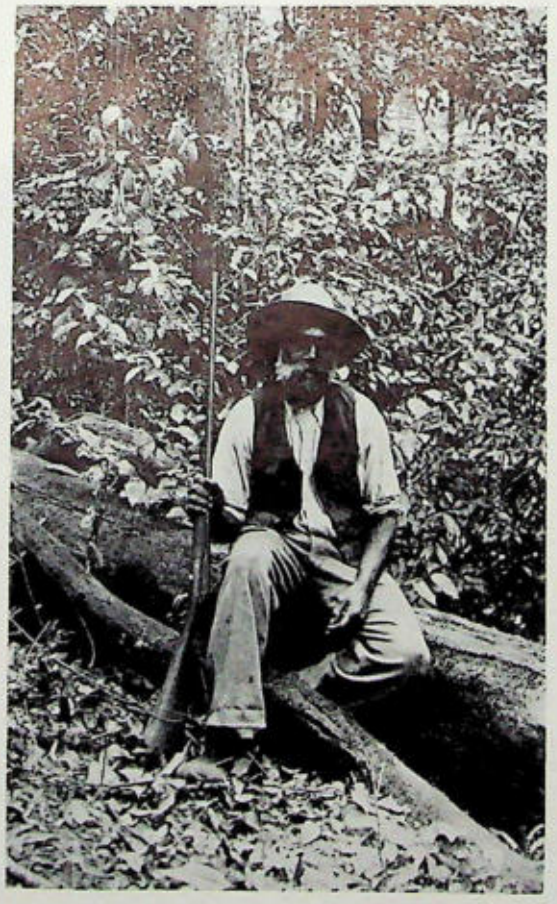


"boongarry" of the aborigines was at last rewarded. He didn't forget to be generous to his cannibal guides and friends. One native received a shirt, another a handkerchief, while all received an extra allowance of food and tobacco.

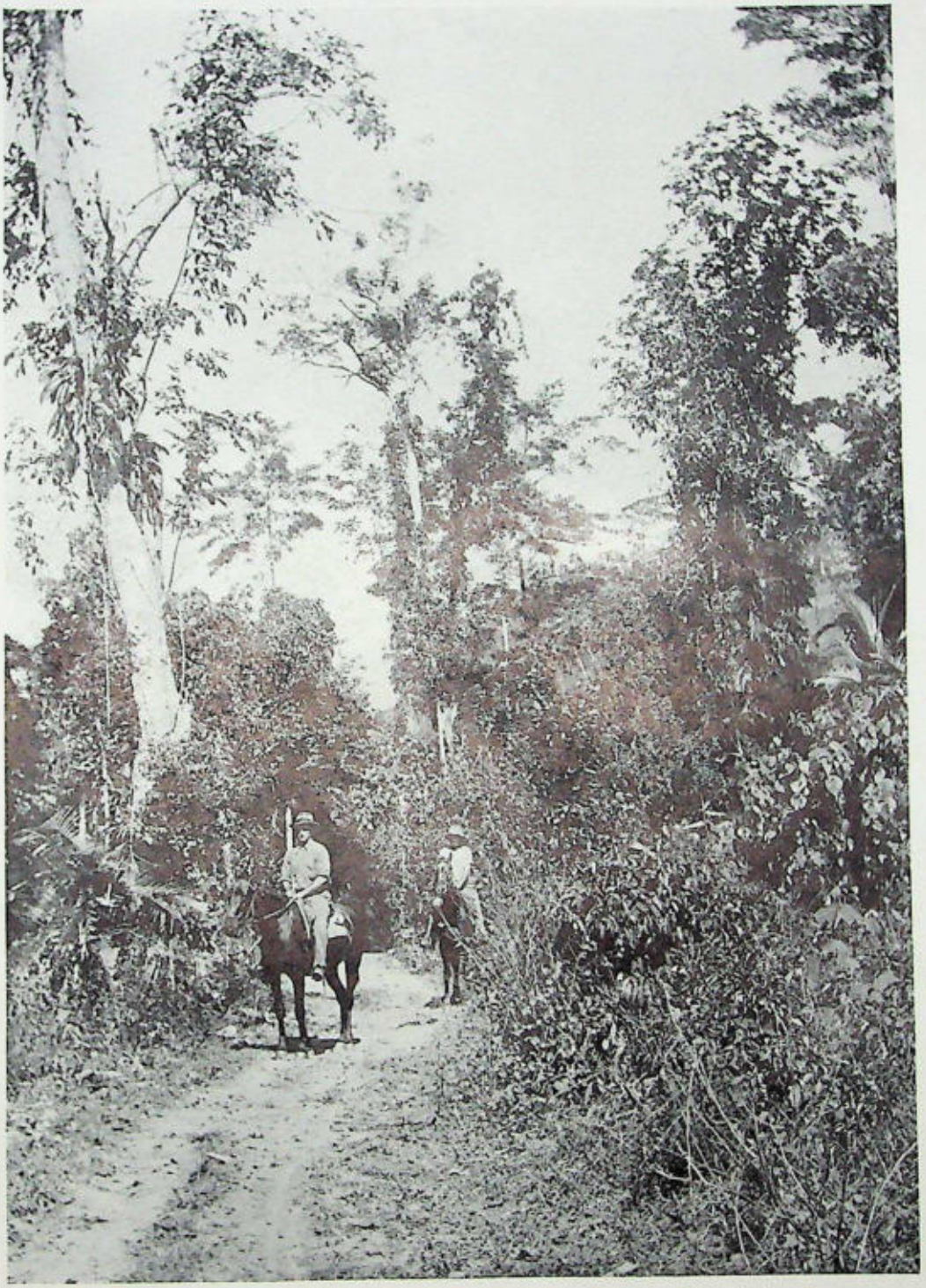
That was long years ago. When I visited the "boongarry" country, in 1928, there were few aborigines there, and none was a cannibal! Cannibalism now is as a tale that is told, among the blacks of the Herbert River district. Much of the country has been cleared and cultivated. But farther afield I was in a wild and little-known region. My headquarters were on the Daintree River, where, in a morning's "run" down stream aboard a launch or a lugger, you may see ten or a dozen crocodiles. They bask on the mud-banks and lurk among the mangroves. Blue peaks in the distance lured me—the range where tree-kangaroos live.

It was my fortune to see only one specimen, captured near a mountain top, by bushmen. Money could not buy it. *Dendrolagus* was hard to get, and worth keeping, I was told.

Bennett's tree-kangaroo (*D. bennettianus*) was described from the Bloomfield River district, north-eastern Queensland. It was observed in its haunts by my late friend, Mr. D. LeSouef, who obtained 16 specimens for the Melbourne Zoological Gardens, of which he was for so many years the Director. I saw the animals often, climbing or perched on boughs of the tree in their enclosure. They lived happily enough for a time; but, one by one, died, until *Dendrolagus* was unrepresented at the Zoo. Tree-kangaroos rarely survive capture for any length of time. The New Guinea species, shown in my photograph, lived for less than a year after reaching Melbourne.



Ancient and modern hunters. *Upper:* Old time aborigine, in full dress, casting a spear with a throwing stick. The blacks are clever spearsmen. *Lower:* A modern hunter in civilized dress who uses a gun. This aborigine was once the author's guide in the wilds of Queensland. From photographs by Charles Barrett.



A jungle path in the forest of North Queensland. In this forest region is the haunt of the Lumholtz tree-kangaroo. From a photograph by Charles Barrett.

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THE KOALA ..... *Cover*

BULLETIN

NEW YORK ZOOLOGICAL SOCIETY

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Editorial Staff

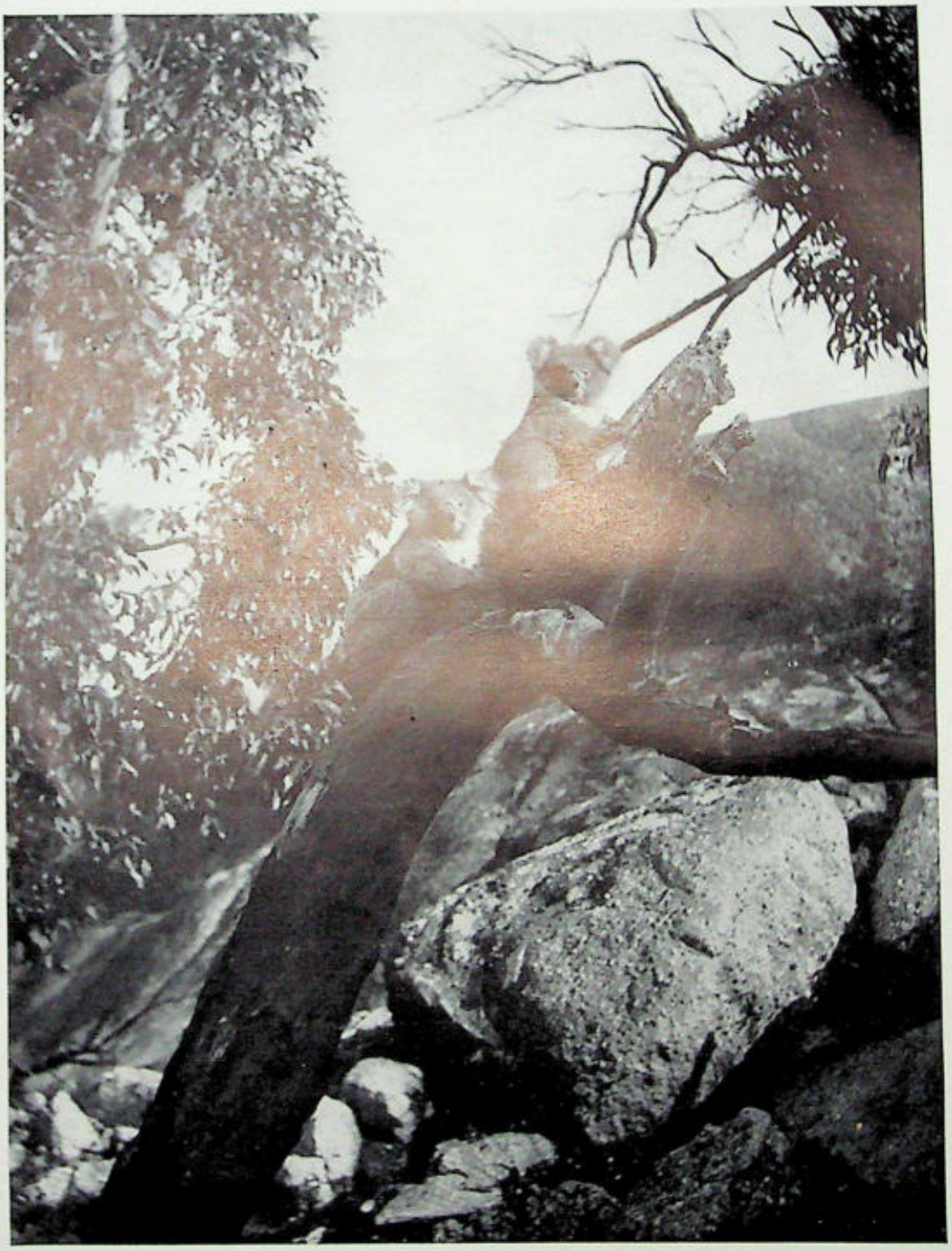
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The koala is a poor climber. Its hind feet are admirably adapted for climbing, but possibly because it lacks a tail, its progress is painfully slow. It is not for lack of practice, since it spends the greater portion of its life at lofty heights in gum trees, the leaves of which being almost exclusively the sole diet. Except for an occasional meal of roots, it is gum leaves or nothing else. No other food will answer, and even with an abundance of the latter, the koala is not easily kept alive in captivity in its own land. Photograph by Charles Barrett.

BULLETIN
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Some Australian Marsupials

RAYMOND L. DITMARS
Curator of Mammals and Reptiles, Zoological Park

A brief introduction to the various marsupial forms that have been exhibited in the Zoological Park, together with a short account of the Koala, the "Native Bear" of Australia, by Charles M. Barrett. Illustrations for the Koala were made by Mr. Barrett as indicated under the cuts, and the other illustrations were made from the collections in the Zoological Park.

AUSTRALIA has a mammalian fauna markedly different from all other continental areas, from several points of view. The most striking feature is the absence of species of the various orders so abundantly represented on other tropical and temperate land areas in various parts of the world. There is but one native carnivore (the dingo), and there are no native hoofed animals. There are less than two dozen species of rodents, these of rather monotonous development. Representatives of the Insectivora are lacking. The second remarkable condition rendering the island-continent unique, is the abundance and variety of form and size of the Marsupialia, or pouched animals, which in other parts of the world are but scantly represented. What is true of Australia is largely true of New Guinea, and to the south, Tasmania and even New Zealand, between all of which there appears to have been land connections in remote times.

Another point worthy of note is the sole occurrence of an order of egg-laying mammals, remnants of the most ancient and primitive of the mammals of the World. It is indicated that these forms have not only survived but that they originated in Australia.

The point of most striking interest among the mammals of this area is the development of the marsupials, large and small, into specialized forms to "match" species of unrelated orders. This remarkable parallelism is carried to such an extent that, despite the absence of other orders of mammals, the Australian marsupials present a versatility of form to amply take their place. Thus the kangaroos and wallabies take the place of deer and antelopes on the plains; the phalangers are like squirrels in the forests; some even having developed scaling planes like the flying squirrels. The wombat is like a big woodchuck, even to the broadening of incisor teeth for cutting; there are marsupial "rats and mice," a pouched wolf, marsupial "cats" and weasels, the masquerade having radiated to the extent of varied forms to include those like moles and anteaters to parallel insectivores and edentates.

With a fauna like this from which to draw for zoological exhibition, scientific institutions specializing in living specimens have naturally long been keen in procuring specimens from Australia. Such has been the case with the Zoological Park, and we have been particularly fortunate in maintaining representative series of mammals from Australia and adjacent land areas. The most familiar of these mammalian forms, of course, are the kangaroos, which are found nowhere else in the world.

The elaboration of species of kangaroos is not generally known. Including the kangaroos and wallabies—the larger and smaller kinds—approximately three dozen species of these



A black swamp-wallaby carrying her young in the marsupium, where, from the time of its birth, it spends at least six months before it begins to forage on its own account. But one is produced at birth. A tiny bit of life less than an inch in length and so thoroughly undeveloped that it might puzzle a scientific scholar to give it classification. The immature young is placed in the marsupial pouch by the mother and the feeding from that time is purely mechanical and at the will of the parent. Various theories have been advanced concerning this function, but the one mentioned seems most plausible, considering the very helpless state of the young one at birth. There are some three score members of this family, all found in Australia and the closely adjacent land areas.

unique animals occur in Australia. These are divided into eight distinct genera. The species vary in size from a body length of about twelve inches—creatures which hop along like a rabbit, and of similar habits to that type—to the Giant Red Kangaroo inhabiting the plains of the Murray Basin, which lives in herds, is in excess of five feet in combined length of head and body, and when reared upon its powerful jumping legs can stand higher than the average human. Specimens of the Giant Red Kangaroo, the Great Gray Kangaroo and the equally powerful Euro Kangaroo or Wallaroo, have been on exhibition in the Zoological Park for a long time. These creatures consume the same food and require similar care to hoofed animals. Our collection of kangaroos was started in a series of stalls in the Small-Deer House, but the title of that building has become a misnomer. The collection has so increased by purchase and breeding that the structure is now given over to the exhibition of kangaroos and wild swine.

The carnivorous marsupials are of great interest. Largest among them is the so-called Tasmanian Wolf, *Thylacinus cynocephalus*, approaching in dimensions and form a true wolf, and certainly resembling the latter in habits. It hides in caves during the day, hunts at night, has keen scent, and preys upon the wallabies and smaller mammals, also committing depredations among the sheep belonging to settlers. The body is gray, with a series of blackish cross-stripes on the posterior two-thirds. The species is confined to Tasmania.

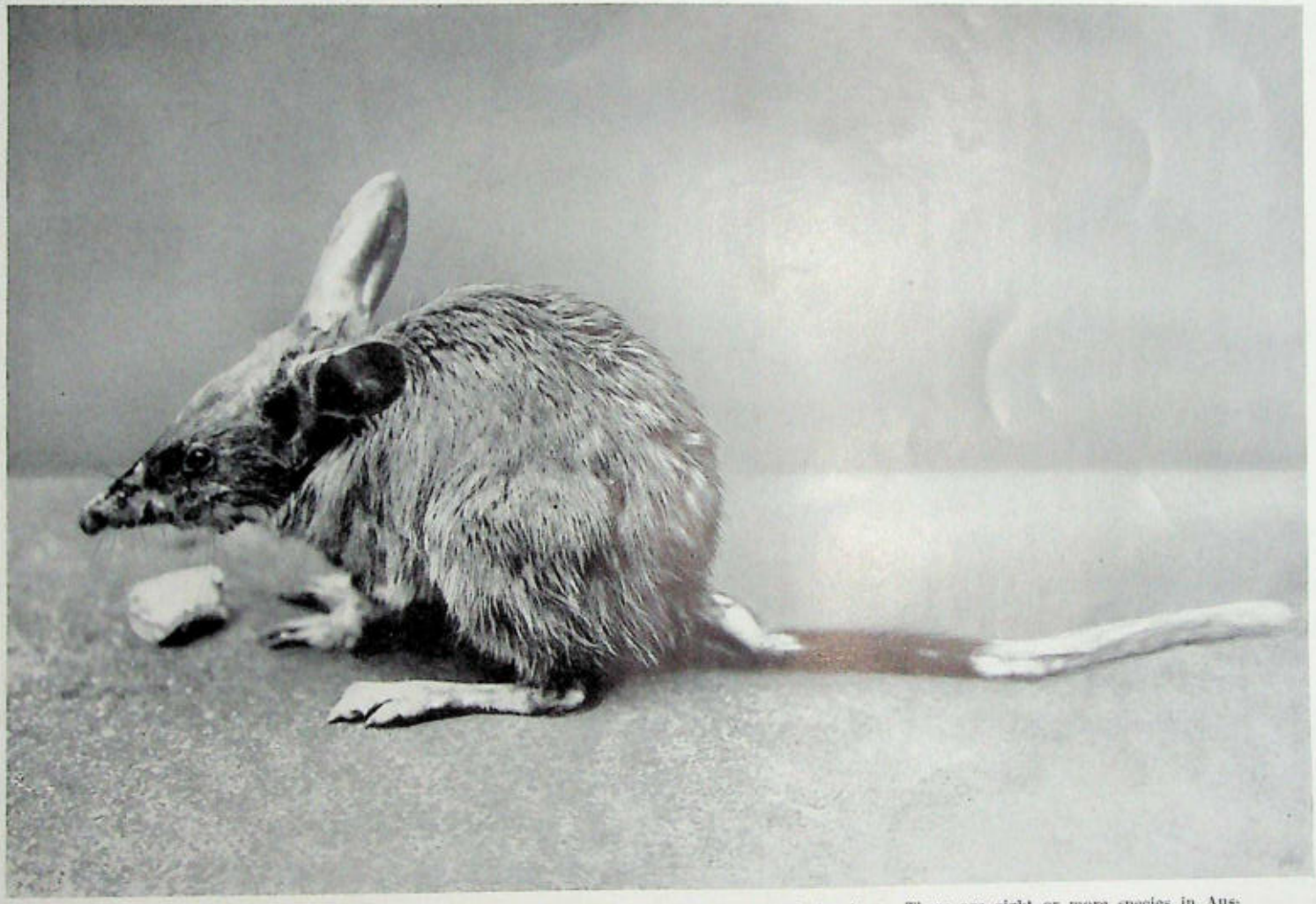
Strangely enough, Tasmania has another characteristic marsupial, the Tasmanian Devil, *Sarcophilus ursinus*, now becoming rare in all but the wildest country. This animal is of approximately the size and form of a small and stocky bull terrier. Its head, however, while proportionately very broad posteriorly, extends forward in rather pointed fashion in the excessive development of deep and very powerful jaws. By comparison with the animal's size, the crushing force of these jaws is quite astonishing. The animal can split large bones to obtain their marrow contents. It is a savage fighter, more than a match for any but a large dog, and in the past has proven very destructive to poultry and sheep. It remains savage as a captive.

The Dasyures or Australian "Native Cats" (*Dasyurus*) are in form a parallel composite of feline and civet. There is a fair series of species, most of them prettily marked with white or yellow spots on a dark gray or blackish ground. The average length is around eighteen inches for head and body, and twelve inches for the tail. They commonly occur in easterly Australia and Tasmania. These animals are strictly carnivorous and frequently raid poultry yards. They are expert climbers and live in the trees as well as on the ground.

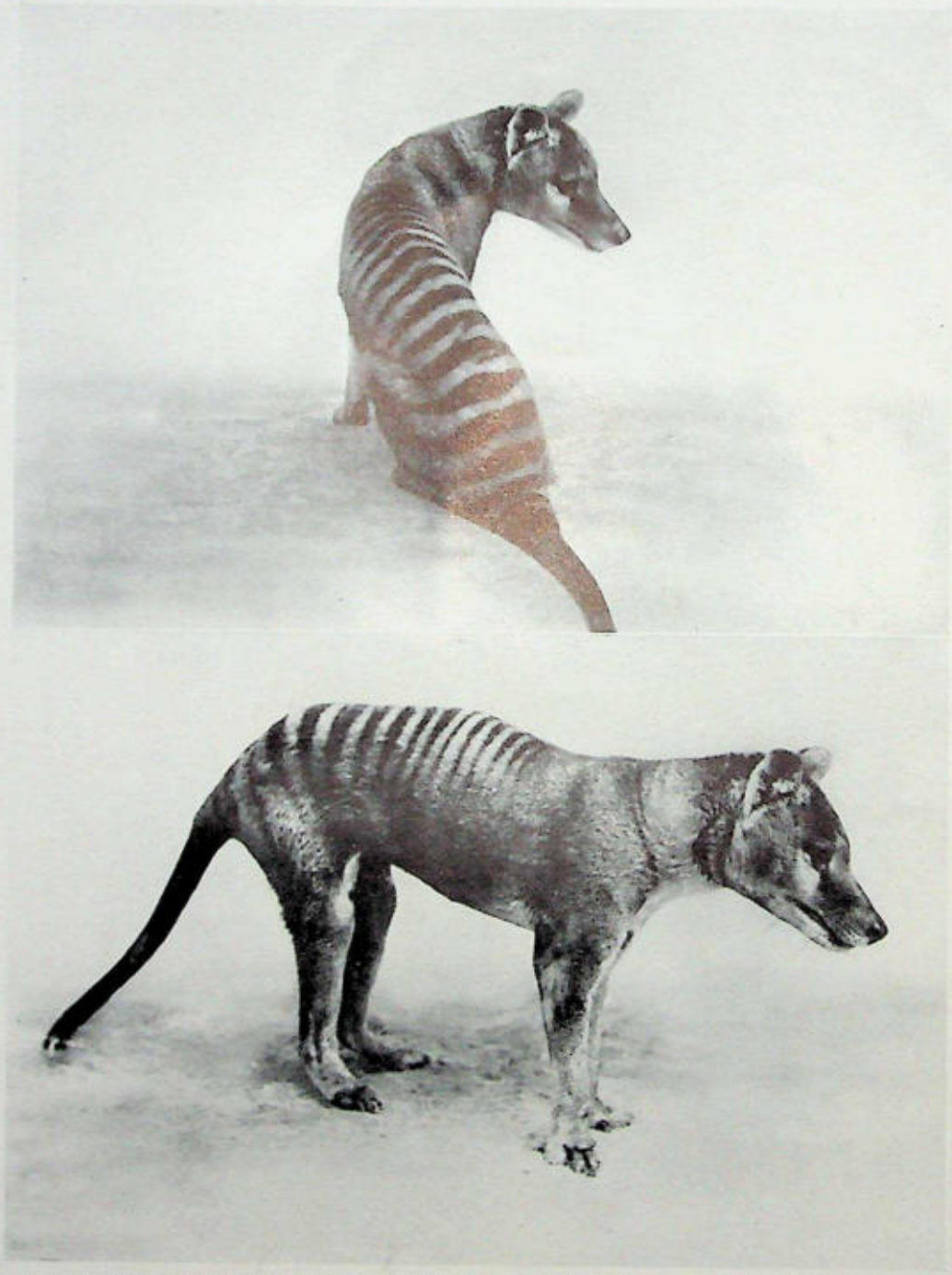
In building up a representative collection of Australian marsupials, the forms paralleling rodents should be well represented to indicate versatility of form and habits among the smaller kinds. Some are extremely difficult to obtain. Mr. Ellis Joseph, a resident of Australia, has at odd times brought us a number of rare specimens.

Largest among the pouched rodent-like forms, is the Wombat, *Phascolomys mitchelli*. This thick-set creature is tailless, and a big specimen will have a head and body over forty inches in length. Here is a replica of the marmot or the woodchuck, but grown out of bounds. Large examples weigh well over fifty pounds. The incisors have undergone specialization to the extend of looking quite like the powerful gnawing teeth of the typical rodent. The creature lives in burrows, digs rapidly with powerful claws, and is altogther herbivorous. Another "rodent" type is the Thick-tailed "Dormouse," which, with the exception of the stout caudal appendage is astonishingly like members of the European dormouse genus. They curl into a ball to hibernate, like those creatures. The Feather-tailed Flying "Mouse," *Acrobates pygmaeus*, is also called the Pygmy Flying Opossum, although it is decidedly mouse-like. There is distensible skin between the limbs, and the tail is so furred that it looks like an elongated feather, appearing to function as a rudder in guiding the animal's scaling flight.

The phalangers, commonly called Flying Opossums, genus *Petaurus*, are replicas of large flying squirrels in form, and have extensive areas of elastic skin between fore and rear limbs, for gliding. These are particularly pretty animals, with very soft and deep pelage, silvery gray, and with striped head markings. The eyes are large and luminous. Closely allied to the flying phalangers are the typical Australian



The bandicoots are graceful little animals, although they have rather an attenuated structure. There are eight or more species in Australia and several others in New Guinea. The tail is long, but not prehensile, and the marsupium opens in the opposite direction to that of other marsupials. They are burrowers and feed on insects and are partial to larval forms found on acacias, and consume at certain seasons great quantities of roots. The female usually produces two young at birth.



The thylacine, variously called wolf, hyena, tiger and zebra, the last names derived probably from the transverse black bars, sixteen in number, on its crupper, is a large and handsome animal confined to Tasmania. This largest of the carnivorous marsupials measures, when full grown, with the tail, nearly five feet in length, and has a very long muzzle and powerful jaws. He is nocturnal in habit, and is ill at ease in the glare of the sunlight, blinking like a distressed owl. The thylacine hunts in solitude and not, like wolves, in packs. The pouch easily accommodates the four young, which is the actual number at birth.



The wombats are burrowing animals and have been termed the badgers among the marsupials, to which they bear some resemblance. The wombat is a lusty digger and the damage he can do among roots is prodigious, as he has the assistance of short, powerful legs, armed with eighteen curved claws and twenty-four effective sharp teeth, although they have no roots. The bulk of the animal, compared with the short legs and small feet, is striking. The weight of sixty to seventy pounds is seemingly out of proportion to his means of supporting it. Despite his bulk, he can run swiftly, but can neither leap nor climb. It reproduces its young slowly, usually one at a time. The only sound it is capable of making is a peculiar hiss when irritated. There are two species, one found in Tasmania.





Upper: The fat-tailed marsupial mice are active, tiny animals, with soft gray pelage and round prominent ears. They are terrestrial, do not burrow and live on insect food. They have a well-developed pouch in which they carry the three to four young. This species is found generally over Australia, except in the north. *Lower*: The Tasmanian devil is appropriately named. Its disposition suitably deserves the appellation. It is utterably untamable and this trait is the more remarkable by comparison with the gentle disposition of most other marsupials. The "devil" is entirely black, except for a white band or two. It is more dreaded by dogs in combat than the thylacine. It produces four to five young at birth.



The phalangers are arboreal and by Australians they are called oppossums. They are nocturnal in habit, coming out at night to feed on gum leaves and the wild fruits of the forest. The tail is prehensile, and their modes of progression through the tree-tops combine the awkward groping of the koala, the swinging movements of the 'possums, and the parachute-like flight of the flying squirrels. Their delicate gray fur makes them a prize for the pelt hunter.



The flying phalangers are as graceful and attractive little animals as the flying squirrels of our own country. In a sense, the name is a misnomer, as they do not actually fly. In nature these creatures can only descend in the air. When they wish to ascend a tree, they run up the trunk, the apposable thumb on the hind feet giving them a good grip on the branches. On the ground they are as awkward as a bat. When they wish to cover an intervening distance, they spread the loose skin of the abdomen, which is dark above and white or yellow underneath, and sail gracefully through the air. It is a marsupial and when the young one leaves the pouch it is carried on the parent's back.



Arboreal animals are usually light, lithe and active, but the koala is the antithesis of this; it may be wondered, indeed, how such a heavy and clumsy animal can get a living among the swaying boughs of the giant eucalyptus, but its powerful limbs, armed with short, sharp claws, enable the koala to secure so firm a hold on the smooth bark that it is dislodged with difficulty.

opossums, which are also commonly called phalangers. The Vulpine Phalanger is one of the largest. Its coat is of yellowish hue and woolly texture.

The rarest of all Australian marsupials in American collections is the Koala or "Native Bear," *Phascolarctus cinereus*. This unique creature, like a miniature silvery-hued bear, with its big furry ears and most gentle ways, feeds largely upon eucalyptus leaves, and except upon the extreme west coast of the United States this diet is hard to match. Of all animals, from any country, it is one of the drollest and most attractive. It stands as a star in a country where most of the animals are unusual.

Even in its palaeontological features, the marsupials appear to dominate in Australia. Larger forms preceded the existing animals. Among the fossil types was one approaching the size of a rhinoceros, but of form to indicate that it was dull and inoffensive. There was at least one carnivorous giant, larger than a bear, as well as kangaroos standing twelve feet high. All of this may seem strange and different from the findings in other lands, but the modern fauna of Australia is quite in keeping.

KOALA: NATIVE BEAR

Australia's Most Popular Mammal

CHARLES BARRETT, C.M.Z.S.

KOALA and kookaburra, one a mammal, the other a bird, are the most popular of all Australian animals. The kangaroo is regarded as a national figure, and is represented in the coat of arms of the commonwealth supported by the emu; but neither of these famous natives has won the affection that is enjoyed by our Koala, native bear, and *Dacelo*, the Great Brown Kingfisher, kookaburra.

Phascolarctus cinereus charms everybody but the flint-hearted pelt-hunter, who has taken heavy toll of the species, and almost exterminated it in parts of its range, which extends from Northern Queensland to Victoria. But the koala is strictly protected now in two of the three states he inhabits, and, at least in Victoria, is making up the leeway of many years of persecution. We have a great National Park, Wilson's Promontory, where I have seen nearly fifty koalas during a long day's ramble.

Where to begin a biography of the koala, is a problem. Gleaning from field notebooks, I could give you a mosaic of observations, or a formal account of *Phascolarctus* viewed, coldly, through scientific eyes. Taking the privilege of a nature lover, I present this odd little, grey-furred creature as a personality.

At the Melbourne Zoological Gardens, the koalas' tree, a widespreading old gum, is circled by a high wire-netting fence. Our native bears may remain for weeks without inclination to wander, then the desire for a tree-change rules them. Lack of food—eucalyptus leaves—is a frequent cause of koala migrations, which may be a no greater change than from one tree to another. I recall an exodus, however, which took hundreds of koalas from a sheltered hollow thick with trees, to fresh forests by the open sea. The trees in the old haunt were dying, entirely denuded of foliage by the bears. The pioneers of this koala family had long lived in clover, until their numbers had increased so greatly that the trees in which they lived failed to produce foliage beyond the requirements of this great army of hungry lodgers.

Phillip Island, a favorite resort of holiday-makers within easy reach of Victoria's capital, is also a sanctuary for native bears. There, in the roadside trees, koalas are quite at their ease. They peer down at motor cars whirring by; calmly returning the gaze of nature lovers and the merely curious trippers, and show not the least sign of fear. They know that they are protected; though occasionally one is secretly caught and smuggled away from the Island.

Fear, these toy-like marsupial dwellers of the giant trees, unluckily for its species in the past, either lacks that emotion or expresses it only when hard-pressed. Should you disturb a bear perched in the fork of a tree or clinging to the bole or a bough, it will gaze at you inquiringly, merely indicating a very mild surprise.

The ordinary call of the koala is quite loud and discordant, and literally grates on the ears. It is truly a grating noise, very much like that produced by a saw cutting through a thin slab of wood. These sounds, as they resound at night in the bush, have startled nervous folks unfamiliar with wild life. They gave rise



An albinistic phase of the koala, with her young "Joey" on her back. "Joey" is the Australian common nomenclature for the young of this quaint marsupial. Photograph by Charles Barrett.

once, in a Victorian district, to a bunyip scare! The bunyip is Australia's mythical creature, living in aboriginal legend and camp-fire yarns of the white man. It has been variously described, as a fearsome monster, inhabiting dark, mysterious swamps; and roaring or bellowing a menace to man. Nobody ever has seen the bunyip, but everyone in Australia has heard of it, and some credulous white folks more than half believe that it exists.

Our flying phalanger (*Petauroides*), squirrel it is usually termed—has also a very loud voice, and its cries may frighten "new chums" camping-out in the wilds. Voices of the night are music to the naturalist—unless he be weary and trying to woo sleep, when he may think hardly even of a "bear."

My photographs, taken mostly in the wilds, show the koala in characteristic poses; they form a gallery, unique in its way, for I have hunted *Phascolarctus* with the camera for years, and from the tropics to bleak southern shores. I have climbed tall trees to interview them, and been clawed till the blood flowed, by young ones captured for closer inspection. Koala, although mild-mannered by nature, can fight, or rather, struggle for freedom. It has sharp claws with power behind them, and uses them gamely enough. Its limbs are strong; indeed the whole animal is very bulkily made for an arboreal species. It looks clumsy when progressing along the ground, but up aloft, the koala is seen at its best. Its face is truly, its fortune. No other mammal in the world, surely, has a more appealing, childlike expression than that of a koala in repose, and this popular favorite of ours is as inoffensive as it looks. It does no harm, excepting to gum trees, the kinds whose leaves are richest in oil. It is from these Eucalyptus that oil is distilled in vast quantities for various uses. Eucalyptus oil on loaf sugar is taken as a cure for colds and coughs, yet the bears, who feed most exclusively on gum-leaves, have voices as hoarse as you please!

Fur-hunters are responsible for the decline of *Phascolarctus*, in many of its haunts and disappearance from others; but disease, also, has been its enemy. During three years, 1887 to 1889, the mortality from opthalmia and a disease of the skull was terrible. Another visitation spread over the period 1900 to 1903. Millions of koalas were victims of the scourge, and this may occur again if the species should ever increase to multitudes, since we cannot guard them from disease. In the south no open season for koalas is allowed, but should the fur-hunter, given a month or two of free killing, it might place the koala with the dodo. Our protected bears are prospering now; disease is claiming only a few, the normal percentage probably.

Excepting in the season that makes all creatures sociable, the koala is solitary. Of course, there are communities of sorts. A tree may be the home of several koalas; and all the trees of a group be tenanted. Still, communal life is lacking.

Parent and young are frequently seen, and present a charming picture. In mid-winter—June is the usual month I believe—the baby koala is born. Large, even moderate-sized families are rare among koalas. One cub is the rule, and twins would be a novelty. For about three months the little marsupial lives cosily in its mother's pouch. Then it is ready for the open air. The change is not much of a venture, since the cub merely climbs to its parent's broad back, a safe perch for another quarter of the year. When six or seven months old, the woolly youngster—"Joey" is a bush term for it—literally ceases to be a burden on its mother. It is now able to fend for itself, and chooses, perhaps after wandering for a while, a comfortable low fork in a gum tree as sleeping quarters in the daytime. The koala is mainly nocturnal in habits and usually is found asleep between dawn and sunset. It feeds at night among the topmost branches, having a nice taste for gum-tips. When the supply of tender shoots fails, koala shifts his quarters to a neighboring tree if there be one available not already eaten out. He may have to travel a bit, or go shares with other bears not at all anxious for his company.

Climbing is as natural to the native bear as swimming is to a duck; only the marsupial going aloft cuts rather a sorry figure compared with the cruising water-bird. Koala digging his claws into the bark, makes a kind of jump, rests, and jumps again. The ascent is jerky and ungraceful, but not so slow as you might imagine it to be. Though I'm an experienced climber, I've often been beaten easily by a bear. I tried once to head off a mother and



A naturalist's camp in the heart of tropic Queensland. The lovely Cycad, *Bowenia*, grow here in great abundance.
Photograph by Charles Barrett.



Breaking camp. Loading a pack-horse in the Queensland forest country.
Photograph by Charles Barrett.

babe to get them within range of a stand-camera. The mother with "Joey" clinging tightly to the dense, woolly fur of her back, jumped to the ground, lumbered through bracken for twenty yards or more and climbed a tall tree-stump very quickly. I snapped the pair easily then—securing the first photograph of the kind—an albino koala with a cub of the normal grey-brown hue.

This was at Red Hill, on Wilson's Promontory (our park of 101,000 acres, all reserved for wild life). Gum trees grow under the Hill in the swampy land where snakes are to be seen, and in spring where the dainty white butterfly-iris blossoms. I rode among the eucalypts, counting teddy bears. They were there in dozens; solitary, several in a tree, and mothers each carrying a cub on her back. The month was October. When I passed directly beneath their perches, the koalas dozed on or looked down in their droll, inquiring manner. Drumming with a stick on the tree-trunk woke the sleepiest fellows; two or three of them grunted, and moved to higher forks; mostly they declined to move, excepting their heads, to gaze at the noisy intruder.

As a pet, the koala indulges its instinct for climbing by getting on to human shoulders when given a chance to do so. It grips firmly, and a stranger unused to its ways may be scratched severely if he ventures to handle a tame teddy bear. A young farmer friend of mine in Queensland has a whole family of koalas as pets. They are gentle as dormice with their owner, nestle in his arms, squat upon his shoulders and plainly enjoy his company.

The koala's face has an almost human appearance, so pensive and droll as to lend itself readily to caricature. In our newspaper cartoons, in comic supplements and in fairy stories the quaintest little mammal in the world figures to the delight of grown-ups and children.

The koala when wounded clings to his tree so tenaciously, oft-times, that even in dying the hold is not relaxed, and the victim's body may not fall until some time after death. Though arboreal and devoted to a diet of leaf shoots



The haunt of the koala in a gum forest in Victoria's National Park, Wilson's Promontory. Some of the trees are nearly denuded of their leaves by the multitude of koalas which are here protected by the Commonwealth. Photograph by Charles Barrett.



A koala climbing a gum-tree. Only the smooth-barked species with high oil content are selected by the bear for his food, and only a few species form suitable food-trees. Photograph by Charles Barrett.



The koala has one young at birth, which is born about June. It is carried in the pouch for three months and spends the rest of the year on its parent's back, when it is then ready to shift for itself. Photograph by Charles Barrett.

on the lofty boughs, the koala at times goes for a terrestrial ramble, progressing clumsily on all fours. These excursions as a rule are made in quest of food.

Color variation in the koala is not considerable beyond the range from light to dark grey, which is the general hue of the thick fur. Mottled specimens occur, however, and of albinism in the koala I have several records. Unfortunately these attractive little animals suffer much from parasites, hideous ticks, which often increase until they sap the life from their host. I have found, lying on the ground in the forest, the bodies of bears killed by ticks. Intestinal parasites, also, afflict the koala. All things considered, despite his indolent life, *Phascolarctus,* is in no better case than many other creatures of the wilds. Under protection he is thriving and dimly may be aware that we acknowledge his right to a place in the sun.

Koala really does resemble, superficially, a small bear. He has no tail, his ears are broad and furry, and his head and the stout limbs are bear-like. Native bear he is termed almost universally, in Australia. The title "Native sloth," mentioned by Lydekker, in his volume on "Marsupials," I have never heard applied to *Phascolarctus,* whose sluggish habits certainly might have suggested it to an uncritical observer.

Browsing through old books, travellers' tales and records of the early days when our cities were towns or villages, and aborigines still hunted on the outskirts of settlements, I have gathered some marsupial lore. Here is a sample, Colonel Patterson's account of the hunting of koalas by the blacks in the vicinity of Port Jackson:

"The natives examine, with wonderful rapidity and minuteness, the branches of the loftiest gum-trees, and upon discovering a koala they climb the tree in which it is seen, with as much ease and expedition as a European would mount a tolerably high ladder. Having reached the branches, which are sometimes forty or fifty feet from the ground, they follow the animal to the extremity of a bough, and either kill it with the tomahawk or take it alive. The koala feeds upon the tender shoots of the blue gum-tree, being more particularly fond of this than of any other food; it rests during the day in the tops of these trees, feeding at ease, or sleeping. In the night it descends and prowls about, scratching up the ground in search of some particular roots."

An old Bushman of the sixties gives an entertaining account of the koala, describing it—a pretty good portrait—as "about the size of a large poodle dog, of a light grey color, with white throat and rump and no tail; and a very comical-looking fellow he is, with his round, bald face, small black eyes, and square fringed ears." This early observer, who shot kangaroos and other animals and birds for the markets in Melbourne town, had scruples about shooting at the bears with shot, owing to the cruelty involved. The koala's hide is thick, and a bullet only will be fatal when the animal is at any height—unless the victim is riddled with shot: a miserable kind of sport!

The aborigines regarded the flesh of the koala as a delicacy—good eating, as we say. I've never tried it, nor am I likely to do so! It is said to be eatable, at a pinch, the flavor being not unlike that of a true bear—the species not named by my authority, the author of an Old Time book of wanderings in the Australian wilds.

Millions of koalas have been killed for the sake of their pelts; millions of opossums (phalangers), of kangaroos, and other marsupials. The trade, so hateful to lovers of wild life continues, but not unrestricted now. We are protecting species in danger of extinction, and giving more thought to conservation generally. The notable work done in the United States is known and highly appreciated in this Commonwealth of ours. The saving of the koala in Victoria, shows what may be done when the State guards its wild life with the approval of its people—all but those who profit by freedom to kill the fur-bearer. The wild dog of Australia *Canis dingo,* often met with in koala country, still flourishes, though it has for nearly a century been warred against, and wherever it ranges has a price upon its head. He is a sheep-killer and preys also upon wallabies, ground-birds, and other creatures. This is a pest animal, native but not marsupial, that has but few friends excepting among the aborigines, who alone are able to domesticate him. Grown up, it is treacherous, sneaking, and practically untameable, but as a pup, it has some charm—as my photograph proves.



A young Queensland settler and his family of pet koalas. The koala is both guileless and gentle and when disturbed it gazes down from its perch without exhibiting fear. The voice of the koala is distinctive, a hoarse, grating call, and vies with the phalanger as being the loudest sound made by a native animal. Photograph by Charles Barrett.



The Kookaburra.
More than half of the kingfishers known to science occur nowhere out of the Australian region, and among its wonders are kingfishers that do not care for water and never eat fish except in captivity. This interesting bird does not frequent water courses and feeds on reptilian forms and other dry land fauna.

KOOKABURRA

The Giant Kingfisher of Australia

LEE S. CRANDALL

IN Eastern Australia, probably no bird is better known or better liked than the giant kingfisher or laughing jackass, familiarly known as the kookaburra. Various subspecies are found, ranging from Cape York in the north to Victoria and South Australia. In the vicinity of Sydney, New South Wales, it is particularly abundant, and is often seen perched on telegraph wires, or on dead stumps in clearings. For unlike the kingfishers of America, the laughing jackass is a bird of field and open forest, rather than of lake and river. Its food consists largely of insects and mice, with any unfortunate small birds or mammals it may be able to capture.

This habit of bird catching is a trait which has made the kookaburra less popular than it might be with some nature lovers. In fact, it is not above raiding the barn-yard for young chicks, when other food is scarce. But its friendly, familiar habits more than make up for its delinquencies.

The name "laughing jackass" is derived from the bird's loud, rattling call-note, which might easily be taken for wild, demoniac laughter. This is heard most frequently just as darkness is falling and again just before dawn, while it is still quite dark. So regular is the bird that it is known, in the back stations, as the "bushman's clock." At certain seasons, the birds roost together in small flocks. Then, when they call in chorus, the noise is deafening and can be heard for considerable distances, in the stillness of dusk or dawn.

Once commonly imported by American dealers, restrictive laws in Australia have made the laughing jackass extremely rare outside its own domain. Fortunately, however, it is a hardy and vigorous bird, adapting itself readily to the conditions of confinement, and usually living out a long span of years. Consequently, there is usually at least one specimen to be seen in the Large Bird House of the Zoological Park.



In Australasia there are two species of wild dogs, the dingo or warrigal of Australia and the native dog of New Guinea. The dingo is the most widely spread of the few native animals that are not marsupial. It is found all over the continent, but not on the Island of Tasmania. Zoologists have not been able to account absolutely for the presence of a wild dog, a typical representative of the fauna of the outside world, in Australia. It is supposed that it came to Australia with the Aborigines "at some period in that vague borderland of time where the geologically recent meets the historically remote." An Australian scientist has stated that the dingo is nearer the ancestral type than to the other races of dogs. Photograph by Charles Barrett.

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BULLETIN

NEW YORK ZOOLOGICAL SOCIETY

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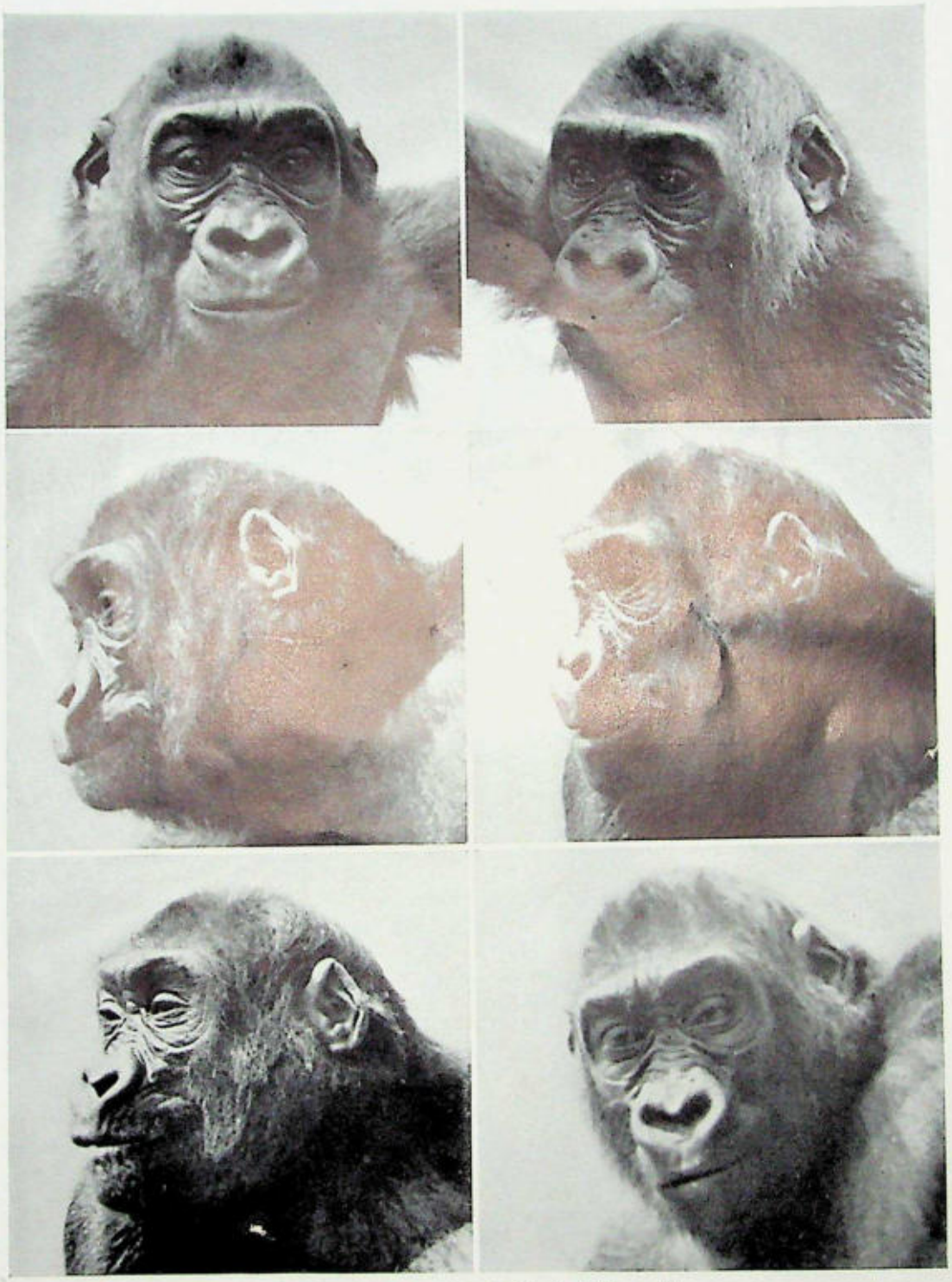
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Several recent portraits of the Society's gorilla.

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The Zoological Park's Young Female Gorilla, Janet Penserosa

With notes concerning her companion a young female chimpanzee, Ellen Allegra

CHARLES V. NOBACK
New York Zoological Park

Illustrations, from figures five to twenty-eight, represent a record of development from the day the gorilla arrived until the present time. Figures 5, 6, 7, and 8 were made by the International News Photo Service, and those following by E. R. Osterndorff. The illustrations, other than those mentioned, taken by Elwin R. Sanborn in 1931, show the gorilla's excellent condition at this time. All photographs were made in the Zoological Park.

ALTHOUGH vague descriptions of large and shaggy, man-like apes, living in the heart of Africa and called gorillas, are found in earlier literature, it may be recalled that the gorilla (*Gorilla gorilla*) was virtually an unknown animal one hundred years ago. The gorilla as known today was definitely identified for the first time by Savage and Wyman in 1847, only eighty-five years ago. Yerkes and Yerkes in their outstanding work, "The Great Apes," speak of Savage and Wyman as those "who discovered this animal to the scientific world."

An adult gorilla, which may range from four to six feet in height and weigh approximately four hundred pounds, has never been seen alive outside of its native habitat, which includes part of the Belgian Congo, Gaboon Country and the Cameroons of Central Africa. Relatively few living infant gorillas have been brought from central Africa to any civilized country, as most of them either perished on board ship or died soon after reaching civilization.

It was not until 1855 that the first living infant gorilla was brought from Africa to Europe. The following quotation from "The Great Apes" by Yerkes and Yerkes, contains references to the first infant gorillas that reached Europe:

"In 1855 there was shown in England as a chimpanzee named Jenny, an ape which was subsequently identified as a young gorilla. It is known in the literature as Wombell's gorilla. The first description which we have discovered is that of Waterton (1858) who mistook the animal for a chimpanzee. This specimen, which seemingly was the first living gorilla to reach Europe and to be presented as an exhibit, Waterton tells us, continued with the menagerie until it reached Warrington where 'without any previous symptoms of decay, Jenny fell sick and breathed her last.' Further information about this first gorilla may be found in Sclater (1877), Keith (1896), Scherren (1905), and elsewhere. Confusion of dates appears, in that certain authors refer to the animal as exhibited about 1860.

"The second European specimen, and the first to be exhibited in Germany, apparently is the Falkenstein gorilla which in June, 1876, was purchased from Dr. Falkenstein by the Berlin Aquarium for the sum of twenty thousand marks.

"What appears to have been the first specimen to be exhibited in France is described by Milne Edwards (1884) as a male estimated at about three years of age. Presumably the animal arrived in Paris in 1883. He survived a short time."

In "*News Bulletin* of the Zoological Society," No. 2, published by the New York Zoological



Fig. 1. Photograph of a baby gorilla which probably was the first one of this interesting anthropoid ever brought alive to the United States. The animal arrived in Boston, Massachusetts, May 2, 1897. It lived but a short time, dying five days later. A reference is made to this incident in the text. Photograph from an unknown source.

Society in October, 1897, Dr. W. T. Hornaday records the arrival of what is known as the first living infant gorilla to reach the United States:

"For many months I have watched with great interest the work of two American ape-fanciers, the Edwards Brothers, in training orang-utans and chimpanzees, which they continually exhibit. Ever on the watch for new simian 'talent', they found in Liverpool last April [1897] in the possession of a dealer, a genuine baby gorilla, alive and well. They promptly purchased the strange little creature, and on May 2, the first specimen of *Troglodytes niger* (*Gorilla gorilla*) ever seen alive in this country, arrived in Boston and was exhibited there.

"It was twenty inches in height, fifteen and one-half pounds in weight, and its portrait is reproduced herewith (Fig. 1). The sailors who brought it to Liverpool from the Gaboon country stated that its capture was due to an accident to its mother, who was killed by a falling tree. When first captured the natives fed it on plantains and rice, but on reaching civilization

its bill of fare was extended to include milk, dry bread, apples, oranges, figs and bananas.

"Although the little creature was a hearty eater, an energetic fighter, and apparently desirous of long life, fate proved unkind. For such a delicate and sensitive animal, it was brought across the Atlantic a little too early. On the voyage over it contracted a severe cold, which resulted in its death only five days after it reached Boston."

Three infant female gorillas have been received at the New York Zoological Park at different times during the past twenty years. The first one was received on September 23, 1911, and died twelve days later. The second, Dinah, lived at the Park for over eleven months, from August 24, 1914, to August 1, 1915. The third infant gorilla received at the New York Zoological Park is Janet Penserosa, the subject of this article.

Early in the summer of 1928, Rev. W. Reginald Wheeler left the Gaboon country in West Central Africa for the United States by way of France, bringing with him three baby gorillas and a baby chimpanzee when he sailed from Duala, a West-Central African seaport. The anthropoid apes were quite ill during the voyage to France, and two of the gorillas died on board ship and were buried at sea.

Although the surviving baby gorilla and chimpanzee were ill during the remainder of the journey, they managed to live on a diet of milk, bananas and bread. Upon reaching France they were taken to Paris and boarded at the Jardin des Plantes, where they were nursed and treated until arrangements could be made to transport them to New York. They left France for New York in October 1928, sailing from Cherbourg on board the White Star S.S. *Olympic,* housed in the ship's animal quarters.

The midnight of October 30, 1928, was calm as the *Olympic* quietly docked at Pier 59, North River, with a sick baby gorilla and chimpanzee as part of her living freight.

Mr. William White Niles, Secretary of the New York Zoological Society, arrived at the pier the following morning to accept the rare gorilla for the Society from Rev. W. Reginald Wheeler. Acting under instructions from Dr. W. Reid Blair, Director of the New York Zoological Park, the writer proceeded to Pier 59 early in the morning of October 31, to make a preliminary examination of the anthropoid apes. Mr. Niles and the writer went on board ship where they saw the weak, emaciated gorilla and chimpanzee huddled close together in one of the comfortable cages of the ship's animal quarters. Fortunately such excellent accommodations had been provided for them as otherwise they might not have survived the ordeal of so long a journey.

The dock was a beehive of activity as the huge ship's cranes unloaded baggage while passengers left the ship to greet their friends on shore. Those who passed the customs examination left immediately and were soon lost in the maelstrom of the big city, unmindful of the fact that a baby gorilla and chimpanzee were soon to be on their way to the New York Zoological Park. After an inspection, at about eleven o'clock, the customs officials permitted the gorilla and chimpanzee to leave the dock. Each one was carefully wrapped in a warm woolen blanket and carried to a waiting automobile where a motion picture was made by Rev. Mr. Wheeler. They were soon on their way, through crowded city streets, bound for the Hospital at the New York Zoological Park.

They reached their destination at one o'clock in the afternoon, and upon arrival at the Hospital were placed in a sanitary cage, which had been provided with clean, fresh straw. Here they were allowed to remain alone in order that they might relax and recover from the fatigue of their long and strenuous journey.

They appeared to be somewhat bewildered when first placed in their warm, comfortable quarters within the quiet atmosphere of the Hospital. Their curiosity was soon aroused, however, as they gazed about to inspect their new home. The cage in which they were temporarily housed was virtually a four-foot cubic room whose ceiling and front consisted of a wire network.

They played with the straw or moved about cautiously. Both would immediately huddle close together like two lost children and hold on to each other at the sound of strange voices or footsteps in the hall. The chimpanzee literally "mothered" the baby gorilla. It was with great difficulty that they could be separated as they would most strenuously resist.



Fig. 2. Radiographic record made on November 3, 1928, showing the bones of Penserosa's hand. Four of the wrist bones (carpals) stand out quite clearly. A fifth is very faintly revealed in the negative. Fig. 3. A few months later, March 10, 1930, five wrist bones appear in the radiograph. Fig. 4. A year later, when the age of the gorilla was estimated to be three years, a full set of wrist bones (carpals) were found by radiographic examination. Nine carpal bones were present, where usually there are but eight; the extra one being the centrale. Her four permanent molars (comparable to the six molars in man) also had erupted at this time. These observations, together with her rapid increase in weight (as may be seen in the table which is printed elsewhere in this article, indicate that physical development in the gorilla is quite rapid. A full set of carpal bones is not present in man until about the ninth year.

At two o'clock they received a few pieces of orange pulp and a banana, which they ate very slowly. Later, at about four o'clock in the afternoon, a cup of milk with an egg beaten in was offered to them. The chimpanzee readily drank her cup of milk with egg but the baby gorilla was very slow and persisted in her refusal to eat. It took more than half an hour to coax her to take her share of milk and egg.

About six o'clock after finishing their evening meal, they moved about in their new quarters until sunset. At seven o'clock in the evening the last person left the building, leaving the infant gorilla and chimpanzee by themselves without the benefit of a night nurse or attendant. Upon observation it was noted that they gave no audible indication of fear when left in total darkness. After their journey and the excitement of travel they were apparently very tired as both were soon fast asleep. While on his tour of inspection, the night watchman observed them every two hours during the night. His report the next morning stated that they were found to have been quiet and fast asleep during the night. The watchman did not turn on any of the electric lights in the hospital building but used a small flashlight instead.

Early the next morning they were wide awake and played about the cage together, the chimpanzee pushing the baby gorilla around so that at times the gorilla would cry, and then the chimpanzee would mother her again.

The infant female gorilla weighed seventeen and one-half pounds (7.84 kg.) while the baby chimpanzee weighed eighteen pounds (8.18 kg.). They were estimated as being about eighteen to twenty months of age since each had a full set of milk teeth, although the canine teeth of the gorilla were not fully developed.

After an examination was made it was found that both of them were greatly emaciated and weakened from malnutrition and a cold. They were also afflicted with a skin disease (dermatitis). Because of their illness and poor condition it was not believed that they would survive very long, consequently they remained at the Hospital for care and treatment. Since they were emaciated and ill, the veterinarian's immediate problem was to keep them alive and then to do everything possible to restore them to a state of sound health.

The general plan of procedure was, first, to allow them to rest and relax in their quiet hospital quarters; second, to prescribe an adequate, nutritious diet, and third, to render indicated medical care and treatment.

Rest and Relaxation

A roomy cage twelve by fourteen by nine feet, enclosed with one-inch electric weld wire mesh, was built in one of the larger Hospital rooms. This was provided with a wooden floor, a bench, a pole one and one-half inches in diameter, and a trapeze. Straw covered the floor of the cage and a large skylight admitted a flood of sunlight. Their smaller cage served as a sleeping compartment while the larger one was used as a playroom for recreation and relaxation.

Diet and Method of Feeding

The next consideration in the care of the baby gorilla and chimpanzee was the choice of a suitable variety of foods to supply the necessary elements for growth and development. The food requirements of an infant gorilla are quite similar to those of the human infant so far as physical growth is concerned. Milk, eggs, fruits and vegetables, with a small amount of bone meal and cod liver oil were selected to form the basis of her diet.

With the object of providing a wholesome, nutritious, palatable and adequate diet for the baby gorilla the following feeding schedule was prescribed and followed out from the first day of her arrival to the present date. The only important change in the diet was that as she grew and increased in weight the quantities of food were materially increased.

Feeding Schedule:—Breakfast at eight o'clock consists of milk and eggs prepared as follows: Two tablespoonfuls of whole dried milk and three eggs are added to a quart of diluted condensed milk. This combination is then thoroughly mixed with an egg beater. She is permitted to take as much of this food as she desires. During the first few months at the Hospital a prepared baby food was also added but later discontinued. Two to four teaspoonfuls of Norwegian cod liver oil with some bone and blood meal are given at nine o'clock.

The principal meal of the day is fed at 12:30 to 1:00 P.M., and consists wholly of fruits and

vegetables. Bananas form a substantial part of this meal. The young gorilla may eat from two to six each day. It is interesting to note that the gorilla as well as the chimpanzee are very fond of eating the inner white lining (endocarp) of the banana peel. They will frequently eat the whole banana skin. While human beings usually prefer to eat fully ripe bananas which taste relatively sweet, the gorilla and chimpanzee prefer those which are not quite fully ripe, that is, bananas with a tinge of green in the yellow skin and which to the average human taste are somewhat bitter—the taste of bananas not quite ripe. The ripe bananas naturally contain more sugar while the others have more starch.

Ripe oranges are fed each day and are relished by them. The chimpanzee prefers the orange pulp but does not care for the rind or skin. The baby gorilla, however, is very fond of eating the endocarp of the orange skin.

Apples are usually fed on alternate days. Various combinations of the following vegetables are fed daily—unpeeled potatoes, boiled or raw; lettuce, carrots, and rice in the form of a simple rice pudding with a good supply of raisins. Like children, they pick the raisins out first. They are permitted to eat as much of the above fruits and vegetables as they desire. Their food, though plain, is wholesome, nutritious and inexpensive.

Some writers state that gorillas live upon and like to eat young shoots of the bamboo plant. Our gorilla, however, refused to eat some canned bamboo shoots which were obtained from a Chinese restaurant. She likes white bread, butter, and Swiss or mild American cheddar cheese if they are offered to her. Sunflower seeds, peanuts and chocolates are also relished. These articles of food have at times been offered to her but they do not form a part of her diet. Later it was observed that the gorilla was very fond of picking grains of wheat from the heads of straws and eating them. She also likes to eat leaves, buds and the tender bark of wild cherry, sweet gum and other trees.

Medical Care

Appropriate medical treatment was prescribed when necessary. As a part of the general plan in the care and treatment of these apes it was decided not to "coddle" or pamper them in any way but to let them become self reliant.

They were irradiated for fifteen minutes each day with ultraviolet light from a mercury vapor lamp at a distance of not less than six feet. The first exposures were from three to five minutes and then the time of exposure was lengthened. The ultraviolet light seemed to improve the hair coat but it cannot be definitely stated what the exact effect of the light was. The use of artificial "sunlight" continued until spring, as will be noted later in this article. During their first winter at the Park they were kept indoors because they were ill.

An X-ray examination of the gorilla's hand was made on November 3, 1928, and indications that she had been suffering from the effects of malnutrition were present. This X-ray record was the first of a series of radiographs which later served to indicate that the bones of the hand in the growing infant female gorilla develop more rapidly than those in the hand of the human child (Figs. 2, 3, 4). Observations on the development of the teeth and semi-monthly weight records were made which also tended to support the view that growth is very rapid in the young infant gorilla.

Within ten days after her arrival the infant gorilla gradually became accustomed to her new home (Figs. 5, 6, 7, 8 and 9). Her daily routine began with a breakfast of milk and eggs at eight o'clock, followed by a rest period of half an hour, after which, at nine o'clock, she received her cod liver oil. The remainder of the day was spent in the playroom where she would play with the chimpanzee or else rest and relax.

The midday meal, consisting of oranges, bananas, lettuce, rice and raisins, apples or potatoes, was served at 12:30 to 1:00 P.M.

As the walls of the play cage consisted of an electric weld, one-inch wire mesh, the gorilla and her chimpanzee companion would climb all around the inside of the cage at will, or they would climb up the pole or swing on the trapeze until late in the afternoon. After their evening meal they would be left to themselves until early the next morning. With the chimpanzee lying on her back and the gorilla on her side, they would sleep throughout the night.



Fig. 5. The emaciated and weakened condition of Penserosa at the time of her arrival is apparent in the accompanying photograph, which was made soon after her arrival, at which time she weighed a trifle over seventeen pounds. A point of interest shown in the picture is the manner in which she balanced herself on the knuckles of her hand.



Fig. 6. She was so weak at first that it was necessary to use a spoon in feeding liquid foods, such as milk and eggs beaten together. Cod liver oil, a necessary part of the diet, was also given her in a spoon.



Fig. 7. As she gained in strength, an interest was manifested in toys. She clasped a large rubber ball in her arms as she toddled awkwardly around, but like an infant appeared to be more intent upon chewing upon it than bouncing it about.



Fig. 8. Occasionally the ball would be discarded in favor of a toy drum, which she treated in the same way. Improvement in her physical condition is evident by her rotund appearance.



Fig. 9. Bananas are a favored article of food among the great apes, and in the strictly limited dietary of Penserosa this fruit was included. She ate bananas with relish, preferring them, contrary to the tastes usually shown, not too ripe. Toward the middle of December, 1928, when this picture was made, the result of careful feeding was quite apparent.



Fig. 10. The infantile state of the young gorilla is well illustrated in the following five pictures. She clings to her chimpanzee companion Allegra, who in turn mothers her little charge, manifesting the true maternal instinct.



Fig. 11. The courageous Allegra apparently senses a self-imposed responsibility, as she places her protecting arm about her timid companion. An instinct which is often revealed among wild animals.



Fig. 12. When strangers arrive, the two little apes invariably cling tightly to each other. The gorilla ever dependent upon the more intrepid and fearless Allegra.

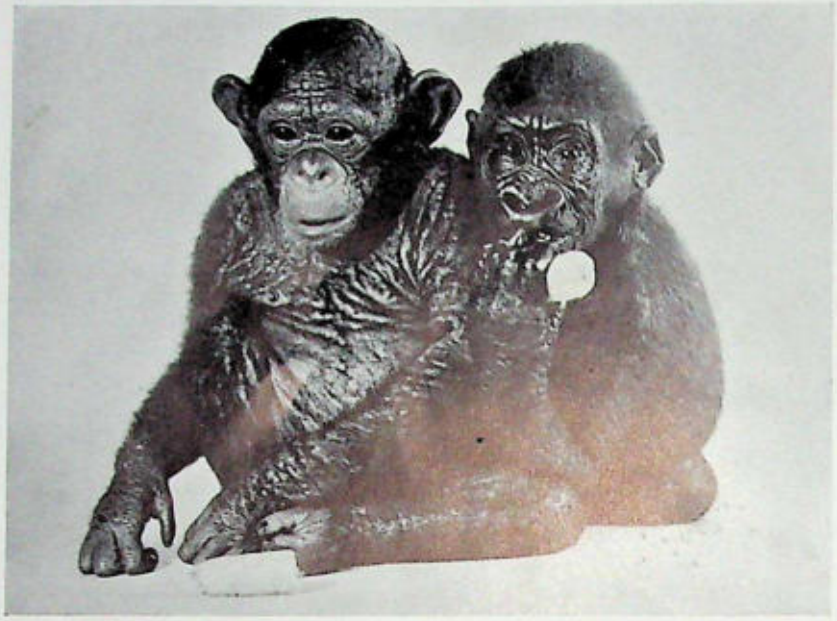


Fig. 13. The ever alert and active chimpanzee is all attention and interested while the gorilla hovers timidly behind her protector, nervously clutching a partially eaten banana.



Fig. 14. They sit for the photographer with the same joy as the human. It is an ordeal which they endure with a pose of watchful waiting, seizing any opportunity to slip off the perch and go back to play.



Fig. 15. When eating they present two extremes: the more high strung and active chimpanzee seizes the pan of milk, quickly raises it and speedily disposes of the contents, while the placid gorilla has very leisurely taken the first sip.



Fig. 16. They were taken out-of-doors for the first time on May 15, 1929, by their keeper. Their condition is reflected in the lustrous condition of the hair and the animated expression of the faces. This is a positive index of increasing good health.



Fig. 17. Both animals were allowed to play in the open like human children. Freedom in the warm sunshine, in which they indulged with tremendous zest, stimulated drowsy relaxation and restful sleep.

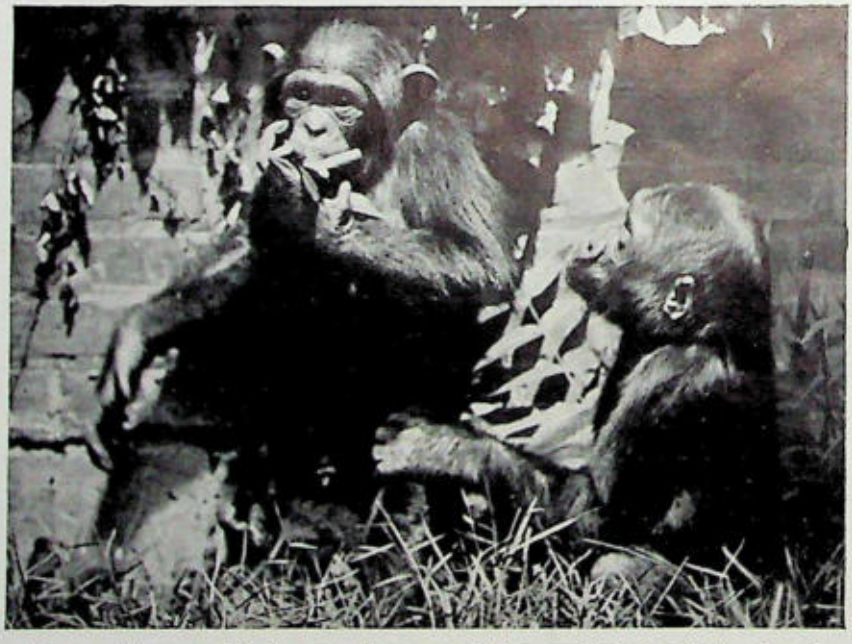


Fig. 18. A branch of fresh, green leaves was both a novelty and a feast. They instinctively enjoyed a return to their natural diet, which they shared impartially and without greed.

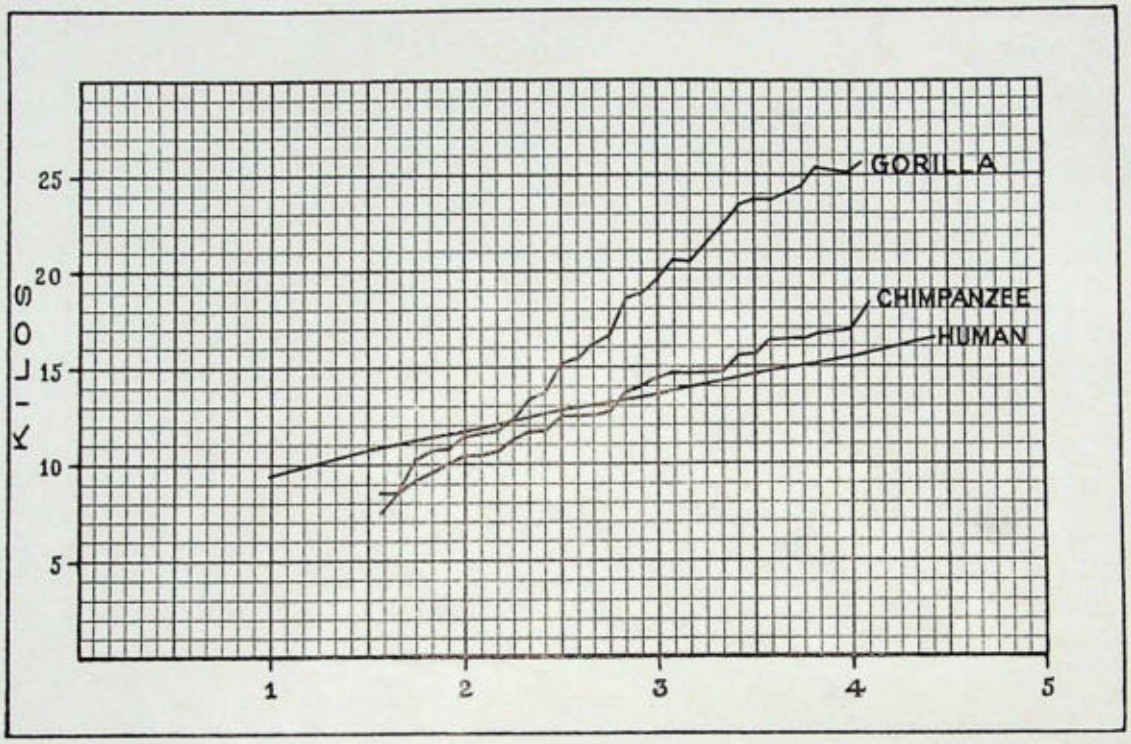


Fig. 19. This chart is a graphic representation of the weight record of the young gorilla and chimpanzee from the time of their arrival, October 31, 1928, to April 16, 1931, over a period of two and a half years. They were estimated as being about 19 months of age on October 31, 1928. For comparison, the average weight record in the human female is also plotted. The figures along the base line indicate age in years, the small intervening spaces representing months. Weight is recorded in kilos. (1 kilo—2.2 lbs.) The chimpanzee's weight-curve closely follows that of the human, while the gorilla's line indicates a rapid increase in body weight.

The baby gorilla gradually became more active and soon climbed about upon the trapeze and danced around on all fours in an awkward, yet rhythmic manner. She grew more friendly and would sit in the keeper's lap each morning and permit herself to be petted. On December 8, 1928, it was noticed for the first time that the baby gorilla climbed up the pole in her playroom. The pole was an inch and a half in diameter and eight feet high. She was apparently learning to climb.

The accompanying photographs which were made a few weeks after these apes arrived, illustrate how they appeared when received at the Park. They also serve to show how the chimpanzee mothered the dependent infant gorilla (Figs. 10, 11, 12, 13 and 14).

During November and part of December, 1928, their condition improved as they slowly gained in weight and strength. Penserosa (Fig. 9), the gorilla, gained in weight more rapidly than the chimpanzee.

On December 4, 1928, she weighed twenty-two pounds, a gain of five pounds since the first of November.

While being fed, the baby gorilla utters a low, soft purring sound. Piteous cries are made when her chimpanzee companion deserts her. If greatly excited, as for example, when one forcibly takes the chimpanzee away into another room, the gorilla will open her mouth, retract her lips, show her teeth and let out a long, high-pitched shriek, like the scream of an angry child.

Because of her slow, deliberate movements, deep-set soft brown eyes, and a serious, sometimes pensive facial expression of her face, suggesting a thoughtful mood, the name Penserosa was given to the infant female gorilla. She had been known as Janet, therefore, her full name is Janet Penserosa.

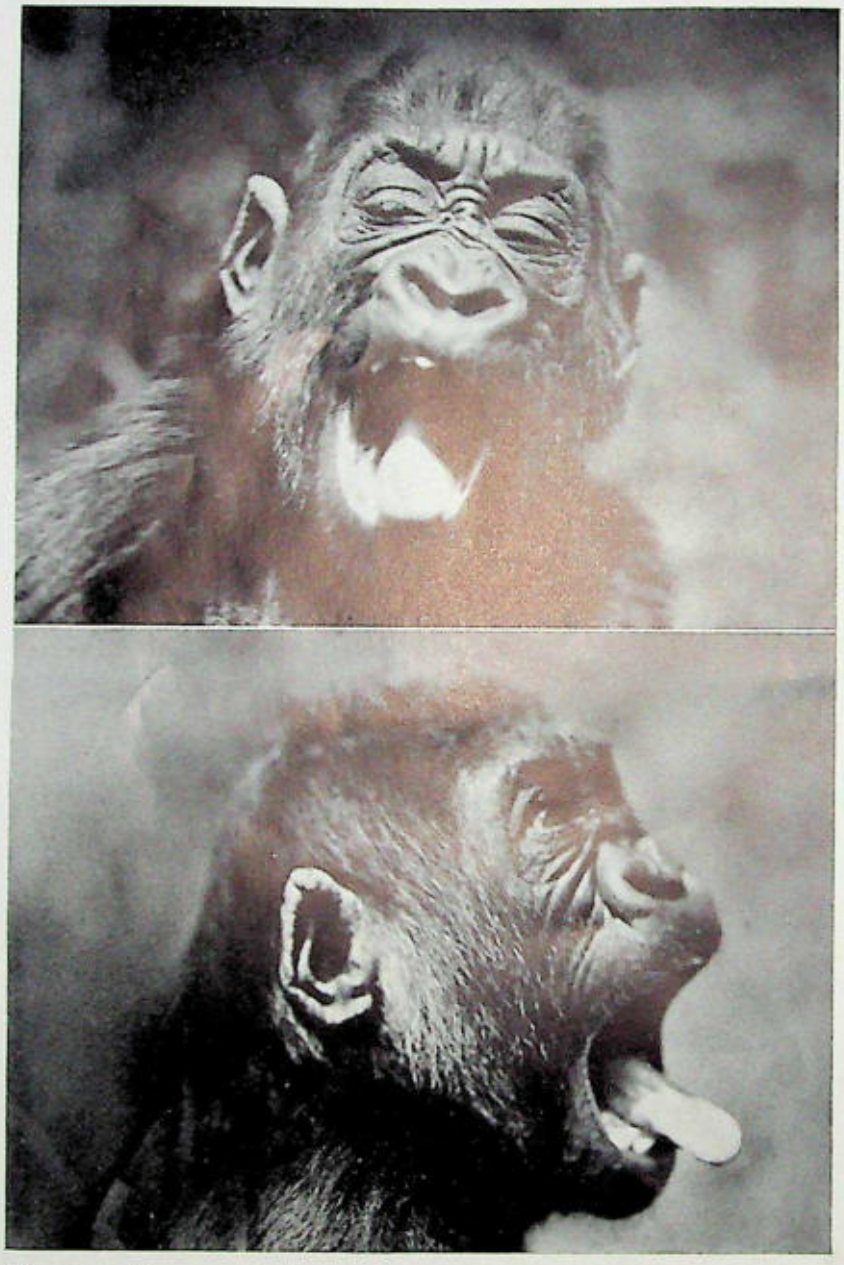
In contrast to the gorilla, the quick smooth movements, long slender fingers, large ears ready to catch the slightest sound, alert twin-

Age, Estimated	Weighed	Gorilla*	Chimpanzee†	Human Female‡
— months	Oct. 31, 1928	7.84 kilos	8.18 kilos	
20	Nov. 9, 1928	8.93	....	
—	Nov. 18, 1928	8.75	8.98	
21	Dec. 4, 1928	10.00	9.34	
—	Dec. 26, 1928	10.34	9.65	
22	Jan. 15, 1929	10.34	9.86	
23	Feb. 5, 1929	10.68	10.11	
—	Feb. 15, 1929	11.12	10.00	
24	Mar. 2, 1929	....	10.11	11.1 kilos
—	Mar. 28, 1929	11.13	10.22	
25	Apr. 13, 1929	11.47	10.34	
26	May 1, 1929	11.70	10.68	
—	May 22, 1929	11.53	10.68	
27	June 6, 1929	12.30	11.13	
—	June 14, 1929	11.90	11.25	
—	June 24, 1929	12.95	11.25	
28	July 5, 1929	13.18	11.42	
—	July 20, 1929	13.56	....	
29	Aug. 12, 1929	13.86	11.81	
—	Aug. 30, 1929	14.10	11.81	
30	Sept. 10, 1929	15.00	....	
—	Sept. 30, 1929	15.00	12.50	
31	Oct. 11, 1929	15.34	12.61	
32	Nov. 10, 1929	16.13	12.50	
33	Dec. 5, 1929	16.93	12.84	
—	Dec. 27, 1929	17.60	13.30	
34	Jan. 21, 1930	18.30	13.60	
35	Feb. 13, 1930	18.86	13.97	
36	Mar. 7, 1930	19.54	14.30	13.6 kilos
—	Mar. 18, 1930	19.43	14.31	
—	Mar. 30, 1930	19.77	14.43	
37	Apr. 21, 1930	20.45	14.65	
38	May 9, 1930	20.34	14.54	
39	June 2, 1930	21.36	14.54	
40	July 10, 1930	22.20	14.66	
—	July 24, 1930	22.70	15.20	
41	Aug. 12, 1930	23.63	15.40	
42	Sept. 2, 1930	23.80	15.68	
43	Oct. 1, 1930	23.90	16.02	
—	Oct. 20, 1930	24.09	16.02	
45	Dec. 9, 1930	24.65	16.13	
46	Jan. 5, 1931	25.2	16.77	
—	Jan. 26, 1931	25.68	....	
47	....	....	....	
48	Mar. 2, 1931	25.0	17.00	15.2 kilos
—	Mar. 27, 1931	25.79	17.80	
49	Apr. 16, 1931	26.36	18.60	

*Penserosa; †Allegra; ‡Human: Weight in kilos. of human (fem.); end of 1st year 9 kilos; 2nd year 11.1 kilos; 3rd year 13.6 kilos; 4th year 15.2 kilos. After C. B. Davenport "Human Metamorphosis". *Am. Jour., Physical Anthropology, Vol. IX, No. 2 pg. 215, and Table C, pg. 229; April-June 1926.*



Figs. 20-21. Four interesting photographs of the changes in facial expression of the gorilla. In repose, grave and solemn, like a serious old man; relaxing with wrinkled brow into a drowsy yawn.



Figs. 22-23. The very peak of a yawn. Not so very beautiful, but indicating complete lazy satisfaction. At the finish, Penserosa comes to life, showing in her countenance a curious mixture of awe, surprise and bravado.



Fig. 24. Both the gorilla and chimpanzee have been allowed access to their out-door cage in the coldest winter weather. Penserosa is shown in this picture with the temperature below freezing, nibbling bits of ice. Life in the open air had developed a heavy coat of hair.



Fig. 25. As a further demonstration of her indifference to cold, this picture, taken on February 25, 1930, shows her playing in the snow outside of her open-air quarters.



Fig. 26. All of the great apes manifest a consuming curiosity for any mechanical object and display at times great intelligence in attempting to solve the intricacies of its construction. She was instantly attracted by the crank operating the tilt of this camera, which she turned.

kling light brown eyes, and a cheerful, mischievous facial expression suggested the name Allegra for the young chimpanzee. She had been known as Ellen, therefore, her full name is Ellen Allegra.

Toward the end of December, 1928, Penserosa appeared depressed and feverish with symptoms of conjunctivitis, congested eyes, rhinitis and general malaise at first, which later developed into an attack of bronchopneumonia. Treatment consisted largely of rest, medication, and the use of dry heat from an infra red lamp which appeared to relieve congestion. During this illness she became so weak that it seemed she was destined to meet the fate of most young gorillas brought to civilization, i. e., to become a victim of pneumonia.

About the middle of January, 1929, recovery seemed assured as she gradually began to play again. Her weight on January 15, 1929, was twenty-two and three-quarter pounds.

The inflammatory skin disease, dermatitis, cleared up under treatment. Her hair began to grow out in short, stubby bristles, which soon became long smooth hairs.

On February 10, 1929, the wrist of Penserosa's right hand became quite tender, painful, and somewhat swollen, and arthritis was suspected. Radiographic examination was negative, the bones appearing normal.

From this date on she remained in good health. The temperature of the Hospital was kept at 65° F. (18° C.) to 78° F. (25° C.) As mentioned previously in this article, she was kept indoors during the winter of 1928 and early spring of 1929.

Despite the rough journey in the fall of 1928 and the setback of pneumonia in December and January, 1929, her general condition continued to improve.

With the approach of spring as the outdoor weather was becoming milder and more pleasant, it was planned to permit the baby gorilla and chimpanzee obtain the benefit of being out of doors during the day. Accordingly, on May 28, 1929, Penserosa and her chimpanzee companion, Allegra, were permitted to play on the lawn in the Hospital yard. A bank about eight feet high with a gently sloping side covered with a grass lawn adjoins the yard, and on the top of the bank are several small trees and shrubs, among them a wild cherry and a small sweet gum tree.

When first brought out of doors Penserosa





Figs. 27-28. These pictures were made in February and September, 1930, and show the rapidly maturing facial development, and the thick coat of hair, which indicates her vigorous state of health by the glossy appearance.

stood still on all fours, resting on the knuckles of her hands and the soles of feet. She curiously cocked her head to one side and tried to locate the source of the song of a chirping bird in a nearby tree. Then she awkwardly romped about on the lawn, climbing up the bank to a small black birch tree, and ate some young leaves and bark. She apparently enjoyed her first day out of doors.

The use of artificial sunlight—the ultraviolet light from a mercury vapor lamp was discontinued as they were now to receive the benefit of natural sunlight.

A large double cage consisting of an indoor and an outdoor compartment separated by a sliding door, was provided for them. A bench and trapeze were installed, after which the gorilla and chimpanzee were transferred to their new quarters each day. From this time on they had access to the outdoors at will during their waking hours while at night they were returned to their sleeping cage.

Feeding time offers an opportunity to observe some general behavior characteristics of the gorilla and chimpanzee. They awaken around six or seven o'clock each morning, tumbling and wrestling about in the straw of the sleeping cage for an hour or more. About half past seven their keeper enters the hospital kitchen to prepare their morning meal. While their food is being prepared the clatter of aluminum pans and the whirring sound of the egg beater can easily be heard in the Hospital.

The alert, restless chimpanzee is constantly on the move, jumping, crying, and climbing about the cage anxious to get her share as she finally directs her eyes toward the kitchen. The keeper enters with a pan of milk and as soon as it is placed on the floor of the cage the chimpanzee, Allegra, seizes it and hurriedly drinks her portion. In a few minutes she has finished her morning meal.

The gorilla, Penserosa, on the other hand, moves about cautiously and with the exception of a single glance toward the kitchen, is undisturbed as she rolls about the straw or plays with her fingers and toes. When her pan of milk is offered to her, Penserosa will frequently pay no attention to it, or she may simply glance at the milk and continue to go on her way, climbing about the cage or even lightly beat her chest. After a pause of a few minutes she will lie down on her abdomen in a comfortable position (Fig. 15), take the pan in her hands, deliberately and slowly drink some of the milk, stop, leisurely look about her, make a low-pitched purring sound, then finally finish drinking the milk. Frequently it is necessary to coax or cajole her before she will take her portion.

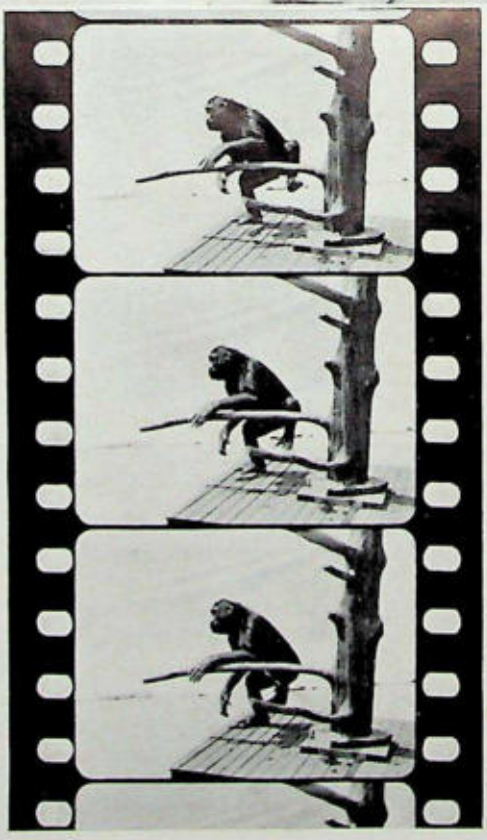
Between half past twelve and one o'clock the keeper feeds them in the large outdoor cage, except during rainy weather, when they are fed indoors. As the time for feeding approaches, Allegra the chimpanzee is as agile and active as ever and as soon as she hears the keeper approaching with the large pail of fruit and vegetables, she often cries and screams.

Penserosa, the gorilla, is as quiet and retiring as usual although she may purr or make a sound which resembles a deep, subdued growl.

When the bananas are given to the chimpanzee she seizes them one by one and soon has more than she can hold. Then she begins to hoard them in a corner of the cage and refuses to allow the gorilla to take any. If the keeper gives the gorilla a banana, the chimpanzee immediately takes it away. The gorilla is fed in a separate part of the cage away from the chimpanzee, whose hoarding activities prevent the slow-acting gorilla from getting her share of food. If, however, the gorilla is very hungry she will fight the chimpanzee and refuse to give up her bananas.

Improvement in the physical condition of Penserosa continued steadily as can be seen when we compare the photographs made at the time she was received with those taken in June 1929 (Figs. 16, 17, 18), eight months later. Her chimpanzee companion also improved but the gorilla showed a more marked gain in weight for on June 14, 1929, the gorilla weighed twenty-six and one-quarter pounds (11.9 kg.) while the chimpanzee weighed twenty-four and three-quarter pounds (11.25 kg.). When comparing them it must be taken into consideration that the gorilla is the larger and heavier, an adult of the species weighing over four hundred pounds while the adult chimpanzee attains a weight of from 160 to not more than 200 pounds. The significance of the weight increase seems to be that both were approaching a normal condition after overcoming the setbacks due to travel and ill-





ness. The graph (Fig. 19) on page 88, indicates the progress in the total body weight of Penserosa and Allegra in comparison with the weight curve of the infant human female. While it appears from this chart that the gorilla gains more rapidly in total body weight in comparison with the chimpanzee and human, the record is presented simply as an observation, but no generalization is made at the present time.

Outdoor exercise with rest and relaxation by basking in the warm sunshine aided materially in maintaining their improved condition. The young gorilla's facial expression reflects her moods. Figure 20 illustrates her usual serious mood, while her response to the soothing effect of a balmy June day is expressed by a yawn of relaxation as illustrated in the series of three photographs (Figs. 21, 22, 23) which were made on June 14, 1929.

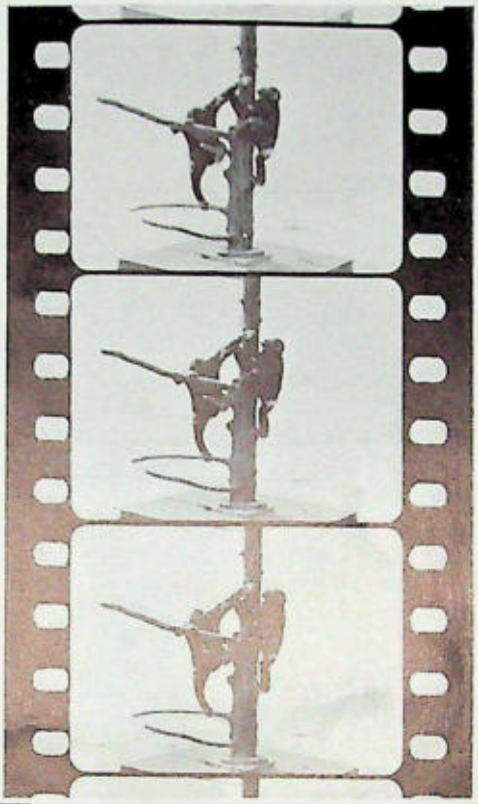
Penserosa was becoming more self reliant in that she could be separated from Allegra and would play on the lawn, climb the small cherry tree, eat buds, young leaves, and remove the tender young bark from the slender branches of the wild cherry tree by skinning

it off with her teeth. Later branches and twigs of the sweet gum tree were given to her and she enjoyed eating the young leaves and buds of this plant also, but was very fond of the fruit burrs of the sweet gum.

The hot, sultry days of the New York midsummer depressed the gorilla more than her chimpanzee companion. Penserosa would lie and pant on very hot days and drink considerable quantities of cold water. On July 20, 1929, beads of sweat were seen rolling down her face, but except under her arm pits, her body was dry. As she did not exercise strenuously, it cannot be definitely stated that visible perspiration does not take place on other parts of the body.

A luxuriant coat of hair, steady gain in weight, clear eyes, clean pink mouth with sound white teeth and healthy gums reflected the beneficial effect of sunlight, fresh air and wholesome food.

It may be recalled that she had been kept indoors during her first winter at the Park, due to her weakened condition at the time of her arrival. Notwithstanding the use of artificial









sunlight and the special care in keeping her in a warm environment she suffered from the effects of a "common cold" and the sequellae of broncho-pneumonia.

In their native state gorillas may be exposed to a wide range of climatic conditions. Those found in the Cameroons live in hot, humid jungles during the wet season. Those found in the foothills and along the mountain sides are exposed to varying temperatures, especially at altitudes of 4,000 to 6,000 feet, where low temperatures are prevalent at night. The so-called mountain gorilla of the Kivu Mountains is covered with long, shaggy hair which protects it from the cold of high altitudes.

It has been the usual practice at zoological parks to keep captive young gorillas in artificially heated quarters during winter weather. As autumn was passing plans were being considered as to how Penserosa should be cared for during the approaching winter of 1929-1930. Whether to keep her in heated quarters or to send her to a milder climate like that of Florida or Cuba were considered as possibilities.

Since she was in good condition and enjoyed

being out-of-doors during the daytime, and because gorillas in their native state may be exposed to cold weather, it was decided to let Penserosa get the full benefit of the early winter sunlight and outdoor air. Penserosa and Allegra were therefore given free range of the combination in- and outdoor cage from morning to night. The indoor cage, however, was provided with hot-water heat.

They thus continued to remain out-of-doors during September and October, apparently happy and contented. The cool crisp October air had an exhilarating effect on Penserosa as she romped about the cage, clapping her hands, beating her chest, or at times dancing about rhythmically.

She continued out-of-doors during November with apparently no harmful effects at all. On November 22, 1929, the thermometer registered 40° Fahrenheit (4° Centigrade), that is, only eight degrees above freezing according to the Fahrenheit scale. On November 30, 1929, Penserosa was outdoors during the day when the thermometer registered 18° Fahrenheit, a temperature below freezing. Her coat of hair









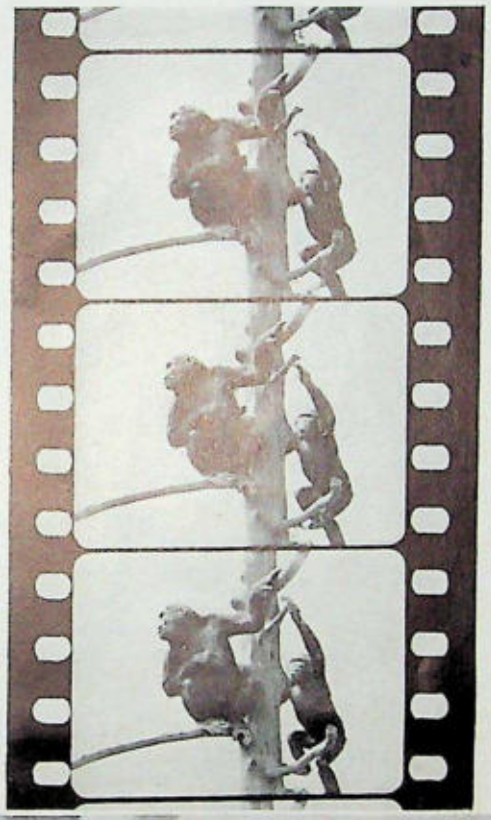
became heavier and more luxuriant as the winter progressed. She did not suffer from the cold as her breath steamed in the sharp morning air, while she played in the outdoor cage. Allegra, the chimpanzee, however, shivered and remained in the indoor cage most of the time.

Snow was falling lightly on the floor and bench in the outdoor cage on the morning of December 3, 1929. The cage door was slid open and out romped both gorilla and chimpanzee. At first they looked about them inquiringly for a moment or two as the snow fell around them. They tried to catch a few snowflakes in their hands, and then picked up some snow from the floor of the cage, lifted it to their mouths and ate it. Like little children they seemed to enjoy their first snowstorm. Later the gorilla would pick up small pieces of ice and crunch them between her teeth (Figs. 24, 25, 26, 27).

Penserosa continued to enjoy being out of doors each day throughout January, February, March, April and May—one whole year, with no bad effects. She did not contract a cold during this time and remained in good condition. This is perhaps the first time that a gorilla has

been kept out of doors during the day for an entire year in the North Temperate zone. In this case it would appear that cold weather does not have a harmful effect upon a young female gorilla. It seems probable that these anthropoid apes are more liable to succumb to respiratory infectious diseases on account of a low degree of resistance when brought into contact with infected human beings.

From about the middle of February to the end of March in 1930 Penserosa did not eat very well and appeared to be fretful and irritable. She did not gain in weight during this period. It was with considerable difficulty that her mouth was examined. The gums behind the milk teeth were swollen, tender, reddened, and painful. Her first permanent molar teeth, which correspond to the six-year molar in man, were in process of erupting through the gums. This condition was the cause of her irritability. All four first permanent molars were visible during the last week of March, 1930. She now had twenty-four teeth, of which twenty were temporary milk teeth, and four were permanent molars. Her age at this time was estimated as









about three years. The chimpanzee's permanent molars appeared during this same period of time.

When in good humor she manifests her pleasure by slapping her abdomen with her hands or by rolling over and over on the floor. Frequently she builds a simple circular nest of straw and as a diversion rides about on the back of the chimpanzee.

From a distance, one is impressed by the bulk of her body and strong, broad shoulders. The head, with its beetling brow protruding over deep-set light brown eyes and large round open nostrils, is set close to her body. Two prominent vertical wrinkles in the middle of her forehead, deep semi-circular wrinkles below her eyes and firm lips add to her old, serious appearance. The texture of the black facial skin is soft. The outer portion of the lips is smooth and black while the inner part of the mouth is pink.

She lies on her back and spins herself around very rapidly by pushing against the sides of the cage, and dances about the floor beating her chest with her hands in a slow and even tempo,

which would seem to indicate a sense of rhythm.

Hair Coat

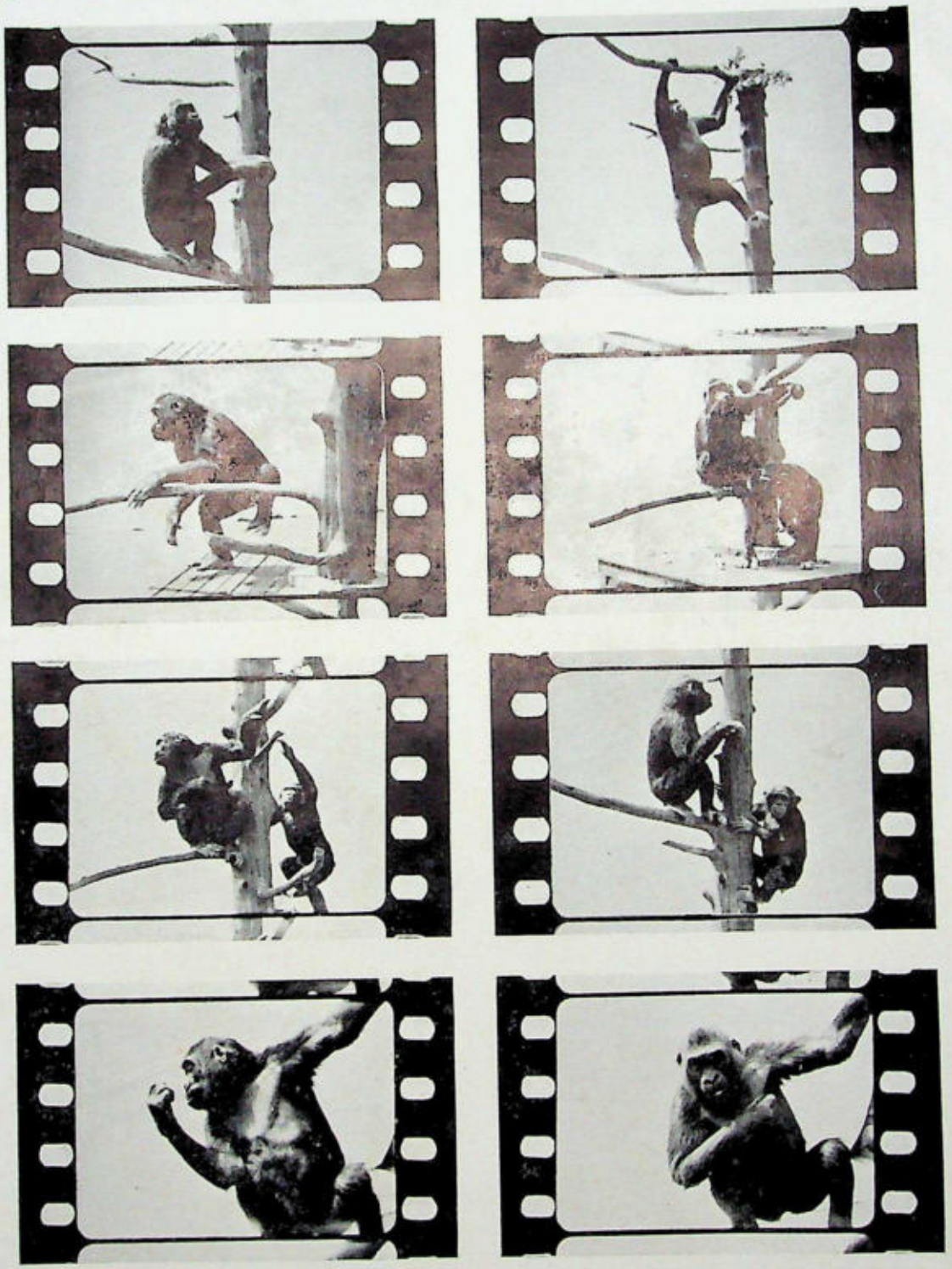
On general examination the smooth hair coat of Penserosa appears to be solid black with the exception of three small areas of white, two white patches on the cheeks in front of the ears, and an area of white surrounding the anal region. The hair covering the crown of the head is close cropped and stands out in a pompadour fashion. It consists of a mixture of rufous (red), black, white and grizzled hairs, giving the crown a variegated appearance. On closely examining some of the individual hairs from this region four color types were found: 1. Black. 2. Black and white banded. 3. Rufous with black tips. 4. White.

Individual hairs from the body were mostly solid black although a few scattered individual black and white hairs were also found. A considerable number of black and white banded hairs were found upon the outer thighs which on general examination present a grizzled appearance.

Her chest is partially covered with a sparse coat of hair. The skin is dark grayish in color while the skin of the body has a light flesh color which can be seen as the hair is pushed back.

With the exception of a slight, acute enlargement in the softer tissues of the right wrist (radiographs revealed the bones of the wrist as apparently normal), Penserosa at present appears to be in good physical condition. Her weight on March 18, 1930, was forty-two and three-quarter pounds (19.4 kg.) while the weight of Allegra was thirty-one and one-half pounds (14.31 kg.), Penserosa being heavier by eleven pounds. The greater part of each day was spent out of doors during the summer and fall of 1930. She continued to remain out of doors throughout the winter of 1930 and 1931, remaining free from colds and steadily gaining in weight. Her weight reached fifty-eight pounds (26.3 kg.) on April 16, 1931, while the chimpanzee was forty-one pounds (18.6 kg.).





The series of poses of the gorilla and the chimpanzee on this page, and also those on pages 96 to 102, are shown to illustrate spontaneous attitudes during activity as recorded by the camera.

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BULLETIN

New York Zoological Society

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Australian Brush-turkey, photographed in the Zoological Park. The Brush-turkey includes several species found in New Guinea and the nearby islands, as well as the Australian bird. The latter is distinguished by the large yellow neck-wattle of the male.

BULLETIN
NEW YORK ZOOLOGICAL SOCIETY

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Avian Mound Builders and Their Mounds

Notes on the habits of the Australian Brush-turkeys, by Charles Barrett, with a brief introduction by Lee S. Crandall, concerning specimens of the family Megapodiidae that have been exhibited in the Zoological Park.

Illustrations from photographs made in the Zoological Park, and from field photographs by Mr. Barrett and other naturalists.

INTRODUCTION

THE mound builders, or megapodes, are a fairly large family of birds, about forty forms, of seven genera, having been described. They have a wide distribution in Australia and the islands to the north of the "island continent," including New Guinea and the Solomons, extending west to the Nicobars and north to the Philippines. Their affinities are undoubtedly with the gallinaceous or fowl-like birds, and their most obvious physical characteristic is the proportionately great size and power of the feet and legs. This peculiarity is correlated with the mound building habit, for it is with these implements that the birds gather the huge heaps of debris which serve as incubators for the eggs.

Only three species of this interesting family have been exhibited in the Zoological Park. These are the mallee fowl or ocellated megapode, the scrub-fowl and the brush-turkey, all described by Mr. Barrett in the following article.

The ocellated megapode (*Leipoa ocellata*) is found in the southern portions of Australia, two subspecies being recognized. In its native land, it is known variously as lowan, mallee fowl, mallee hen, native pheasant, etc. Never a common bird in captivity, this megapode is now seldom seen in collections and rightly, for there seems no doubt that it is rapidly becoming scarce. Moreover, it does not seem to thrive particularly well in confinement, at least in the climate of New York, and none of our specimens has lived for more than a few years. It is a bird of dull and lethargic temperament, disinclined to exercise, which may account, to some degree for our lack of success with it.

The scrub fowls (*Megapodius*), on the other hand, are alert and active little creatures, much like perky domestic fowl, with out-sized feet. Mr. Barrett's bird is *M. reinwardt tumulus*, found in the Northern Territory and northern Queensland, Australia. Some thirteen other subspecies of *M. reinwardt* are listed, from New Guinea and neighboring islands. Our representatives of the genus were Reinwardt's scrub-fowl (*M. reinwardt reinwardt*), from the mainland of New Guinea. During the Zoological Society's expedition to that island, in 1928, I saw many nest mounds of *Megapodius*, and several times surprised the owners close at hand. Although they can run with speed, they usually took flight, flapping through the heavy bush on clumsy wings. In spite of their abundance, however, I was unable to secure living specimens. The birds exhibited here were obtained from dealers.

The brush-turkey (*Alectura lathami lathami*) of Queensland and New South Wales, was once a fairly common bird in capitivity but the re-



"Isle of the dead." The lonely burial place of an extinct Australian aboriginal tribe. This isle is really a great, flattened sand dune, with the river flowing past one side and a creek round the other. Here the blacks buried their dead in the sand, and hundreds have been interred. Some of the graves are marked by rotting logs, piled there by men who long ago were themselves buried on the Isle. In the spring and early summer this primeval cemetery is fairly alight with masses of gayly colored wild flowers. Photograph by Charles Barrett.

strictive laws now in force in Australia have placed it among the rarities. Fortunately, it is extremely hardy—two specimens now in our collection have been here since 1922.

Perhaps because of the propensity of the males for killing their mates, we never have been successful in breeding the brush-turkey, although this has been accomplished on several occasions in Europe. However, our birds are constantly building mounds and almost daily may be seen busily adding to the heaps of sand, leaves and twigs in their separate enclosures.

In 1918, a male brush-turkey escaped from his run in the Zoological Park and disappeared. Nothing was heard of him for several days, when we learned that the grounds force was greatly incensed over a huge heap of leaves which had been erected in a tangle of underbrush near the Jungle Walk. Small boys were suspected of this sacrilege but constant watching had failed to disclose the culprits.

Our truant brush-turkey came instantly to mind and we went at once to the scene of the reported vandalism. A loud rustling and scratching under the rhododendrons, which ceased as we drew near guided us to the spot. We found a circular mound of leaves, sticks and rubbish which measured, roughly, twelve feet across and three feet high. For many yards around, the earth had been scraped quite clean. Too clean, it seemed, to be the work of a large and clumsy bird. But we had only to wait silently for a few moments, when a dark form emerged stealthily from the shadows and revealed itself as our lost brush-turkey. Immediately he went to work, his back toward the mound, throwing clouds of leaves and debris behind him, as he progressed, crab-fashion, toward his objective. There was a small brook to cross but this was no real obstacle. Sturdily the bird scraped his rubbish into the water, then scraped it out again on the homeward side.

For some weeks the mound grew and took shape, and many interested persons had opportunity to watch the bird at work. Then one morning, we found him dead, the victim of the type of visitor against whom we are always on guard, though not always with success.

THE nest-structures of the mound-building birds of the Australasian Region, are not unlike miniatures of the ancient man-made mounds in America, works of the prehistoric Indians where skeletal remains and stone implements are found in these huge artificial hillocks scattered through Ohio, Illinois and other areas in the United States.

These marvellous birds, in their nesting habits, reveal kinship with reptiles. A reptilian characteristic has survived through the ages in the Megapodiidae. They do not sit upon their eggs, but deposit them in big mounds of earth and sand, sticks, twigs, and rotting vegetation. The "hot-bed" in the mound is an incubator: heat produced by decomposition of the vegetable matter hatches the eggs. The chicks are most precocious; they are born feathered, work their way to the surface of the nest-mound, and are able both to run and to fly when only a day old.

None of my birdland memories is more deeply etched than that of the first glimpse of a mound-builder in its haunts. Twenty years ago, in the victorian country, I met with the Lowan, and excavated one of the natural incubators, which are as remarkable, in their way, as the Bower-builders' play-halls. Since then, I have enjoyed many outings among the Lowans, and the other mound-makers that live in sub-tropical scrubs and the jungles of North Queensland.

The small family Megapodiidae is almost confined to the Australasian Region, and, as Newton observes in his "Dictionary of Birds," is highly characteristic of some parts of it: this applies mainly to the peculiar dry areas of south-eastern and south-western Australia, which we term Mallee, from the fact that the principal vegetation consists of dwarf Eucalypts or gum trees (the dominant form over great areas is *Eucalyptus dumosa*). Some species of Megapodes actually bury their eggs in the ground (a distinctly reptilian trait); others are more advanced, being mound-builders. Morphologically, the Megapodes are very primitive, possibly lower than any other family of birds.

More than four centures ago, the remarkable habits of a mound-building bird were observed, in the Philippines, by Antonio Pigafetta, a survivor of Magellan's famous voyage. Under date,



The nesting mound of a Scrub-fowl, *Megapodius reinwardt*, in the jungle. These mounds are used year after year and thus increase to large proportions, the birds scraping out the egg-chamber and adding new material at each nesting period. In a mound seven feet in diameter and three and one-half feet high, there were about three cartloads of earth, leaves and sticks. The heat generated in the egg chamber is as high as 95 degrees. Photograph by Charles Barrett.

April, 1521, Pigafetta gave in his journal the earliest record of an avian mound-maker. He describes the bird as being about the size of a fowl, and states that it lays, in the sand, eggs as big as those of a duck, which are hatched by the heat of the sun. There are other very early records; and, in 1703, in his observations on Birds of the Philippines, Petiver communicated to the Royal Society of London an account of the Megapode of Luzon. The species that inhabit Amboina and Celebes, respectively, were described in 1726, by Valentyn. But the learned men of Europe were skeptical; accounts of the Megapodes' strange nest-habits, from that given by Pigafetta to Valentyn's description in his work on the East Indies, were discredited, as merely marvels, by naturalists.

It was an Australian mound-builder, the brush-turkey (*Alectura lathami*), which won for the Megapode family scientific recognition. It was originally described by the naturalist whose name it bears, Latham, in 1821; but he called it the "New Holland Vulture." Later, he discovered his error, in classing among the carrion-eaters a bird of Galline character.

We have, in Australia, only one species; in New Guinea and other islands there are six or more different Brush-turkeys. Our form is the largest. About the size of a domestic hen-turkey, it is of a general sooty-brown to blackish-brown color, the under surface being brownish-gray with white edging to some of the feathers. The nearly bare head and neck are pinkish-red and this brightly colored skin, which is beset with fine bristles, contrasts with a large bright yellow wattle on the breast. This is a portrait of the male; the female is similarly colored, but lacks the ornamental wattle. The birds are really hen-like in appearance; usually they carry the tail partly folded, and upright.

The brush-turkey ranges from Cape York, North Queensland, down into eastern New South Wales, and is plentiful enough in many localities. It is one of the most remarkable creatures of the palm scrubs of the eastern coastal ranges, and also occurs inland, in places where the conditions are suited to its needs. It is known commonly as brush-turkey, but often is called the Wattled Talegallus. One has glimpses of it running rapidly through the un-



Mound constructed by a Brush-turkey in the forest along the Jungle Walk in the Zoological Park. The bird escaped from his quarters, and for several days remained entirely concealed, although the Park was hunted over with great care. Subsequently a report was sent to the office that some person had been heaping leaves into a pile in Beaver Valley, which, upon investigation, proved to be the work of the missing Brush-turkey. The heap was about twelve feet in diameter and three feet in height, and the ground around the edge of the mound was scraped entirely clean of leaves and debris; an excellent illustration of the speed and perseverance of this strange bird.



The side of a Scrub-fowl's nest in Queensland in the heart of the Australian jungle. This is the southern limit of the range of the Scrub-fowl, where now banana plantations are encroaching on its haunts. The banyan (Ficus) tree in the photograph is one of the largest known in Queensland, and it is frequented by hordes of fruit bats, the flying-fox, which finds shelter in the dense foliage of the upper branches. Photograph by Charles Barrett.



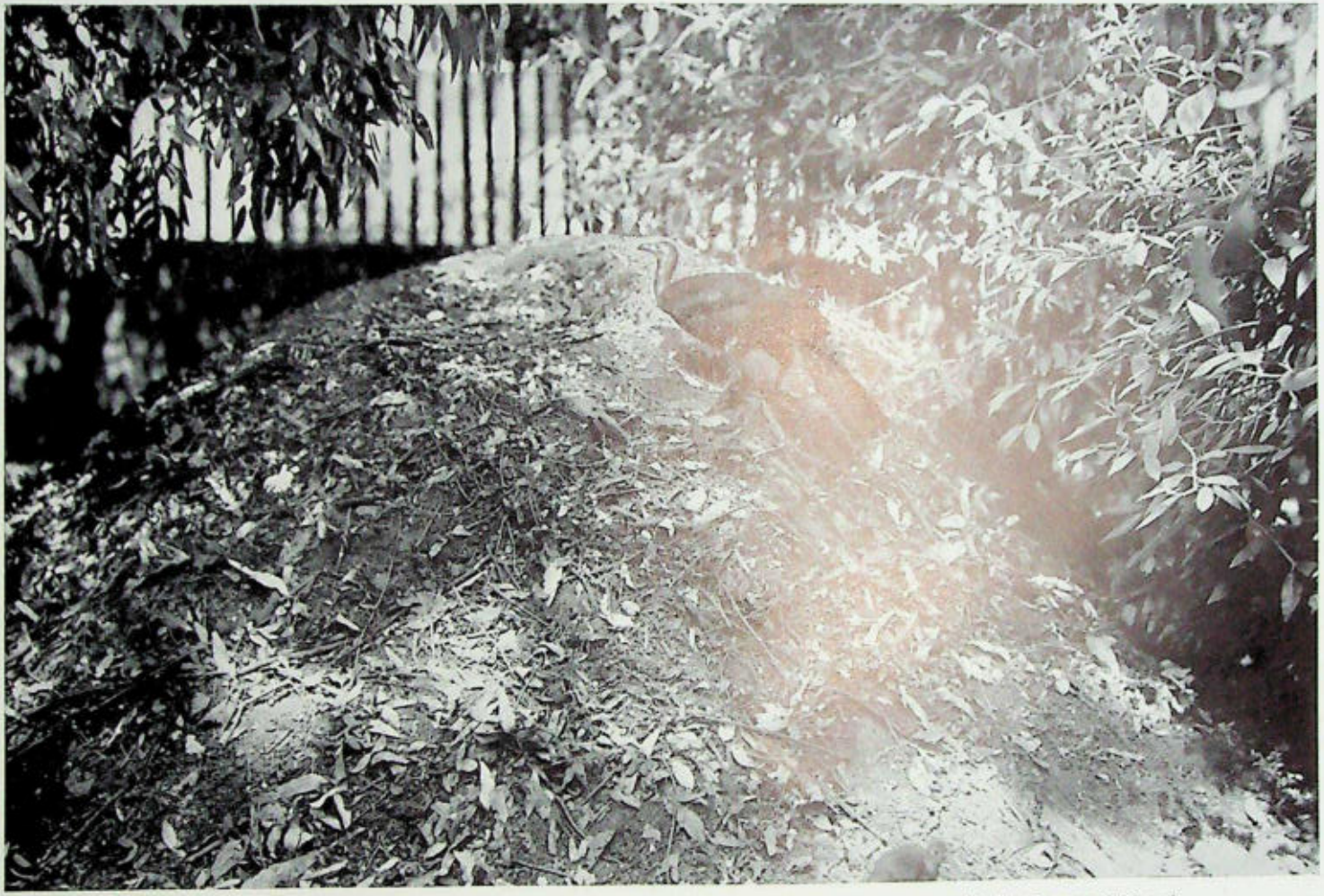
A Brush-turkey, called by Gould the Wattled Talegallus, in the Zoological Park. Often wild animals adapt themselves readily to confinement and with encouragement manifest the instincts common among them, particularly that of breeding. The perpetuation of the species is the most irresistible impulse, and the mass of sticks and vegetation, a rough imitation of the nesting mound which was placed in the yard, was an invitation which the occupant could not ignore. Photograph by Lee S. Crandall.

dergrowth, dodging easily the thorned stems of the lawyer-vine (*Calamus*), and other obstructions to the progress of an intruder in its haunts. Its carriage facilitates quick movement where the ground is cumbered with growth and rotting logs, snake-like roots and stems, and crowding ferns. The body is carried with a forward dip, while the bird is travelling through the scrub.

Immense mounds are raised by brush-turkeys, usually in the midst of dense scrub or in forest glens, frequently on the slope of a hill. They are more or less circular and dome-shaped. Size varies, of course, but a fairly typical mound would measure, at the base, about thirty-six feet in circumference, and about three feet in height. But larger mounds are not rare: I have seen one six feet in height and nearly fifteen feet in diameter. The pyramidal form is usual, not invariable; nor is a steep slope always chosen; mounds on fairly level spots often are met with. But the birds have a distinct preference for secluded home-sites.

Long before egg-laying time, the birds are busy preparing collecting material for the nest-mound. They work industriously, clearing a space perhaps forty or fifty yards in diameter, of debris—fallen twigs and leaves from the jungle trees and bushes: the ground may be left almost bare for many yards around the great heap, which gradually rises. Brush-turkeys are accomplished scratchers, and seem to enjoy their mound-building activities. I have watched them at work. Some observers state that each mound is raised by one pair only; others, that several birds assist in its construction. It is not unusual to see one male turkey joyously scratching and scraping on the mound; also I have observed two or three birds thus employed. The late Mr. D. Le Souef, Director of Melbourne Zoological Gardens, closely watched brush-turkeys, both in the wilds and in captivity. His observations indicate that the male makes the mound unaided, and jealously keeps the hen birds away, should they attempt to scratch holes in the heap before he considers it to be ready for eggs. "He beats them off unmercifully."

Brush-turkeys have been reared at the Melbourne Gardens. From the huge mound in the Talegallus enclosure, seventeen young were



A Brush-turkey in the Zoological Gardens, Melbourne. This photograph illustrates very graphically the magnitude of the labor performed by these birds in constructing their nesting mounds. When the size of the mound is compared with that of the bird, the performance seems almost incredible. In the wilderness these nesting sites gradually assume enormous proportions, as they are used year after year and frequently by several birds. This mass of vegetation ultimately becomes a rich compost heap that encourages the growth of shrubs and trees, and in time become so thickly filled with living roots as to destroy its use as an incubator. The birds, unable to cope with this condition, then seek another site and again construct their mound. Photograph by the late D. Le Souef.

hatched, one season; they made their own way to the surface, and all but one was reared to maturity. During another year, no fewer than fifty-six eggs were deposited in the mound: there were several birds in the enclosure. This clutch was a failure, through lack of sufficient vegetation in the mound to generate the heat required for hatching. The newly-emerged chick is of a dark-brown color. It does not chip its way out of the shell, which is brittle at the stage when hatching is imminent; but bursts the egg into small pieces by its "struggle for freedom." The day-old chick is nimble-footed and partly feathered, its wings being developed sufficiently for a little flight to some lower branch of a tree near the mound, should danger threaten.

When only one pair uses a mound the complement of eggs will be from about twelve to sixteen; while a community mound may contain several dozen. A hen, when the urge to lay prompts her, scratches a hole in the mound, less than a foot in depth and near the summit, usually. After the laying, she leaves, and the hole is filled in by the male with debris, which he tramples down. Eggs in all stages may be found in the same mound; they are placed in a perpendicular position, and, roughly, in tiers.

The parent birds frequently are seen at the mound, and perhaps are watchers during the whole period of incubation, which is lengthy, since fresh eggs may form the final, central, layer or circle, while those first laid at one side of the incubator, are on the point of hatching. Whether the females are in constant attendance, when hatching is likely, and frequently uncover and cover the eggs again, with the object of helping any young that may have appeared, I do not know. That such is the case, some of the aborigines assured Gould; but others declared that the young received no assistance.

Decayed leaves, etc., mingled with fine debris, form the central part of a mound; coarser layers follow, and, finally the builders add bushels of fresh material—twigs and leaves, and sticks of assorted sizes.

Brush-turkeys have many human enemies: the birds are shot for food, by settlers, in some districts, and their mounds are robbed, since the large white eggs (elliptical in shape, with coarse textured shell) are good eating. Among natural enemies are the great lizards popularly called "goannas". Our monitors are of formidable size, one species attaining a length of over 9 feet. They dig into the mounds with their large and strong claws, and devour any eggs discovered.

The scrub or jungle-fowl (*Megapodius reinwardti*), the second of our trio of mound-raisers, was named *M. tumulus* by Gould. Besides the Northern Territory of Australia and North Queensland, its range includes New Guinea, and some of the lesser islands, as Aru, Banda and Flores, and Lombok. From Wallace's Line to the tropical north of Australia, is an extended distribution. My first acquaintance with the scrub-fowl was made on an isle of romance which bears the prosaic name of Dunk! I was staying with my old friend, the late Mr. E. J. Banfield, whose books, "Confessions of a Beachcomber", "My Tropic Isle", and "Tropic Days", have made the lovable man and his island home familiar to readers in many countries. No one has written such an intimate account of the jungle-fowl as that contained in The Beachcomber's earlier pages. He has written delightfully, too, of this, a favorite species, in letters to me. Sometimes on the island, together, we watched his bird friends in the jungle, or the bungalow garden. They were always entertaining. And mounds were not far distant. Often, in the evening, as the birds were going to roost, we heard their loud, chuckling notes.

The scrub-fowl, also called "Scrub-hen," has dark chestnut-brown plumage, dark grey on the under surface, a brown crest, and reddish-brown feet. The sexes are similar in appearance. They are comical birds, and, with due encouragement, become confiding. I quote from one of Mr. Banfield's letters: "Since you left the island those big blue and green butterflies (*Papilio ulysses*) have been plentiful, and the scrub-fowls so cheeky that the pups hunt them out of the garden. I saw five scrub-fowls among the orange trees the other day, in very holiday humor, playing circus or merry-go-round, or some other circumlocutory pastime. With outspread wings sweeping the ground, they danced with zest while cackling as if the whole isle belonged to them. The swamp-pheasants (Pheasant-coucals) are wonderfully tame and the cheeky Honeyeater alighted on the head of the couch while I was reading, the other afternoon."



A flock of Brush-turkeys, with a number of sand grouse, in captivity. At the first glance the birds could be mistaken for the domestic turkey of our own country, the one element lacking to make the illusion convincing, a strutting gobbler. This species is not so shy as several of the others and this seems to be borne out by the placidity of the behavior of the birds in this photograph. One species of the brush-turkey is found in Australia, but there are several others in New Guinea and the adjacent islands. The family Megapodiidae, to which the brush-turkey belongs, ranges through the Australasian Region, and occurs also in the Philippines, Borneo and the Nicobar Islands, localities that are not within this area. Photograph by the late D. Le Souef.

On Dunk Island, there is an old mound beneath the branches of a giant fig tree (*Ficus*) and near the edge of the beach, where vegetation begins. It has seen many seasons, and when I saw it was overgrown with little pioneer jungle plants. Commonly, mounds are formed within a few hundred yards of the tropic beach, but also far from the sea. At Byfield, for example, a district about nine miles inland, we found the scrub-fowl at home, and plentiful, in "brush" on the hills and along creeks that flow through this Queensland plateau to the sea. Byfield, the southern limit of the scrub-fowl's range, is a banana-growing district with rich soil on the slopes and summits of its hills, so that the jungle is doomed. Farms on the hillsides have deprived *Megapodius* and other birds of much territory. The mean annual rainfall of Byfield is seventy inches.

We located several mounds. One, situated on a mountain plateau, measured 25 feet in diameter and eight feet in height. Hidden in dense scrub, it was steep-sided and rather small at the top. Another mound measured forty feet in circumference and nearly ten feet in height. Here we disturbed a raider: a monitor lizard emerged from the hollow in the mound, where it had been delving for eggs.

The scrub-fowl is a mighty builder, using "cartloads" of dark, sandy soil mixed with decaying vegetation, twigs, sticks, etc. Sand and shells are the principal building materials when the egg-mound is near the seashore. These rounded structures—sometimes conical—dwarf those raised by the brush-turkey and the Lowan. The Megapode mound measured by Gould's collector, Gilbert, in a far northern locality, was 150 feet in circumference and fifteen feet in height, and contained, it has been estimated, almost 9,000 cubic feet of soil and debris.

While the mallee-fowl and the brush turkey both open up their mounds for the purpose of egg-laying, the megapode burrows into the tumulus to deposit each egg. The holes may be over six feet in depth, and one egg only is laid in each, at least as a rule. After the laying, the hole is filled up, soil being scratched into it lightly by the bird with its powerful feet; the work is done expeditiously, for these jungle dwellers are master scratchers.

The large eggs, of long ellipse shape and pinkish or yellowish-buff color, are hatched by the heat which fermentation of the mass produces at a depth of several feet. The temperature is about 94 deg. The complement varies, the average being eight or ten eggs. Almost invariably, only a pair of birds is observed at a mound at the same time. The eggs, apparently, are deposited during the night, and at fairly long intervals—several days. Occasionally, eggs are deposited in the open; at least, I have seen one lying in a "cave" among the buttress roots of a tall jungle tree. The megapode of Savo, one of the Solomon Islands, dispenses with the mound, instead burrowing into the sand. Into a main burrow, side ones lead, an egg being deposited in each. All the burrows are filled in after the laying.

Megapode mounds are used season after season, and added to annually, until, from small hillocks they have grown to huge proportions.

The third of our trio of mound-builders, birds that are industrious workers but dispense with the duty of incubation, is the Lowan or malleehen (*Leipoa ocellata*), often termed "native pheasant." None of the megapodes has been more intensively studied than the Lowan, which inhabits dry, scrub-covered country in the southern half of Australia, ranging from Southwestern New South Wales, through north-western Victoria, southern parts of South Australia, and the western state—an extensive distribution. The bird is closely associated with mallee (dwarf species of gum-tree—Eucalyptus), and, deprived of its shelter and seclusion, soon disappears from age-old haunts of its species.

Settlement has encroached on vast tracts of the Lowan's territory, and steadily the advance continues. In Victoria an area of over 30,000 acres of Mallee country has been reserved, as sanctuary for wild life and the mallee flora. Ere another half century has passed, the mallee-fowl or hen may be nearing extinction in Victoria, outside reserves. There are still extensive tracts of untamed Mallee, but the process of converting our northwestern wilderness into wheatfields continues, and the native fauna receives scant consideration when its haunts are coveted for cultivation. We are fortunate to save an area here and there, wherein to conserve the country's original animal inhabitants. There is not a wild aborigine left now in the



Mound of the Scrub or Brush-turkey in Queensland. In the lightest timbered country with belts of thin scrub, the brush-turkey makes its mound, and here also the wallabies abound. The nesting mounds in this locality, as described by Le Souef, were three or four feet high and seven feet in diameter. The birds do not start to build up their nests until the vegetation is sufficiently moist to generate the heat necessary for the incubation of the eggs. Photograph by the late D. Le Souef.

whole state; only a handful of blacks on stations, none of whom has experienced the primitive life of a Stone Age people.

As a member of the Wonga Park Committee of Management, I have visited the reservation several times, and traversed it in all directions, and have camped on its lakes, which are dry, grass-grown hollows, excepting for a year or two after successive seasons of ample rainfall. The mallee is a land of little rain, and our Park's small lakes are linked by a winding creek with big Lake Albacutya and Lake Hindmarsh. Albacutya may remain dry for years, but while it is empty, the Park creek and lakes also are waterless. But we have drinking-places for the cockatoos, parrots, and other species—troughs filled from wells, and the Park is a paradise for the bird lover, especially in nesting time. It is the only mallee reservation in Victoria, and should be four times as large to ensure the future of the Lowan and some other birds peculiar to the dry north-western region. The Outlet Creek, remnant of a river, is Wonga Park's central feature, flowing—when it *does* flow—from lake to lake, between gum-tree lined banks to Pine Plains, one of the oldest stations (ranches) in Victoria. Much of the area consists of sand-hills, covered in darf Eucalypts and other typical mallee vegetation. There are high and low ridges covered in Murray pines (*Callitris*), and wide valleys, alight with wild-flowers in the Spring and early Summer time. One depression, a water-mirror for the sky at intervals of years, we call Golden Lake, because a beautiful-flowered acacia grows freely on its borders, bushes all golden with bloom in September.

About ten square miles of the Park area consists of typical Mallee-fowl country, and some nest-mounds have been located there: we hope that it contains many. Occasionally I see Lowans in the Park, but observations on this wonder bird were made chiefly in other districts, before settlement had tamed the wilderness of scrub and sand and pine-ridges.

Pine Plains homestead has been my headquarters during several camera-hunting expeditions among creatures of the Mallee; and for half a century this historic station has been noted among naturalists. Hollows in dead gum trees

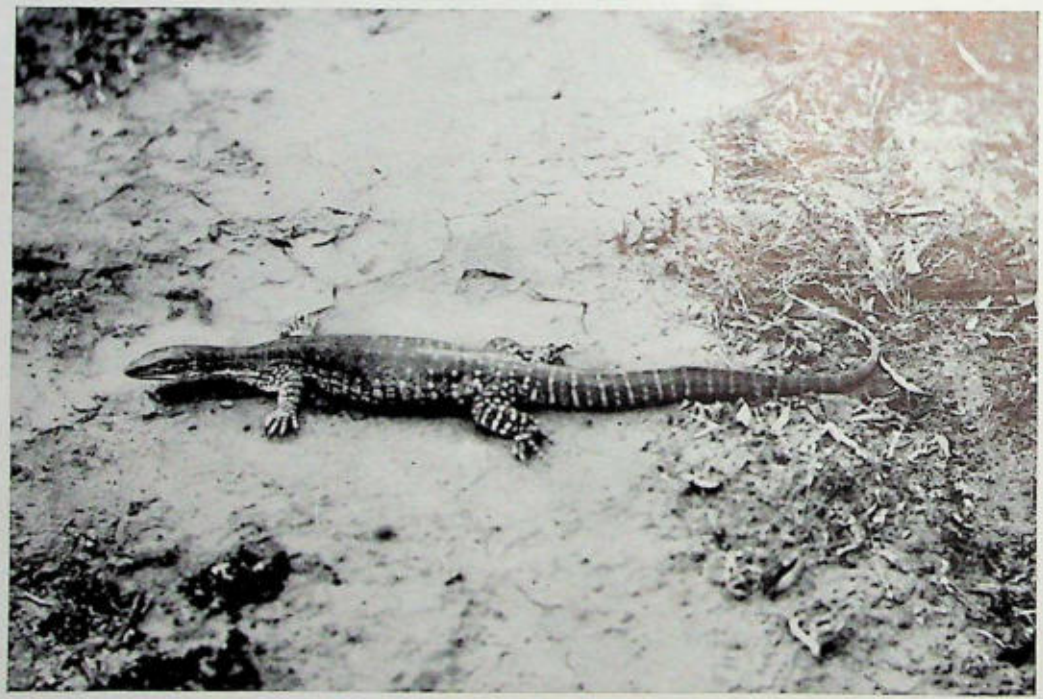
that dot the home-paddocks are nesting-places of parrots and cockatoos. Wonga Park is the only area in Victoria now, where the lovely Regent Parrot (*Polytelis anthopeplus*) still rears broods every season. Wonga, also, is one of the very few nesting haunts, in the State, of the pink cockatoo (*Cacatua leadbeateri*). When any naturalist from America visits Victoria, I propose a trip to our Mallee reservation.

"This remarkable bird," Gould wrote of the Lowan, nearly seventy years ago, "is among the most important of the ornithological novelties which the exploration of Western and Southern Australia has unfolded to us. Like the Wattled Talegallus, it is rendered highly interesting from the circumstance of its not hatching its own eggs, which, instead of being incubated in the usual way, are deposited in mounds of mixed sand and herbage, and there left for the heating of the mass to develop the young, which, when accomplished, force their way through the sides of the mound and commence an active life from the moment they see the light of day."

We have learned much concerning the habits of the Lowan since Gould's "Handbook to the Birds of Australia" was published (in 1865); but this "outline" sketch has only been filled in, as it were, and we are planning, even now, further team observations. A mound must be watched, day-long, throughout building time and the actual breeding season.

Sir George Gray, explorer and, later, a Colonial Governor, one of Britain's vice-consuls of Empire—was a pioneer observer of the malleefowl "at home," and in a letter to Gould, dated September, 1842, gave a detailed description of the nest-mounds. It was in the Wongan Hills, western Australia, that Sir George found Ngouoo, or gnow (aboriginal name for *Leipoa*) hillocks, in the midst of dense scrub. The Wongan Hills are about 1300 feet above sea level, and their slopes are covered in gum trees, while for miles around extends the mallee scrub.

The Lowan, though always forming its mounds in the seclusion of the scrub, favoring the densest places, is not confined to it, but frequents also the more open tracts and those wide sunlit valleys between the dunes that are



The monitors of Australia are confirmed marauders, large, powerful and active. As their diet includes the eggs of various birds, they work great havoc among the mounds of Megapodes. Their uncanny instinct in detecting the presence of eggs in the mounds of the turkeys, has made them formidable enemies of these isolated and unprotected nests and frequently they make use of these natural incubators as a repository of their own eggs. An interesting instance of two widely separated living forms from the Reptilian stem using the same medium for the incubation of their eggs. Photograph by Charles Barrett.







In the Mallee scrub country of Victoria. The picture at the top is a bit of typical mallee scrub, a haunt of the Mallee-fowl—Lowan—and where this species constructs its nesting-mounds. The scrub is a species of mature, dwarf Eucalypt—Mallee gum trees. In the center is a settler's home in the Mallee country which has been cleared of the scrub for cultivation. The lower picture shows the method employed of rolling down the scrub to clear the land. As the land is cleared, the nesting sites of the Mallee-fowl are destroyed, thereby forcing the birds farther back into the wilderness to seek more isolated areas. Photographs by Charles Barrett.



Nesting mound of the Mallee-fowl. A rare and unusual photograph showing this shy bird on the mound filling in the egg-chamber with twigs and decayed vegetation. A second bird is standing just at the edge of the mound. Evidently this is a pair both at work on the nesting site. These nests are made about August and both birds assist in their structure. With other species the male alone does most of the work. The male and female Lowan differ very slightly in their markings, and their color harmonizes so closely with their surroundings that they are rarely seen. Photograph by the late C. H. McLennan.

wild-flower gardens in the Spring. I have met with our mound-builder even close to a settlement, in a small, uncleared area, and seen it run across a roadway. Still it is shy and wary, and one obtains merely glimpses of the Lowan, unless observing from a hide near the mound.

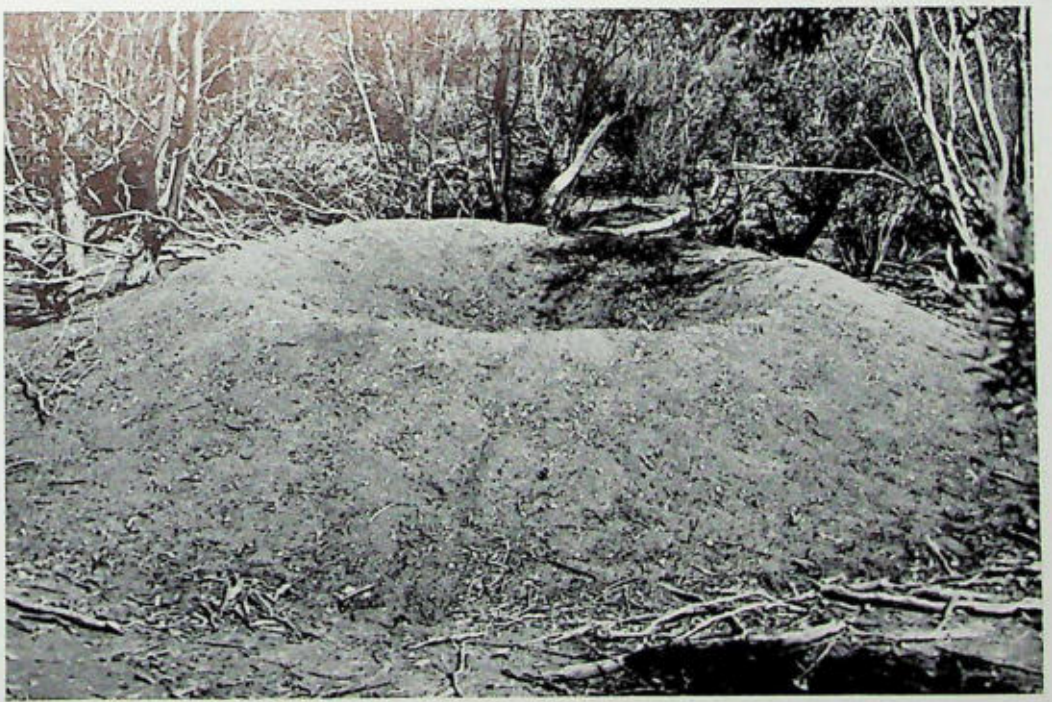
Rather like a small hen turkey, in size and general appearance, the Mallee-fowl is charmingly colored: back and wings are spotted black, white and brown; the neck is of a light fawn-grey color, and bare portions of the head and face are delicate blue; the eyes are light hazel, but brilliant; legs and feet, dark brown. The Lowan eats the seeds of shrubs of different species, the leaf-buds of one or two kinds, and berries, also insects, including ants, which abound in its haunts, Phasmids, beetles, etc. Its gizzard is very hard and horny. Though able to go for long periods without moisture, excepting such as they obtain from foliage in the early morning hours, or from their insect victims, these birds drink on occasion—during or just after a rainfall. They are rapid runners, and dodge through the scrub, if pursued, for some distance, seldom taking wing. They roost on low branches—there are few high ones in their usual haunts.

Mounds may be very isolated, or several be formed by different pairs of Lowans, within a restricted area. Little more than two hundred yards separated two mounds I discovered near Ouyen, when that township was an infant settlement, an islet in a sea of scrub. The size of the mound varies a good deal; a fairly large one measures, at the base, over twelve feet in diameter and three or four feet in hight. I have seen mounds over 40 feet in circumference, and others much smaller.

Though swift-footed at need, the Lowan's usual gait is dignified, a slow walk. It is mostly a silent bird, as befits its solitary habits: its subdued, soft note, uttered occasionally, is in tune with the spirit of the lonely mallee scrub.

Much hard work goes to the making of a mound, and unless driven off by encroaching settlement, or otherwise disturbed by man, birds may use the same nest year after year. They are, of course, annual renovations. When a new





The pictures on this page and the two on the opposite one represent various stages of mound-building of the Mallee-fowl. The one at the top is a mound just completed, perhaps but a few days, and is generating heat in the hot-bed of decaying vegetation preparatory to the laying of the eggs. The lower picture shows the mound opened by the birds down to the egg-chamber.





Eggs of the Mallee-fowl lying to one side of the egg-chamber. The materials used in forming the hot-bed or incubating chamber were leaves of the dwarf eucalypt or gum tree. The lower picture shows the mound after the eggs were deposited. This mound contained one tier of eggs. Photograph by Charles Barrett.



A road through the heart of the desert country of Australia. Although there are miles upon miles of trackless scrub and sandy wastes on both sides of the trail, Mallee-fowl are often seen and evidently find means of existence in this dry and desolate sandy region. In the preceding pictures it is apparent that after the egg-chamber is completed, sand is used to cover the chamber and forms the greater part of the mound. Photograph by Charles Barrett.

mound is required a hollow, perhaps two feet in width, and seven or eight inches deep at the centre, is scraped out of the chosen site. This depression is filled in with leaves and twigs and other debris, scraped off the ground around it, or brought from a distance: both wings and feet are used in gathering and transporting material. In the scrub one sees many trails, due to the Lowans' wing-sweeping and foot-scraping operations. They are most industrious as builders!

The hollow filled, the birds proceed to build up a low mound of the material—less than a foot above ground level, and in the centre of this make an excavation, perhaps six inches deep and over a foot across: the egg-chamber. Next comes mound-making proper. Sand, or dry grey earth mixed with sand in some localities, is heaped around the egg-chamber or nest, which then is ready for the rains. Work at the mound ceases until winter downfalls have soaked the heap of vegetable matter and other debris forming the "hot-bed," which may be several months after preliminary work in the autumn. Sand, then, is scraped over the mound to a depth of six inches or more, and another period of waiting follows, only a few days perhaps, while the decaying debris beneath the sandy dome, is generating heat. At length, all is ready for egg-laying, and the female bird scrapes a great deal of sand out of the egg chamber, leaving a two or three inch layer at the bottom.

I have opened many Lowan mounds, and found eggs in plenty, but as to the birds' mode of placing eggs in position, must quote my late friend, D. Le Souef: "She then lays her egg, and holding it upright with one foot, with the small end downwards, she scrapes the sand round it with the other foot until it can stand alone. The bird has to lean well back to enable her to use both her feet. She then covers the whole with sand."

Whenever an egg is laid, the egg-cavity must be scraped out, and refilled. The eggs are deposited in tiers, usually at the outer edge of the cavity. When those first laid have been covered several inches deep in sand, another tier is begun. Three tiers are usual, each composed of three to five eggs. The full complement varies much, however from eight or nine or a dozen up to eighteen; the average being about fourteen. Dawn is the hour for egg-laying, at three-day intervals. The period of incubation extends over about five weeks. The temperature of the egg-chamber varies but slightly—95 deg. to 96 deg.

Lowan eggs are delicious, unfortunately for the species: in the days before protection under our Game Laws, nearly every mound discovered was robbed by the settlers; and even now, there is poaching of the kind. The eggs measure between three and four inches in length (3.73, 3.52, and 3.44, are sample measurements), and are elliptically inclined, or of a long oval shape. The very thin, coarse-textured shell is pale pink, or pinkish-buff colored when the egg is fresh, but soon darkens.

The young are so precocious that they run quickly when just out of their mound-nursery, and are even able to fly, their wing feathers being sufficiently developed to support them in the air over a short distance. They work their own way to freedom, according to some observers, while others believe that the old birds aid them. Certainly, the parents do open up the mound to some extent almost every day, and the heap of sand and debris thus never becomes set while in use. Chicks from eggs of the topmost tier have a fairly easy task in getting to the surface; those of the lower tiers would benefit by parental aid. Dead chicks are found in a mound occasionally. The late C. H. McLennan, a Bush naturalist and keen observer, widely known as "Mallee Bird" (his pen name), often watched Lowans at their mounds, and took the unique photograph here reproduced. The birds, he recorded, have a habit of flattening out the "nest" at about 10 o'clock in the morning, in order to admit the heat of the sun, and about 3 P. M. building it up again.

Foxes (introduced, for sporting purposes, from England) are enemies of the mallee-fowl: they dig into the mounds after eggs. I have found evidence of their raids at many a mound. The big Monitor lizards (goannas) also rob the Lowan of its eggs, but man has been the worst enemy since the era of progress began in north-western Victoria and other parts of the wonder-bird's range.

When a new area is thrown open for settlement, clearing begins on the blocks (640 acres each), the virgin scrub being actually rolled down in swathes, almost as easily as wheat falls to the harvester. Stems of the dwarf mallee eu-





Ocellated Megapode (*Leipoa ocellata*) in the Zoological Park. In captivity this bird lacks the stamina of the Brush-turkey. The gray, fawn and black color-pattern is distinctive of this species. A nesting habit of one of the Megapodes of the out-lying islands is interesting as opposed to that of *ocellata*. Instead of erecting a mound, a hole three or more feet in depth is made in the sands along the shore above high-water and a single egg deposited about every twelve days, until six or eight have been laid, which eventually are hatched by the heat of the sand.

calpts are brittle at the root, and the great log or iron roller, drawn by a team of bullocks or of horses, smashes them down—it is the Juggernaut of the mallee. Lowan mounds do not escape; they may be rolled nearly flat, and hundreds of small birds' nests are destroyed completely by the ruthless roller. When the rolled scrub has become dry enough, it is burnt; and grubbing out the roots—in great demand as fuel—is the final clearing operation on a settler's block.

A Victorian Shire is called Lowan, the aboriginal name for the mallee-fowl, and one of the most musical in any Australian tribe's vocabulary.

At my request, the Chief Inspector of Fisheries & Game for Victoria (Mr. F. Lewis) wrote especially the following account of the present status and future prospects of the Lowan in the State:—

"The Lowan or Mallee-fowl was once very common in what is known as the Mallee section of Victoria, but of late years a very big proportion of this country has been cleared for the purpose of growing wheat. A large section of the Mallee country is considered, at the present time, unfit for settlement, and in these parts the Lowan is still fairly common in spite of the depredations of the imported fox and of the settler in search of fresh eggs.

"It is most likely that, for a good number of years yet, a considerable portion of the drier parts of the Mallee will remain unsettled, and as long as this is so the Lowan will continue to exist. Should there come a time, however (and it is not at all improbable that this will eventuate) when improved methods of cultivation will enable the drier portion of the Mallee to be settled, the position of the Lowan will then be very precarious. The education of the public will probably result in the bird and its eggs not being interfered with by man, and the losses by the fox, judging by present experience, are not very serious, so that the most important factor in the preservation of the bird or otherwise is the spread of settlement.

"To counteract this it will be necessary to make large reservations of typical Mallee country before it is all alienated. There is at the present time a large National Park in the Mallee which, so far as it goes, is excellent. The greater part of this Park being composed of the valley of a river which once flowed through this country is not typical Mallee and therefore unsuitable for the breeding and preservation of the Lowan. To preserve this most interesting and unique member of our fauna, further reservations of typical Mallee country should be made at once. If this is done, I see no reason to fear the ultimate loss of this bird. If these reservations are not made it will only be a matter of time before the Lowan will disappear, from Victoria at least."

Encourage Vireos.—During the summer almost anywhere in the United States at least one species of vireo, and usually more than one, is to be found flitting about in the trees or shrubbery. In the East and Central regions the common species is the red-eyed vireo, but the white-eyed, warbling, and yellow-throated vireos also are abundant. The Philadelphia, blue-headed, Hutton, and Bell vireos are more or less widely distributed. As with other common species of birds, the question as to whether or not vireos are beneficial is legitimately raised, and to answer it, the Biological Survey has made a study of their food habits.

The food of the several vireos is shown to be very similar though sometimes varying in proportions. Most of the insects eaten are either neutral or definitely injurious in their economic relations, and may be placed on the credit side of the account of these birds. All vireos are especially fond of caterpillars. Scale insects are a notable item of vireo food, and other tree pests are freely eaten. Many destructive weevils were found in the stomachs examined, including such forms as the clover-leaf, clover-root, cotton-boll, and nut weevils, the plum curculio and bark beetles. Vireos also destroy ants and grasshoppers. Useful insects taken by the vireos include some of the hymenopterans, predacious bugs, and beetles, among which are ladybird beetles, which are almost uniformly beneficial. Although it is regretted that vireos consume as many ladybirds as the evidence indicates, yet they also devour many of the pests attacked by the ladybirds, which must, in part, excuse them. As fruit eaters the vireos are practically harmless.



On the bank of the creek flowing along one side of the "Isle of the Dead" stands an old tree, known to the settlers of that part of the country as the "Canoe Tree." As the legend runs, over a century ago the aborigines cut from its trunk the bark for one of their primitive canoes. The serrations in the trunk indicate that the bark was lifted only after arduous labor, afterwards to be converted into a funeral craft ferried by an aboriginal Charon. Photograph by Charles Barrett.

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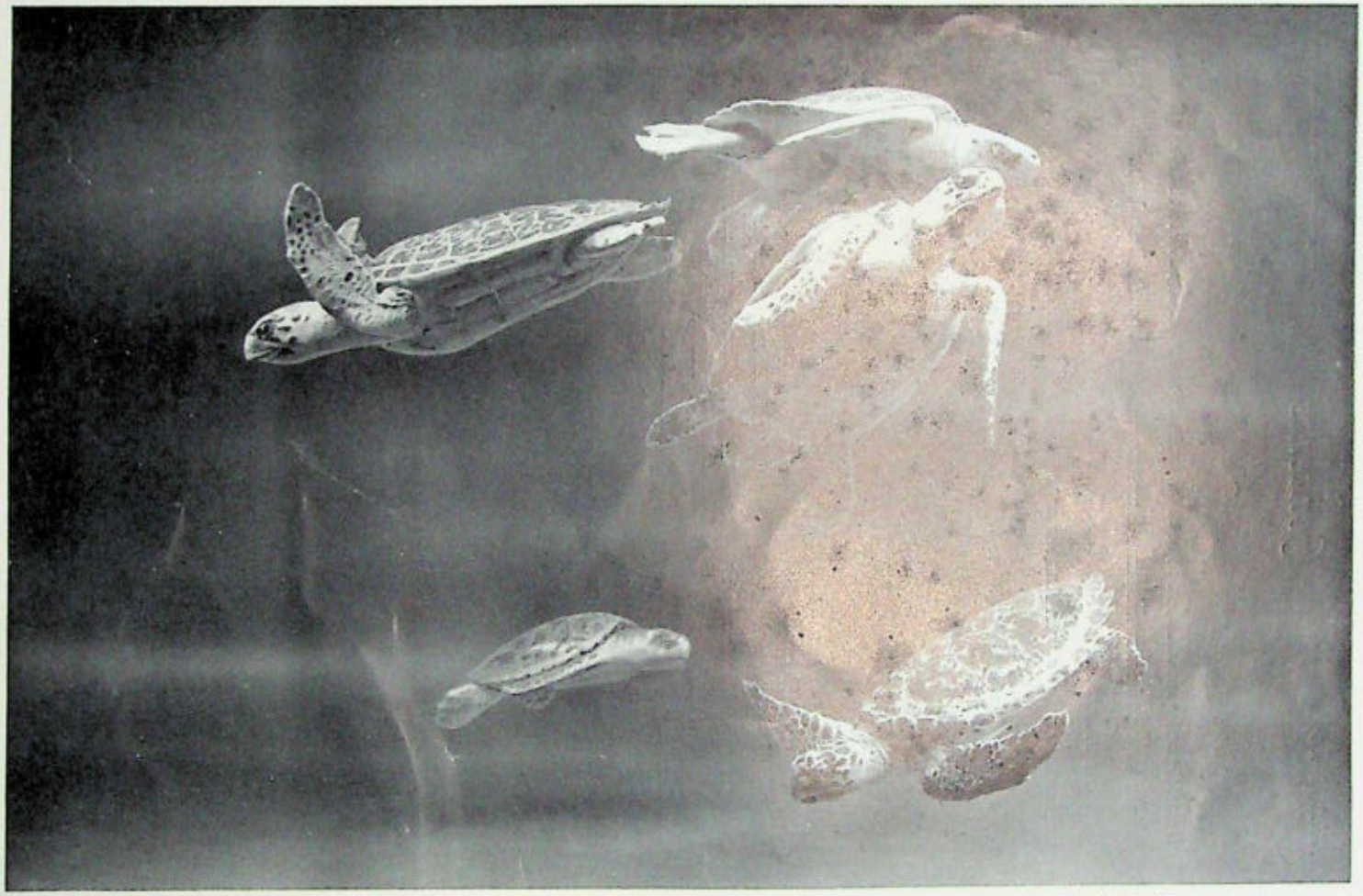
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Sea Turtle Group, photographed in the New York Aquarium. Sea turtles are cosmopolitan in distribution, being found in all warm seas. They breed on the sandy shores of many islands and countries lying in the intertropical zone. The Pacific islands are favored as egg-laying spots and the West Indies are a counterpart to the East Indies in this respect. The specimens shown are Kemp's Bastard Turtle, a native American species found only in the Atlantic; and the Hawkbill, represented by two species, one in the Atlantic and the other in the Pacific. The saw-tooth edge of the darkly mottled shell is diagnostic of the Hawkbill (tortoise-shell turtle), while Kemp's species is a solid grey above with a pale colored head and underparts of a creamy white texture.

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The Turtles of the Northeastern States

The turtles and terrapins of the North Atlantic and New England States with a brief description of the various species.

C. RALPH DE SOLA

The illustrations in this article are from photographs in the collections of the New York Zoological Society, and were made from specimens in the Zoological Park and the New York Aquarium.

INTRODUCTION

THE northeastern coastal plain, or Atlantic slope, of the United States contains Maine, New Hampshire, Vermont, Massachussetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware and Maryland, and this region forms a zoogeographical entity as regards reptilian forms. The nineteen species of terrapins and turtles evenly distributed over this area have received little or no attention, existing accounts being scattered and hidden in the literature of herpetology. With the exception of Ditmars' "Reptile Book" written in 1907 and Babcock's "Turtles of New England" (1919), nothing can be found that treats upon the turtles of the North Atlantic states as a group. It is interesting to note that nineteen turtles ranging through eleven states are all within a two hundred and twenty-five mile radius of New York City.

Regarding the words "terrapin" and "turtle," the suggestion made by Dr. Hornaday has been adhered to in this article; he advises that all turtles having purely terrestrial habits be termed "tortoises," that all turtles leading an aquatic existence be termed "terrapins," and that all marine forms of the ocean be termed "turtles." This ruling has been used in the popular names which are followed by the taxonomic nomenclature devised by Stejnegar and Barbour in their "Check List of North American Reptiles and Amphibians."

Only turtles and terrapins are dealt with here as tortoises are restricted in their range to the warmer and somewhat tropical regions of our country. (See remarks on Box Terrapin). The sea turtles, although hatched in tropical waters of Central America, the West Indies and our own Southern coasts, are frequent summer visittants to Northern harbors and off-shore ocean waters. The terrapins, on the other hand, are native to the region under consideration and hibernate during the winter.

The sea turtles (Trunk-back, Kemp's, Loggerhead, Green, and Hawkbill) are to be found along the coasts of all states from Maine to Maryland.

The fresh-water terrapins (including Spiny Soft-shell, Soft-shell, Snapping, Box, Redbellied, Western Painted, Eastern Painted, Map, Diamond-back, Muhlenberg's, Sculptured, Spotted, Mud Box and Musk) are distributed in equal abundance over the entire area. However, the local Diamond-back Terrapin is restricted to the coastal region from Massachusetts to Maryland.

Turtles Found from Maine to Maryland, Including Vermont and Pennsylvania

Name of Turtle	States: New England	Vt.	NY & NJ	Pa.	Md.	Del.
Sea Turtles						
Trunk-back Turtle *Dermochelys coriacea*	Xr	..	Xr	..	Xr	Xr
Kemp's Bastard Turtle *Caretta kempi*	Xr	..	X	..	X	X
Loggerhead Turtle *Caretta caretta*	Xr	..	X	..	X	X
Green Turtle *Chelonia mydas*	Xr	..	X	..	X	X
Hawkbill Turtle *Eretmochelys imbricata*	Xr	..	X	..	X	X
Land and Pond Turtles, Terrapins						
Spiny Soft-shell Terrapin *Amyda spinifer*	X	X	X	X	X	..
Soft-shell Terrapin *Amyda mutica*	..	..	..	X	..	..
Snapping Terrapin *Chelydra serpentina*	X	X	X	X	X	X
Box Terrapin *Terrapene carolina*	X	X	X	X	X	X
Red-bellied Terrapin *Pseudemys rubriventris*	X	X	Xr	X	X	Xr
Western Painted Terrapin *Chrysemys marginata*	..	..	Xr	X	..	..
Eastern Painted Terrapin *Chrysemys picta*	X	X	X	X	X	X
Map Terrapin *Graptemys geographica*	Xr	Xr	Xr	X	..	..
Diamond-back Terrapin *Malaclemys centrata concentrica*	Xr	..	Xr	..	X	X
Muhlenberg's Terrapin *Clemmys muhlenbergi*	Xr	Xr	X	X	..	..
Sculptured Terrapin *Clemmys insculpta*	X	X	X	X	Xr	Xr
Spotted Terrapin *Clemmys guttata*	X	X	X	X	X	X
Mud Box Terrapin *Kinosternon subrubrum*	X	X	X	X	X	X
Musk Terrapin *Kinosternon odoratum*	X	X	X	X	X	X
Total species by states:	17	11	18	13	15	14

Total species listed: 19

(X indicates occurence of species in state)
(Xr indicates species is rare)

Key to the Identification of Turtles

Adapted after Pratt's "Manual of the Vertebrate Animals of the United States."

Class: REPTILIA: REPTILES—Back-boned, bilaterally symmetrical animals, covered with scales or plates.

Order: TESTUDINATA: TURTLES—Reptiles having jaws without teeth; whose wide and short bodies are enclosed in a shell made up of a top shield, the *carapace*, and a bottom shield, the *plastron*. Carapace and plastron are covered with horny plates and the head, neck and limbs of the body with scales.

Families, Genera and Species:

a-1 LAND and POND TURTLES: TERRAPINS—Aquatic turtles found on land and in the inland waters (ponds, streams, rivers and salt marshes); limbs not in the form of flippers.

b-1 Shell covered with horny plates.

c-1 Short tail without horny scales on top; plastron large and oval.

d-1 Plastron with 9 to 11 horny plates; margin of carapace turned downward, not flaring.

Mud Terrapins, *Kinosternidae*, genera *Kinosternon*.

e-1 Plastron very narrow and not covering the soft parts.

f-1 Head with yellow stripes.
Musk Terrapin, *K. odoratum*. (Fig. 19.)

e-2 Plastron, covering the soft parts when closed.

f-2 Head spotted with yellow.
Mud Box Terrapin, *K. subrubrum*. (Fig. 18.)

d-2 Plastron with 12 horny plates; margin of carapace flaring outward.
Sliders, Pond, Wood and Box Terrapins, *Testudinidae*.

e-1 Plastron without hinge, immovably joined to carapace.

f-1 Carapace usually keeled.

g-1 Size small; mostly under 6 inches long; keel often indistinct.
Wood Terrapins, *Clemmys*.

h-1 Carapace with small yellow spots on a black background.
Spotted Terrapin, *C. guttata*. (Fig. 17.)

h-2 Carapace with deep concentric grooves in each plate and serrated behind.
Sculptured Terrapin, *C. insculpta*. (Fig. 16.)

h-3 Head with a large orange or yellow spot on each side.
Muhlenberg's Terrapin, *C. muhlenbergi*. (Fig. 15.)

g-2 Size moderate, carapace over 6 inches long.

h-1 Salt marsh terrapins; plates with growth lines.
Diamond-back Terrapin. *Malaclemys*.

i-1 Shell rough, carapace dark olive in color.
Diamond-back. *M. centrata concentrica*. (Fig. 14.)

h-2 Plates nearly smooth.
Map Terrapin. *Graptemys*.

i-1 Carapace depressed and with a keel; lower jaw notched at tip. Triangular yellow spot back of eye.
Map Terrapin. *G. geographica*. (Fig. 13.)

f-2 Carapace not keeled, smooth. (See also *C. guttata*.)

g-1 Carapace smooth, with rounded margin; size small.

h-1 Carapace with red markings on marginal shields.
Slider Terrapins, *Chrysemys*.

i-1 Plastron immaculate yellow.
Eastern Painted Terrapin, *C. picta*. (Fig. 12.)

i-2 Plastron with blackish oval patch on yellow.
Western Painted Terrapin, *C. marginata*. (Fig. 11.)

g-2 Carapace with serrated hinder margin.
Slider Terrapin, *Pseudemys*.

h-1 Plastron red; lower and upper jaws serrated.
Red-bellied Terrapin, *P. rubriventris*. (Fig. 10.)

e-2 Plastron with hinge across the middle, enabling the animal to close its shell. Body arched; plastron rounded behind; upper jaw hooked in front.
Box Terrapin, *Terrapene carolina*. (Fig. 9.)

c-2 Tail very long, with top row of horny scales; plastron small, cross-shaped. Head covered with soft skin. Carapace with 3 blunt keels. Large head.
Snapping Terrapins, *Chelydra serpentina.* (Fig. 8.)

b-2 Shell not covered with horny plates, but with a leathery skin.
Soft-shell Terrapins, *Trionychidae.*

c-1 Fore part of carapace smooth; body brown in color, irregularly blotched.
Soft-shell Terrapin, *Amyda mutica.* (Fig. 7.)

c-2 Fore part of carapace with conical spines; body olive-brown, with numerous dark round spots, each margined with black.
Spiny Soft-shell Terrapin, *Amyda spinifer.* (Fig. 6.)

a-2 MARINE TURTLES, TURTLES: pelagic turtles found in the Atlantic Ocean along our coasts and occasionally entering our harbors; limbs in the form of flippers; size very large.

b-1 Shell covered with horny plates.
Sea Turtles, *Cheloniidae.*

c-1 Four costal plates on each side of the carapace.

d-1 Plates of carapace imbricated.
Hawkbill Turtle (Tortoise Shell Turtle), *Eretmochelys imbricata.* (Fig. 5.)

d-2 Plates of carapace not imbricated. Body olive or brown above and splashed with yellow.
Green Turtle, *Chelonia mydas.* (Fig. 4.)

c-2 Five costal plates on each side.

d-1 Body brown above, yellowish below; feet with two claws each.
Loggerhead Turtle, *Caretta caretta.* (Fig. 3.)

d-2 Body a uniform dusky brown; similar to *C. caretta,* but with ridges on the crushing surfaces of the jaws under the horny sheaths.
Kemp's Bastard Turtle, *Caretta kempi.* (Fig. 2.)

b-2 Shell covered with a smooth leathery skin; carapace with 7 longitudinal ridges.

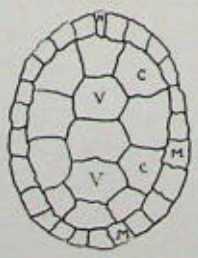
c-1 Color dark brown to black; weight often over 700 pounds.
Trunk-back Turtle, *Dermochelys coriacea.* (Fig. 1.)

Names of Turtle Shields Used in Identification of Species

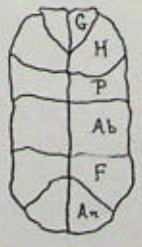
Drawn from a typical species, the Western Painted Terrapin, *Chrysemys marginata.*

Note:—All measurements are taken along the straight line of the carapace or plastron. Size records given for each turtle are approximate.

CARAPACE



PLASTRON



Key:
N—nuchal shield
C—costal shields
V—vertebral shields
M—marginal shields

G—gular shields
H—humeral shields
P—pectoral shields
Ab—abdominal shields
F—femoral shields
An—anal shields

THE TRUNK-BACK TURTLE, *Dermochelys coriacea* (Linne), Fig. 1. This species occurs infrequently on our coasts and is the largest known to man in recent times, reliable records of weight being in excess of 1500 pounds. However, the average weight ranges from 700 to 900 pounds. It is unique among turtles in that neither the ribs nor the vertebrae are united to the carapace but are free within it. As seen from the key, this species is distinguished from all other marine turtles by the absence of horny plates, being covered with a tough leathery skin; thus it bears the same relation to the sea turtles that the soft-shell terrapins bear the other terrapins.

The trunk-back turtle, so named because of the seven ridges that give it that appearance, is of mythological interest. Sir John Hawkins, an eminent musicologist of the early nineteenth century, mentions a story of Homer in his "Harmonia Manualis":

> The lyre is the prototype of the fidicinal or stringed species of instruments and is said to have been invented about the year of the World 2000 by Mercury, who, finding on the bank of the river Nile a shell-fish of the tortoise kind, which an inundation of the river had left there, and observing that the flesh was already consumed, he took up the back-shell, and, hollowing it, applied strings to it.

Statues of Mercury often show the seven stringed shell mentioned by Homer and if they be of Greek origin, not only are seven strings shown but the hollow reverberating surface of the shell (the inner carapace) is molded so as to present seven distinct ridges.

Size and Color: Museum specimens have an average measurement of six feet from tip of snout to end of tail. The color of the body is a uniform dark brown occasionally spotted with yellow.

Habits and Economic Use: Little or nothing is known concerning the life of this pelagic form. Occasionally adult specimens are caught but it is not known where breeding takes place or what parts of the ocean are most favored for feeding. From the appearance of the very heavy notched jaws it has been assumed that its appetite is omnivorous. Its flesh is not used for food but Dr. Hornaday says that a pint of oil can be extracted from every square foot of the thick blubber-like coating overlying the bony carapace.

KEMP'S BASTARD TURTLE, *Caretta kempi* (Garman), Fig. 2. The bastard sea turtle is so named because it bears a resemblance intermediate to the green and to the loggerhead turtles. Many interesting but unrecordable tales are told concerning the origin of this species. It has no outstanding features inasmuch as its habits are like those of other sea turtles and its flesh is not valued.

Size and Color: Specimens taken in Lower New York Bay by the *Sea Horse*, the collecting boat of the New York Aquarium, measure from a foot and a half to two feet in length. The carapace is a uniform, dusky brown and the plastron is a whitish yellow. It is differentiated from the loggerhead turtle in that the crushing surfaces of the jaws under the horny knife-like sheathes are ridged.

Habits and Economic Use: For habits see accounts on green and loggerhead turtles. So far no commercial use has been found for the Bastard Turtle.

THE LOGGERHEAD TURTLE, *Caretta caretta* (Linne), Fig. 3. This, next to Kemp's turtle, is the commonest of the sea turtles and is frequently found off our coasts and entering our harbors. Its flesh is coarser than that of the green turtle and consequently is less sought after. It is, as its name implies, provided with a large head which serves to distinguish it from Kemp's and the green turtle. Pausanius confused it with the trunk-back or lyre turtle as he wrote:

> On Mount Parthenon in Arcadia, the Gods conserve the great turtles as sacred animals and only kill them when they need a shell which they find necessary in the construction of their lutes. The animals are guarded over by the god Pan.

Another ancient writer, Corvilio Polio, credits himself with the invention of encrusting objects with the shell of the hawkbill turtle and knowing:

> . . . that the lens of the Loggerhead's eyes was valuable as a stone to mount in gold and use as a necklace that was much in demand by the rich Etruscan women.

Pliny who compiled Aristotle's observations on the breeding of sea turtles gives a number of recipes that he considers useful and that can be made from the several parts of the loggerhead.

Size and Color: Length of carapace usually over three feet. Specimens of this size weigh over two hundred pounds. The body is light brown above and yellow below.

Habits and Economic Use: The breeding



Fig. 1. Trunk-back Turtle, *Dermochelys coriacea*. Among the larger denizens of the deep the trunk-back turtle finds a place at par with dolphins, porpoises and sharks, being protected from their attacks by a hard, leathery shield and aided in locomotion by powerful swimming organs, flipper-shaped limbs. The photographs illustrate the gigantic proportions of this marine monster. In life this specimen measured over seven feet and weighed nearly half a ton. The species is little known in the annals of natural history, although it is the largest turtle of recent times.

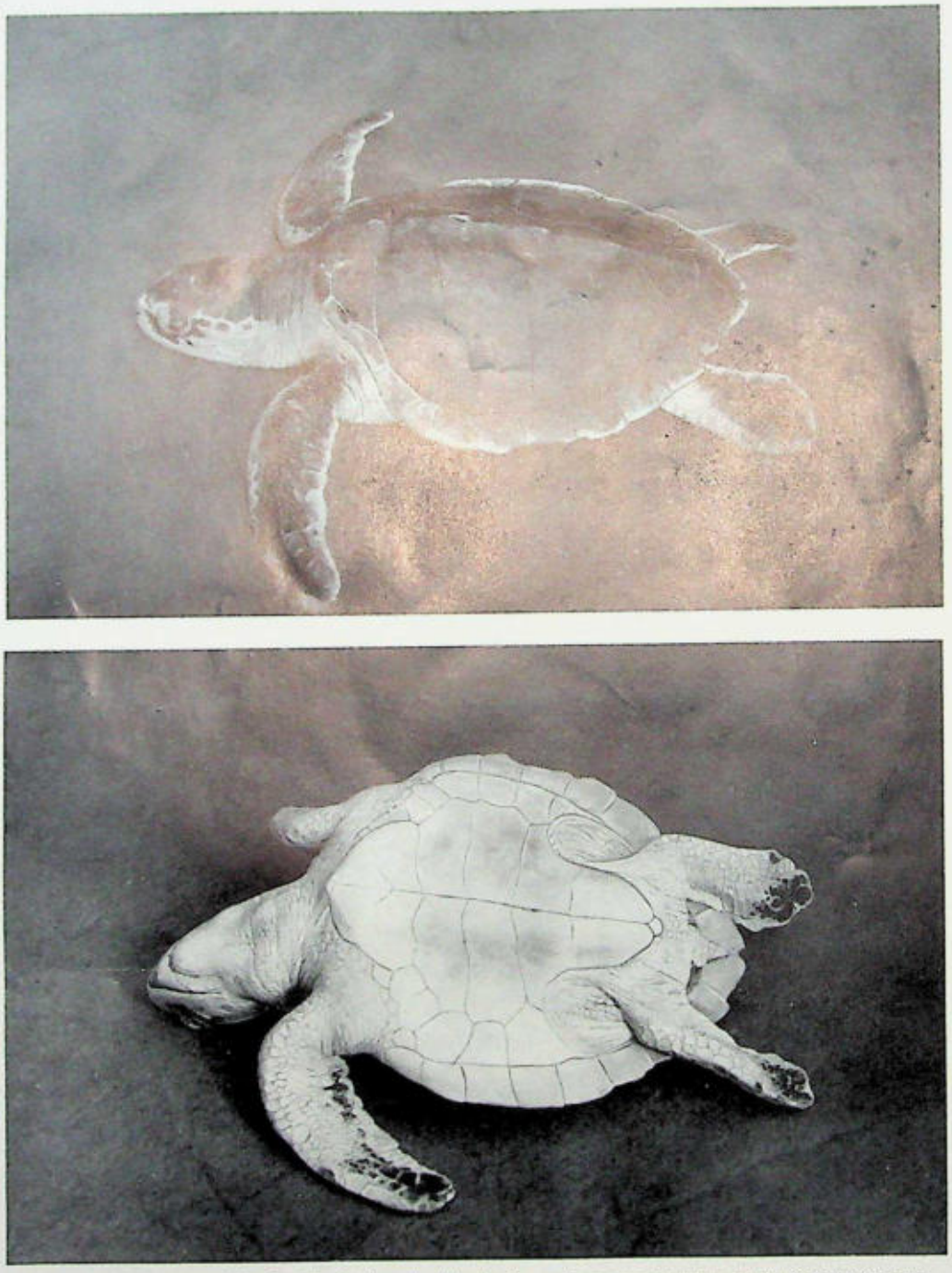


Fig. 2. Kemp's Bastard Turtle. *Caretta kempi*. This turtle was long considered to be the hybrid offspring of the loggerhead and hawkbill sea turtles. An allegation of this sort led to the appellative of illegitimate in the naming of what has been found to be a valid species. Individuals seldom exceed a length of two feet and specimens of that size weigh about fifteen pounds. Breeding occurs on the coast of Georgia during July with hatching taking place the following November. The Gulf Stream carries many of these turtles to our northern shores every summer. It is the species most commonly found in New York waters.



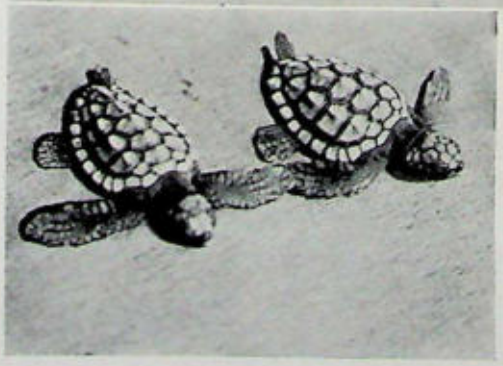


Fig. 3. Loggerhead Turtle and Young, *Caretta caretta*. The loggerhead is carnivorous and little esteemed for food. However, in many parts of the tropics its eggs are sought after and prized as a delicacy. The young loggerheads shown above differ from adult specimens in that their plates are imbricated and dark brown or blackish in color. Full grown specimens have a smooth carapace, a rich brown in tone, while the plastron is a clear yellow. Such individuals weigh about one hundred and twenty-five pounds and seldom exceed five feet in length. Considerable interest centers around the shield variations of this species. There takes place, during the lifetime of many individuals, a numerical reduction of the many small horny plates which, gradually becoming larger, afford the turtle a strong protective armor-like plating.

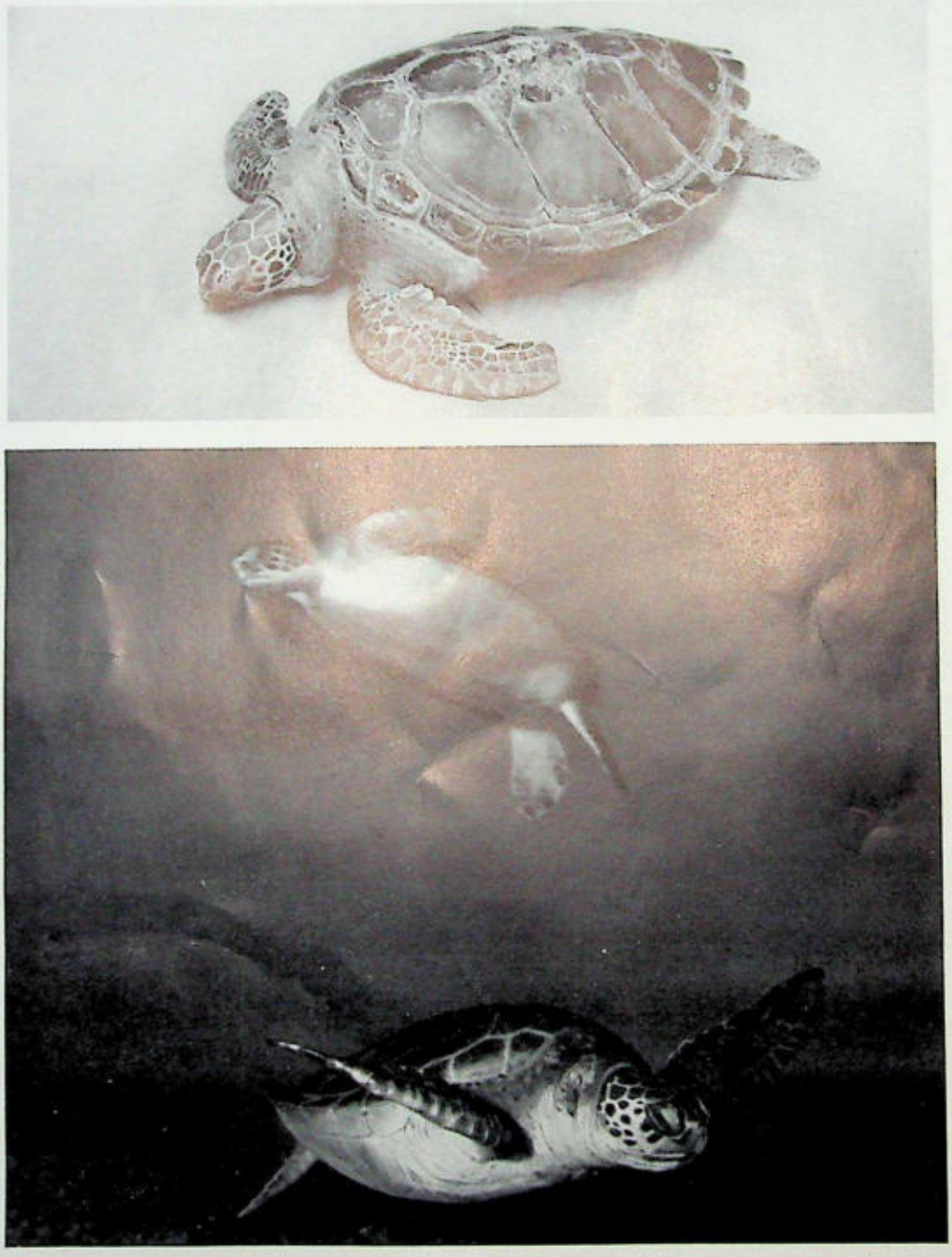


Fig. 4. Green Turtle, *Chelonia mydas*. This is the edible turtle valued the world round for its tender and succulent flesh. It has been hunted with such persistence that it is rapidly becoming extinct and another hundred years will find it relegated to museum storerooms and books dealing with recently extinct animals. The top view gives some idea of the size and bulk of the creature, while the bottom illustration depicts the underparts of this valuable marine reptile. These turtles are shipped to the New York markets from West Indian and Central American ports, while Europe receives her share from the shores of West Africa and Ascension Island, which is a famous center for the commercial operation of turtle fishing.

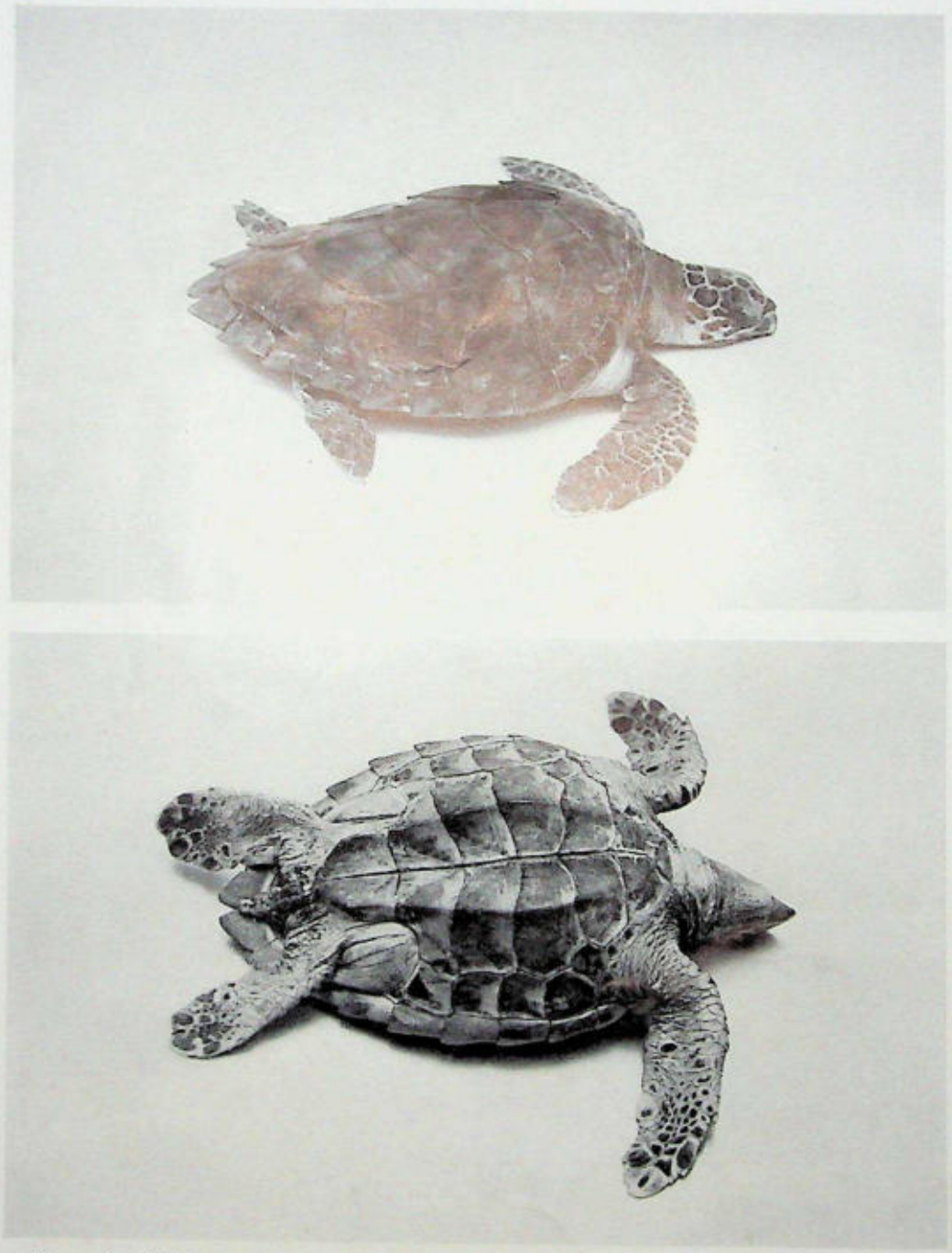


Fig. 5. Hawkbill Turtle, *Eretmochelys imbricata*. The tortoise-shell turtle, prized for many thousands of years, is represented in the upper and lower views. The over-lapping plates of the upper shell make the better grades of the tortoise-shell of commerce, while the clear and less clouded shields of the ventral surface are used as filler and where an inferior product can be substituted. Like other sea turtles the hawkbill has a remarkable homing instinct: females return to the same beaches year after year at breeding time. The Florida Keys were once considered the finest fishery in the world for this species, but over-fishing has resulted in the collapse of the industry. A small quantity of shell is still imported from Cuba and Colombia and prices for articles made or encrusted with it are prohibitive in price.

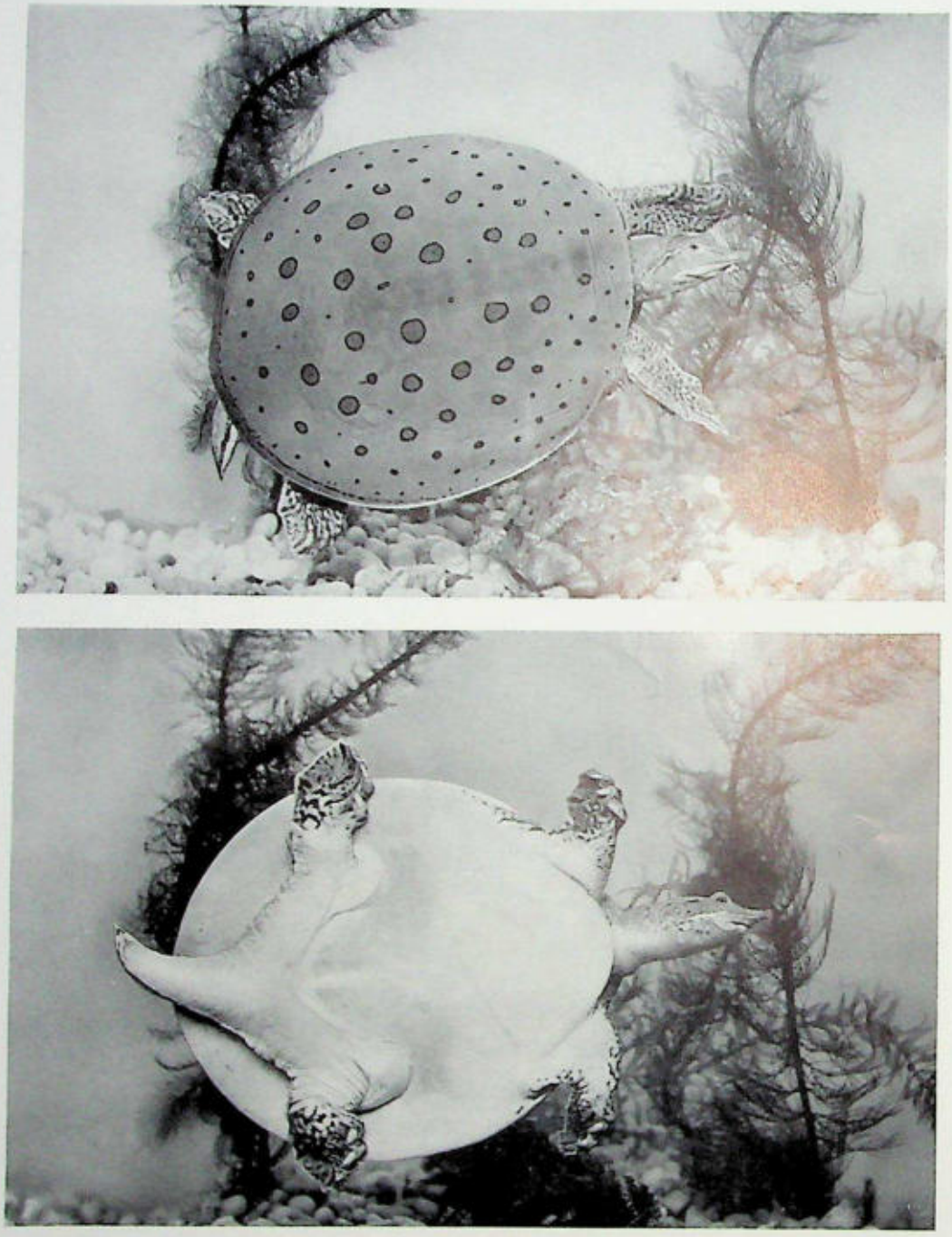


Fig. 6. Spiny Soft-shelled Terrapin, *Amyda spinifer*. Dorsal and ventral views of one of nature's anomalies—a terrapin without a shell. Like a somewhat related form, the trunk-back turtle, the spiny soft-shell terrapin is devoid of bony shields; even its jaws are sheathed in a fleshy covering. The under-lying bony structure with sparsely developed and widely separated parts in no way resembles the highly organized and closely knit skeleton of other chelonians. Caution must be observed in handling soft-shells.

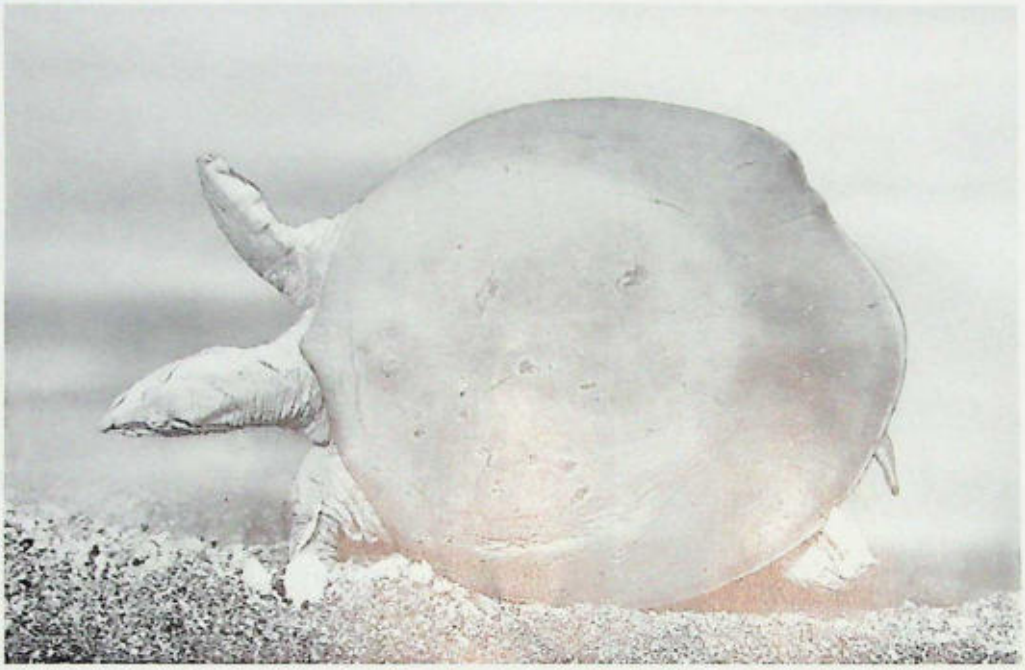
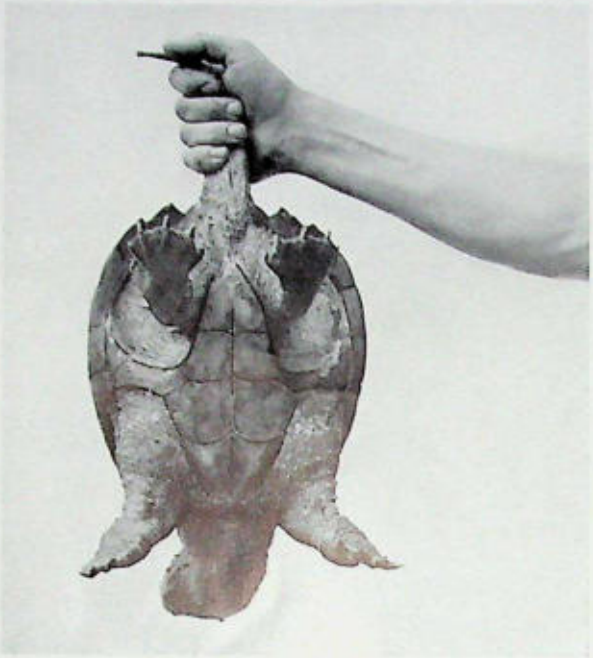


Fig. 7. Soft-shell Terrapin, *Amyda mutica*. Upper view of a soft-shell terrapin found through western New York State and Pennsylvania in the tributaries of the St. Lawrence River and in the Erie Canal. Like the spiny soft-shell, this species is both voracious in appetite and vicious in manner of attack.



Radiographs of the Box Terrapin, *Terrapene carolina*. The radiograph on the left of the page is an anterior-posterior exposure showing the extended limbs and head, as well as the pectoral and pelvic girdles reminiscent of human shoulder and hip bones. The other view, with head and neck retracted, illustrates the remarkable protection afforded by the bony shell. This shell is made up of ribs fused together. The center longitudinal line of the picture represents the back bone; the little bones, issuing at regular intervals from each side of the vetebral segments, are the beginning of the ribs. These ribs fuse together to form the bony, box-like covering of the animal. Radiographs taken at the Broad Street Hospital through the courtesy of Drs. Nahon and La Corte.



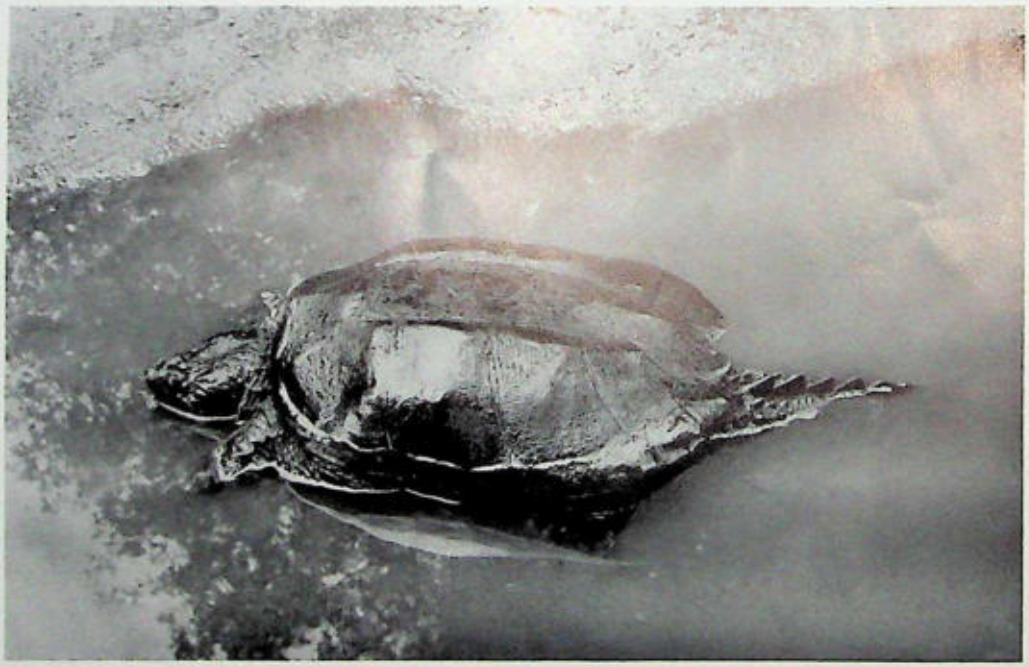
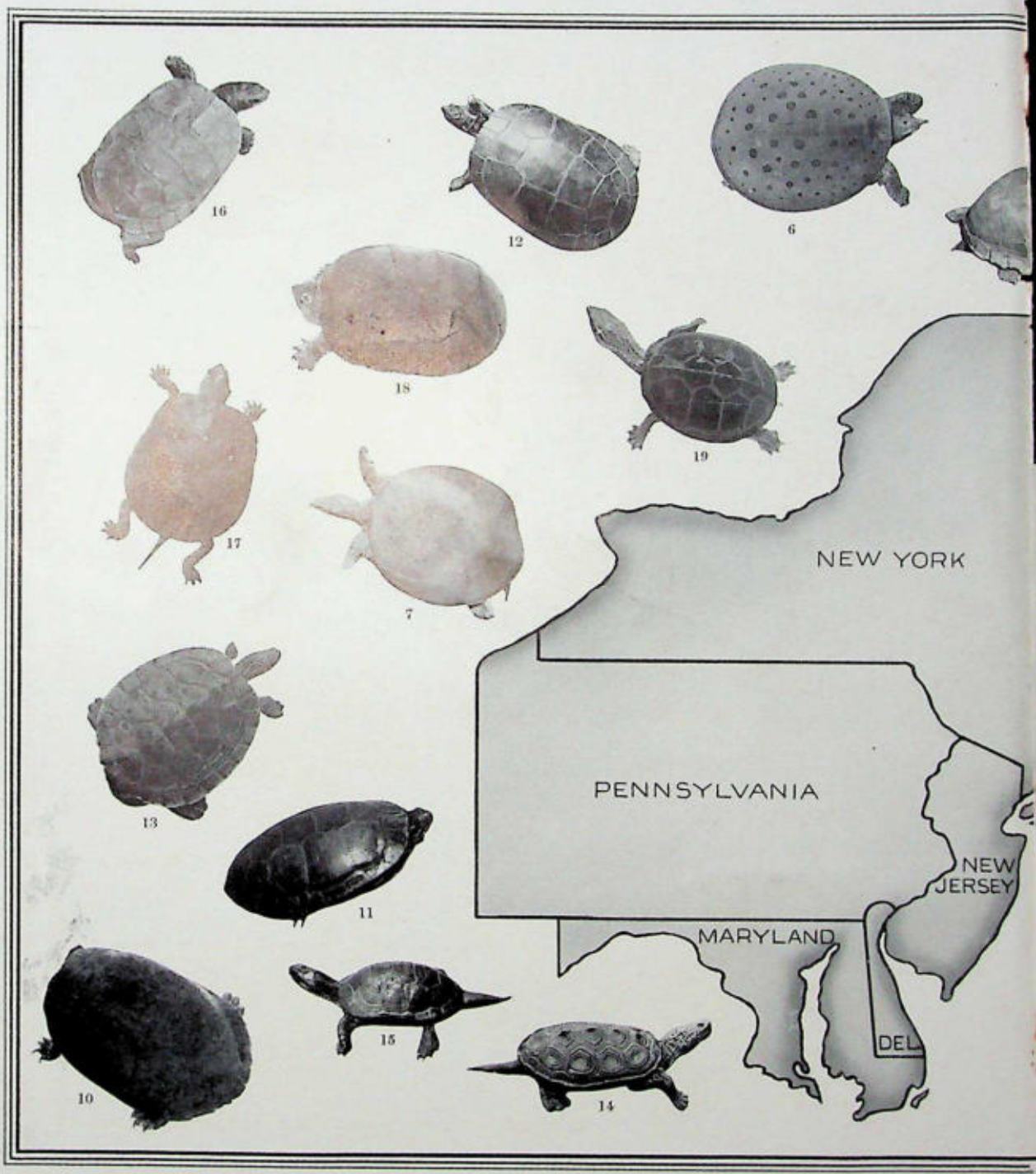


Fig. 8. Snapping Terrapin, *Chelydra serpentina*. The snapping terrapin is by far the most powerful and dangerous creature treated upon in this article. The photograph of its ventral surface shows the only manner in which this species may be safely handled. For this photograph, the terrapin was held by the tail and extended away from the body of its captor. Snappers are best in the soup pot, as they wreak havoc in many ponds and streams where water-fowl and game fish abide.



DISTRIBUTION OF TURTLES FOUN

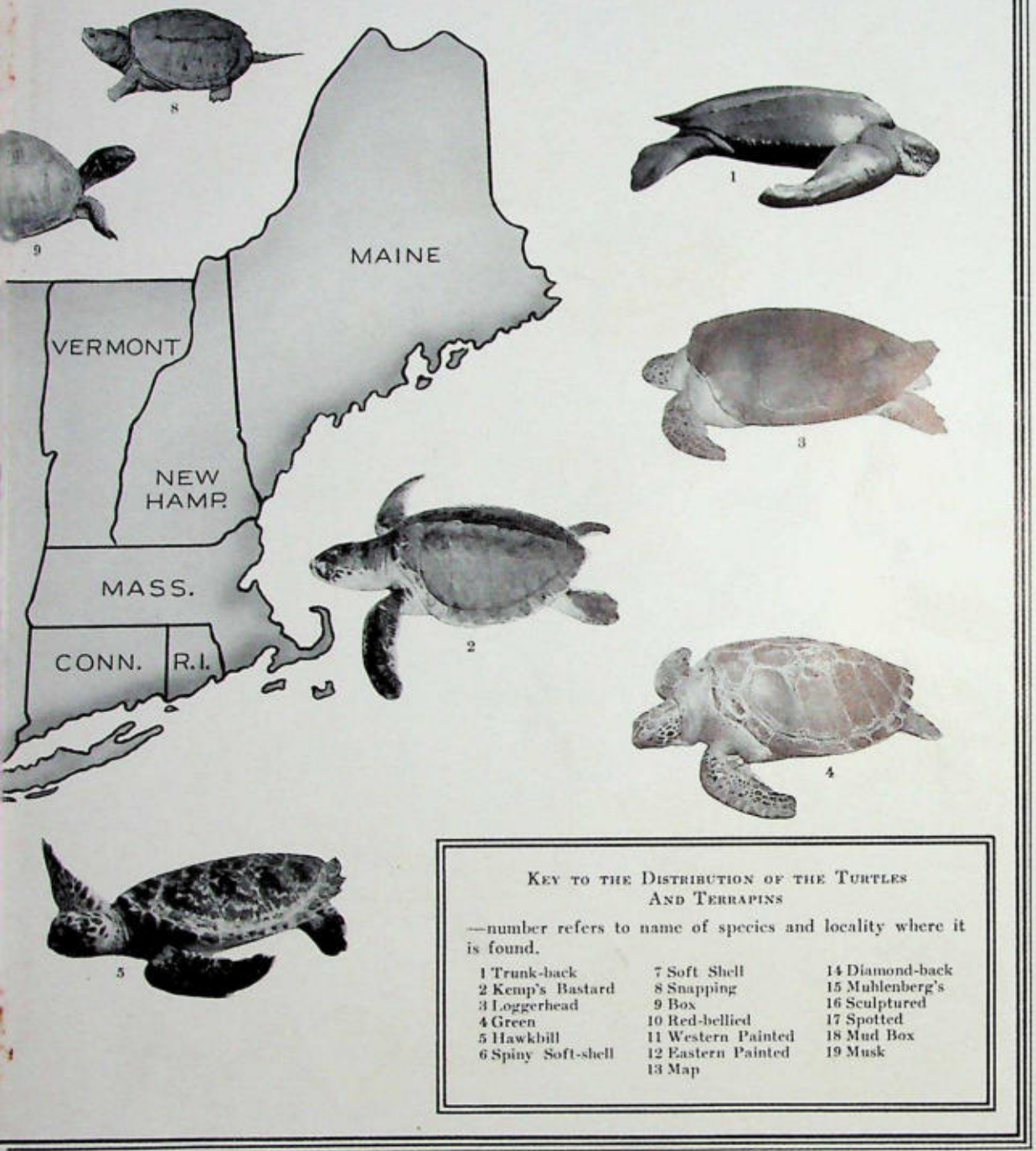
Attention is called to the figures of turtles bordering the map of the north-eastern coastal plain. Each turtles figured is named and numbered; the number corresponding to its location on the map shown and to the following explanatory notes.

Turtles 1 to 5 inclusive are taken from the coastal states only, as they are Sea Turtles.

The following turtles appear in equal abundance over the entire area shown on the map: 6, 8, 9, 10, 12, 13, 16, 17, 18, and 19.

The distribution of the foregoing species is widespread.

N. B. The turtles shown are not reproduced in scal



KEY TO THE DISTRIBUTION OF THE TURTLES AND TERRAPINS

—number refers to name of species and locality where it is found.

1 Trunk-back	7 Soft Shell	14 Diamond-back
2 Kemp's Bastard	8 Snapping	15 Muhlenberg's
3 Loggerhead	9 Box	16 Sculptured
4 Green	10 Red-bellied	17 Spotted
5 Hawkbill	11 Western Painted	18 Mud Box
6 Spiny Soft-shell	12 Eastern Painted	19 Musk
	13 Map	

IN THE NORTH-EASTERN STATES

The following turtles do not occur in Maryland or Delaware:—6, 11, 13 and 15. Delaware also is lacking in number 7.

Number 11 is restricted to northern New Jersey, western Pennsylvania and western New York, while number 7 is found on the western border of Pennsylvania and New York.

Number 14 is peculiar to salt marshes and occurs in favorable parts of the coast, and northern New Jersey.

Number 15 is confined to southern Rhode Island, south-eastern New York, eastern Pennsylvania and merely serve as a key for general identification.

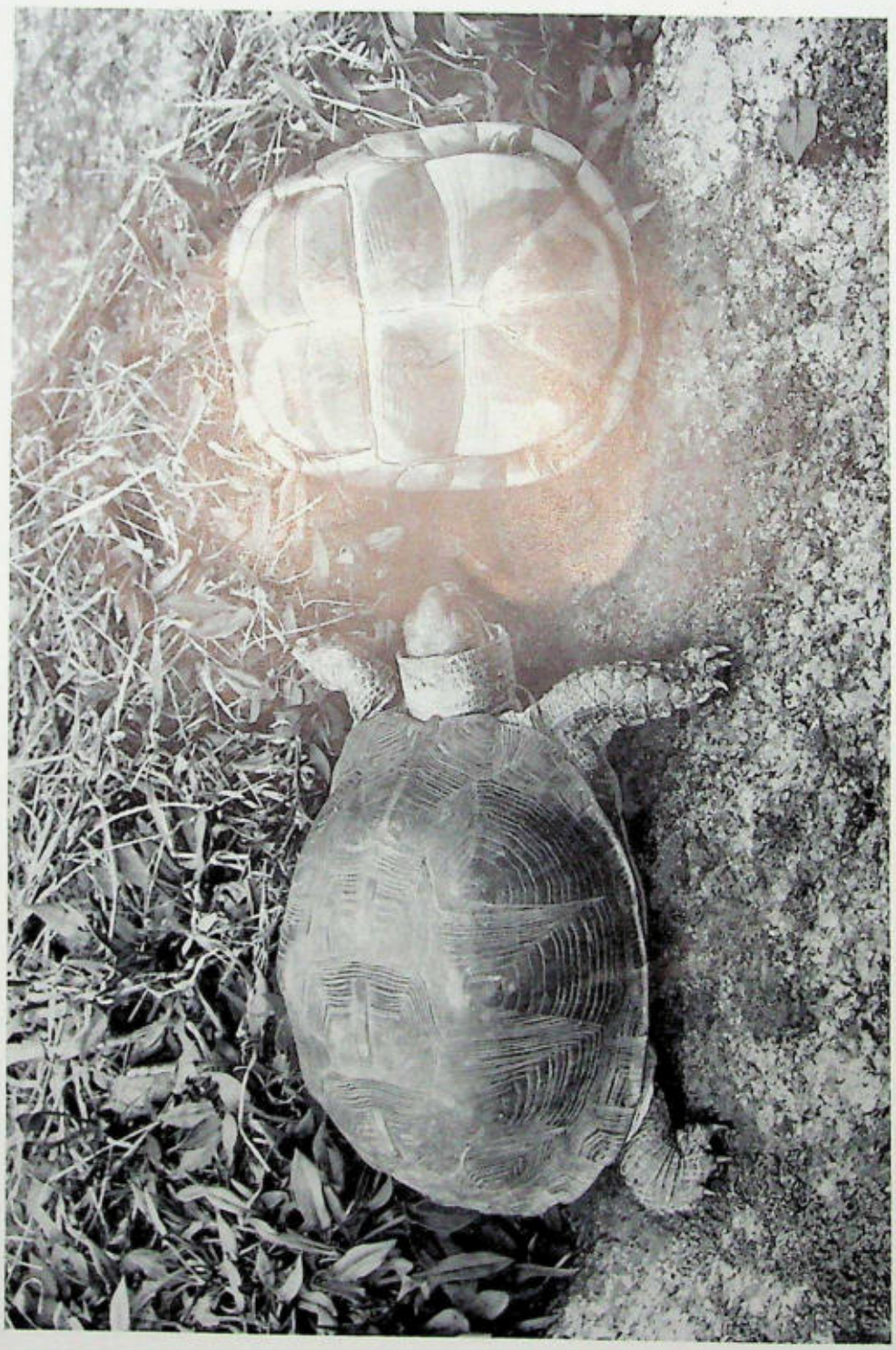


Fig. 9. Box Terrapin, *Terrapene carolina*. Tortoise-like in appearance, this attractive terrapin represents a transitional stage intermediate between terrestrial tortoises and aquatic terrapins. Along with the painted terrapin it is the commonest species of the eastern United States. Box terrapins are noted for their fearless attitude towards man and lend themselves to rapid domestication. The color pattern of the species undergoes great individual variation, ranging from bright lemon-yellow to deep orange-red.

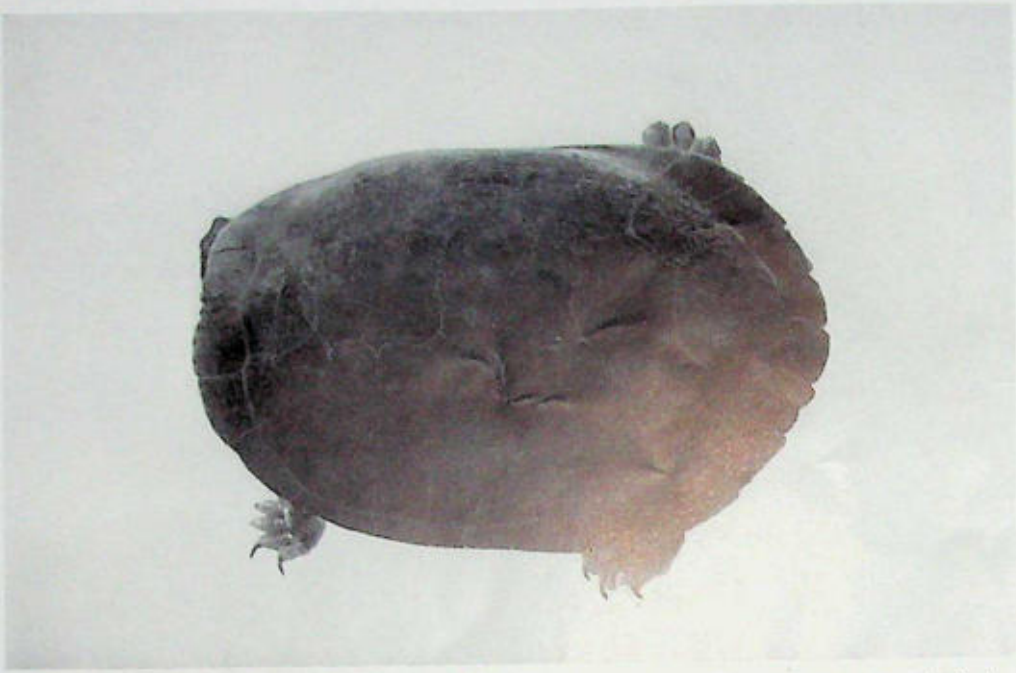


Fig. 10. Red-bellied Terrapin, *Pseudemys rubriventris*. When seen in its natural state, the red-bellied terrapin forms a most attractive spot of rapidly moving form and color amidst the green pond vegetation and clear running water. In the ponds about Plymouth, Massachusetts, it is still common and is used by the natives as an article of food.

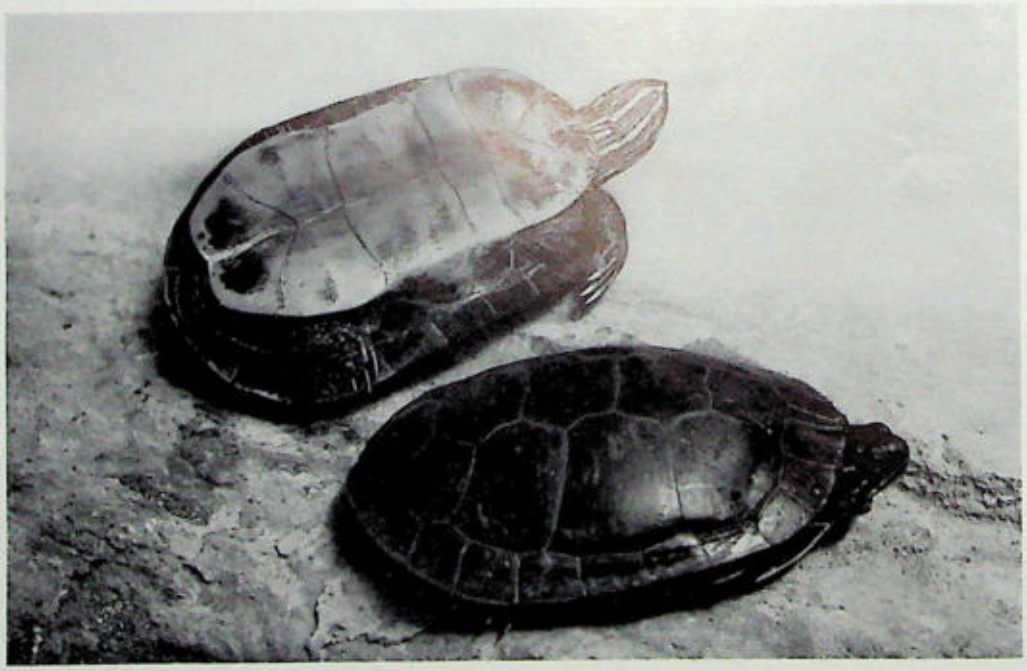


Fig. 11. Western Painted Terrapin, *Chrysemys marginata*. The palm for beauty is surely awarded to the painted terrapins. Their vividly contrasting colors set them apart from all other terrapins. The marginal shields are delicately splashed with red, while the plastron is a golden yellow, sharply defined from the deep brown olivaceous color of the carapace. In the western species the plastron is marked with a dark ovoid patch and the carapace has a pattern outline, as shown in the drawing following the key to identification. Photograph by Dr. R. L. Ditmars.

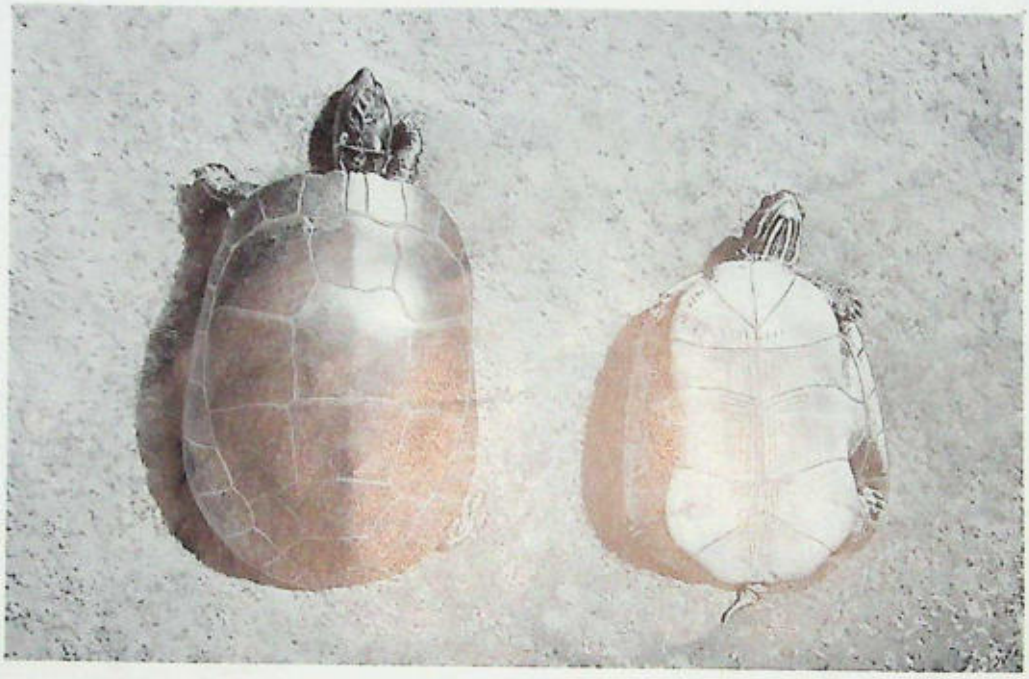


Fig. 12. Eastern Painted Terrapin, *Chrysemys picta*. A species closely allied to the form found in the westerly portions of the terrain under consideration but differentiated from it, as may be seen in the photograph, by a plastron of immaculate yellow. This painted terrapin is the species most commonly found in this locality. Specimens can be seen in almost every pond and lake of the Atlantic coastal plain and are familiar to anyone who has occasion to be in the country.

and feeding habits of the species are similar to those of the green turtle. Many observations have been made of the loggerhead as it lays its eggs along the coasts of Florida, Georgia, the Carolinas and sometimes as far north as Virginia. The loggerhead is a strong swimmer carrying its fore flippers well elevated, in a manner simulating the wings of a bird. Its flesh is often substituted for that of the green turtle. Ditmars says of its habits ashore:

> To discover one of these sea monsters on the beach is to experience a certain feeling of awe. The great, floundering brute, in the fulfillment of parental duties, is practically at man's mercy, yet clumsily alert. It suddenly exhales the breath with a deep, roaring sound, while the bleary, seal-like eyes stare in a seemingly vacant fashion. If a big conch shell is shoved within reach of the jaws, it is seized and crushed in a single grasp. Turned on its back, the giant is helpless. If not hindered it makes for the sea, causing a great commotion in reaching the water, as it flounders for sufficient depth where it may find purchase for the paddle-like fins.

The Green Turtle, *Chelonia mydas* (Linne), Fig. 4. The Green Turtle is valued for its succulent flesh, being the delight of epicures and the substance of green turtle soup and turtle steak. Specimens brought to market from West Indian and Florida waters weigh about fifty pounds and command fancy prices. The species is found in all warm seas and is carried to our coasts by the Gulf Stream, a warm body of moving water that is responsible for the occurrence of many tropical forms taken along northern shores.

Size and Color: The decimation in recent years of this species so highly prized for its flesh has resulted in a decrease of the figures given for size and weight. Six foot specimens were common in the past but today the average length is about three feet. The body is olive-brown above and mottled with yellow. The plastron is yellow.

Habits and Economic Use: During the course of the breeding season (April to June in the Bahamas) the female turtle crawls out on the sand above tide line and digs a hole about two feet deep, using her hind flippers as scoops. She lays between one hundred to two hundred eggs which are carefully arranged in the nest. She then smooths the loose sand over the hole and so skillfully levels the beach surface that no trace of the nest can be seen. The nest is

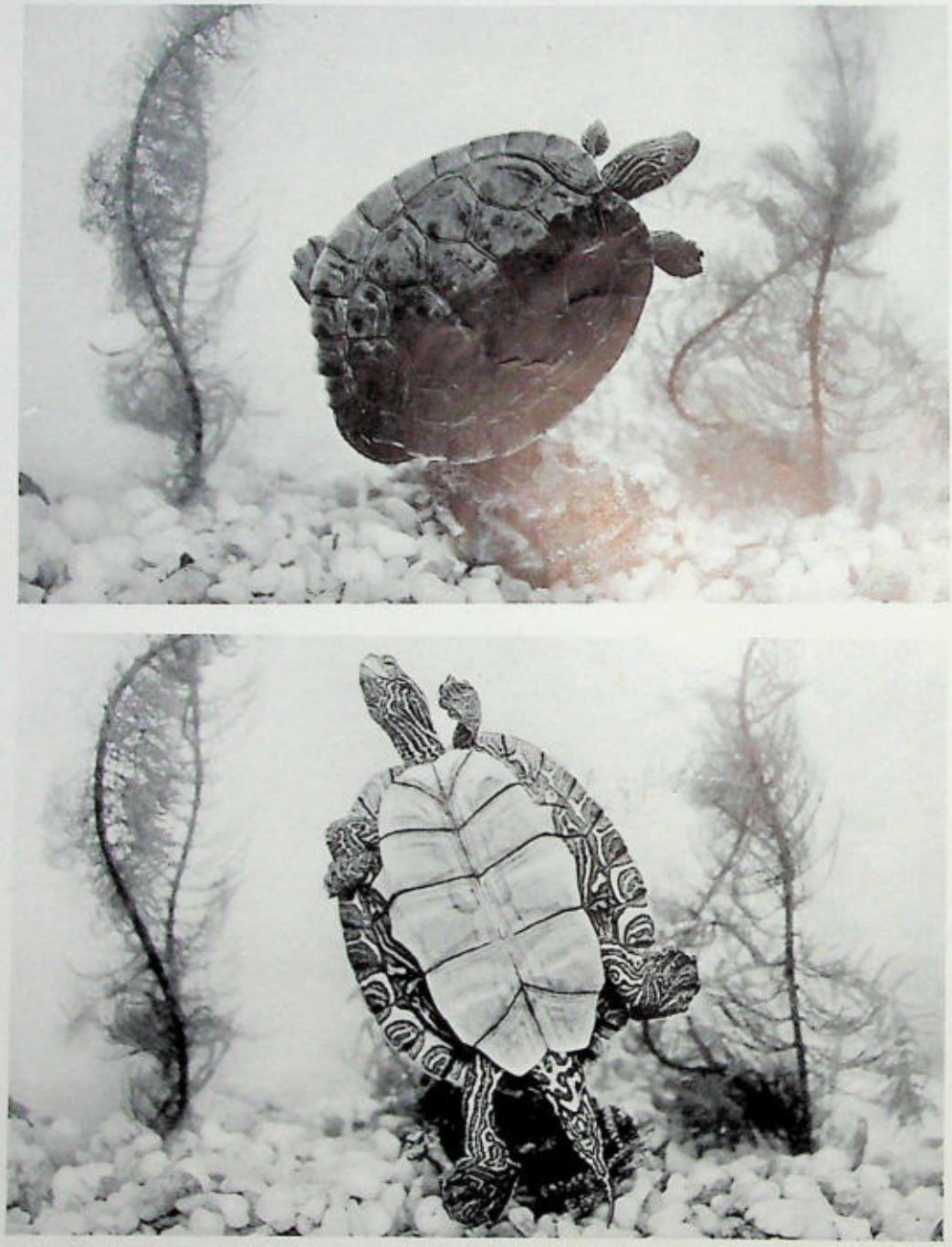


Fig. 13. Map Terrapin, *Graptemys geographica*. Evenly distributed over the entire area considered in this article, this attractively figured terrapin passes in pet shops as the "Japanese Turtle." In its natural habitat it prefers shallow soft-bottomed ponds, but if fed on raw beef (not ant eggs) and kept in a warm, moist terrarium with some water for swimming and drinking purposes, it will attain a size of half a foot or more at maturity. It seems unable, like all fresh-water terrapins, to eat unless under water. Like the red-bellied terrapin, it is edible.



Fig. 14. Diamond-back Terrapin, *Malaclemys centrata concentrica*. From an economic and a gastronomic standpoint the diamond-back terrapin is our most valuable reptile. The photograph reproduced above is an excellent study showing many salient points of interest. The photographs on the opposite page give some idea of governmental efforts in developing methods to propagate the species. Photograph made in the New York Aquarium by the late Leonard H. Spencer.

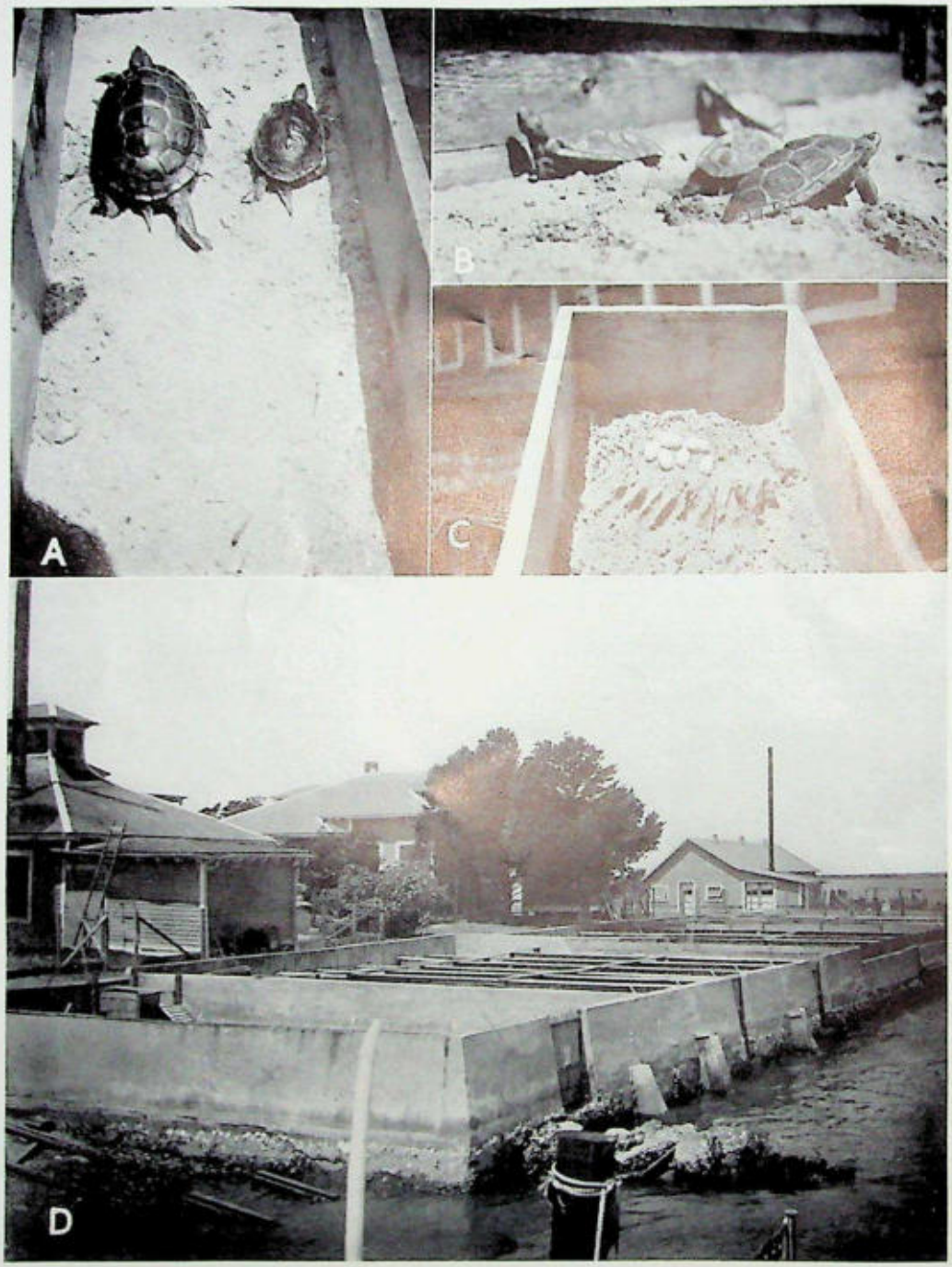


Fig. 14a. Diamond-back Terrapin, male and female. A marked difference in the size of the sexes is shown in this view. The male is much smaller than the female and consequently less valuable as food. Commercial hatcheries are acquainted with this fact and achieve good results by placing one male with every fifteen female terrapins. Fig. 14b. Diamond-back Terrapin on nest. The females shown are engaged in depositing their eggs in the loose and moist sandy beds provided for egg laying. Fig. 14c. Diamond-back Terrapin eggs. An uncovered egg clutch laid by one female terrapin at the Bureau of Fisheries hatchery. Fig. 14d. Diamond-back Terrapin pens at Beaufort, North Carolina. The terrapin pens are shown at high tide. The beds of sand are banked so as to make laying spaces as well as pools in which food is eaten and where the terrapins "crawl" for the best part of the time. The change in tide either floods part of the crawls with clean sea water or drains off the accumulated filth depending on whether the tide is high or low.



Fig. 15. Muhlenberg's Terrapin, *Clemmys muhlenbergi*. A rare and exotically marked wood terrapin peculiar to sphagnum swamps of southeastern New York, northern New Jersey and eastern Pennsylvania. A few specimens have been reported from Rhode Island. Land reclamation has laid toll to these creatures as in the case of the diamond-back. The brightly colored orange patches on the side of the neck at once distinguish this species from all others. Photograph made in the New York Aquarium by the late Leonard B. Spencer.

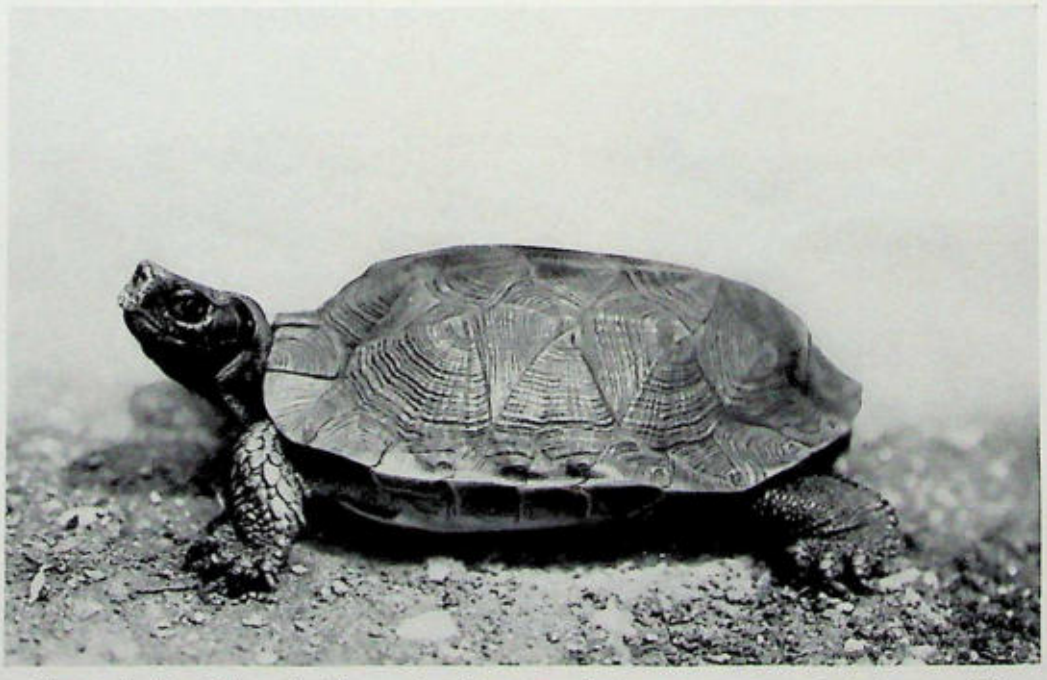


Fig. 16. Sculptured Terrapin, *Clemmys insculpta*. An upland wood terrapin noted for its remarkable tameness as well as its edible qualities. State legislation in New York and New Jersey protect the species from molestation and help to insure its existence. Experiments in turtle trailing at the Wyanokie Zoological Station of the New York Zoological Society tend to demonstrate its well-developed sense of direction.



This intimate photographic study depicts the remarkable tameness of the sculptured terrapin. Head Keeper Toomey's daughter is shown feeding a banana to her pet.

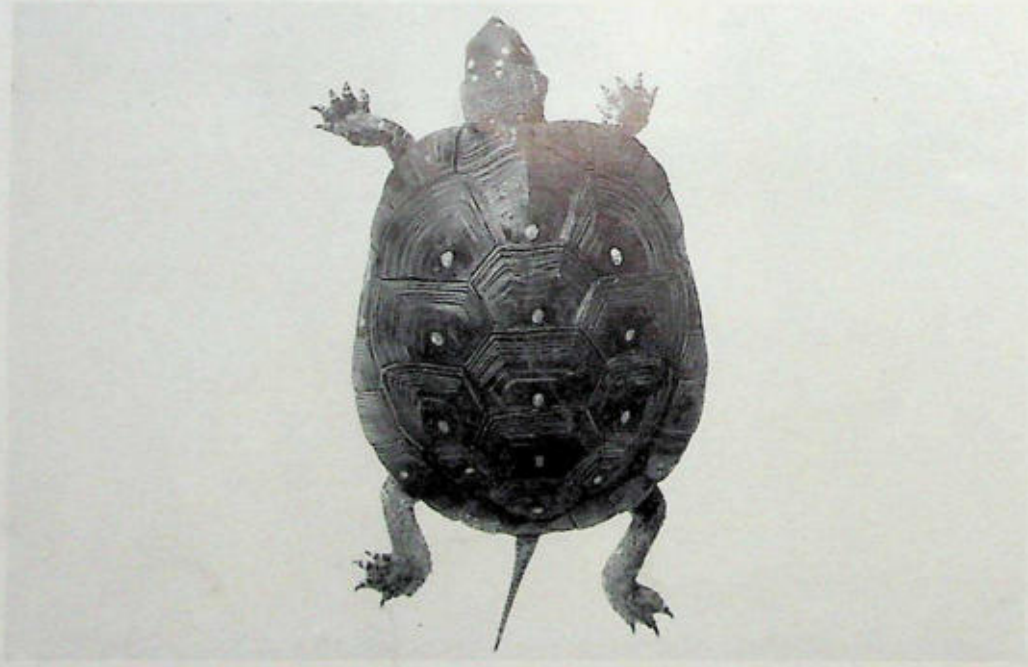


Fig. 17. Spotted Terrapin, *Clemmys guttata*. Closely allied to the Muhlenberg and sculptured wood terrapins this species exhibits no special characteristics. The bright yellow spots appearing on each black dorsal shield render it both conspicuous and pleasing to the eye of the observer. It feeds on frogs, toads, insects and dead fish. The wood terrapins are less aquatic in habit than the slider forms: painted, red-bellied and map terrapins indicating a semi-aquatic mode of life.

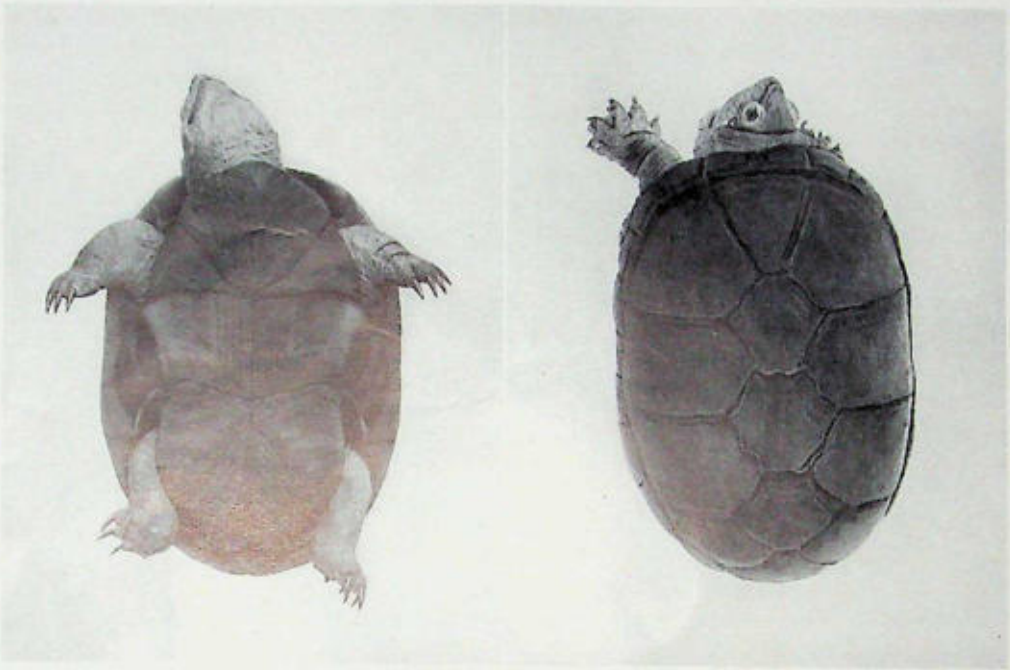


Fig. 18. Mud Box Terrapin, *Kinosternon subrubrum*. Well shielded above and double-hinged below, this mud terrapin is further protected by the possession of musk glands that exude a strong fetid odor when the animal is handled or pursued. The species is notable among reptiles in that the males have a sound-producing mechanism which they use to attract females during the mating season. By means of horny scales on the hinder limbs, stridulating sounds like the chirp of crickets are produced.

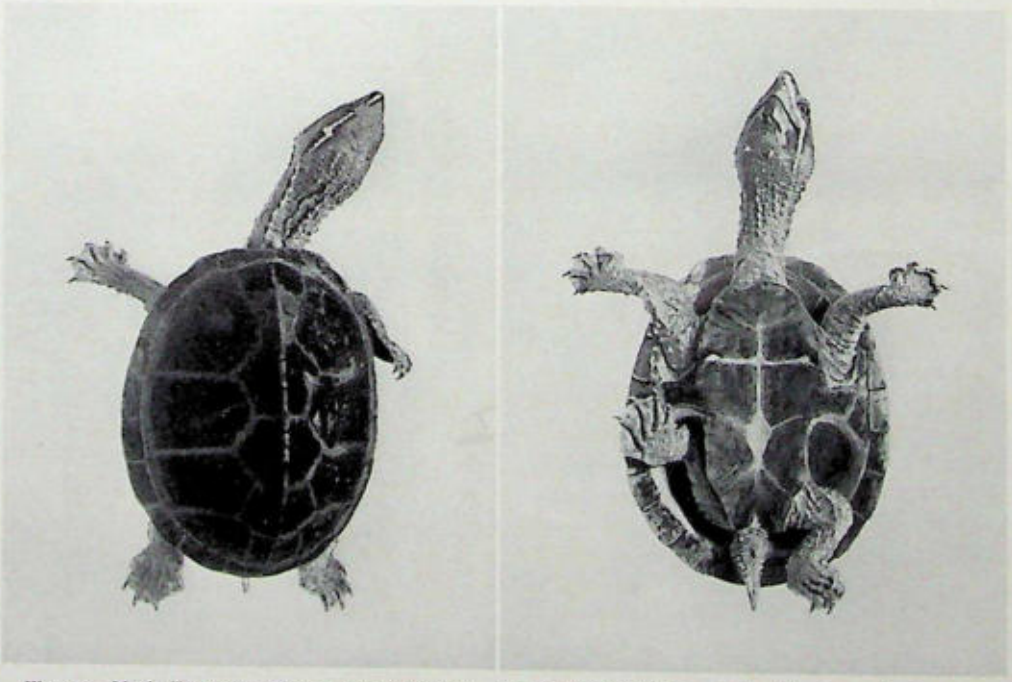


Fig. 19. Musk Terrapin, *Kinosternon odoratum*. As in the preceding species this terrapin is armed with a defense mechanism in the form of scent glands. It has been suggested that this odor may be used at the pairing season in much the same manner as crocodilians, who leave a scented wake through the water in order to attract members of the opposite sex. The musk terrapin is choleric of disposition and resembles the snapper in its manner of darting out an angry pair of snapping jaws in the direction of its captor. It inhabits the bottoms of muddy ponds and swamps.

not revisited, the eggs being incubated by the sun's warm rays. The young turtles have an egg tooth, a hook-like protuberance on their upper beak which enables them to break through the shell; and then digging their way out of the sand, they make for the water. However, sea birds are on the alert for these delicate morsels and only about thirty per cent of the turtles hatched have a chance to reach maturity. Fishermen prey upon the nests and remove the eggs which are sold for attractive figures, two dollars a pound being the current price at Key West, Florida. In the Pacific, off the coast of Panama, I have observed great numbers of these turtles feeding on patches of sea-weed. Marine plants such as turtle-grass (*Zostera marina*) and small crustaceans form the principal diet. The meat is prized the world over and a fine cosmetic oil is produced from the eggs.

The Hawkbill Turtle, *Eretmochelys imbricata* (Linne), Fig. 5. The hawkbill turtle is the species that yields the valuable tortoise shell of commerce. This turtle has been pursued for hundreds of years and today it is a rare species with the price of articles made from the horny plates of its shell ranging from twenty-five to twenty-five hundred dollars. Craftsmen from before the time of Cellini to the present day have utilized this shell to produce articles ranging in size from the bath tub of the Emperor Nero to the expensive little cigarette case so valued by this generation.

Size and Color: Seldom over two feet in length. Body brown mottled with yellow above, and with clear yellow beneath.

Habits and Economic Use: Its feeding and breeding habits are similar to the green and loggerhead turtles. It is rare along our coasts, occurring only in mid-summer. The turtle is chiefly sought for the plates of the carapace, called "tortoise shell," which is much thicker, stronger, and deeply clouded with richer colors than those of any other species. On the south coast of Cuba I have observed fishermen catching these turtles with the remora or sucking-fish (*Echeneis naucrates*) to the tails of which they attach a line; the fish are thrown in the direction of the basking turtle, and seize on to its shell with their sucking-disc. The fishermen then pull up their turtle capture. The turtles are killed and left to rot on the open beach. When decomposition has set in sufficiently to loosen the epidermal plates, these are removed and immersed in vats of boiling water. This softens the shell and renders it workable. It is then cleaned and placed into steam molds which shape it into commercial forms. In the East Indies the cruel practice of immersing the live turtles in vats of boiling water or holding them over slow fires until their plates are loosened is frequently recorded. The meat is of no value, having a disagreeable taste and odor.

The Spiny Soft-shell Terrapin, *Amyda spinifer* (Le Sueur), Fig. 6. This fresh-water terrapin occurring along the shores of Lake Champlain and southward except in Delaware; with its related species, the soft-shell terrapin, *A. mutica,* is distinct from all chelonians in that its powerful jaws are covered with fleshy lips instead of the usual horny-sheath. A leathery skin covers the shell, no horny plates being present. The species is fairly common although its flesh has a market value. It has a fierce disposition and feeds in much the same manner as the snapping terrapin. The soft-shelled terrapin can remain under water for several hours as they have true aquatic respiration, taking water into their mouths and expelling it about fourteen times a minute.

Size, Color and Sex: Carapace fourteen inches long. Female wider than male in front on forward edge of carapace with the spiny tubercles larger than those found on male. The plastron is clear white. The tubercles distinguish it from the soft-shell terrapin, *A. mutica.*

The Soft-shell Terrapin, *Amyda mutica* (Le Sueur), Fig. 7. A species closely resembling the spiny soft-shell terrapin in habits and appearance. It occurs in the western part of Pennsylvania along Lake Erie and may possibly be found near Niagara Falls, New York. It is not as common as the foregoing species and less definite information is known about its habitat.

Size, Color and Sex: Carapace six and one-half inches long, the comparative width of the anterior portion determines sex as in *A. spinifer,* the spiny soft-shell terrapin. The carapace is a uniform dull brown and is sometimes blotched. The carapace of the former species has many round dark spots margined with black, while this species is only found spotted in very young specimens. Locality alone should serve to distinguish the species from each other and

the presence of tubercles indicates the spiny soft-shell invariably.

The Snapping Terrapin, *Chelydra serpentina* (Linne), Fig. 8. With the exception of the sea turtles the snapping terrapin is one of the largest species in the United States.* It is evenly distributed over the entire region of eleven states and is considered a pest for it lives on fish, water-fowl, and small mammals thus becoming fair prey of keepers and wardens of game preserves and wild life reservations. It is ferocious in its way of securing food and voracious in its appetite.

Size and Color: Over two feet long from the tip of its dangerous head to the end of its thick, horny tail. The carapace measures a foot and a half. Specimens of this size weigh thirty pounds or more. Body color black with greyish mottled skin parts.

Habits and Economic Use: Usually found in shallow ponds or along banks of small streams and rivers resting on the bottom and carefully eyeing the surrounding locality. When a waterbird or fish passes near it will shoot its head up with lightning-like rapidity, seizing the creature in its heavy jaws and dragging it to the bottom. Here a few well inflicted bites finish off the coveted prey and then it begins to tear apart the carcass, devouring it in a short time. Medium sized specimens are capable of severely injuring a man's hand and great care must be exercised in handling the terrapin. Grab it by the horny tail and hold it extended at arms length, lest it reach out with its long retractile neck and seize part of the body or clothing of its captor. The meat is sold and furnishes the famous Philadelphia snapper soup. Some old hostelries of that city still raise the turtle flag with the snapper shown against a white background, when terrapin is being served. This custom dates back to the early years of our country.

The Box Terrapin, *Terrapene carolina* (Linne), Fig. 9. This species, sometimes called the Box Tortoise, exhibits considerable individual variation in shape and color and is common throughout the Eastern states. It prefers the seclusion of open wooded country near small streams but, in its desire to get to better food territory or to find a mate, it also frequents roads and is often run down by careless motorists.

The box terrapin appears to represent a transitional state between terrapins and tortoises. The high-domed shell suggests a tortoise and this thought is reinforced by the club shaped or elephantine limbs that are peculiar to tortoises. On the other hand it is often found in the water and, unlike true tortoises, is a good swimmer, observations having been recorded of its swimming streams. The digits have a small web and tend to spread apart as in terrapins; in tortoises the digits are bound closely together.

Size, Color and Sex: Full grown specimens measure up to seven inches along the middle line of the plastron and for this size are usually about four inches wide. Their colors are made up of a lemon-yellow or orange background splashed with black markings on each shield of their shell. The skin is an orange or yellow hue, this hue corresponding to the color of their shell. Many males have bright red eyes; females sometimes have reddish eyes but these are invariably mottled with black or brown shades. Sex is primarily determined by the rather hollow or concave plastron of the males which differs from the flat, plane-surfaced plastron of the female.

Habits: Often found nibbling the edges of umbrella-like mushrooms and sometimes eating slugs and dead fish that have been washed up on the bank of a stream. This terrapin is prized as a household pet and with some patience will respond to anyone who fancies it for domestic purposes. It is quite tame and has never been known to bite. A bowl of water, some lettuce leaves or raw vegetables daily, bits of fresh raw meat twice a week, and the turtle is quite at home. In captivity it seeks cool dark corners in summer and warm radiators in winter. Its movements are usually restricted to regular trips in search of its food. I have kept several specimens alive in my apartment for periods of two and three years during which time they exhibited every sign of good health.

Red-bellied Terrapin, *Pseudemys rubriventris* (Le Conte), Fig. 10. Next to the snapping terrapin this is the largest terrapin found from Cape Cod to Cape Henry. In New England this aquatic species is restricted to ponds near

* A larger species occurs in the southerly states. This is the alligator snapper, *Macrochelys lacertina*, attaining a weight of 125 lbs.

Plymouth, Massachussetts, living in fairly deep water and exhibiting strong swimming powers.

Size, Color and Sex: Carapace twelve inches long by seven inches wide. Carapace brownish, streaked or blotched with red. The red plastron and flesh parts accounts for its specific name, *rubriventris*. Sex is readily determined by the long thin nails on the fore feet of males and the short stubby nails of the females; other dimorphic factors are present but to a lesser extent.

Habits and Economic Use: The species is shy and very active when escaping or disturbed. Hibernation lasts from October to early April in Massachusetts. Food consists of snails, tadpoles, crayfish and water plants. The eggs are laid in June in clutches about five inches wide which are excavated by the tail. A separate hole is made for each egg and then the whole clutch is covered and smoothed over so as to safeguard the eggs from crows and muskrats. This species, often called Slider ranks second to the diamond-back in food flavor.

Western Painted Terrapin, *Chrysemys marginata* (Agassiz), Fig. 11. This species is like the Eastern painted terrapin in habits, but is not as widely distributed being found in the western part of Pennsylvania and New York and a straggler into northern New Jersey where it was found at the Wyanokie Zoological Station (Haskell, N. J.) in the summer of 1928.

Size, Color and Sex: Size same as the species that follows, the eastern painted terrapin. Colors same but for plastron which has a large blackish oval patch extending from the humeral to the femoral shields and occasionally encroaching on the gular and anal shields. Sex determined as in the eastern species, *C. picta*.

Eastern Painted Terrapin, *Chrysemys picta* (Schneider), Fig. 12. This pond terrapin is a familiar form to every boy and girl who plays near ponds or goes wading in brooks. The creature is always on the alert and slides from its bank or log the moment anything disturbs the peaceful quiet of the locality. This habit of sliding off into the water has undoubtedly given rise to the popular name Slider applied to all pond terrapins. Its occurrence is very common.

Size, Color and Sex: Carapace five inches long by three and three-fourths inches wide. Black or deep olive above, each plate margined with yellow and throat striped with yellow. The plastron is an immaculate lemon-yellow. The marginal plates are "painted" with a brilliant red; hence the name painted terrapin. The vertebral plates are nearly in the same line as the costals; in the western painted terrapin these plates alternate. Sex is determined as in the red-bellied terrapin.

Map Terrapin, *Graptemys geographica* (Le Sueur), Fig. 13. The map terrapin is found along the shores of Lake Champlain, in New York and Pennsylvania rivers having their outlet in Lake Erie and was probably introduced in Bayside, New Jersey.

Size, Color and Sex: In large specimens the carapace measures nine and one-half inches. The color arrangement has given rise to its popular name, Map Terrapin. Carapace olive or brown, covered with thin reticulate green or yellow lines. The plastron is a pinkish-yellow in newly captured specimens. Sex again is determined as in the red-bellied terrapins.

Habits and Economic Use: Food is swallowed under water, consisting of mollusks and crayfish. The shape of the notched beaks adapts the terrapin for this type of hard shelled food. Like the red-bellied terrapin, it is used as a food substitute for the diamond-back, being less expensive as it is more abundant than other edible species.

Diamond-back Terrapin, *Malaclemys centrata concentrica* (Latreille), Fig. 14. The diamond-back species of this article ranges from Buzzards Bay in Massachussetts to Chesapeake Bay in Maryland. These terrapins inhabit the salt and brackish coastal marshes and were once very abundant. However, as its flesh is regarded as one of the greatest treats known to gourmands, the demand for them has resulted in overfishing and a marked decrease in their numbers has resulted. In 1923 the price for terrapins having a six inch plastron (average size) was $35.00 per dozen, while larger specimens commanded higher prices. This condition led the state of North Carolina to prohibit the taking of diamond-backs for a five-year period and the state in cooperation with the Bureau of Fisheries began experiments in an effort to save the species from extinction. At Beaufort, N. C., such work is carried on and the accompanying photographs taken by Mr. Pinney Schiffer, tell the story of terrapin culture. The species is still very rare and every

effort must be made to foster measures to rehabilitate a terrapin so useful in man's larder. Circular No. 60 of the Bureau of Fisheries Dept. of Commerce, should interest all persons desiring to learn more about the diamond-back.

Size, Color and Sex: Plastron six to seven inches long. Shell rough with each plate showing deep concentric growth rings. Carapace dark-olive or greyish; plastron yellow. For sex factors see photographs facing Fig. 14.

Muhlenberg's Terrapin, *Clemmys muhlenbergi* (Schoepff), Fig. 15. This attractive terrapin is found near peat and sphagnum marshes. The gradual reclamation of these areas will doubtless result in the disappearance of the species for it does not seem to thrive when this ecological environment is changed. In New England it is found in one corner of Rhode Island and when it occurs in other states it only does so in widely separated localities. These gaps in distribution are accounted for by the isolated and widely scattered location of sphagnaceous swamps over the mass of the terrain. Its related forms, all members of the genus *Clemmys*, are usually found in the same places, although these species (the spotted and sculptured terrapins) appear in many states and under conditions adverse to Muhlenberg's terrapin. In habits the group is a semi-aquatic one, their food embracing a variety of the smaller floral and faunal representatives. They are all harmless and seem to do well in captivity.

Size, Color and Sex: Specimens collected at the Wyanokie Zoological Station measured three and one-half inches along the carapace. The body is a uniform dark brown having a bright red or orange spot on the hinder portion of each side of the head. This marking identifies the terrapin at a moment's glance. Concavity of the plastron, longer nails, and heavier tails set the males apart from members of the opposite sex. Females exhibit a plane plastron, short nails and short tails thickened at their bases. These factors apply to the other wood terrapins, the spotted and the sculptured terrapins.

Sculptured Terrapin, *Clemmys insculpta* (Le Conte), Fig. 16. The deeply chiseled markings on the shell of the species serve as a guide in rendering the popular name in harmony with the specific one (*insculpta*). The terrapin is eaten in many country places, the strawberry colored legs supplying the meat for a delicate preparation called "country turtle." As in most terrapins, with the exception of the Box, mating takes place in or close to water; occurring in the spring with hibernation lasting from late fall through the long winter and into late April when the fertilized eggs are laid. The eggs hatch out during the same summer. It is an established fact that a female will return to the same nesting grounds year after year and will only seek another when local conditions make egg deposition absolutely impossible.

Size, Color and Sex: A large species having over a seven inch length of carapace. The shell is a light brown, while the plastron beneath is blotched with black on every shield. The limbs and flesh parts are a bright orange while the head retains the general body color or is black on top and brown beneath. Sex as in Muhlenberg's terrapin.

Spotted Terrapin, *C. guttata* (Schneider), Fig. 17. This common species exhibits two distinct phases in the form of its shell as it is found in both fresh and brackish water; the former habitat producing a smooth black shell while the latter results in a sculptured and rusty looking shell. The terrapin resembles the two former species in respect to locality and habits and is intermediate in size and form to the large sculptured terrapin and the small Muhlenberg terrapin.

Size, Color and Sex: Carapace four and one-fourth inches in length. Females smaller in size than the males with tails only half as long. The females, like the males, are covered with little yellow dots on each shield but have about 15% more of these dots and perhaps this renders them conspicuous in the pairing season. Other sex factors apply as in the examples given for the two foregoing wood terrapin.

Mud Box Terrapin, *Kinosternon subrubrum* (Lacepede), Fig. 18. As seen from the generic name (*Kinosternon*) the species is related to the musk terrapin. (See account on musk terrapin). It has the same vicious habits and emits the same musky odor when handled and at mating. Its plastron, like that of the box terrapin, is hinged and when closed can cover all the fleshy parts.

Size and Color: Carapace three and one-half inches long by two and one-fourth inches wide;

plastron three inches long by one and three-fourth inches wide; color dark brown with the same modifications as the musk terrapin. The plastron shows lines of annual growth as in many other terrapin. From the center of the original shield, one growth ring is added every year and by counting the rings on several shields and taking an average a figure will appear that may be used to indicate the age of a specimen. In old individuals these rings are often eradicated by wear.

Musk Terrapin, *Kinosternon odoratum* (Latreille), Fig. 19. The species inhabits small, sluggish streams and ponds. Like its related form, the mud-box terrapin, it emits a disagreeable musky odor from scent glands having their openings under the fore limbs. This heavy and somewhat fetid scent serves to attract prospective mates and to repel other animals.

Size and Color: The carapace averages three and one-half inches long by two and one-fourth inches wide; dark brown, striped or blotched with a deeper color but it is oftentimes covered with a fine green pond slime that renders these colors inconspicuous.

Habits: In disposition its ferocity and ill temper resemble that of the snapping terrapin. This unpleasant creature feeds entirely on animal food, stomach contents revealing fish, crayfish, slugs, worms and insects to be its diet. Care should be exercised in handling specimens lest nasty bites be inflicted. The musk has never been utilized by perfumers, possibly being of an inferior quality.

Author's Note: Mr. E. R. Sanborn's photographs and suggestions have greatly contributed to this issue, as well as the critical help of Mr. J. T. Nichols and Dr. R. L. Ditmars.

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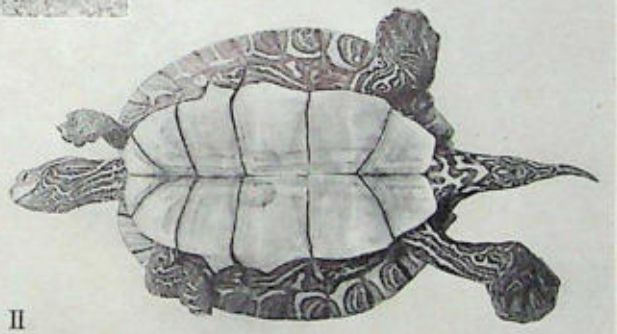
Regional Adaptive Radiation

Turtles so differ in structure and habits as to prevent competition. Radiating from their original home—the land,—to ponds, swamps, rivers and the sea; these four typical turtles have filled all available habitats of this region. Radial adaptation to regional environment is the factor of natural selection which has made for their survival.

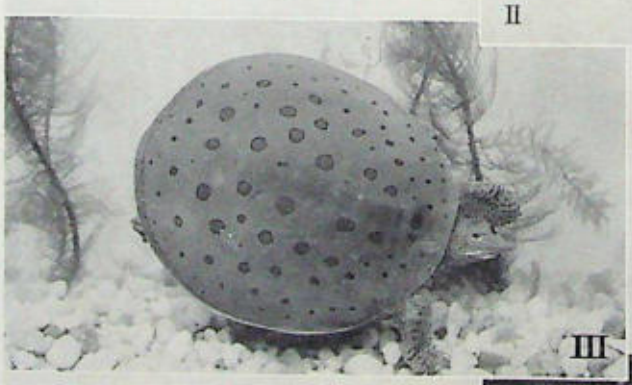


I—The highland-living Box Terrapin exhibits the ambulatory or terrestrial type of limb adaptation; with typical tortoise characteristics: a high and dome like shell, club shaped limbs with stubby nails and a very short tail. The creature's habitat is usually high and dry land, which is said to be the original habitat of turtles.

II—The pond-living Map Terrapin indicates an important transitional stage from terrestrial to amphibious life with a corresponding limb adaptation showing typical terrapin characteristics: a depressed arched shell, webbing between the slender nails of the flat feet and a long tail which is useful as a rudder in swimming. The habitat is restricted to ponds and lakes.



II



III—The river and swamp-living Spiny Soft-shell Terrapin shows the extreme of transition to aquatic life in that its limb adaptations are of the natatorial type while the completely flattened body, covered with a leathery skin and containing few bony structures, indicates high evolutionary development. The feet are completely webbed and palmate in shape.

IV—The marine-living Kemp's Turtle represents the ultimate in adaptation to environment. The fore limbs are fused into powerful swimming organs: paddle-like flippers; the body is beautifully stream-lined and so presents a minimum of resistance to the surrounding media (the water); while the hinder limbs, also paddle shaped, serve admirably as steering rudders during swimming.



IV

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Shark and Shark-Sucker.....*Photograph by Elwin R. Sanborn* *Cover*

BULLETIN

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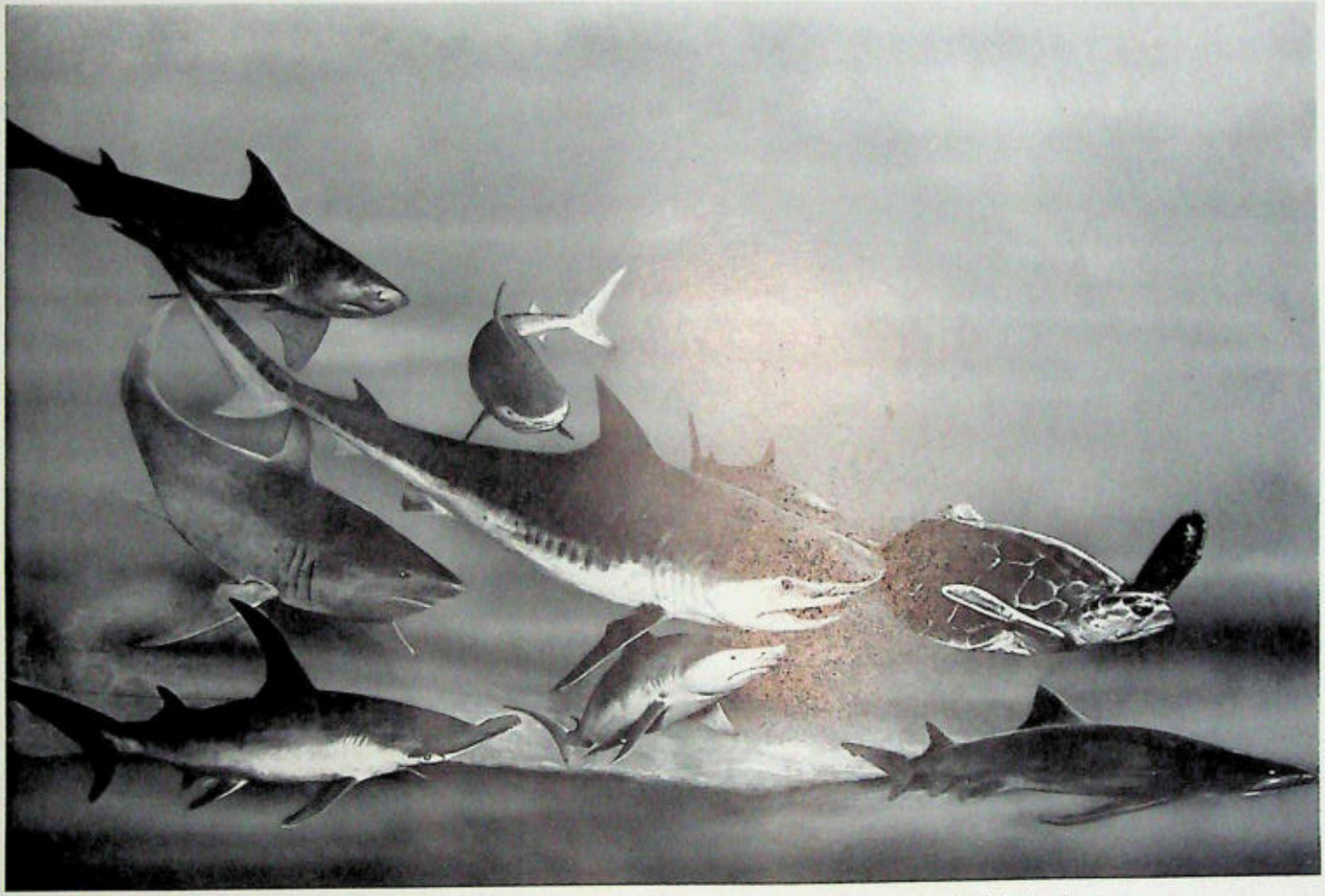
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A school of sharks, led by a twelve-foot tiger shark, attacking a sea turtle. On the left is a large hammerhead shark, and in the background a huge man-eater. Sketch from the group in the American Museum by F. L. Jaques.

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Concerning the Shark

CHARLES HASKINS TOWNSEND

Illustrations made from photographs taken in the New York Aquarium and various other sources as noted under the cuts.

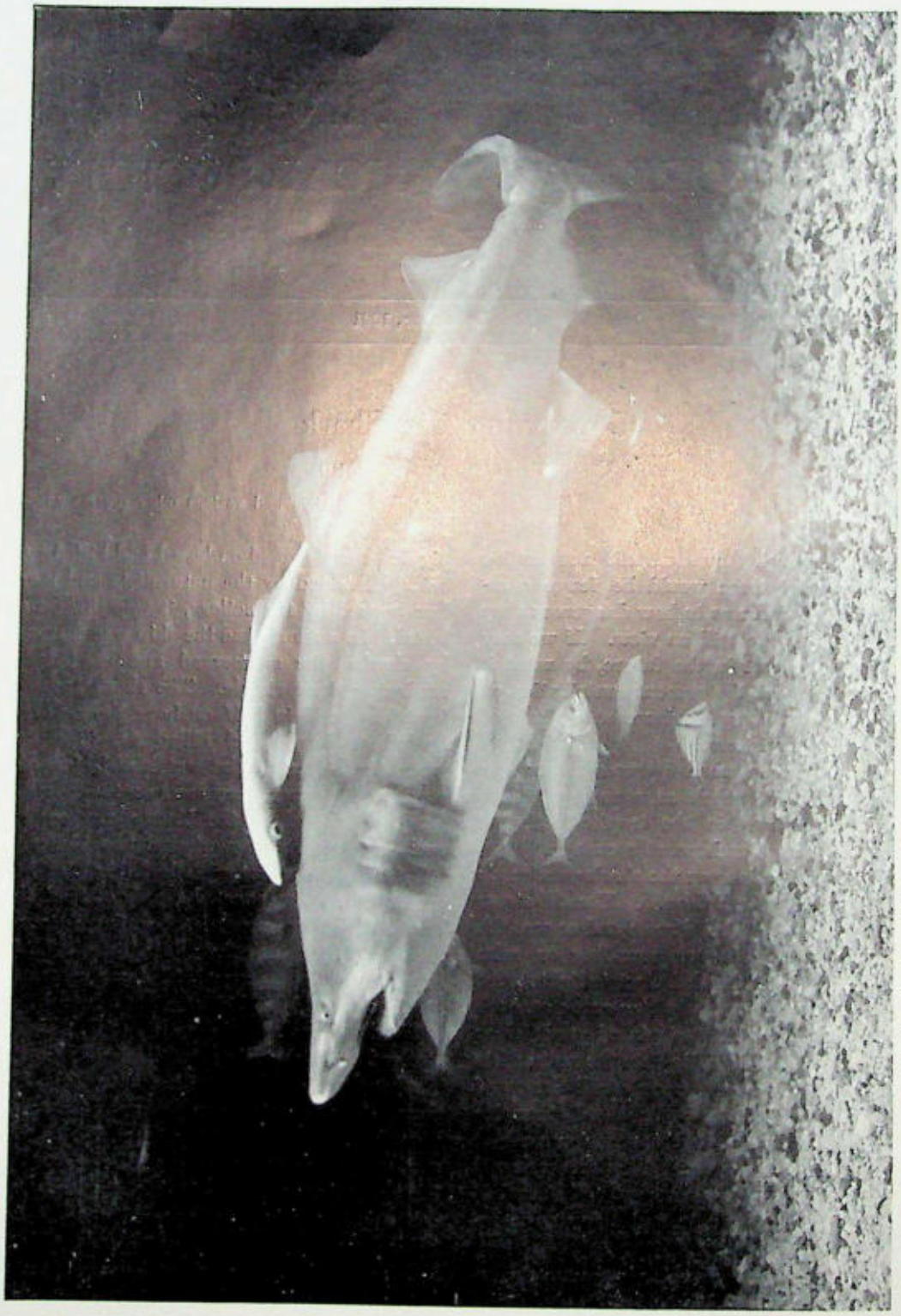
IF the New York Aquarium did not exhibit living sharks, there would be fewer questions for us to answer as to how dangerous they are. The sharks are still on view. If we may judge public interest in the future, by what it has been in the past, the present contribution on the subject should serve to increase the sale of the BULLETIN to visitors.

There was a time when I was more or less skeptical about the shark as a man-eater but after several cruises in the tropics with the *Albatross* my views underwent a change.

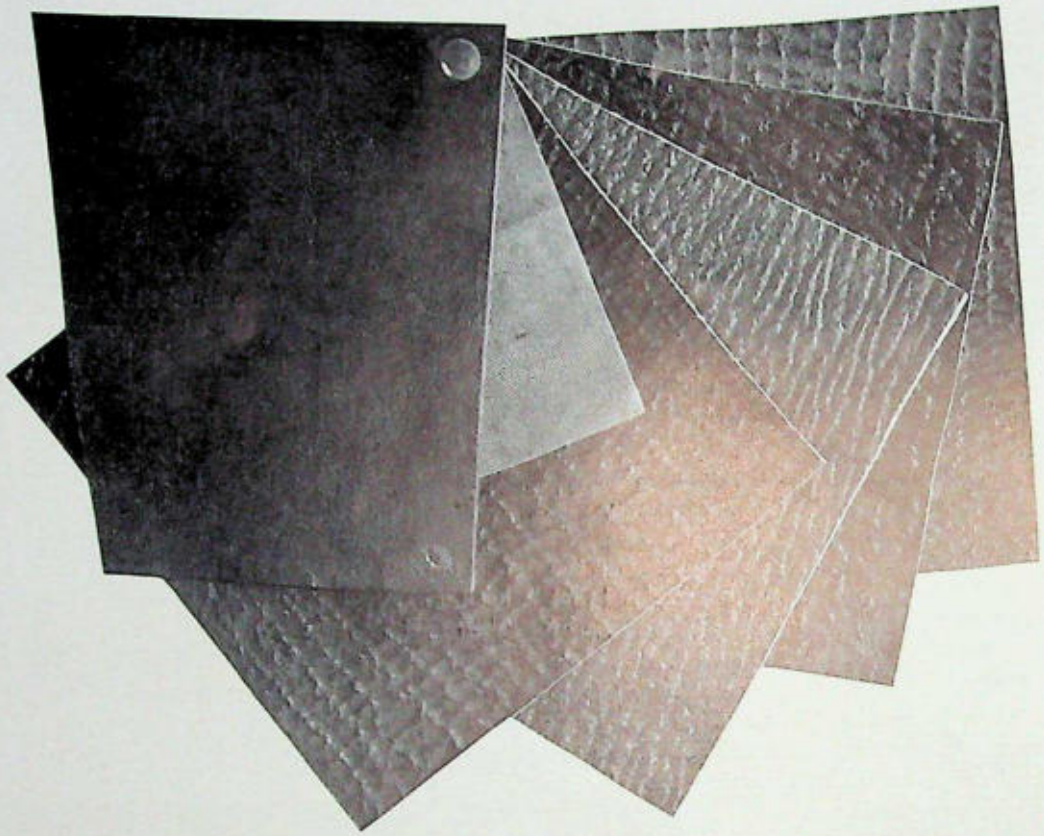
Our first observations on the shark were made one dark night off the Bahamas. The *Albatross* was sounding in the Gulf Stream and as was the custom when the ship was sounding on calm nights, insulated and hooded electric lights were suspended a foot or more in the water on each side of the vessel and a couple of yards clear of the side. With gauze dip-nets the naturalists on board could pick up many small forms of surface life attracted by the light and otherwise not readily obtainable. On this occasion a school of young flying fish, dazzled by the unusual illumination, remained near enough to be reached with the long-handled nets and many were secured.

Someone having observed a shark, the sailors put over a heavy shark hook with chain and stout line attached, and in a few minutes the big fish was dragged on board and killed. After being examined by the naturalists and more or less hacked by the sailors, it was thrown overboard. In a short time the ship was surrounded by sharks, the submerged and shaded lights rendering them visible. The shark tackle was kept busy and in half an hour the sailors had hauled on board and killed nearly a dozen, when the officer of the watch objected on account of the sanguinary mess on the deck. The sharks attracted by the bloody carcases gradually being thrown overboard provided an exhibition of how hungry sharks behave in the presence of an unexpected supply of food. Someone said to Lieutenant Benson (now Rear Admiral): "The water's fine; let's jump in." "Jump in yourself," he snapped, "I don't want a bath at present."

Sharks were usually around when the ship stopped for sounding or dredging in calm weather day or night and the sailors often caught them. They must be rather evenly distributed over the watery wastes for they soon appear in any warm sea when a vessel stops. At first there is a lone shark swinging carelessly about the ship, evincing no special interest in it. Other stragglers appear each taking his own leisurely course. The size of the company depends chiefly upon the duration of the ship's stay but it may be affected considerably by



Shark, with his satellites—shark-sucker and pilot-fish. The other fishes shown in the photograph do not seek the shark's company. Photograph by Elwin R. Sanborn.



Samples of shark leather. Black, brown and tan—smooth and shrunken.

what the cook's mate has been throwing into the galley chute. The killing of one of the sharks is usually followed by a rapid increase in numbers, provided the evidences of its violent death have been washed off the deck into the sea.

It is likely that sharks can detect the beat of a steamer's screw at great distances but they gather as readily about a becalmed sailing vessel. The explanation probably is that the wandering selachians discover the more or less oily wake of the ship and follow it. We cut open the sharks killed from time to time to ascertain the nature of their food but discovered little more than such kitchen wastes as had been thrown overboard. There is little in the way of galley refuse that sharks will not pick up. We found by dissection that they swallowed things indiscriminately; there were ham bones, mouldy bread, decayed oranges, greasy rags, oily cotton waste from the engine room, empty sardine tins, and parts of other sharks killed by the sailors. When sharks have been excited by a few mouthfuls of food, they will seize almost anything. A fourteen-foot shark in captivity at Honolulu, after being fed a large piece of meat, seized a box a foot square and crushed it. The stomach of another large shark taken at Honolulu contained a horse's leg with hoof and shoe, a gunny-sack, a tin can six inches square, one squid, a peck of turtle shell and various small articles. It is evident that some of the stuff so cheerfully swallowed is indigestible.

When our deep-sea explorations had carried us among the islands of Eastern Polynesia we caught many kinds of sharks large and small. The sailors were always ready to amuse themselves by dragging them on board for our examination. As we became acquainted with the island traders and natives we learned that they regarded sharks as dangerous under certain conditions and were accordingly circumspect in dealing with them. After a couple of winters'



Shark fishing station at Djibouti, French Somali.
Photograph from Capt. W. E. Young.

work in tropical waters we came to realize the great abundance and ferocity of sharks and that danger from them was not confined to those of large size. Each group of islands had its tale of injuries or fatalities to human beings from small or large sharks. A shark not so large as a man can easily mutilate and pull down the helpless swimmer without having the size to carry him away bodily.

The Polynesian has the same regard for the shark's prowess that the African has for the lion and like the latter, does not fear to hunt and kill him when the conditions are favorable. The shark however, takes no such toll of human life as he cannot stalk his prey on land. The Polynesian is amphibious and in some parts of the South Seas will plunge down after a lone shark and kill it with a knife, but this exploit is not attempted with all kinds of sharks, nor indeed, by many natives.

The attitude of the native toward the shark is different in the daytime from what it is at night; the shark has the advantage in the dark and is more aggressive. In some parts of the South Pacific where sharks are numerous, they are persistent in following boats and canoes at night, nipping at the oars and paddles and not infrequently at the light outriggers of the native canoes. Large sharks are especially dangerous at night and frequently tear heavy oars away from the hands of the rowers. There are many authentic cases in which they have seized the floating outriggers—used on all South Sea canoes and capsized them with fatal results to the occupants. A tragedy of the Ellice Islands was related to us at widely separated points in Polynesia. About forty natives, crossing in canoes at night between islands several miles apart, were caught in a squall. One of the canoes was swamped and the occupants were seized by sharks which had been following the fleet of boats and nipping the paddles. In a few minutes great numbers of maddened sharks were seizing paddles and outriggers, until all the canoes but one had been swamped and their occupants devoured. Two natives only escaped to describe the disaster. A similar account we got in the Fijis where one of the large double sailing canoes was capsized well off shore and over twenty natives clinging to the wreck were pulled



Jaws of white shark. St. Lucia, West Indies.
Photograph from Capt. W. E. Young.



Hammerhead Shark (*Sphyrna zygaena*), torn by another shark while fast in net. Shark-leather Station. Photograph from Capt. W. E. Young.

under by sharks only a few escaping.

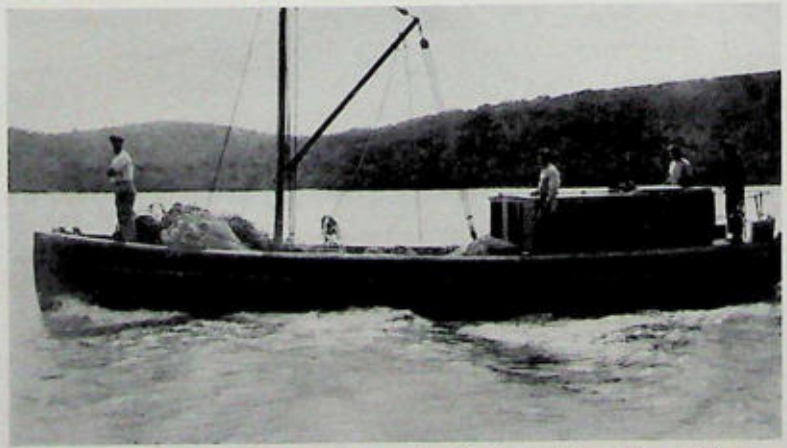
When in the Low Archipelago we found that the natives often swim and dive freely in the lagoons of certain atolls, when they would not think of doing so in the deep entrances to the atolls, where a big lone shark keeps watch. He can be seen about dusk and it's best to visit him in the whaleboat. Natives will sometimes swim about anchorages or even bathe near the deep entrances to lagoons in the daytime, when they could not be persuaded to do so at night. Sharks are often so abundant about certain islands, that a regular fishery is maintained for shark fins —always marketable in China.

There are reefs here and there among the islands to which the natives resort for some of the larger food fishes and such places are usually infested with sharks which cause great annoyance by following the canoes and seizing fishes that have been hooked. When a too persistent shark menaces the frail canoe it must be beaten off with paddles or fish spears. The native fishing on the more distant banks off shore will gladly avail himself of the use of a good-sized dinghy or whale boat which has no outrigger to be seized by an ugly shark. It is not by any means the largest sharks that are most dangerous. Many small but active species move in schools and at times actually swarm about a canoe, not merely interfering with fish catching but endangering the light craft.

Sharks have always been regarded as distinctly dangerous in Australian waters where there are several large species. They were particularly so at Sydney, where for a time butcher shop wastes were allowed to be thrown into the harbor. Swimmers about the docks were carried off by sharks on several occasions in the daytime. In the Solomon Islands the singular ferocity and boldness of the sharks are said to be due to the native custom of throwing dead bodies into the sea. Where the carrion is, there will the vultures be gathered together. At such times sharks come to eat and their temper is not misjudged by those who understand them.

At Pepekeo, Hawaii, in 1907, a Japanese fisherman holding a net fell from his boat and persons on the cliff near by who could do nothing to help him saw him pulled under by a shark.

On October 8, 1907, a Japanese fisherman at Kalepolepo, Island of Maui, while diving to take



Shark boat, *Venus*, with shark gill-nets. Shark-leather Station, Virgin Islands. Photograph from Capt. W. E. Young.



Tiger Shark (*Isurus tigrinus*). Shark-leather Station, Porto Rico. Photograph from Capt. W. E. Young.

fish from a net was seized by a shark which stripped the flesh from his arm. He was taken to the hospital at Wilku where the arm was amputated at the shoulder.

On January 8, 1908, at Mana, Island of Kauai, a Japanese fisherman swam out to gather fish floating on the surface which had been killed by dynamite. When warned of the presence of a shark, he swam frantically for the rocks but was seized and pulled under. As he disappeared in blood stained water, it was seen that he had his arms around the shark's body.

At Hilo, Hawaii, in 1910 two fishermen in a small boat were thrown into the water by a heavy sea. One reached a place of safety but the other was forced to cling to the rocks at the water line. Before he could be rescued a large shark carried him off.

In March, 1914, a Japanese gathering shellfish near Honomu, Hawaii, was observed to be engaged in a struggle of some kind. Before help could arrive two sharks had carried his body beyond reach.

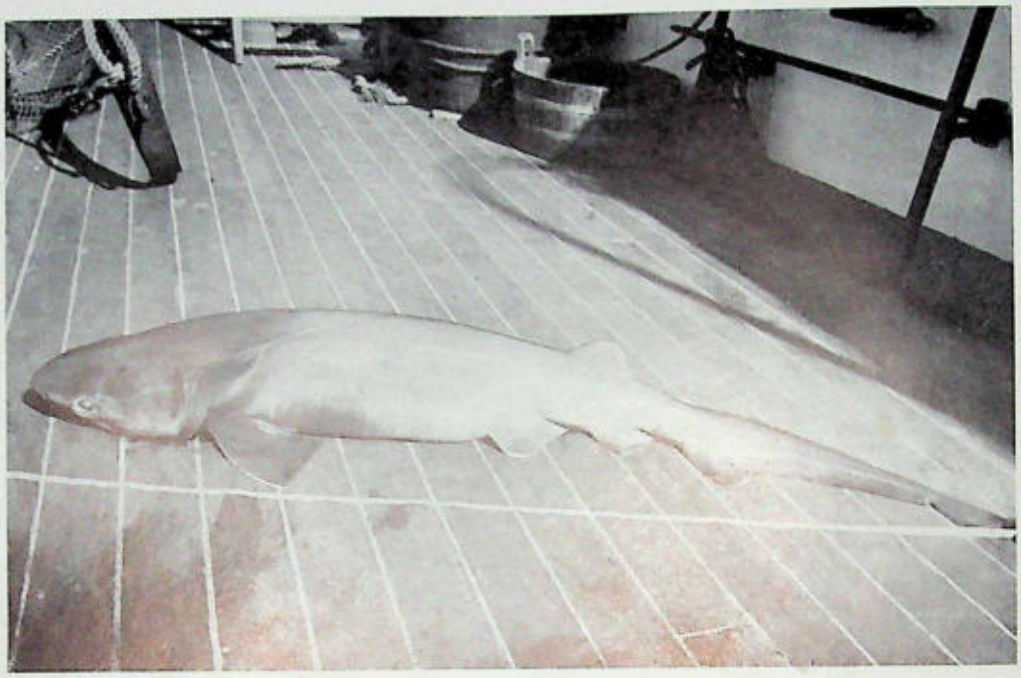
It is unnecessary to continue the recital of the gruesome records in my note- and scrapbook begun many years ago when we surveyed the Hawaiian cable route. The *Albatross* sounded every five miles along the 2000-mile track between San Francisco and Honolulu. Every stop lasted an hour and toward the southwestern end of the route there was plenty of opportunity to get acquainted with sharks and put numbers of them out of business. Sailors like to torture sharks. We had to forbid such practices as propping their jaws wide open with a stick, or cutting off their tails and then heaving them over alive but helpless.

The customary question of the skeptical, "Did you ever see a man killed by a shark?" may properly be met with a similar one: "Did you ever see a man murdered?" In conversation there is generally some one to defend the shark. I usually say, "don't care to bother with amateurs."

Natives in the Hawaiian Islands are cautious about venturing into deep water near steep cliffs and then seldom without a long bladed knife. The native surf-board riders disport themselves in waters where sharks are not often



Mouth of tiger shark, with seven rows of teeth, numbering 250 to 300, having cutting edges that shave like razor blades. Photograph from Capt. W. E. Young.



Six-gilled Shark (*Hexanchus corinus*), coast of Washington. A Pacific representative of a very large *Hexanchus* found in the North Atlantic. Photographed on the U. S. S. *Albatross*.

seen, the shallowness of the water and the disturbance made by the surf-board riders serving to keep the sharks at a distance, but accidents occur.

We need not consider here the comparatively few instances of loss of life from these big fishes in northern waters. It is in the warmer seas where sharks of all kinds are more abundant that we find them a menace. And yet the tragedies are rare. Sharks do not likely succeed in killing as many persons in a year in all Polynesia perhaps, as are killed by automobiles in any large American city in a single week.

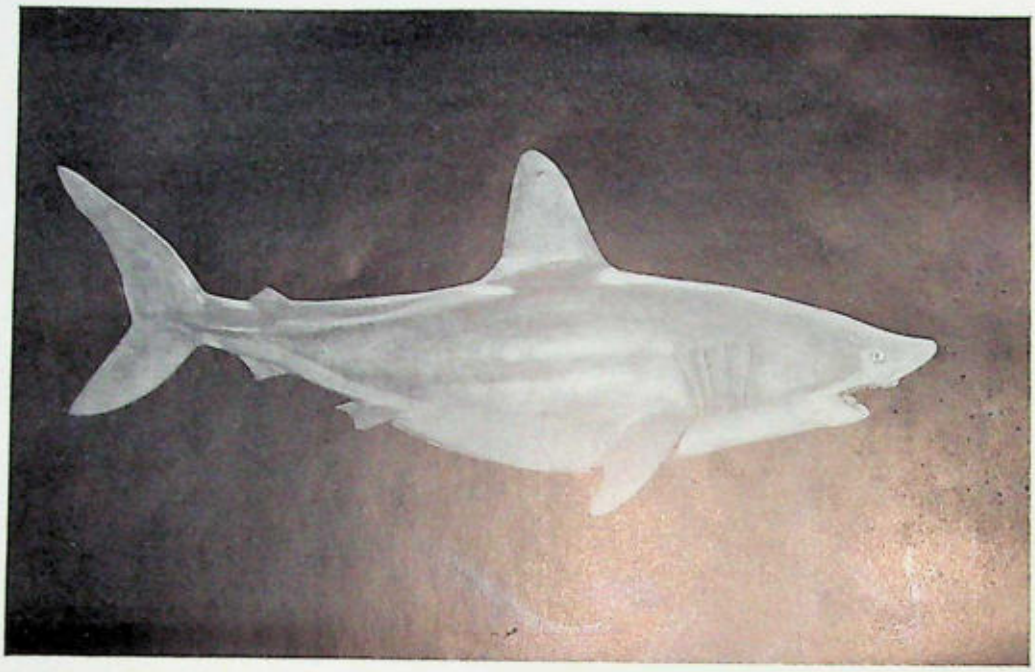
While cruising with the pearl divers of La Paz, I once put on the heavy diving suit and went down on a coral bank, but the promised sharks did not appear. The divers did not fear them, saying that the upward-leaping air bubbles from their helmets kept sharks away. They had however, a wholesome respect for the huge manta rays, always full of curiosity, whose broad wings had been known to hit their air and life lines almost jerking them off their feet.

We refrain from quoting old-time published accounts of killings of human beings by sharks. They are to be found here and there, in the writings of the early missionaries in the South Seas, the early navigators and travellers.

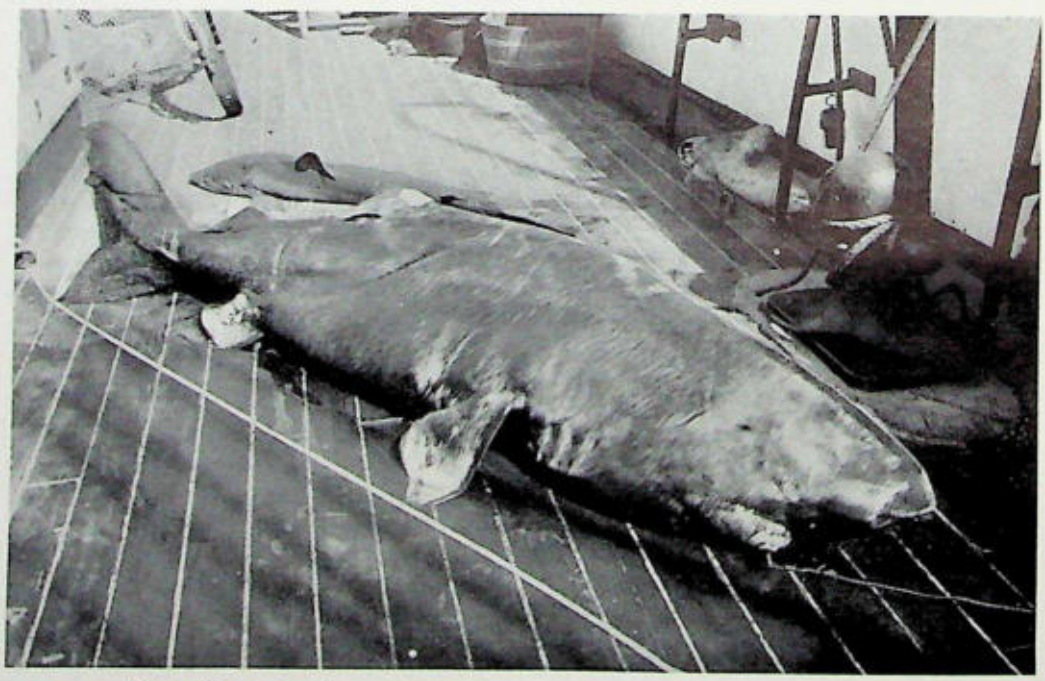
Certain additions to the above mentioned scrap-book during the past three or four years served to reawaken my interest in the shark as a man-killer. Several selected newspaper clippings were sent to naturalists in Hawaii, Australia and Porto Rico with requests for details if obtainable. The director of the aquarium at Honolulu, the economic zoologist of the museum at Sydney and the director of the Bureau of Agriculture at San Juan, all responded to the effect that the killings by sharks all happened practically as reported in local papers:

The letter from Mr. T. C. Roughley, Economic Zoologist of the Technological Museum, Sydney, under date of October 23, 1929, is especially interesting:

> ". . . . That we have sharks in Australian waters which are a menace to humans goes without saying, for scarcely does a summer pass without one or several fatalities being recorded . . . We usually regard the following species as prone to attack man: Whaler (*Carcharhinus macrurus*), Tiger Shark (*Galeocerdo arcticus*), Hammer-headed Shark (*Sphyrna zygaena*), Grey Nurse (*Carcharius arenarius*), Blue Pointer (*Isurus glaucus*), and the White Shark (*Carcharodon carcharias*).



Great Blue Shark (*Prionace glauca*). A plague to whalemen when "cutting in" whales. From a life-size model in the New York Aquarium.



Sleeper Shark (*Somniosus microcephalus*), coast of Washington. A large northern shark inimical to whales. Reaches a length of twenty feet. A nuisance to northern whalemen. One of many sharks photographed on the U. S. S. *Albatross*.



Whaler Shark (*Carcharhinus macrurus*), effectively enmeshed in a shark net. Photographed by T. C. Roughly. From The Australian Museum Magazine.

". . . . Up till about 20 years ago the fatalities were confined to the estuaries, but at about that time surf bathing began to have an extensive vogue, and shortly afterwards an occasional fatality occurred amongst surf bathers, but always when they were swimming outside the first line of breakers. It was thought for many years that bathers were safe so long as they kept in the broken water, but during the last couple of years bathers have on two occasions been attacked right in the surf.

"Persons attacked usually have their flesh torn most frightfully, the amputation of one or more limbs may be rendered necessary, and frequently the patient dies from shock and loss of blood. After the initial attack the shark usually returns quickly and continues the attack until it is frightened away by other bathers rushing to the rescue. There have been many heroic deeds by bathers in their rescues of persons attacked.

"The greatest risk of attack appears to be at dusk; it is then that the greater proportion of the fatalities have occurred.

". . . . The number of attacks by sharks upon surf bathers has increased during recent years, but that is probably due solely to the fact that the number of bathers has increased. During the summer months, on week-ends and holidays, some of the ocean beaches in the vicinity of Sydney are so crowded with bathers that it is difficult to move freely in the water. . . ."

Mr. A. H. Chisholm of the Sydney Daily Telegram, at the request of Mr. Roughley, wrote me under date of July 28, 1929, as follows:

"Pretty well every Sydney beach has its shark tower and warning bell, and, moreover, all kinds of other devices are tried from time to time. The death-roll is not large by comparison (shall we say) with motor mishaps, but the helplessness of the victims, and the shocking manner in which some of them are torn always causes public tumult. In approximately twenty years past some thirteen people have been mauled by sharks on the beaches of Sydney and Newcastle, and the death-roll has been about 40%. . . ."

The following is an extract of a letter received from Mr. Gilbert P. Whitley, Ichthyologist of the Australian Museum at Sydney under date of July 16, 1929:

". . . . In Australia, human beings have frequently been attacked by sharks. A special look-out is always kept on the beaches by a man stationed in a shark-tower overlooking the water. When a shark is sighted in the clear water, a bell is rung and the bathers lose no time in leaving the surf. . . .

". . . . Some fifteen persons have been badly injured or killed by sharks in New South Wales in the last ten years and it is noteworthy that most of the attacks took place towards dusk and between January and April, when the summer is hottest and people flock to the surfing beaches. Some of the cases recovered after receiving



Skinning a Tiger Shark, Shark-leather Station, Tortola, B. W. I. Photograph from Capt. W. E. Young.



Carcharhinus commersonii. A shark about ten feet long regarded as dangerous in Caribbean and Mediterranean waters. Called Ground Shark in Florida. Photograph from S. A. Williams, Dunedin, Florida.

frightful injuries whilst the majority of the victims died. . . .

". . . . The shark menace is a very real one around Sydney in the summer and many efforts at building shark-proof fences across beaches, netting sharks, and catching them by other devices have been made. . . ."

Mr. F. A. Potter, Director of the Aquarium at Honolulu, in addition to reporting on the clippings sent to him cited several other instances of killings and mutilations by sharks. In his comments on the subject he says: "Sharks will at times attack not only men but canoes—when sharks are hungry they grab at anything they see in the water."

Mr. O. W. Barrett, Agricultural Director, Porto Rico, under date of August 28, 1928, reported:

". . . . We have had several fatal cases near San Juan during the past five years. . . . One of our worst cases was that of an American school teacher who was swimming too far from the beach, and the whole right hip was taken off with one bite.

In the Journal of Tropical Medicine, October 1, 1930, Dr. J. Burton Cleland, Professor of Anatomy, University of Adelaide, Australia, describes in detail seventeen cases of killings or mutilations by sharks and refers to eleven others described in two previous medical articles published by himself.

Dr. James M. Phalen, U. S. Army, Canal Zone, writes in The Military Surgeon, March, 1929, of a "Fatality from Bite of Shark" in Panama Bay.

Extract from a letter from Mr. John E. Kirby (New York, October 14, 1927) to Captain Dinning and by him sent to me:

". . . . Soon after the surrender of the Spanish army at Santiago, Cuba, I was one of a party of thirteen out in a sail boat. The boat capsized and sank. We were compelled to swim to the shore and out of thirteen men the sharks dragged down six. We could see the sharks very plainly. After that we were stopped from bathing by the commanding officer, until a wire mesh was placed to protect us."

During the month of October, 1931, it chanced that three friends in New York spoke of shark accidents:

Mr. Edwin Lefevre told me of attending when a boy, the funeral of a schoolmate in Panama who had been killed by a shark.

Mr. Ralph De Sola told of an attack by a shark which he witnessed in Tampico harbor in June, 1929:

"Just as the freighter *Casanova* [on which he was a passenger], was dropping her anchor, a member of the crew dove over the side for a swim. He disappeared only a boat's length away. The third mate seized a boat hook and descended into the waiting pilot's launch. The man's head appeared and signs of a struggle were seen as the dorsal fin of a shark appeared near the seaman's head. He was rescued minus a leg, bitten clean off below the right knee, and sent to the hospital."

Mr. H. C. Raven said that while in the Dutch East Indies an officer of a Dutch steamer told him of a fatal shark accident:

"While anchored off one of the Natuna islands, an engineer was swimming near the ship. A shark appeared and bit off his leg. His body was recovered before it sank."

The Cuban Government on September 5, 1931, cancelled the exclusive shark fishing conces-

sion held by a Havana company and declared shark fishing open to the public. This action was taken in the hope of ridding the waters near Havana of man-eaters "which have killed three bathers in the last ten days."

Lack of space does not permit consideration of the abundant note- and scrap-book material remaining at hand on this subject. It extends from the Caribbean Sea to the Indian Ocean and will serve for another equally unpleasant chapter later on.

Fortunately for the commercial fisheries as well as for humanity in general, the recent extension of the shark-leather industry to many parts of the world has served to put a worth-while price on the head and hide of an old criminal still at large, long known to sailors as "Jack Shark."



The steam-powered, whale-killing boat of to-day is usually about 100 feet long and has a harpoon-firing cannon mounted on the bow. Photograph from Bryn, Sandefjord, Norway.

Where the Nineteenth Century Whaler Made His Catch

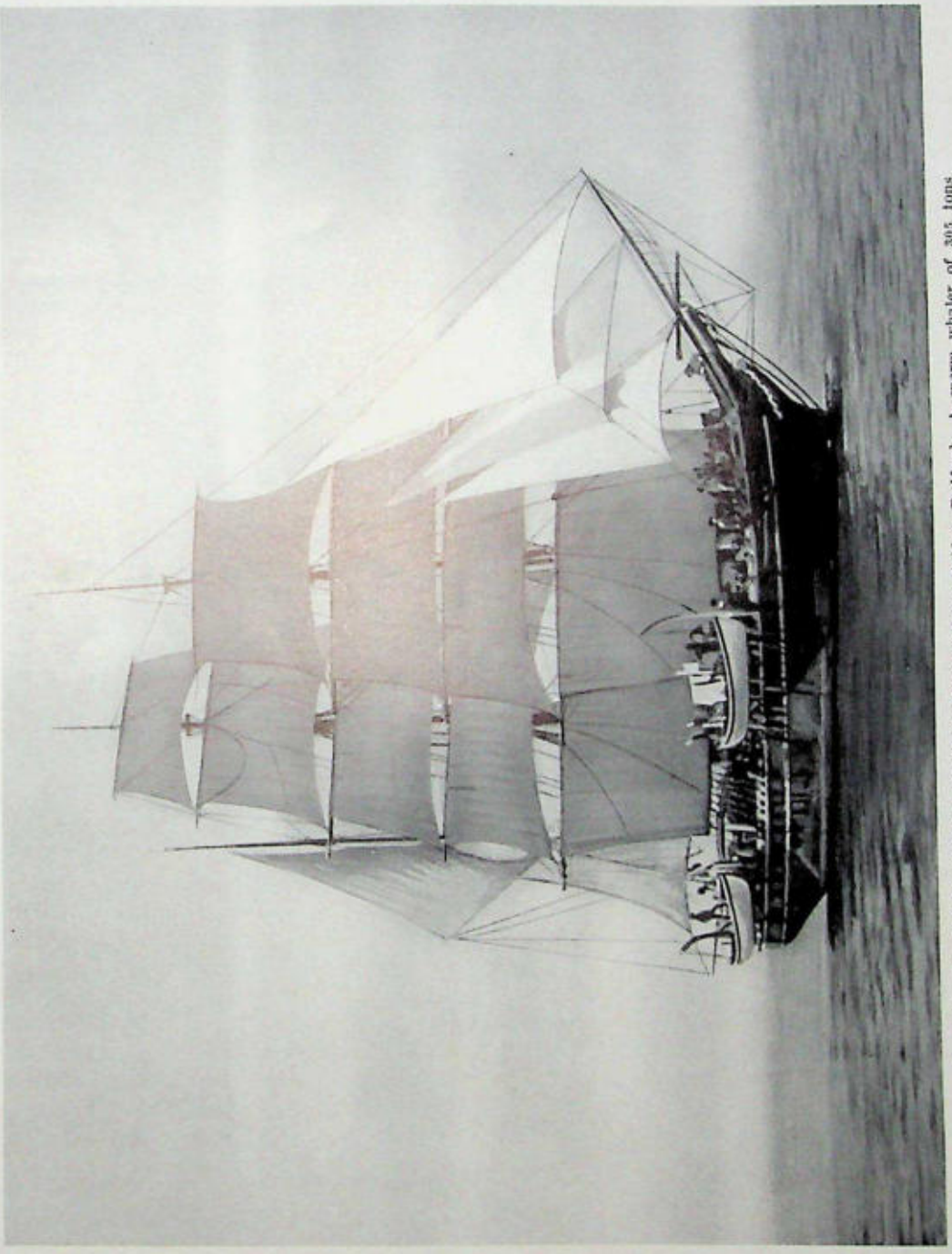
Charles Haskins Townsend

IT has always been recognized that the distribution and seasonal movements of whales in the wide expanse of the seas were not well known.

While examining logbooks of whaling vessels in the New Bedford Public Library, it became apparent to me that they represented a supply of hitherto unused records available for additional information on this subject. The logbooks, hundreds in number, show clearly where the nineteenth century whaler made his catches of sperm, bowhead, right, gray, humpback and occasionally other species. A little experimental plotting on a chart indicated that much could be learned of distribution by extensive work of this sort and by using a separate chart for each species. It was also evident that by using a distinctive color for each month's captures, the movements of whales would be apparent to a considerable degree. The plotting of the positions of whaleships on days when whales were taken, threw light on the locations and dimensions of the "whaling grounds" frequented by the old-time whalers as well as the seasons when they were visited.

Another large collection of nineteenth century logbooks was found in the Whaling Museum of Old Dartmouth Historical Society in New Bedford. Other important collections of whale-ship logs have been located at Nantucket, Salem and other New England ports celebrated in the history of the whaling industry. The compilation of records to be found in these towns will be taken up on behalf of the New York Zoological Society as soon as the work in New Bedford is completed.

The chart presented herewith contains only the first lot of records on sperm whaling. The



A nineteenth century whaler, the bark *Morning Star* of New Bedford. A sperm whaler of 305 tons built in 1853. Photograph by Tripp, New Bedford.

total number of sperm whales represented by the plottings on it is 11,026. Each month's captures being distinctively colored, they present evidence of considerable movement of whales away from the Equator according to season. A study of this chart shows that the catch of sperm whales by the nineteenth century whaler was made chiefly between the north and south latitudes of forty degrees. The known distribution of this species both northward and southward is somewhat wider. It is in general an inhabitant of tropical and temperate seas, ranging into cold waters only in limited numbers. A few stragglers are now being taken in Antarctic waters. The sperm whaler made voyages lasting from two to four years. He sailed all tropical and temperate seas and operated at all seasons. The "whaling grounds" as shown on the six charts now in preparation are naturally very widely scattered, whales being found in cold, temperate and tropical seas both north and south. Some species are of limited distribution while others migrate extensively according to season, sea temperature, breeding range or food supply.

We are here dealing with whaling operations as conducted when sailing vessels were employed and whales were killed with harpoons thrown from open boats. The whales taken were the slower species that could be captured by such methods and that did not sink when killed. The nineteenth century whaler did not take the great blue whale, the finback and other kinds now being captured in great numbers by more effective equipment and his logbooks contain little or nothing about them.

Twentieth century whaling, at present involving the killing of over 30,000 whalebone whales a year, is vastly more destructive. The catch is made by steam-powered hunting boats carrying small cannon and whales are towed to a limited number of stations on shore or to large cruising factory steamers. Forty factory vessels and a smaller number of shore stations are sufficient for the enormous annual catch of today, while the old time sailing fleet numbered hundreds of vessels. In 1846 there were 735 whaling vessels sailing under the flag of the United States. At its best period that great fleet probably captured less than 10,000 whales a year.

The plottings on the sperm whale chart



Sperm whale with mouth open. This is the only large whale with teeth.
Photograph from Bryn, Sandefjord.



The Antarctic whaler, *Sir James Clark Ross*. Showing slip through which whales are pulled on board. Photograph by C. H. Townsend, 1931.

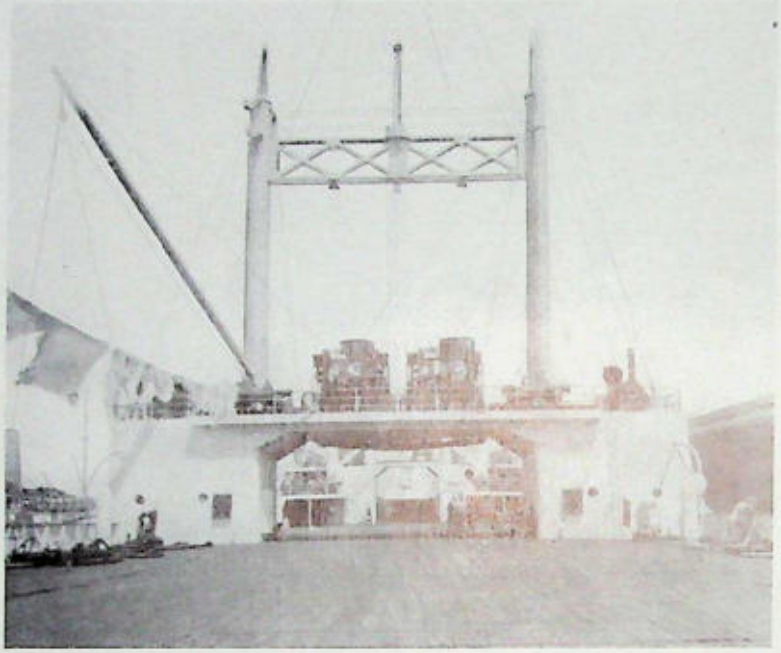
massed along or near the Equator, are confusing. The chart became overloaded with data before we realized that there might be a better method of presentation. As there is a similar supply of records on hand representing perhaps more than 10,000 additional captures of sperm whales, these are being plotted on two charts—one for the April-September season, the other for the rest of the year. These cannot be completed until after further records have been copied from logbooks, especially those coming from Nantucket. The charts already show clearly the seasonal oscillation of sperm whales between north and south latitudes.

The plottings on the chart presented in this Bulletin make it of service chiefly as showing positions and extent of whaling grounds. It is not to be expected that the seasonal movements of sperm whales in the broad Pacific will correspond very closely with those of the much narrower Atlantic. The great currents of the two oceans differ in direction and force and there are great climatic differences. The movements of sperm whales in the Indian Ocean are geographically limited at the north. Most of the catch there was made south of the Equator. Such conditions affecting movements of whales as winds, temperature, salinity and food are not considered here. The food of the heavily-toothed sperm whale is altogether different from that of the whalebone whales of paramount commercial importance today.

It will be seen that in the North Atlantic, the plotted areas above latitude twenty-five degrees are with few exceptions, for the April-September period. The massed plottings in the Sargasso region are almost entirely those pertaining to the summer season of the northern hemisphere. Between



Antarctic whaler, *Sir James Clark Ross*. View toward slip through which whales are pulled on board. Photograph by C. H. Townsend.



Antarctic whaler, *Sir James Clark Ross*. View aft along the flensing deck. Photograph by C. H. Townsend.

north latitude twenty-five degrees and the Equator, whales were taken chiefly during the October-March season. Along the east coast of South America, the catches were largely made during the same season or summer time in the southern hemisphere. Along latitude thirty-five degrees south, toward the Cape of Good Hope, whaling data are also for the October-March season. Off Japan and along latitude thirty degrees north, the plottings are those of the April-September season.

In the Pacific and to some extent in the Atlantic equatorial belts, catches for all months of the year are represented. Off the west coast of South America south of the Equator, the plottings pertain mostly to the summer season of the southern hemisphere. There was much whaling off Peru at this season. Off the west coast of South Africa, the extensive whaling during all months of the year may be attributed to the effect of the cool, northward-flowing Benguela Current. The massed areas off the west coast of northern South America, where whaling was also carried on at all seasons, may be similarly explained by the cool northward-flowing Humboldt Current. This current, deflected westward at the Equator is responsible for the uniformly cool sea temperatures about the Galapagos Archipelago where large numbers of sperm whales were taken during more than half a century.

Whaling Grounds.—There is frequent mention in the logs of sperm "whaling grounds," twelve of which were in the North Atlantic: Western Grounds (31°N. 50 W.). This is the great mid-ocean Sargasso region, its center being in the latitude of Bermuda and nearer Bermuda than Madeira. Whaling was carried on here almost entirely during the season from April to September, inclusive.

The Western Islands Ground (37°N.25°-33°W.), was around the Azores where sperm whaling was done mostly in summer. The Charleston Grounds (30°N.70°-77°W.), lay between Hatteras and the Bahamas, mostly to the eastward of the Gulf Stream. The Cornell Ground (6°N.20°W.), was a winter ground between the Cape Verde Islands and the Equator.

The Steen Ground (31°-36°N.21°-24°W.), lay west of Madeira, where sperm whales were taken both in summer and winter. The Two-Forties (40°N.40°W.), lying northwest of the Azores, was visited in summer. On the Twenty-Twenties (20°N.20°W.), north of Cape Verde Islands, whales were taken during the winter months. The Two-Thirty-sizes (36°N.36°W.), southwest of the Azores, was mostly a summer ground. A mid-ocean whaling ground known as the Twelve-Forty (12°N.40°W.), between the West Indies and Cape Verde Islands was visited from February to May inclusive. This area is frequently mentioned in the logs.

The St. Antonio Ground (18°N.26°W.) seems to be about the same as the Twenty-Twenties.

The Southern Ground (36°-38°N.72°-74°W.) had its center in the latitude of Norfolk. It was an extensive Gulf Stream area as indicated by the plottings, frequented almost entirely in

summer. The Hatteras Ground, also visited in summer, lay off the Cape along the Gulf Stream.

Another summer whaling ground was called Gulf of Mexico Ground (28°-29°N.89°90°W.). Often mentioned in the logs was the Commodore Morris Ground (50°-52°N.21°-24°W.), a summer whaling field southwest of the British Isles, the most northerly Atlantic sperm whaling ground according to our records, its moderate sea temperature being influenced by the North Atlantic Drift of the Gulf Stream. There were four sperm whaling grounds in the South Atlantic frequently mentioned in the log books: The Brazil Banks, actually off Argentina, (roughly 39°-42°S.57°-60°W.), was also a right whaling ground, first fished about 1774; the Cornell Ground (17°S.8°W.) around St. Helena; the Platte Grounds (34°-37°S.48°-52°W.) off Rio de la Plata, visited by sperm whalers from October to March inclusive, and the Tristan Grounds (33°-39°S.10°-23°W.) being the region around Tristan da Cunha Islands. Woolwich Bay (Walfisch Bay) west coast of Africa, and coast of Patagonia are common logbook names of sperm whaling grounds.

In the North Pacific a sperm whaling region often referred to was the Japan Grounds (29°-32°N.160°-175°E.) extending westward from Midway Island. It was a famous whaling area discovered in 1820. Sperm whaling was also practiced off the coast of Japan but so far we find no logbook name for this ground.

The Off-shore Grounds (5°-10°S.105°-125°W.) lay west of the Galapagos Islands, on and south of the Equator. It was the most famous of the Pacific sperm whaling regions and was visited at all seasons. It was discovered with much acclaim in 1818. The whaling grounds called On The Line lay along the equatorial region westward from the Off Shore Grounds. Sperm whales were taken there at all seasons.

French Rock Grounds (32°S.180) fished during most of the year, lay around the Kermadec Islands north of New Zealand. Middle Ground was between New Zealand and Australia.

Whalemen often referred to other Pacific sperm whaling areas, the positions of which are obvious: Panama Bay, Galapagos, Coast of Chili, Callao and Coast of New Holland (or later Australia) generally in reference to the west and south coasts. Among the islands between Australia and the Philippines there was sperm whaling at all seasons, one area being the Sooloo Ground in the Mindoro Sea. There was a distinct seasonal movement of whales between the Sulu Sea and the Celebes Sea. Sperm whaling grounds in the Indian Ocean were known as Coast of Arabia, Mahe Banks, Seychelles, Delagoa Bay, Zanzibar and Mozambique. Whaling in the Arabian Sea (Lat. 15°N.) was done chiefly in December and January.

In listing the sperm whaling grounds, frequented by the old-time whalers, we have taken only the names used in the logbooks. Other grounds are referred to but not in connection with sperm whaling.

It should be explained that on a few whaling grounds where the plottings are very dense, the draughtsman extended the areas slightly for lack of space. These are off the west coast of South Africa and off the east coast of South America; around the Galapagos Islands; off Northern New Zealand and off the north coast of Japan.

In other charts now in preparation, this difficulty is avoided by omitting some of the data, rather than extend the ground beyond actual whaling limits.

The sperm whale, formerly abundant, still figures in the catch of the twentieth century whaler. It is taken, but to a very limited extent, mostly at shore stations on the coasts of Japan, Norway and South Africa, stragglers being found as far south as South Georgia and the summer border of the Antarctic ice. The total number of sperm whales taken during the season of 1929-30 was 1,352, the world catch of all species for that period being 38,563—the greatest number of whales ever taken in one season.

The additional charts in preparation for the New York Zoological Society will show positions where many thousands of whales, of five species, were taken during the nineteenth century.

The Whaling Season of 1929-1930

The Norwegian Whaling Gazette in the September number of 1931 announces the world catch during the season of 1929-1930 to have amounted to the surprising number of 38,563

whales. Of this record number, 19,080 were blue whales, 14,350 finback, 1923 humpback, 922 sei, 1,352 sperm and 936 of other species. The bulk of the catch, 30,654 whales, was made in Antarctic waters and chiefly by Norwegians. The remainder, 7,909, were taken in tropical and northern seas, that of Japan being largest with 1,714 whales. Thirty of these were the rather scarce gray whales, confined to the North Pacific and 753 were sperm whales.

Operating off the Santa Barbara Islands along our own coast and off Lower California, the whaler *Lansing*, with which the writer cruised in 1929, took 300 whales. Shore stations in Alaska and British Columbia captured 675 whales.

On April 20 the writer boarded the Norwegian Antarctic whaler *Sir James Clark Ross* at Staten Island where the vessel's catch, 55,000 barrels, was sold to one firm for soap making, at an estimated value of over $1,500,000. The *Ross* had seven steam whale-killing boats, a crew of 245 men and had taken during the season 1,445 whales. This vessel was followed to Staten Island ten days later by the Antarctic whaler, *C. A. Larsen*, with a catch of whales nearly as large. The total world yield of whale oil for the season of 1929-30, exceeded 3,427,000 barrels. There was great overproduction and most of the oil went to storage, with the result that whaling in general is suspended for the present year. The whales need a respite, in fact a longer one than they are likely to get.

The Antarctic field, in the whaling industry of the past few years, has been exploited with remarkable intensity.

The Supply of Fresh-water Fishes

During recent years the Aquarium has found it increasingly difficult to maintain a satisfactory collection of Eastern fresh-water fishes. The local sources of supply, fairly productive twenty-five years ago, no longer yield fishes of the larger sizes. The exhibits of basses, perches, pickerels, catfishes, sunfishes, et cetera, representing numerous species of these families, have long consisted of rather small specimens.

Among the causes contributing to the diminution of the supply are a great increase in the number of anglers, as a result of extensive road building, and the ever rising numbers of automobiles cruising through the rural sections of the whole country. Angling waters have become more and more accessible to campers. Waters once pure now suffer from manufacturing wastes, sewage and oil washed from highways. The fish supply of the markets is now derived chiefly from the sea. There is little fresh-water market stock available except what comes from the Great Lakes, the lakes of Canada and the Mississippi River. The Great Lakes have suffered from long-continued and exhaustive commercial fishing.

In May of the present year the Aquarium secured a truck so that its collector could go farther afield. Permits were obtained for the drawing of seines in distant reservoirs where larger fishes were secured "strictly for exhibition in the Aquarium." This effected considerable improvement in our collection but the results were not all that could be desired. As many years had passed since the Aquarium received fishes from the Mississippi, it seemed advisable to vary the collection with additional species. Accordingly, two of our men were sent to the Government Fisheries Station, at Fairport, Iowa, where they secured about two thousand fishes by seining in the great river. These were held in the Government ponds at Fairport until the work of collecting was completed. By special arrangement with the Nuchem-Messing Live Fish Corporation of New York, one of their tank cars, used in the transportation of live fishes, called at Fairport on its return trip and brought back the Aquarium collection.

In addition to larger specimens of widely distributed fishes, not readily available in the East, there were numerous species belonging to the Mississippi and its tributaries. Among the latter are shove-nose sturgeon, fresh-water drum, buffalo fish, white bass, yellow bass, quill-back sucker, moon-eye, gizzard shad, channel catfish, crappie and various sunfishes. The arrival of these and others equally interesting, has provided a good exhibit of fresh-water fishes.

Growth of Galapagos Tortoises

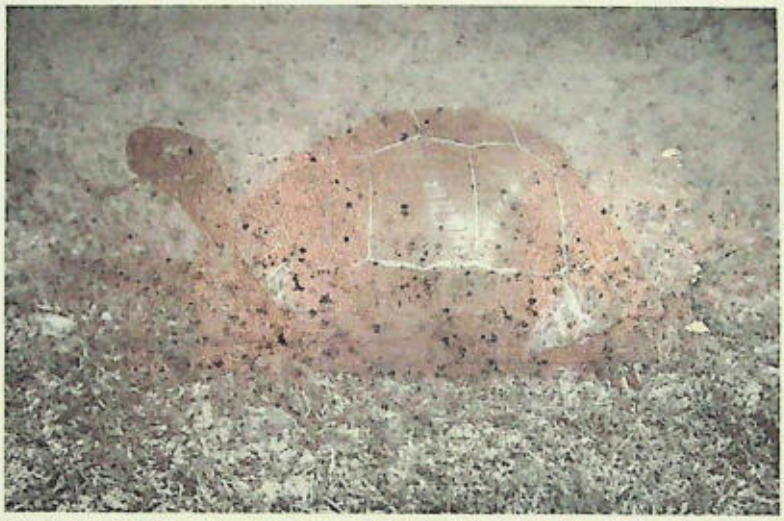
CHARLES HASKINS TOWNSEND

IN a recent issue of Zoologica,[1] the writer published certain records showing the growth of Galapagos tortoises in captivity. Brought to the United States by the writer early in 1928,[2] by authority of the Zoological Society. Located at several places in the South where climatic conditions were believed to be favorable, most of them have increased rapidly in size.

Superior, Ariz.[3]	3	71	126	77
San Diego, Calif....	19	479	1411	195
Bermuda	10	66	299	355
Honolulu, T. H.....	6	159	434	173
Sydney, Aus.	6	20	35	75

[3]Tortoises now at Opa-Locka, Florida.

The uneven rates of growth among the different colonies of tortoises as shown in the above record, are attributable to location and method of treatment. The tortoises in Arizona lived almost entirely on prickly pears, abundant in the cactus grove where they were confined.



Galapagos Tortoise (*Testudo vicina*). Weight, October 1, 1928, forty-eight pounds. Its growth was slow until January, 1930, when as the result of heavier feeding, the white lines indicative of rapid growth began to develop. Its weight on August 1, 1931, was eighty-seven pounds. It is about twelve years old.

As these animals are known to attain weights exceeding 500 pounds, they were popularly supposed to be of slow growth. Tortoises of great size were believed to have lived a century or more. The records of growth of the Zoological Society's colonies were, when published, surprising to most naturalists. The rate of increase in size has continued to be rapid since their individual weights were recorded in 1930. The following table shows the total weight attained by each colony between 1928 and 1931:

Place	Number of tortoises	Total lbs. 1928	Total lbs. 1931	Increase %
Brighton, Fla.	5	35	254	626
Opa-Locka, Fla.....	5	42	248	490
Biscayne Is., Fla....	18	334	714	114
Lignum Vitae, Fla..	8	248	635	157
New Orleans, La...	7	100	365	265
Houston, Texas	14	192	984	413
San Antonio, Texas.	8	111	455	310

[1]Zoologica Vo. IX. No. 13. N. Y. Zool. Soc. 1931.
[2]Zoological Society Bull. Sept.-Oct. 1928.

There were also some early losses in Arizona from cold weather. Those on Lignum Vitae Island subsisted entirely on grasses. All the others lived on grassy ranges in public or private zoological gardens where they also received a variety of vegetables. Very generous feeding at some places served to stimulate growth.

There have been as yet no signs of breeding. Only a few of the tortoises have reached weights exceeding 100 pounds. The breeding age is unknown.

Having among these tortoises three individuals held in captivity at Guayaquil, Ecuador, from infancy, we find that the annual rings of growth on their plates correspond with their known age.

A few young tortoises are still retained at the New York Zoological Park where their growth has been much slower than among those located in the South.

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Fawn-breasted Bower-bird
Bower of Fawn-breasted Bower-bird
Satin Bower-bird—Immature

FAWN-BREASTED BOWER-BIRD ..... *E. R. Osterndorff Cover*

BULLETIN

NEW YORK ZOOLOGICAL SOCIETY

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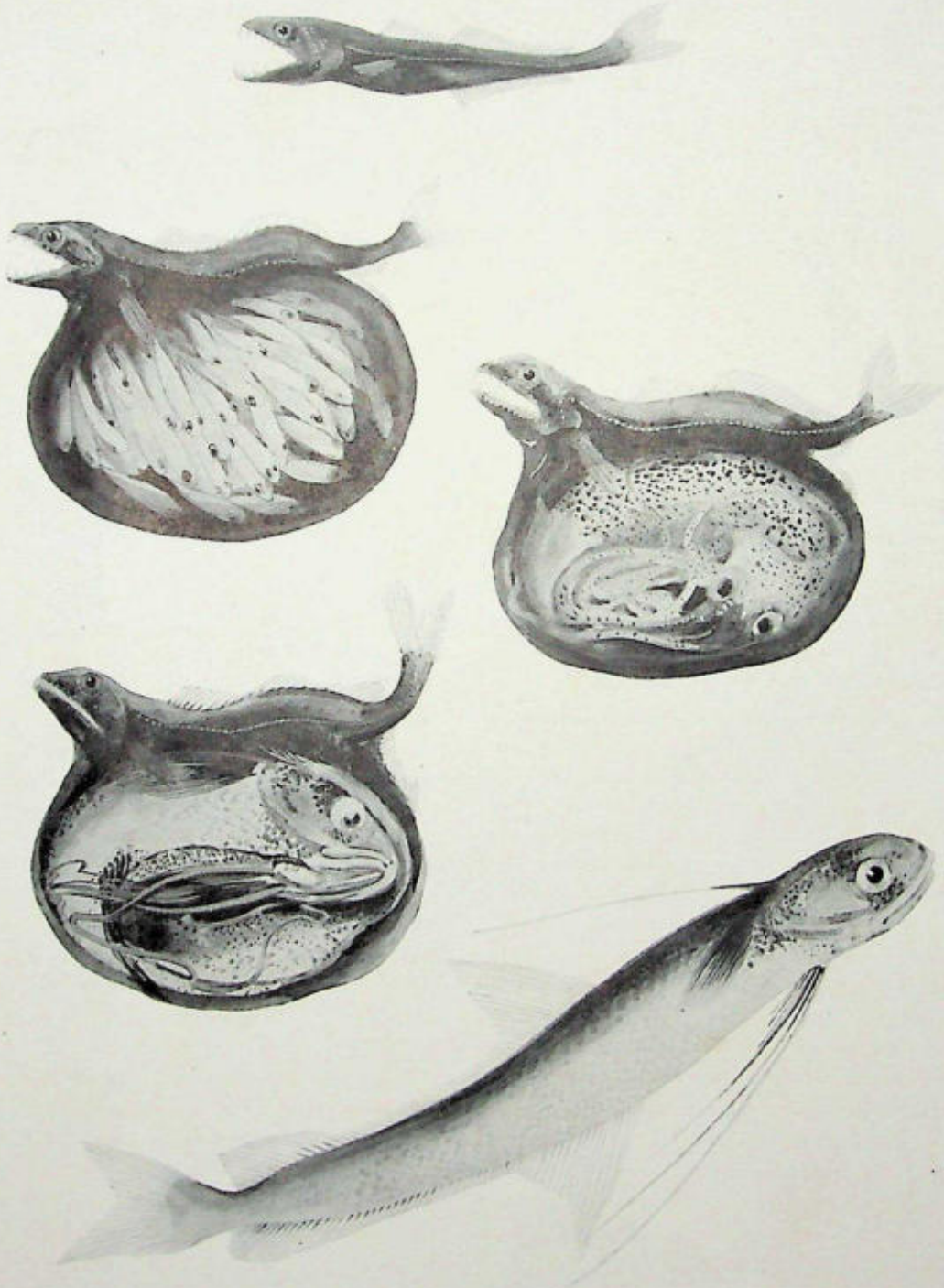
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A deep-sea gourmand, *Chiasmodon niger* Johnson

Top. Normal fish with empty stomach. *Upper left.* After a meal of thirty-one larval lantern-fish. *Upper right.* Having dined off a huge squid. *Lower left.* What would seem a week's ration, after consuming a Unicorn fish (*Bregmaceros*). The latter, which is shown below, is more than twice as long as the Gourmand. From a water-color drawing by Else Bostelmann.

BULLETIN
NEW YORK ZOOLOGICAL SOCIETY

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The New Laboratory for the Department of Tropical Research

EVER since the establishment of the Department of Tropical Research, under the direction of Dr. William Beebe, it has been realized that the time would come when a substantial working laboratory, library, and adequate storage facilities would have to be provided in the Zoological Park for this department.

The valuable collection of specimens obtained by Dr. Beebe and his staff during various expeditions has now reached such importance that in order to make this material readily accessible for careful study purposes a building in the Zoological Park has been completely remodelled and the department's collections installed during the past winter.

The location of the laboratory, which is situated immediately south of the Aquatic Bird House, affords the necessary isolation essential to the carrying on of research work without interruption or invasion by visitors.

The building is a substantial one-story brick building with adequate daylight provisions and fully equipped with electric lights throughout.

The main laboratory room is thirty-six feet long and twenty-six feet wide and is fitted with metal shelves and glass containers which make the specimens readily accessible for gross examination.

The library and record room is twenty-five feet by sixteen feet and affords ample room for expansion. Two rooms about ten feet square are also available for laboratory and storage facilities.

The collections already installed in the new laboratory include all the specimens taken during the British Guiana, the *Noma*, *Arcturus*, Haitian and Bermuda Expeditions, as well as the paintings and drawings made during these expeditions.

During the past winter the staff has been engaged in the identification and study of the deep-sea specimens taken on the Bermuda and *Arcturus* Expeditions, and in the study of the shore fishes of Bermuda with a view to the preparation for publication of a "Handbook of the Shore Fishes of Bermuda" as well as other papers on the same group of fishes. Miss Hollister is continuing her research on the skeletal features of fishes by means of chemical clearing methods.

The value of such a rich collection of scientific material can only be secured through precise zoological classification and study of the specimens taken on the various expeditions.

Much of the work now being done in the laboratory consists of sorting and preparing for shipment to experts in other institutions many of the invertebrate specimens which have not as yet been described.

In this way valuable additions to scientific knowledge will be obtained and bring added prestige to the Zoological Society. *W. R. B.*

DEPARTMENT OF TROPICAL RESEARCH

The World of Bermuda Fish

William Beebe

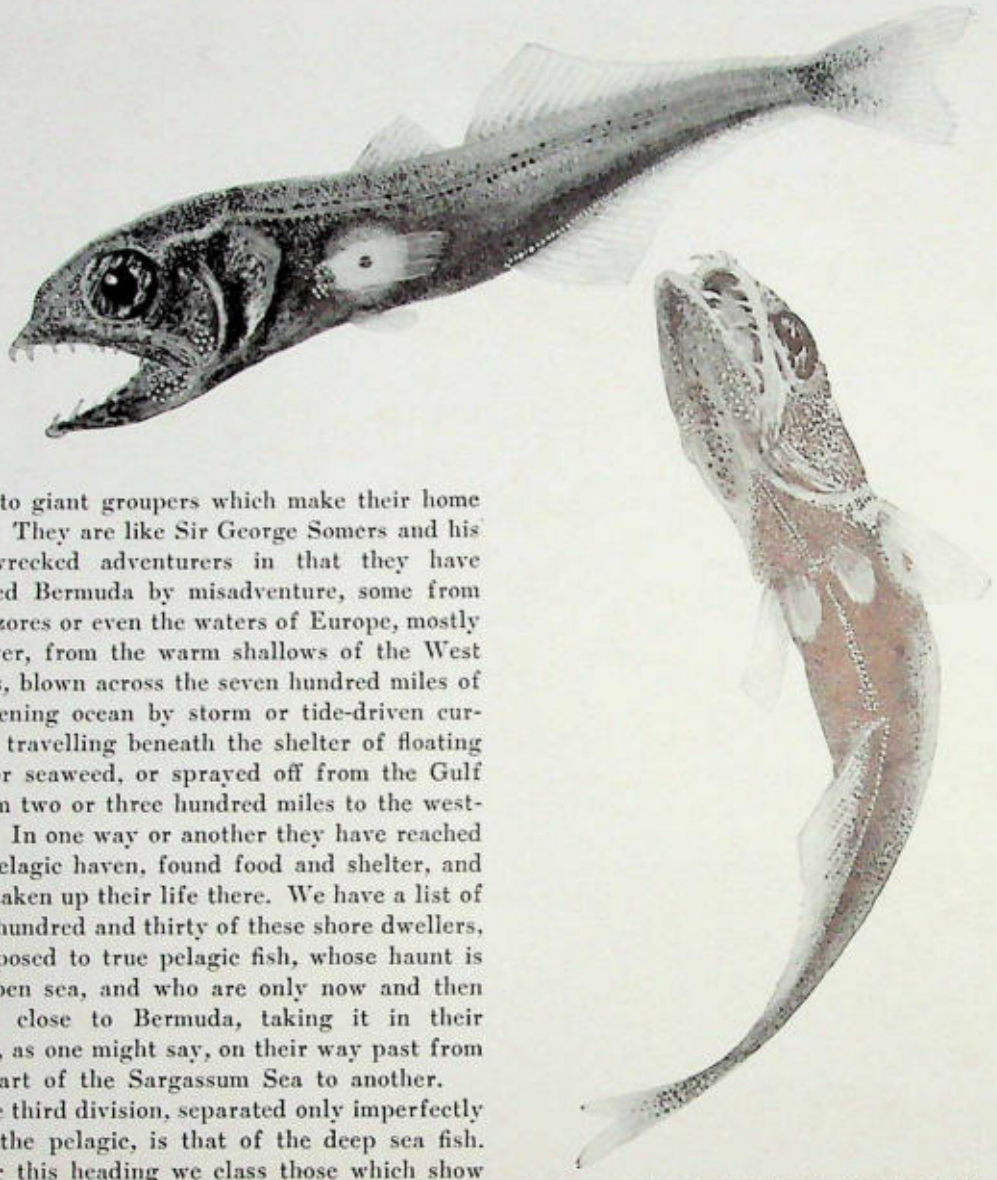
Illustrations from photographs and water-color drawings by the Staff, and also photographs made in the Zoological Park by E. R. Osterndorff.

LITTLE by little the members of the Zoological Society's staff of the Department of Tropical Research are getting a more comprehensive grasp of the big problems they have undertaken in Bermuda. There are two of these problems, the world of shore fish and the realm of deep sea life. This last year the Director and his staff spent six and a half months on Nonsuch, and the result is a better focused picture with much greater detail than ever before.

We have tried to get away from the conventional fisherman's or ichthyologist's point of view and see the thing as a whole. Our visualization is of the lonely mountain peak in mid-ocean and well within the Sargassum Sea, rising up and up two miles from the bottom slime. Close about it at the surface of the water and in all the bays and inlets is a host of fish, from min-



Looking northeast toward future home of the Department of Tropical Research. From a photograph by William Beebe.



A new species of lantern-fish, *Pseudoscopelus stellatus* Beebe. From a water-color drawing by Else Bostelmann.

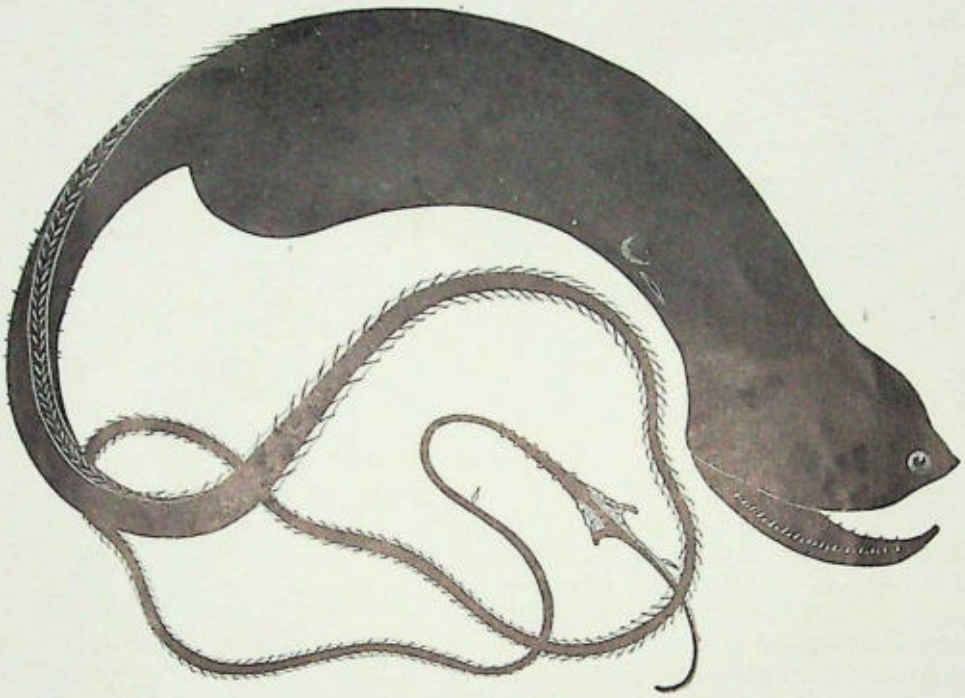
nows to giant groupers which make their home there. They are like Sir George Somers and his ship-wrecked adventurers in that they have reached Bermuda by misadventure, some from the Azores or even the waters of Europe, mostly however, from the warm shallows of the West Indies, blown across the seven hundred miles of intervening ocean by storm or tide-driven currents, travelling beneath the shelter of floating logs or seaweed, or sprayed off from the Gulf Stream two or three hundred miles to the westward. In one way or another they have reached this pelagic haven, found food and shelter, and have taken up their life there. We have a list of three hundred and thirty of these shore dwellers, as opposed to true pelagic fish, whose haunt is the open sea, and who are only now and then found close to Bermuda, taking it in their stride, as one might say, on their way past from one part of the Sargassum Sea to another.

The third division, separated only imperfectly from the pelagic, is that of the deep sea fish. Under this heading we class those which show very decided adaptations to their strange haunts, or which come rarely if ever to the surface. Here again we have recorded over three hundred species.

The usual thing to do in studying the fish life of any one locality is to collect and identify the specimens, make a list and publish it. We did this in Haiti,* although we lifted it well above the rank of a mere locality list, by adding a great deal of new material in the form of habits and other data. This we are planning in Bermuda. In a few months we will have a Hand-Book of the Shore Fishes which will contain keys for naming and adequate descriptions for identification. But this is a mere preliminary.

The ten thousand and one notes we are making in the course of our seasons on Nonsuch deal with the life histories of all the fish, lives of which we know so very little. As I have shown the Zoological Society in lectures, articles and pictures, we are doing all this in every conceivable way, grubbing about in tide-

*Zoologica, Volume X, Number 1.



A new species of deep sea gulper eel fifty-five inches in length, taken at a depth of nine hundred fathoms, *Saccopharynx harrisoni* Beebe. From a pen-drawing by Else Bostelmann.

pools, seining, fishing with hooks and lines, diving regularly to six and seven fathoms in helmets to observe, trap, harpoon, shoot and dynamite the particular specimens we want, besides which we descend to unheard of depths in the Bathysphere. We put live fish in aquariums and watch them for days, or we photograph, paint and dissect. Chiefest of all we try to interpret their activities, not in terms of human psychology, not as man to fish, but as fish to fish. In spite of this however; we are constantly being surprised out of our complacent new point of view by habits and interrelations, by emotions and sustained efforts in definite directions which, to our ordinary conventional beliefs, are as unfishlike as speech would be in a shark, or gills to a human being.

Returning to Nonsuch each year has always the elements of a Christmas morning; there is invariably some surprise awaiting our arrival, usually a gift of the friendly, generous Bermuda government. This last year it was telephone and electric light wires which, for our especial benefit, had been strung across Cooper's Island and Nonsuch Scaur to our laboratories, connecting us for the first time with the mainland and so with the whole outside world, aurally and illuminatingly.

No descents were made in the Bathysphere during 1931, first because there were no protracted periods of absolutely calm weather at sea, and because Mr. Barton was unable to come to Bermuda. The entire apparatus has been overhauled and is in perfect working order for the half-mile descent which we hope to make this summer.

The work in every department of the laboratory made big strides. Mr. Tee-Van devoted much of his time to the shore fish and in the present number of the Bulletin presents an interesting résumé of discoveries regarding the change of pattern in the growth of one species of wrasse; Miss Hollister added an ultra-violet light machine to her battery of apparatus for dyeing and making fish transparent, and the astonishing results are told in succeeding pages; Miss Crane began intensive studies from an entirely new angle, of the scales of the more primitive fishes.

The deep-sea fish catalogue was increased by twenty-five hundred new entries, bringing the total to over twenty-four thousand. The last

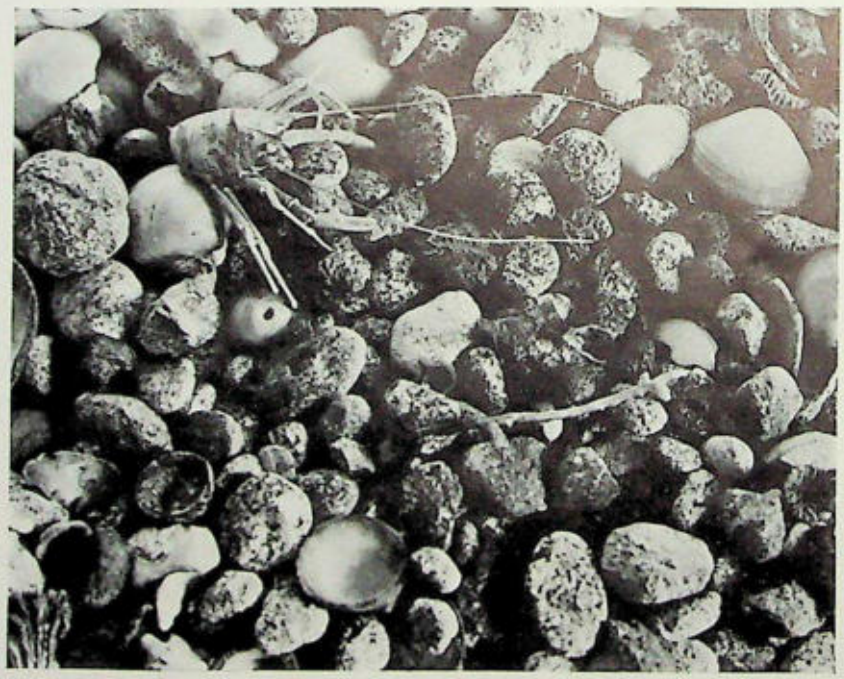
net hauled was number 1350, all within the eight-mile circle, and in the imaginary cylinder from the surface to one thousand fathoms or a mile depth. In the identification of ten thousand deep sea fish, especial attention was paid to color and distribution of light organs, and to growth stages. More than one hundred abyssal fish were kept alive in the refrigerators.

Thirty-three contributions were published during the year, bringing the total of the Department of Tropical Research to three-hundred and seventy-nine. A French translation "*Sous La Mer Tropicale*" appeared and an early British Guiana volume was turned into Braille for the blind.

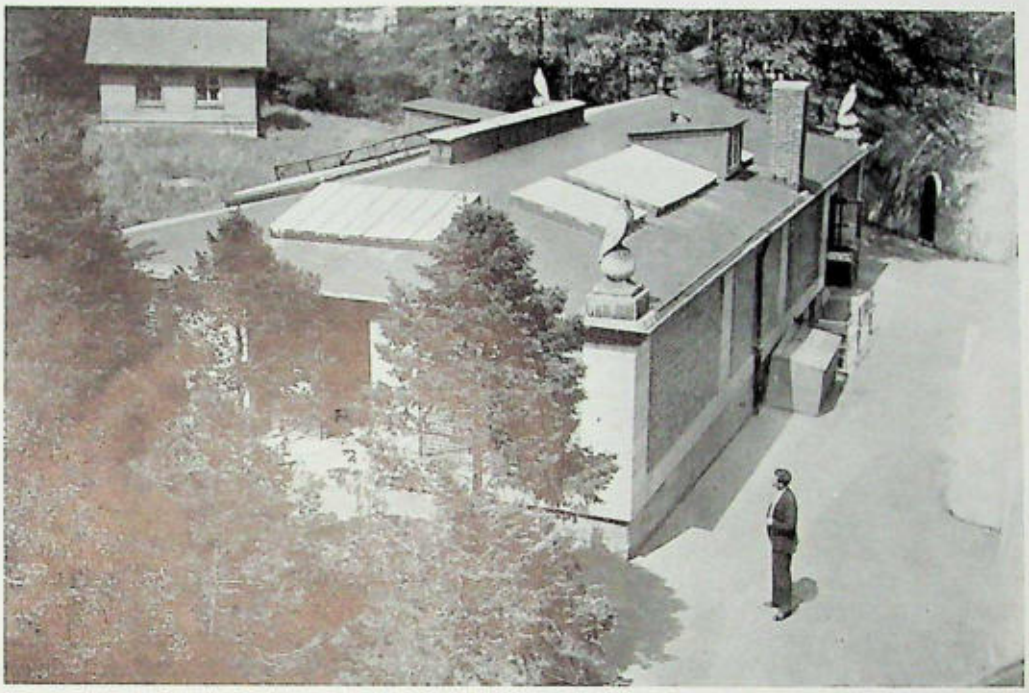
The first of the Bermuda volumes, published under the auspices of the Zoological Society is an introductory series of essays by the Director, "Nonsuch: Land of Water," which has just appeared. Within a few months this will be followed by the Hand-Book already mentioned, and later by the large, monographic Life Histories.

The most unexpected discovery of 1931 was what appears to be a submerged beach, a mile and a half down and over ten miles from Bermuda. In the course of our trawling, whenever a net accidently struck bottom, if it was not torn away it brought up thousands of Pteropod shells, exquisite in delicacy of texture and in beauty of outline. These are literally flying snails which flap their way through life in the dark mid-zone a mile down, and when they die, their shells drift down to the bottom, there to form what is known as Pteropod Ooze. This is found only in a few restricted places in the seven seas, and it happens that the only patch in the north-western Atlantic is on the floor of my trawling area.

When I began dredging in earnest this last year I encountered unexpected difficulties. Strong, iron four-foot dredges were used, and only one or two hauls were made with each before it was lost, or twisted and bent into fantastic shape. The half-inch mesh netting allowed the Pteropods to slip through but retained all the larger material, and this was of the utmost interest. It consisted almost entirely of water-worn pebbles, shells and bits of coral. Hauls at nine miles distance from shore and others twelve miles out yielded identical results. The gradient of the bottom



Water-worn shells, pebbles and bits of coral brought up from a depth of a mile and a half, and twelve miles south of Nonsuch. Alcyonarian, *Dasygorgia* sp. Crustacean, *Galacantha rostrata* Edwards. Photograph by Amos Burg.



New laboratory of the Department of Tropical Research as viewed from the south-east.

from the dry land of present Bermuda to our dredgings is about one in six, which would seem to preclude all possibility of the pushing or rolling of bottom refuse down from the present shore. Furthermore, most of the shells we brought up are exactly like fossil mollusks which occur high up in Bermuda cliffs as well as in the West Indies.

The lowest levels of oceanic water at the glacial periods have permitted to geologists estimates of an increased land area from the present twenty square miles—about the area of Manhattan Island—to twenty times as great, about 230 square miles. I have had no time to extend the dredgings beyond my eight-mile circle, but at a most conservative estimate the addition of an indicated former Greater Bermuda would amount to sixty times the present area, or roughly 576 square miles.

This theory of a submerged beach is well substantiated by the character of all the bottom area of my trawling locality. The sea bottom a mile and a half down is usually rolling but smooth and covered to considerable depths with mud, clay or ooze. Here my nets are almost always torn to shreds the moment they touch, and the heavy iron arms of the dredge are twisted or the cable end is snapped by obstacles in the path of the haul. The small bits of these obstructions which are broken and brought up, show them to be the same water-worn, marble-like projections which characterize the reefs near shore—tall, jagged, iron-hard, sharp-pointed limestone, *in situ*, indicating former exposure to air and wave, wind and rain action. On the other hand the elevation of the sea bottom from a mile and a half to the surface and subsequent return to that depth is an unheard of phenomenon. With my present data I can see no other interpretation however. Further continued investigation will prove or disprove my suggestions. In any event it is as interesting as it was an unexpected result of our dredging.

One, among many amazing fish brought up in the nets from nine hundred and a thousand fathoms, was a new species of *Saccopharynx* eel which I have named *harrisoni* in honor of Harrison Williams, who together with the late Mortimer Schiff made this exploration possible. It was jet black with a huge curved mouth lined with sharp teeth, and measured only five inches under five feet. The anterior part of the body was thickened and was found to contain a good-sized fish also of a species new to

science. The posterior part of the eels was drawn out into a long, attenuated tail, near the tip of which was an expanded, leaf-like, scarlet light organ.

Another new form was a Lanternfish, *Pseudoscopelus stellatus*. Closely related species have been described from preserved specimens as possessing large numbers of mucus glands. In the recently dead fish these were seen to be light organs giving off a brilliant green glow. This, together with hosts of other facts, some of them indicated in the accompanying illustration, points my next paragraph.

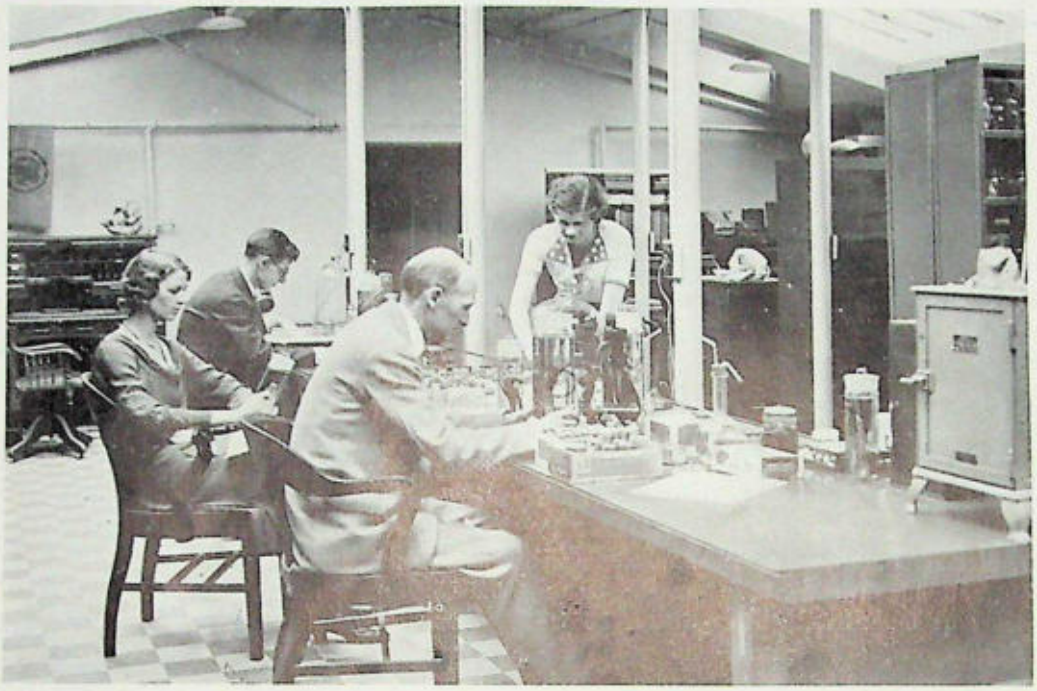
As in all former work on our expeditions, the collections brought home consist only of individuals and series representing some definite fact, or theory or reason for comparison. The major part of our observations and researches are upon living fish in their haunts or in aquariums or immediately after death, before the body organs, skin texture and even patterns and colors have altered or been lost. It is for this reason that a comfortable working station is necessary, with well-equipped laboratory, aquariums, electric light, microscopes, dark room and drawing materials ready and at hand for instant use. And it is because of our first-hand observations under water that we are getting unusual and intimate results.

As to plans and prospects for the present year; the first week in January Mrs. Beebe and I spent in Bermuda attending the opening of the Rockefeller endowed Biological Station for Research near St. Georges. The large building, formerly the Shore Hills Hotel, has, thanks to the efficiency of Dr. E. G. Conklin, been made over into a thoroughly up-to-date marine laboratory. President Conklin installed Dr. J. F. G. Wheeler of Plymouth, England, as Director, and the Station was formerly opened.

Realizing that in the present era of depression, our expedition this year must be carried on with the strictest economy, I looked about and found the solution ready at hand. A well-built house with wide verandahs and generous grounds, situated on a wooded hill, with boat-house fronting on Castle Harbor, close to the Biological Station, and directly opposite Nonsuch was found available at a very moderate price. I rented it at once, taking an option for ten years lease or purchase and thus insured



General view of inside of new laboratory of the Department of Tropical Research, looking south. The collections of the various expeditions of the Department are being studied in these quarters.



Present staff of the Department of Tropical Research. From left to right are, Miss Hollister, Mr. Tee-Van, Dr. Beebe and Miss Crane. Photograph by World Wide Photos.

at least a temporary home. This I consider as my gift to the Society.

The Zoological Society, through President Grant, has become a participant in the new Station, and I have engaged a four-room cottage on the grounds and board for my staff for several months. This will enable us to carry on at minimum expense without sacrificing any of our usual opportunities. Nonsuch can be reached in a few minutes by launch, the daily catches of the fishermen of Bailey's Bay will be available, and the rich reefs of Castle Harbor are at our door. If we find we do not have to postpone deep sea exploration, the tug Gladisfen can tie up at our dock on her way back from sea, and the same facilities apply in the case of a descent in the Bathysphere.

Best of all we will be associated with many workers in various fields of marine research from whom we can get helpful suggestions and whom, in turn, we can aid with our experience and apparatus. With an unlimited field for discovery and investigation, as wide and deep as the ocean, with enthusiasm such as only naturalists and scientists can know, we are looking forward to another year of hard work, conscientious observation and the only reward which awaits such efforts—the solution of problems which make room only for other problems.

In the midst of all the depression, the confusion of life, the upsetting of so many long-established phases of civilization, a few things are encouraging to me and to my trio of co-workers. The number of lectures relating to our Bermuda work which are in demand during the present year from New York to California is astonishing; a month before publication, the Zoological Society's first book on Nonsuch has sold out the complete enlarged first edition. On our island we hear no faintest echoes of the strife of Mongolians, the tragedies of Wall Street, the silly eternal squabble about a scotch and soda, and the murder, robbery and mayhem which fill our papers. Even the fish themselves seem to declare a truce in Bermuda, for we continue to dive safely among the barracudas and sharks, while elsewhere in the world according to non-divers, their single obsession seems to be to crowd into the headline of some newspaper as Man-Eaters! Our good fortune may well be because we sacrifice to Poseidon, Athene and St. Francis!

Color Changes in the Blue-Head Wrasse
Thalassoma bifasciatum (Bloch)

John Tee-Van

FINGER-PRINTING has become such a completely established method of identification of human beings, criminal or otherwise, that no one even ventures to question its results. No matter how we attempt to change our appearance, whether by simulating age, dyeing our hair, growing beards, or altering our clothing or characteristic attitudes, always there remain the loops, whorls and lines that mark us off as unduplicated individuals.

Unfortunately, fishes lack fingers and as no adequate piscine substitute has been found for dactyl tell-tales, misidentifications have arisen, especially among the more brilliantly colored wrasse and parrotfish. Many of these fish change radically as they grow, foreheads become sharper or acquire strange lumps, the tail becomes differently shaped, contours alter, and relative proportions of the body such as the depth and the size of the head and eye are quite different in the young and old. In color even greater alterations occur; some of these can be assigned to growth, others are the product of momentary excitement, either of the chase or of being chased, of food or of sexual emotion.

Because of this lack of a specific determinant, it is inevitable that relationships between extreme forms should not be recognized, and that two or more technical names should sometimes have been given to representatives of the same species. And it is only by the constant gathering of scraps of information, like finding and assembling the parts of a jigsaw puzzle, that the life-histories of fish can be known, and the right sorts joined together.

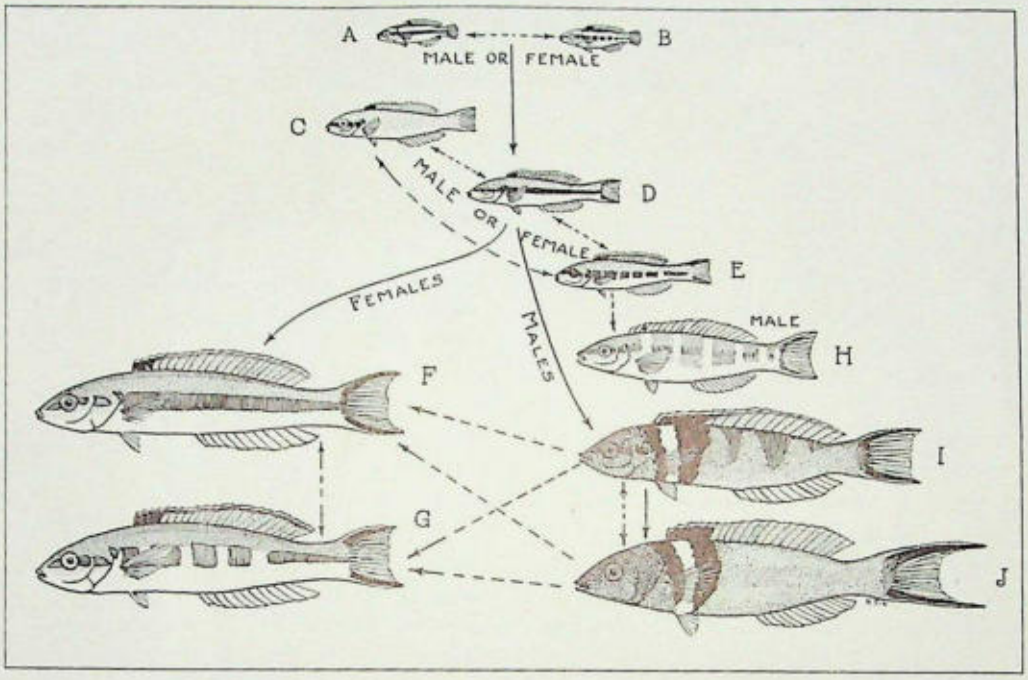
In Bermuda during the last three years, considerable work has been done on the unraveling of the color changes of wrasses, and especially of the Blue-head (*Thalassoma bifasciatum*). This species is of especial interest in that it possesses widely differing color phases, the extreme forms of which hardly resemble each other. A few recent authors have recognized that some of these forms were the same, but this has also been denied. In connection with this it may be mentioned here that the species known currently as *Thalassoma bifasciatum*, *Thalassoma nitidum* and *Bermudichthys subfurcatus* are all the same. The type of the last mentioned is a very dark specimen, whose fins have become damaged so that the spines are difficult to count.

Blue-heads are elongate, small-mouthed fishes growing to about six inches in length, the males being known in Bermuda as "King Slippery Dicks" and the females as "Scotch Slippery Dicks"—the Slippery Dick portion of their name being in allusion to their ability to wriggle through one's fingers when caught. This characteristic and name they share with many of their wrasse cousins.

The name "Blue-head" properly applies only to the adult male of the species, who alone possesses the chromatic qualifications. The males have deep blue or partly green heads, sometimes with irregular purplish spots on the lower sides, followed by two rather wide vertical black bands, separated by a pale blue interspace; the remainder of the body is rich bottle green, each scale of which has a trace of purple. There is also a conspicuous black spot on the anterior part of the dorsal fin, a small one at the base of the pectoral, and a larger more diffuse spot on the tip of the same fin.

The young and females are quite differently colored. During the three years at Nonsuch, where the species is abundant, hundreds of examples have been captured and observed, ranging in size from two-fifths of an inch to six inches in length. These specimens were almost kaleidoscopic in their variations of color and pattern, and yet out of this apparent jumble, there can be shown a progressive change of pigmentation from the smallest fish to the adults, some of the stages of coloration having temporary environmental phases.

Although the variation in color in the Blue-head is wide, and while two specimens are



Color-changes of the Blue-head Wrasse

A. Young, continuous band; B. Young, broken-band; C. Intermediate sizes, yellow outer reef stage; D. Intermediate, continuous band; E. Intermediate, broken-band; F. Female, continuous band; G. Female, broken-band; H. Male, night coloration; I. Male, adult coloration not fully attained; J. Male, full coloration. The broken arrows represent color changes; the solid line arrows represent growth. Drawing by Helen Tee-Van.

hardly ever alike, a number of extreme forms stand out as end products. The color of the male already has been mentioned and that of the youngest will be described later. In addition to these there stand out most prominently the color of the adult female, that of the yellow phase found on the outer reefs, and for want of a better name, what we have termed the "night" coloration.

A typical four inch female, recognizable as wholly different from the male, has the coloration as follows: Upper part of the body and sides of the head yellow green, the lower third of the head pale salmon, and the lower third of the body pale blue with a pinkish tinge; a series of five, indistinct dark blotches along the middle of the sides; a broad reddish-brown band from snout through the eye to the edge of the preopercle; a large similarly colored blotch on the upper part of the opercle. Dorsal fin greenish at the base, then dusky, with a fairly broad transparent band along the upper edge, this band narrowed anteriorly. This dusky band becomes more intense as it progresses forward, becoming a black blotch on the anterior part of the fin. Caudal fin with upper and lower margins almost black. As can be seen from this description practically the only thing common to the male and female in their extreme stages, is the possession of black lobes to the caudal fin.

On the outer reefs, and observable down to depths of sixty to seventy feet are the yellow representatives of the species. A typical one has the general color of the body above and on the sides, including the caudal fin, rich yellow, sometimes with an orange tinge. Lower surface white or bluish tinged with pink. A broad band of terra-cotta red from the snout through the eye, continued as blotches on the preopercle and opercle. Dorsal fin greenish or grayish, sometimes almost colorless, with a pale blue marginal band, and with an intense black spot on the anterior membranes of the spinous portion of the fin. Caudal fin bluish along the upper and lower lobes.

In our aquariums some of these yellow fish have changed first to a pattern similar to that of the adult female, and then to "night" colora-

tion. This can be described as body grass green with six vertical whitish bands narrower than the interspaces, extending downward from near the dorsal fin and merging in the pale pinkish white of the abdomen and lower surfaces. Head bluish green above, the red spots and bands on the head present and conspicuous, this color continued through the eye. Dorsal and anal fins similar to the adult male Blue-head. Caudal fin with its upper and lower lobes bluish. In this form the quadrate black blotches of the adult female are occasionally present in the green.

It must be emphasized here that in the field at Bermuda, intermediate specimens between each of these extreme forms have been found, and individuals have been watched as they changed from one phase to another, so that the entire assemblage has been connected together as a single species.

In tracing the development of the color pattern, we can start with the relatively simple pattern of the smallest fish, which can be altered slightly, and watch the changes as the band on the head breaks up and as the lateral band on the body becomes a series of quadrate blotches, two of which later become the black vertical bands of the males. As the fish grow older, both males and females have the same general color and pattern, varying widely, and assuming yellow or night coloration as they choose. The females, always retain this generalized coloration, while the males at a little over three inches in standard length may show traces of their adult colors, and beyond this length they gradually assume their striking coloration. Even they show reluctance to limitation of their ability to vary, and may at the slightest cause, throw off most of their blue-head color and assume parts or nearly all of their consort's livery. But judging by the dissection of some fifty-two males, any fish that shows a trace of the blue head is a male.

As an easy means of tracing the development of the color patterns, the youngest fish taken by us (2/5ths of an inch long) is described first, its pattern dissected, and then each of these pattern elements followed through the life of the fish.

Young individuals of this size were found quite commonly in tide-pools, but they are not confined to shallow water and also frequent the outer reefs at thirty-five to forty feet depth. They are generally pale grass green above, the lower parts white with a marked pinkish tinge. There is a wide lateral band from the snout where it meets its fellow from the opposite side of the body, through the eye to the caudal fin; the portion on the head reddish to deep mahogany brown, that on the body black. A wide blackish-brown band extends down the middle of the dorsal surface from the interorbital space to the end of the dorsal fin, this is bordered below by a narrow pinkish band rather indefinite in extent. Anterior portion of the dorsal fin between the 1st and 5th spine black, the remainder of the fin dusky, becoming less so posteriorly, and with a rather wide transparent edge which increases in width posteriorly. The anal fin has a narrow, pinkish horizontal band near its base and the remainder of the fin is translucent. The caudal fin is also translucent with a faint yellowish tinge basally and a pinkish tinge in the middle of its lobes. Pectoral and ventral fins colorless.

This small specimen gives us the basic pattern from which all the later color phases are derived. The color units present in the small fish and the few that appear later are listed as follows:

1. General body color.
2. Dark band on body along base of dorsal.
3. Brown spots on side of head, continued as—
4. Black band along sides to caudal fin.
5. Spot on anterior portion of the dorsal fin.
6. Remainder of coloration of dorsal fin.
7. Anal fin coloration.
8. Caudal fin coloration.
9. Spot at base of pectoral fin.
10. Spot at tip of pectoral fin.

Taking these units individually the changes can be shown as follows:

1. *General Body Color.* In the smallest examples this is usually yellowish or greenish yellow above and white below, with pinkish edges to the scales. The yellow may disappear entirely, the result being a white fish with a horizontal black band. But as a general rule

as the fish grow older they retain these brilliant colors, becoming at times completely yellow above and whitish beneath, or else green above and pale below. In the adult male the entire posterior body is rich bottle green and the rest of the body color as it has already been described.

2. *Dark band on body at base of the dorsal fin.* This band is found only on the young and apparently disappears as a conspicuous color unit after an inch and a quarter has been reached, although it may be indicated as a darkening of the dorsal surface in still larger specimens.

3. *Brown band or spots on side of head.* This pattern is one of the most conspicuous and ranges through all stages with the exception of the adult males. In the smallest fish (2/5ths inch) it is in the form of a continuous band, beginning on the snout, going through the eye and crossing the opercle, then joining the black band along the middle of the sides. At an inch to an inch and a quarter the portion before the eye remains as a single elongate spot, while that behind the eye divides into three, the posterior of which is smallest and obliquely elongate. While the blue-head coloration of the male is being attained the group of red spots become smaller and eventually disappear. For a long while the absence of the red on the head of the adult male blue-head seemed to be the last stumbling block to connect this form with the others, but after two year's work, specimens with slight indications were found.

4. *Horizontal band along side of body.* In a 2/5ths inch fish this band is exceptionally prominent, usually quite intense in color and ends posteriorly in a slightly darker black spot which is absent in larger fish. The edges of the scales are pinkish in many smaller fish, similar to the scales of the lower surface, thus giving a pinkish-brown appearance to the band. Even during the earliest stages this band may break up into a series of quadrate spots, usually six in number, the individual fish changing back and forth through life from band to series of spots at will. From an inch and a half in length upwards, and possibly in smaller specimens also, although this has not been observed, this band may disappear entirely and this is especially true of the yellow form, where it is usually absent, but occasionally indicated by a slight duskiness or blueing.

In fish that are in what we have called the "night" phase, this band of spots becomes less intense in color, changing to lighter green, expanding and becoming more diffuse, and extending upward to the dorsal surface, thus producing a fish with wide green bands reaching from the dorsal surface to the lower sides, separated by narrow white bars. This coloration may be restricted to males, as so far we have found it only in that sex.

In the adult males the first and second of the dark quadrate areas are the beginning of the black bars on the anterior body. In males of complete blue-head pattern, however, the posterior spots may suddenly intrude themselves upon the green body.

5. *Spot on anterior portion of the dorsal fin.* This is present at all ages and in every fish examined. In the smallest fishes it is a broad oval, but it soon (¾ inch fish) occupies the space on the anterior membranes of the spinous dorsal from the 1st to the 3rd or 6th spine. The spot does not always extend to the bottom of the fin and it is surmounted above by pale blue. In fishes of reduced coloring it occasionally is reduced to a small spot between the 3rd and 4th spines.

6. *Remainder of dorsal fin.* In the youngest fish the upper part of the fin is transparent, the lower portion dusky, the dusky portion being a pale continuation backward of the anterior black spot. This dusky portion becomes lower and lower as it progresses backward and almost disappears at the posterior end of the fin. In slightly larger fish (1¼ inches) this dark lower part of the fin is present only as a trace. The fin in all later stages is dusky with a greenish tinge or green with a narrow, submarginal blackish line extending from the upper portion of the black spot to the posterior end of the fin, the submarginal band being bordered above by a marginal one of blue. The presence or absence of these lines is variable, and in pale specimens they are visible only as minute ghost lines.

7. *Anal fin coloration.* In small fish there is a narrow pinkish band near the base of the fin, the remainder of the fin being transparent with

a greenish tinge. In older fish this band disappears and the anal fin is transparent with a bluish or greenish border.

8. *Caudal fin coloration.* This fin is colorless in small fish, becoming tinged with blue or gray or green in larger specimens, and in the yellow phases it is often bright yellow mesially. The black along the upper and lower edges of the fin may appear at quite early stages. A ¾ inch fish shows well developed caudal lobe patterns. These black patterns come and go quite rapidly, and may be present or absent at any stage, although always present in the male blue-head.

9. *Spot at base of pectoral fin.* This very small black spot is present on all specimens over an inch in length; no indications of it can be found in smaller fish.

10. *Spot at tip of pectoral fin.* A diffuse black spot is present on the tip of the pectoral fins of larger specimens only.

Reference to the illustration will help to correlate the various elements of the color pattern. An attempt has been made to show by means of solid arrows the changes that occur with growth, and with broken arrows to indicate the temporary changes from one phase to another. It will also be noticed in the illustrations that there are other changes with age in the Blue-head, such as alterations in depth and size of head as well as a complete difference in the shape of the tail. The latter is rounded in the young, becoming truncate as the fish grows older, later somewhat crescentic, and in the adults the upper and lower lobes are produced, to a small degree in the female, and markedly so in the male.

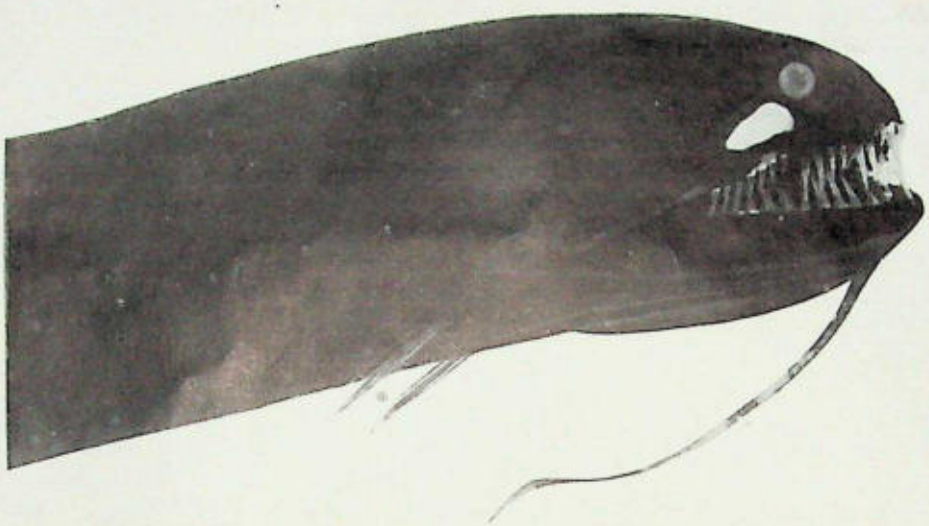
Just what value can be given to the assumption of this variegated and changing Joseph's coat of this wrasse is a question, because in no part of its life, does the Blue-head attempt to adapt its color to the surroundings. At all times it advertises itself, being either black and white or brilliant yellow, or equally bright green and blue. Coupled with this blazing outburst of color is the fact that it is always in evidence on the outside of the reefs, never attempting to hide in crevices or interstices in any way. As is the case with many other reef-inhabiting fishes of vivid coloring, it is doubtful if any value can be attached to the color, either from the standpoint of protective or warning coloration. The only evidence that the Blue-head might be considered as warningly colored, and which is of negative value only, is the fact that we have never taken Blue-heads in any color stage, from the stomach contents of the carnivorous reef-fishes among which they live.

The most abundant phase of the Blue-heads is the brilliant yellow one found mainly on the outer reefs, and whatever the conditions are that produce this color, it is of interest to note that a xanthistic phase is found also in three other Bermudian reef fishes, two of these being wrasses of the genus *Iridio* and the third the yellow surgeon-fish (*Acanthurus heliodes*), which most likely is the yellow form of the blue surgeon (*Acanthurus caeruleus*). The two Iridios and the yellow Blue-heads are often found together in small schools of twenty to thirty, or sometimes up to a hundred in deeper water, apparently paying no attention to each other but doubtless benefiting from association. Both of the Iridios in their normal forms are fairly dark fishes with conspicuous patterns, the first being *Iridio meyeri*, the yellow phase of which can be easily differentiated from the others by the possession of three reddish cross bands across the upper posterior portion of the head; the second, *Iridio garnoti*, which can be distinguished by a narrow blue line along the middle of the sides. The yellow surgeon-fish lives under exactly the same conditions as the others, with the exception that it is usually solitary.

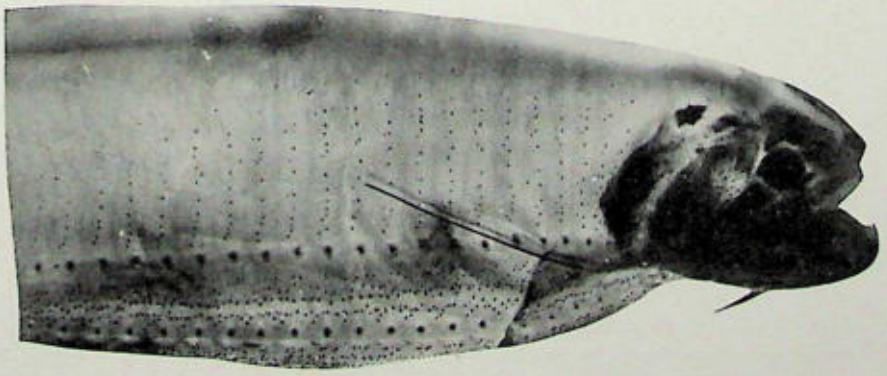
It must be noted, however, that the yellow phases of these three species are assumed only by medium-sized individuals, and it may possibly be that this coloring is characteristic of gregarious adolescent fish, which later spread out and become less sociable.

It can readily be seen that with all of this variation and indeterminateness, that any method or means that would make certain the identity of two fishes of intimate relationship but of casual resemblance, other than piecing minute bits of evidence together, would be of inestimable value in ichthyological studies.

Here lies the preventative of ichthyologist's gray hairs, and he who finds the substitute in fish for finger prints will be called blessed.







Upper, *Echiostoma ctenobarba* Parr, before irradiation. Center, Sun lamp of the Hanovia Chemical Company used for irradiating specimens. Lower, *Echiostoma ctenobarba* Parr, after irradiation, showing tiny skin photophores. Photographs by John Tee-Van and Amos Burg.

A New Use of Ultra-violet Radiation

GLORIA HOLLISTER

IN connection with my studies at Columbia University in 1924 and 1925 I was particularly interested in the bony structure of animals and used several well known tissue-clearing techniques to eliminate tedious and injurious dissection of the specimens. The clearing processes of Lundvall, Spalteholz, and Schultze have been used for many years. But after the specimens were run through the various chemicals to make the soft parts transparent the final results were never clear enough to satisfy my requirements.

During a certain phase of the process sunlight is a necessary agent to extract or bleach pigment from the tissues. Many times, just when the specimens had reached this critical stage, a prolonged spell of sunless days would make progress in depigmentation impossible. In the absence of the sun's rays I began to experiment with incubator heat and bleaching agents, such as hydrogen peroxide, ammonium hydroxide, and various acids. For some time I sought a controlled and adequate substitute for the rays of the sun. Finally, I decided to try exposing the specimens to ultra-violet rays.

Through the courtesy and generosity of the Hanovia Chemical Company of Newark, New Jersey, our department of Tropical Research have had the loan of a quartz mercury vapor arc lamp which is popularly known as an Alpine Sun Lamp. Because the ultra-violet produces pigmentation of the skin, society uses the Alpine Sun Lamp to acquire the popular winter sun-tan. This effect presents a startling antithesis to our results, the black deep-sea fish exposed to the lamp soon become bleached. In the living subject the ultra-violet acts as a catalytic agent producing chemical changes in the skin, but in lifeless tissues it becomes an oxidizing agent and bleaches the skin. This lamp proved so valuable in connection with the bleaching and clearing of hundreds of specimens that it has been in constant use since 1929 in the laboratory in New York City and in the field laboratory on Nonsuch Island, Bermuda.

The most harmless and satisfactory bleaching method had been exposure to sunlight, so the wonderful results from the ultra-violet light were not altogether unexpected. The great convenience of having the essence of sunlight under control in the laboratory ready for use when the specimens need bleaching cannot be overestimated. Ultra-violet rays are much more effective as a source of energy than sun rays.

This is the only treatment which, without damaging the specimens, will extract the black pigment from deep-sea fish and render the tissues crystal clear with every detail of bone visible. Another great advantage of using the ultra-violet light in conjunction wih the clearing process is the fact that the specimens treated are transparent and ready for study much sooner than those that have not been irradiated. Instead of taking weeks and months to complete the whole process it is now only a matter of hours and days.

The illustration shows the Alpine Sun Lamp in the process of irradiating black deep-sea fish. After several hours the exposed sides of the specimens were many shades lighter than the unexposed. The two photographs are of the same fish (*Echiostoma ctenobarba*) before and after two days' exposure to the ultra-violet. The color tone changed from jet black to light brown. The hundreds of minute light-organs in the skin were not visible until after irradiation for two days when the delicate photophores became as clear-cut as though etched. In order to appreciate the full significance of the light systems of deep-sea fish a study of the bleached specimen is almost necessary.

Numerous experiments were made to determine the best fluid in which to immerse the specimens while exposing them to the ultra-violet. Good results were had in combination with several solutions but by far the best proved to be weak sodium or potassium hydroxide. The irradiation in combination with either of these fluids not only bleaches the skin but speeds up the clearing of the tissues. Experiments were also tried to determine the best period during the clearing process to irradiate the specimens. For detailed study of the bony structure it is preferable to irradiate the fish during the early phase of the clearing process before the specimen is subjected to any specific dye.

The preceding introduces a new use of the ultra-violet in the domain of pure science. It

may be interesting now to consider the gradual development of modern heliotherapy from ancient heliolatry.

The existence and the continuation of life depend primarily on energy derived from the sun. Light is the great synthetic force on the earth's surface that stimulates plant and animal growth. Sunlight is the spark that fires the dormant life in plant seeds, and those that fall in a densely shaded spot in a tropical jungle have a poor chance to live. But the fortunate ones, encouraged even by intercepted rays flickering down through the branches of the giant trees, soon enter the competition of the jungle—the rapid race upward to the open fields of treetops and sunshine.

Aquatic plant life also needs light and consequently many of the attached algae are found growing near the surface of the water. In addition, plankton-algae are found only in the upper water layers. As far as we know all forms live within the light penetrating zone.

Many animals instinctively seek the sunshine for a certain part of each day. Like animals, man has worshipped the sun ever since he lost his coat of hair and became man. During the time of drought primitive man worshipped rain-gods and during prolonged rain-spells sun-gods were evoked to help the crops. To-day, the clergy pray to their Supreme Deity to send rain and sun.

In the era of ancient Rome and Roman baths the healthful effects of the sun were recognized and for many years sunshine has been the basis of doctor's prescriptions for those who wished to retain or recover health.

Recently, the vital and apparently indispensible element of the solar rays has been discovered—the ultra-violet. Although the ultra-violet is invisible and according to Cobletz and Stair constitutes less than one per cent. of the solar radiations it is considered the necessary element of sunshine. A single quartz-mercury vapor lamp emits a flood of light which contains approximately twenty-eight per cent. ultra-violet rays which is about twenty-eight times more than is radiated by the sun. It produces artificially the chemical force which the sun supplies in such a small amount.

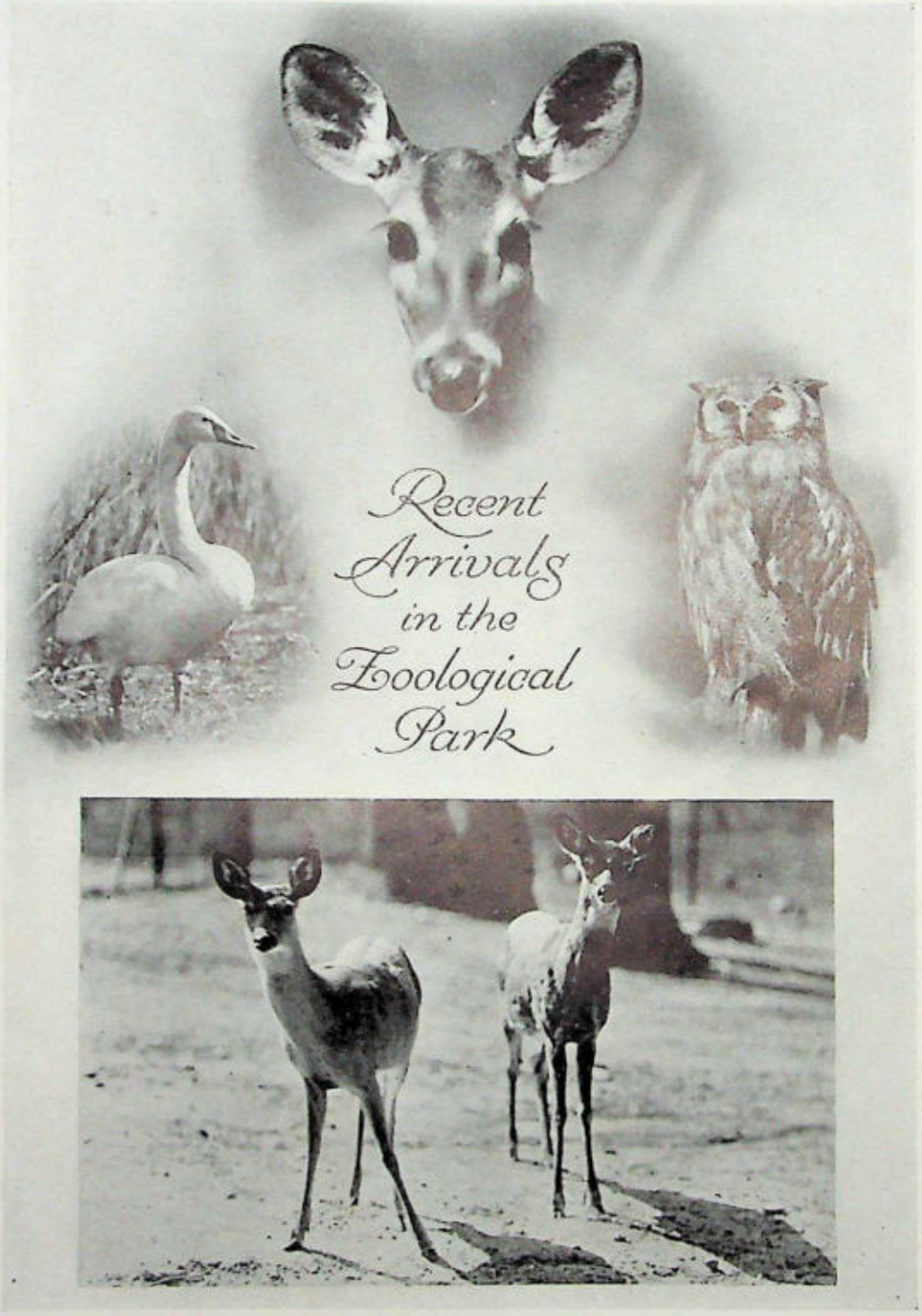
In the commercial and utilitarian world the use of the ultra-violet rays is now widespread. Recent experiments show that certain plants will grow continuously for twenty-four hours if radiated with light. Growth is not checked by excluding ultra-violet rays from the light but the food value is seriously affected for vitamin D is lacking which is valuable in preventing rickets. This quality is readily added by irradiation with ultra-violet rays.

About a decade ago ultra-violet was first tried on poultry as a substitute for sunshine. The beneficial results were so marked that now most commercial poultry farms irradiate the birds, both young and old, at least once a day during the winter months when the sun is low and confinement indoors is necessary. Among the young birds receiving this treatment loss from disease is infrequent and growth and maturity are much more rapid. Fertility and hatchability of the eggs from the old birds irradiated are improved about twenty per cent. and egg production is increased about six times. Veterinarians in private practice and in charge of zoos employ the ultra-violet for preventative and therapeutic measures.

A comparatively new experiment is the irradiation of foods for human consumption such as milk, bread, and cod-liver oil. Initial results hint that this may be a valuable way to revitalize our food and increase its energy producing qualities for the motive power of our bodies and brains.

In the medical world the modern uses of the ultra-violet are many and varied. Physicians use heliotherapy constantly. Because the ultra-violet is powerful in killing bacteria on the surface it is widely used for specific treatment. Dr. Hess has demonstrated that the young, rapidly growing infant thrives best when deprived of the visible rays than when deprived of the ultra-violet rays of the sun. With babies and children the ultra-violet acts as a preventive for rickets, nutritional diseases, and antigrowth factors. Ergosterol, which is present in foods and the skin, is activated by ultra-violet rays and becomes vitamin D which is required for bone formation. This fact alone emphasises the great importance of getting rid of smoke pollution of the air. Smoke, fog, walls, glass, and cloths cut off the ultra-violet rays.

It is an interesting fact that the ultra-violet which is used in so many practical ways can also be a vital tool in the intellectual realm of pure science.



Left, Whooping swan. *Right*, Milky eagle owl. *Lower*, White-tailed Deer.
Photographs by E. R. Osterndorff.



Upper. Young chimpanzee. *Center.* Black-bellied sand grouse. *Lower.* Nine-banded armadillo.
Photographs by E. R. Osterndorff.



Upper. Dalmatian pelican. *Center.* Capybara. *Lower.* European hedgehog.
Photographs by E. R. Osterndorff.



An Australian settler's homestead on the Murray River. Spotted bower-birds frequent the pepper-trees growing close to the main buildings. The bowers of this species are longer than those of the satin bower-bird, in many instances as much as three feet in length. They are outwardly built of twigs, beautifully lined with tall grasses so arranged that their heads meet. These bowers are decorated profusely with bivalve shells, and the crania of small mammals. Frequently the bowers are built at considerable distances from rivers, from the borders of which the birds could alone have procured the shells and pebbles; their collection and transportation, therefore, is a task of great labor. The nests are rather primitive and in no way compare with the elaborate work expended on the bowers. Photograph by Charles Barrett.

The Bower-Birds and Their Bowers

Some interesting notes by Charles Barrett on the Bower-building birds of Australia and the adjacent Islands, supplemented by observations made in the Zoological Park by Lee S. Crandall, Curator of Birds, concerning the Bower-birds, and the bower-painting of the Satin Bower-bird.

Illustrations from field photographs made in Australia by Charles Barrett and other naturalists, and from photographs taken in the Zoological Park.

THE more we learn of animal behavior in the wilderness, the less convincing become the theories based upon the "control" experiments by the professional psychologist. As a field naturalist, I have good reason to differ from such theories particularly concerning the habits and emotions of animals which I have watched often in the field. This brief introduction to a consideration of the Bower-birds will serve its purpose if taken as my reason—not excuse—for writing of Australia's wonder birds without using terms that are dear to the scientific behaviorist.

Recent independent observations by several accredited naturalists have confirmed those made a few years ago by a lonely watcher of the satin bower-bird (*Ptilonorhynchus violaceus*). This bird unquestionably uses a decorative *tool* purposely, and evidently derives pleasure in the beauty of its bower! No discovery in the realm of bird behavior more remarkable than this—that the satin bird paints its bower, using a "brush" for the purpose—has been made, at least to my knowledge.

The "painter" and other species form a fascinating group; and it has been my fortune to see many Bower-birds in their haunts, to observe them at their bowers, and even get on friendly terms with individuals.

New Guinea's Gardener bower-bird (*Amblyornis inornatus*) ranks higher than any other species in its appreciation of beauty—"an appreciation," as Professor Alfred Newton said, "perhaps unparalleled in the animal world." At the base of a small tree usually the Gardener builds, not a bower, but a hut-like structure about two feet in height, with a sloping roof of orchid stems that reach to the ground and radiate in a regular manner from the central support. A cone-shaped mass of moss crowns the support and shelters the gallery round it. Before the open front of their hut, the birds make a garden and place in it gaily colored flowers and berries which are arranged on a bed of green moss. As they wither, these blossoms and berries are removed to a heap behind the hut, and the "spot" is decorated anew.

I have no personal acquaintance with the Gardener, but the facts stated are well attested, and deserve a place in any general account of the Bower-birds.

The golden bower-bird (*Prionodura newtoniana*), with a limited range in north-eastern Queensland, is the master builder among the Australian species, and the most beautiful. The male is a brown and golden bird, with a short crest and neck collar of the bright yellow color which is more charming than that of real gold. The female is demurely dressed in brown. The bower or playground of the golden bird is notable for its size as well as architecture.

The only bower of the golden bird I have seen is that in a National Museum (Melbourne) group. Mr. S. W. Jackson, a field ornithologist with many discoveries to his credit, was the first to publish (in "The Emu") a photograph of the golden bower-bird's playground, and I quote his own excellent description: "The bower . . . which I photographed covered an area fourteen feet by six feet, and in the center the pile of sticks was over four feet high. The whole structure appeared to have no symmetry at all, most of the sticks being piled up about the upright stems of small trees. In the decorations there were large quantities of a long stringy forest moss, varying in color from a yellowish-green to a rich rust color; I also saw numbers of open pods, each containing a black seed, the latter in most cases being covered with a red skin, which was, however, in a state of decortication. In front of the bower and close to the ground hung a vine (*Viti*) in swing form, and this in all probability afforded a swing for these beautiful birds during their play at the bower."

I visited the golden bower-birds' haunts, when on the trail of the tree-kangaroo, but a search for bowers was unsuccessful. Scrubs in the



Male satin bower-bird at the entrance of its bower. Of all the species of bower-birds, this is perhaps the oldest and best known. The bower is usually built in the forest under the shelter of overhanging branches, and in locating its position, a space of two or three feet in diameter is carefully cleared of all debris. The bower is constructed of slender twigs inserted in the ground, arranged so that the tips curve inward and nearly meet at the top. The interior materials are so placed as to offer no obstruction to the entrance of the birds. The male is the chief workman, in the construction of the bower, which is decorated with any brilliant or curious materials that the birds can find, such as gaily colored feathers, bleached bones and shells. It is only the scene of courtship. Photograph by Charles Barrett.

Barron River Valley have been tamed for farming, are being cleared, or are doomed to destruction. Every year the area of wild, beautiful country becomes smaller. One envies the pioneer naturalists in this glorious region. They explored the scrubs or brushes before the richness of the soil germinated, in "practical" minds, the seed of desire for Atherton and other areas. The valley of the Barron offers the most romantic river-gorge scenery in Australia. And, before the era of clearing and cultivation, the tableland, covered in splendid rain-forest, was a paradise for nature lovers. Wild nature has still a share of that region, but is losing it steadily. Has not Atherton tableland soil been described by a great authority as the richest for agriculture in the world? No wonder birds receive scant consideration when their haunts are coveted by farmers! We can hope only that permanent reservations will save the native fauna to delight our descendants.

Kendall Broadbent, whom I knew in his old age, was one of those pioneer naturalists; he discovered the golden bower-bird, in 1882, and gave the original description of its wonderful playground, with little hut-like structures (gunyahs—aboriginal shelters or "huts," he termed them) dotted around it. Five huts were counted in a space only ten feet in diameter. The playing-place with its gunyahs resembled a blacks' camp in miniature. The birds, in their play, chase each other, running in and around the gunyahs!

Usually the bower is built on the ground, either between a bush and a tree, or between two trees. Twigs and small sticks comprise the building material. In the form, roughly, of a pyramid, they are piled around one tree trunk, more or less horizontally, to a height which varies from three or four feet to eight feet, or even a foot higher. One of the bower walls is raised perhaps several feet higher than the other. Around the trunk of the second tree is built a similar, but much lower, pile of sticks and twigs, while stems of climbing plants are used in the construction of an archway between the two pyramids. The arch, the higher wall and the runway are decorated by the bird builders, with white moss, clusters of green, grape-like fruits, blossoms and fern fronds.

Concerning those captivating little huts, opinions differ. Mr. George Sharp, who discovered the first-known nest and eggs of *Prionodura*, states that male birds only assemble at the huge bower, but the females also build bowers, about half the size of that sacred to the male. Mr. Alec H. Chisholm, in his notable book, "Birds and Green Places," records these observations and offers them as a possible explanation of the golden bower-birds' enterprise. What struck Kendall Broadbent as mimic blackfellows' gunyahs, he remarks, "were probably nothing more nor less than manifestations of feminine independence in the genus *Prionodura*."

The golden bower-bird is richly endowed; to its skill as a builder and decorator, is added the power of mimicry. It imitates the calls and song notes of its feathered neighbors, and even the musical croaking of tree-frogs.

Rivalling it in beauty, the Regent bower-bird (*Sericulus melinus*) of northern New South Wales and southern Queensland, ranks far below *Prionodura* as an architect and builder. Indeed, this lovely bird—the male has rich black and yellow plumage—is at the Stone Age of bower-building. But we must judge it on comparatively few examples of its work. Strangely, though the birds are numerous in many parts of their range, less than a score of their bowers have been recorded since 1863, when the first one known to science was discovered. I have camped often in Regent birds' haunts, and spent many an hour observing the black and golden species, yet only one bower of the species has rewarded all my keen searching.

It was in a rocky bit of country, thinly timbered, but with patches of scrub, that I saw my one and only Regent bird's bower. With other naturalists, I had motored from Rockhampton, the capital of Central Queensland, to inspect Olsen's Caves. Three of us left the main party at the caves and wandered off through the Bush. I was collecting land snails, abundant among the rocks, when a shout rang through the timber, "A Regents' bower!" Snails were forgotten, I ran through the scrub towards my lucky companion.

The bower, built on the ground in the lee of a scraggy shrub, was the most primitive structure of the kind I had ever seen. Merely two walls of sticks, loosely constructed, with a suggestion of arching. The walls were seven to eight inches in height and rose from a bed of



"Painted" twigs from a bower of the satin bower-bird, in the Zoological Park. The significance of this newly discovered habit is not yet understood. The substance with which the twigs pictured have been decorated, is a decayed wood-pulp, mixed with a secretion of the bird's mouth. Photograph by E. R. Osterndorff.

sticks, irregularly. At the base they measured about six inches in width, less than half that midway to the top, where they tapered. The avenue was barely four inches across, and a few empty snail shells and freshly-plucked leaves were lying in, or close to, the bower.

But the Regent bird may gain as much pleasure from its primitive bower as the golden species does from its huge and elaborate structure. Here is Mr. A. G. Campbell's description of Regent birds at play: "When first seen there were three birds playing in the bower; two were what we took to be males—but they were immature—and the other was a female. The antics they went through were extraordinary, and they were not in the least disturbed by our presence. One would go into the center of the bower and, picking up a shell, of which there were three, would dance, half opening its wings and then tossing the shell in the air or over its head would run out. While this was going on the other two birds outside were scraping or sweeping the ground with their wings, and when the shell fell, one would pick it up and enter the bower to go through the same performance as the first bird, and so on." ("Nests & Eggs of Austln. Birds.")

Courtship doubtless has its place at "these highly decorated halls of assembly," as John Gould termed the avian bowers; but the observations of many naturalists and others since the great ornithologist's day have proved that the love emotion alone is not responsible for the bower-building habit. The birds build and use them at other times of the year than the breeding season; and both playgrounds and bowers are resorted to for "games" as well as for display and love-making. Besides, they are a manifestation of the birds' aesthetic sensibility. Those who have seen many bowers and playgrounds and observed the actions of their makers, have no doubts upon this point: Bower-birds appreciate beauty, though it be only that of an old bleached bone! Tastes differ with the species, however, and the satin bird, which delights in blue flowers and berries, is not a keen collector of bones.

I offer no theory as to the origin of bower-building among birds—a few species in this island-continent and its northern neighbor, New

Guinea. But consider the ways of the cat-birds, and formulate your own theory. New Guinea has several species; in Australia there are three kinds of Cat-birds, named for their curious notes, which, in some species, resemble the complaining voice of a domestic cat. The tooth-billed bower-bird (*Scenopaeetes dentirostris*), of North Queensland, is found in a restricted area, and is much less familiar than the cat-bird (*Aeluroedus viridis*), of South-eastern Queensland and the coastal region of New South Wales. The former species is classed as a cat-bird, though not cat-voiced; it is an excellent vocal mimic, almost rivalling that famous "mocker"—*Menura*, the lyre-bird.

The cat-bird, which is chiefly green in color, inhabits dense sub-tropical jungles, or scrubs as we term them, of the coastal regions. Its mew-mew call is frequently heard: it was one of the familiar sounds around our camp on the Williams River, New South Wales. The second mew is louder than the first lamentable note; and it was not mere fancy that suggested the popular name for this member of the sub-family Ptilonorhynchinae—bower-birds. Unlike the tooth-billed species, *Ailuraedus* is not a mimic of other birds' notes. The spotted cat-bird (*A.maculosus*) is a North Queensland species.

It is stated that cat-birds (*Ailuraedus*) occasionally form a playground of very primitive type; but I have never seen one, and agree with a friend, Alec. Chisholm, that the practice is not general with these birds. Admit a beginning, a step towards the playground, and the bower-building habit, what is the next stage? The tooth-billed bower-bird's habits, perhaps, represent it. This brown-plumaged dweller in tropical jungle, with its curious notched bill, has the playground habit, though not a builder of bowers. Like the lyre-bird, it clears a space, but not to form a dancing mound. The area, several square yards in extent (Jackson measured one twenty-six feet in circumference), is raked clean by the birds, all dead leaves, and sticks being removed. On the bare ground fresh green leaves are placed, with very rare exceptions, upside down. From about a dozen to over thirty leaves may decorate one playground. They are long leaves from a scrub tree (*Litsea dealbata*), and light-colored on the under sur-



Location of the bower of a satin bower-bird in the National Park, near Sydney, Australia. The large tree in the center of the picture is a giant Eucalyptus, and the bower was built in the scrub almost directly beneath it. A much travelled motor road was about one hundred yards distant. Photograph by Lee S. Crandall.



Haunt of the Regent bird in a cabbage palm grove on the borders of a swamp in southern Queensland. This species is the most beautifully plumaged bird known in Australia; a gorgeous combination of orange yellow and black. The male is about ten inches in length and the female, which is rather dull in color, is slightly larger. The bowers of these birds are small and rather primitive, not greater than ten inches in length. Photograph by Charles Barrett.

face. When they wither and begin to curl, they are removed from the cleared space, which is decorated with fresh ones.

The tooth-bill plays with its *Litsea* leaves—toys is perhaps a better term, and also spends hours, perched, at the playground, during which time it utters its own harsh notes, now and then mimicking the calls of other birds that inhabit the scrub. One bird only, according to Jackson's observations, frequents the playground: a fact that tells against the courtship theory.

None of the other bower-birds is so well known as the satin species, *Ptilonorhynchus violaceus;* none has been so extensively studied. It is widely distributed in Eastern Australia, chiefly the coastal region, from North Queensland to Victoria, where it inhabits the southern forest country, being numerous in many parts of Gippsland. An unfortunate acquired taste for cultivated fruit has made the satin bower-bird unpopular with orchardists in some localities, while it is also rather destructve in gardens and cultivation plots near its haunts, being fond of clover blossoms, sweet potato tubers and cabbages, as well as of cherries and strawberries. Flocks of these birds have been known to strip, in a week, several acres of mandarin orange trees.

Doubtless their depredations have been exaggerated, and satin-birds are not much persecuted in Victoria. They are partial to cake and meat sandwiches, and will fly down close to a picnic party in a national park, or other much frequented spot in their haunts, to take proffered tit-bits.

I have observed, at a distance of two or three yards, a satin bird eating a ham sandwich! This was in the great National Park near Sydney, New South Wales' capital city, where satin birds are commonly seen, and where many of their bowers have been located: one is built close to a roadway which, on Sundays especially, is busy with motor car traffic. Another bower is within "cooee" of a favorite picnic spot. In fact, without going far off beaten tracks, one may visit nearly a dozen play-halls of *Ptilonorhynchus* in Sydney's National Park, where all wild life is well protected.

The male satin bird in full adult plumage, attained at the age of about seven years, is very beautiful, being of a lustrous blue-black color. The eyes are violet-blue, and it is a striking fact that this species manifests a strong preference for blue or blue-tinged objects—flowers, fruits and berries, feathers, even scraps of paper. Experiments have proved this preference. Pieces of paper, cloth, or wool, of various colors have been scattered in the vicinity of bowers; and, in most cases only those of a blue or violet color, either pale or brilliant, were carried off by the birds to their playgrounds. Once, I dropped bits of orange peel at a bower and when the male bird appeared after I went into hiding, he displayed annoyance. The orange-colored objects offended his eyes, for he picked them up deliberately, one by one, and deposited them some yards away from the bower. But polished brown and yellow-brown land shells are commonly found decorating the bowers, or lying close to them. Blue feathers of the crimson rosella (*platycercus elegans*) and other parrots are frequent among the decorations, as also are blossoms of the favorite color, from Bush plants or gardens. Yellow feathers and green ones are given a place, but, in my experience, blue is ever the dominant color note, while red or orange-red is not tolerated.

The color sense of this species, then, is highly developed; it is a blue bird in more than one sense, and amazingly purposive in the decoration of its bower and the cleared space round about it.

While the structures vary a good deal in neatness, they conform to a general plan. A small stick platform first is laid down, and on this base the birds construct two arched walls of sticks, rising to a height of about eighteen inches. The walls may be rather spreading, or beautifully arched with the tops of the longer sticks touching. Again, at the top, the walls may curve slightly outwards. Degrees of skill are evident, if a number of bowers be examined. The less symmetrical bowers may be the work of young birds, apprentices to the craft; but that is mere conjecture.

The avenue in these arched bowers is, usually, about eighteen inches in length. We have watched the builders at work—a fascinating sight, you may imagine. Here, again, the satin bird is selective: it chooses long sticks or twigs, and often is particular in placing them. I have seen a bird fix a stick in the bower wall, remove

it an inch or two, fix it anew, and then be dissatisfied!

More remarkable than its color-sense, than any habit hitherto observed in birds of any species, is the satin bird's use of a "brush" and "paint" in decorative work on its bower! Long before the "brush" was noted, "painted" bowers had been recorded. One I saw had the grey sticks of its inner walls blackened from the base to a height of six or eight inches. They appeared to be stained rather than painted, but on rubbing a few sticks lightly, I had black smudges on my fingers.

Only in recent years has the satin bird's habit of painting its bower walls been observed, though there is no doubt that this unique avian "craft" is constantly practised. Even more recently, the use of a "brush" by the bird was brought under notice.

The principal material for painting is charcoal, pieces of which the bird crunches in its bill. Several observers have described how the "brush" is made and used. Mr. K. A. Hindwood, an Australian ornithologist of the younger generation, on a November morning, watched the whole process at a bower in Sydney's National Park. A male bird, on three occasions, picked up pieces of fibrous bark and, rolling them in his bill, produced a wad. This was the paint-brush, and he kept it inside his bill, except once when an end of the bark protruded. Black substance oozed from between the upper and lower mandibles, and the feathered artist painted the bower walls by wiping his bill against the sticks. Some of the sticks, when examined later, were found to have a brownish substance on them, so that charcoal is not the only raw material of bower-bird paint.

Mr. Norman Chaffer, a bird photographer, in October last, from a hide close to the bower, saw a male satin bird prepare brushes and paint its play-hall. First, small pieces—two or three inches long—of fibrous bark were deposited on the edge of the platform. Then, seizing a piece by the centre, the bird gradually drew it into his mouth by a sort of nibbling action of the mandibles. This was the prelude to painting. "Each stick was carefully and unhurriedly coated. The head, held sideways, was moved up and down, the sticks sometimes being passed between the mandibles. Moisture exuding from the sides of the bill was wiped on to the sticks." (Emu, April, 1931).

The genus *Chlamydera* contains five species, one being a New Guinea bird, the others, natives of Australia. I am well acquained with the spotted bower-bird (*Chlamydera maculata*), which is widely distributed in the drier inland provinces of the eastern half of the continent. It favors the scrub and open, timbered areas, and ranges from Queensland to South Australia. This species has brown plumage spotted with white, the abdomen being of a light creamy-buff color; the flanks are barred with dusky brown, and the tail is buff-tipped. The bird's chief beauty is in the mantle of plumes on the nape of the neck, which are of a lovely rose-lilac color and opalescent.

When staying at Kulkyne, a cattle station (ranch) on the Murray River, in north-western Victoria, I was introduced to a friendly pair of spotted bower-birds. They frequented the pepper trees (*Schinus molle*), growing around the homestead, when not at their playground or away in the scrub, foraging or seeking more decorations for the bower.

Beneath a great straggling clump of boxthorn (*Lycium chinense*)—like the pepper-tree, an alien which flourishes in Australia—the bower was situated. Neatly and strongly built, its parallel walls were composed of grass stalks (inside) and sticks (exterior) fixed into the ground at varying angles. The avenue floor consisted of twigs, trampled down compactly. Around the bower, the twig platform extended, but not widely; it was larger at one entrance than the other—a main approach. A collection of bright objects was strewn and piled at either end of the bower: scores of bleached bones (including a parrot's skull and ribs and vertebrae of sheep), pieces of weather-worn glass (blue and green), a few blue feathers, five glass bottle-stoppers, many fresh, glossy leaves, some red berries—and a large pellet of lead. There were bones inside the bower, but only a few. At another playground, the decorations included over one hundred bones, some large ones, and bits of emu eggshell. Silver coins have been found among bower-birds' treasures, and even pieces of jewelry, lost in the Bush by their owners, have been recovered at a playground of the spotted bower-bird. I have heard of a silver watch being found amid the collection of bones!



Bower of a satin bower-bird in the National Park, near Sydney. At the beginning of the breeding season, the sexes meet in these curious bowers in which the males display their plumage and perform amatory antics. This species has been exhibited in the Zoological Park, and when suitable twigs were supplied, provided an interesting picture of its dexterity and skill in the construction of the bower. The food of the satin bower-bird in its habitat is almost exclusively berries and small fruits. At certain seasons, concentrated raids upon cultivated fruits by flocks of the birds have led to their decimation, through the shot-guns of the settlers. Photograph by Charles Barrett.

Consider the industry of these birds; at one bower, in Queensland, more than 1,300 bones were accumulated.

The Kulkyne birds' playground was in the vicinity of the "Isle of the Dead,"* the lonely and beautiful burial place of an extinct aboriginal tribe. The isle is really a great, flattened sand dune, with the river flowing past one side and a creek around the other. Hundreds of blacks lie buried in the sand. Some of the graves are marked by rotting logs, piled there by men who long ago themselves were buried on the isle, and in spring and early summer, the dune is alight with wild flowers.

The yellow-spotted or guttated bower-bird (*Chlamydera guttata*) is one of the little known kinds, inhabiting Western and North-western Australia, the Northern Territory, and also Central Australia. The great bower-bird (*Chlamydera nuchalis*), of North Queensland and the Northern Territory of Australia, constructs

* Bulletin, N. Y. Zoo. Soc., July-August, 1931



Fawn-breasted bower-bird in the Zoological Park. The habitat of this species is South New Guinea, Louisiade Archipelago and Cape York, in northern Australia. The bower of the fawn-breast is much larger than that of the satin bower-bird, a rather graceful structure, suited to a bird of more gorgeous plumage than its rather somber colored constructor. Photograph by E. R. Osterndorff.

bowers with arching walls about eighteen inches in height, while the avenue measures perhaps thirty inches in length, and is sixteen or eighteen inches wide at each entrance. The stick walls rise from a foundation of the same material. Decorations consist of bleached snail shells and bones, small stones (in some cases), and Bush fruits, all heaped around the entrances.

The fawn-breasted bower-bird (*Chlamydera cerviniventris*) inhabits far North Queensland, some of the Torres Strait islands, and the adjacent coastland of New Guinea. It was discovered at Cape York by John Macgillivray, naturalist on board the *Rattlesnake*, the ship of a famous voyage during 1846-50, in our tropic seas and those of New Guinea and the Louisiade Archipelago. The bower found by Macgillivray, in low scrub half a mile from the beach, near the most northerly point of Australia, was removed to the ship, and ultimately reached the British Museum (Natural History), where it was duly placed on exhibition. It measured, when discovered four feet in length and the walls were eighteen inches in height. Some fresh berries are mentioned as among the decorations. The platform was very thick and composed of thicker twigs than those forming the wide and nearly upright walls.

The bowers, of course, have no connection with nesting, beyond the courtship link, if, indeed, the play-places are used for such purposes in the mating season. Descriptions of elaborate displays, attributed to courtship ardor, have been published. I have witnessed such antics, and also have seen bower-builders enjoying "play-abouts" that obviously had nothing to do with courtship. Male birds frequent the bowers when no females are present to admire their beauty and their graceful or (in our eyes) curious activities. Nests may be built far from any bower.

Generally speaking, the nests are saucer-shaped and composed of sticks, small or large, or chiefly of fine twigs. The golden bower-bird favors bark as nest-material, and mostly builds fairly close to the ground. Other species (spotted bower-bird, and cat-birds) nest high or low, often elevated nearly sixty feet in a tree of the jungle. The satin bird's leaf-lined bowl of sticks usually is situated from forty feet to fifty feet up in a forest tree.

The eggs of some species are curiously marked. Cat-birds lay cream-colored eggs with a dull surface; those of the tooth-billed species have a greenish tinge. The satin bird's eggs also are cream colored, but blotched and streaked with cinnamon-brown and umber; there are also some markings in purplish grey. The spotted bower-bird's eggs have been justly likened to hand-painted ovals of porcelain. The shape is long oval, or inclined to oval, and the slightly glossy shell is of fine texture. On a pale greenish-yellow or creamy ground color appear light grey streaks and blotches, on the inner surface, then hair-fine streaks or lines, in umber and light sienna, zig-zagging around the shell. Finally, comes an overlay of umber markings, few, but heavier and darker than the thin streakings. The regent-bird's eggs also have hair-like markings, which might have been painted on the shell with a fine camel-hair brush; the ground color is of a light-yellowish-stone tint, spotted and blotched with olive-brown or sienna. The golden bower-bird's eggs are pure white. Clutches vary in size. The satin bird lays from two to three eggs; the spotted bower-bird, two, three occasionally; the great bower-bird, one, or two; the regent bird, two, or three occasionally.

Once upon a time, it is worth remembering, the structures due to the skill and aesthetic sense so highly developed in our bower-birds, were thought to be aboriginal cradles! At least, some of the early colonists held that opinion, according to John Gould, who declares that the bowers must be regarded "as the most wonderful instances of bird architecture yet discovered." We have learned much since the great ornithologist made known to the world the amazing bower habits of the bower-builders; but, assuredly, we do not know all the chapters of their life history, and habits as remarkable as the satin bird's "brush"-making and bower-painting may yet be revealed to patient observers.

Some Notes on the Bower-birds in the Zoological Park

Lee S. Crandall

In the preceding article, Mr. Barrett has covered the bower-birds so thoroughly and so well that I can add only confirmation through my own comparatively meagre observations.

The play-house building habits of these birds are extremely interesting; while much has been learned concerning them, other facts undoubtedly await discovery. The "painting" done by a species as well known as the satin bower-bird, first made known in 1924, is a case in point.

A beautiful pair of satin bower-birds which came to the Zoological Park, via Europe, in July, 1909, were probably the first of their kind to reach America alive. Since that time, we have never been without them, as well as various other species of the family. The male of this original pair was in the green plumage of immaturity when he arrived. But a year later, during his first molt with us, he assumed the brilliant, blue-black of the adult. Mr. Barrett makes reference to the statement that seven years must pass before this color change takes place. This claim was first set forth, I believe, by the late Dudley Le Souef, of Melbourne. We never have had a young bird of known age, so that an exact check has been impossible. I do know, however, that of the several young males we have had, none has passed his first molt here without showing color. Moreover, since all of these birds were obtained from Australian dealers, it seems most unlikely that they had reached an age of five or six years before being exported. I think most naturalists will agree that this point requires further observation.

Although this bird lived with us for over ten years, he made no attempt to build a bower, perhaps because his cage was not sufficiently large. Before his death, another adult male was obtained and placed in the large flying cage in the Bird House. In January, 1921, this second bird was seen to be piling dried leaves in two parallel rows. He was given a supply of straight, slender twigs, with which he immediately began to build a bower. By evening, it was complete, the twigs being set together so strongly that the structure could be picked up intact from the leaf-covered concrete of the floor.

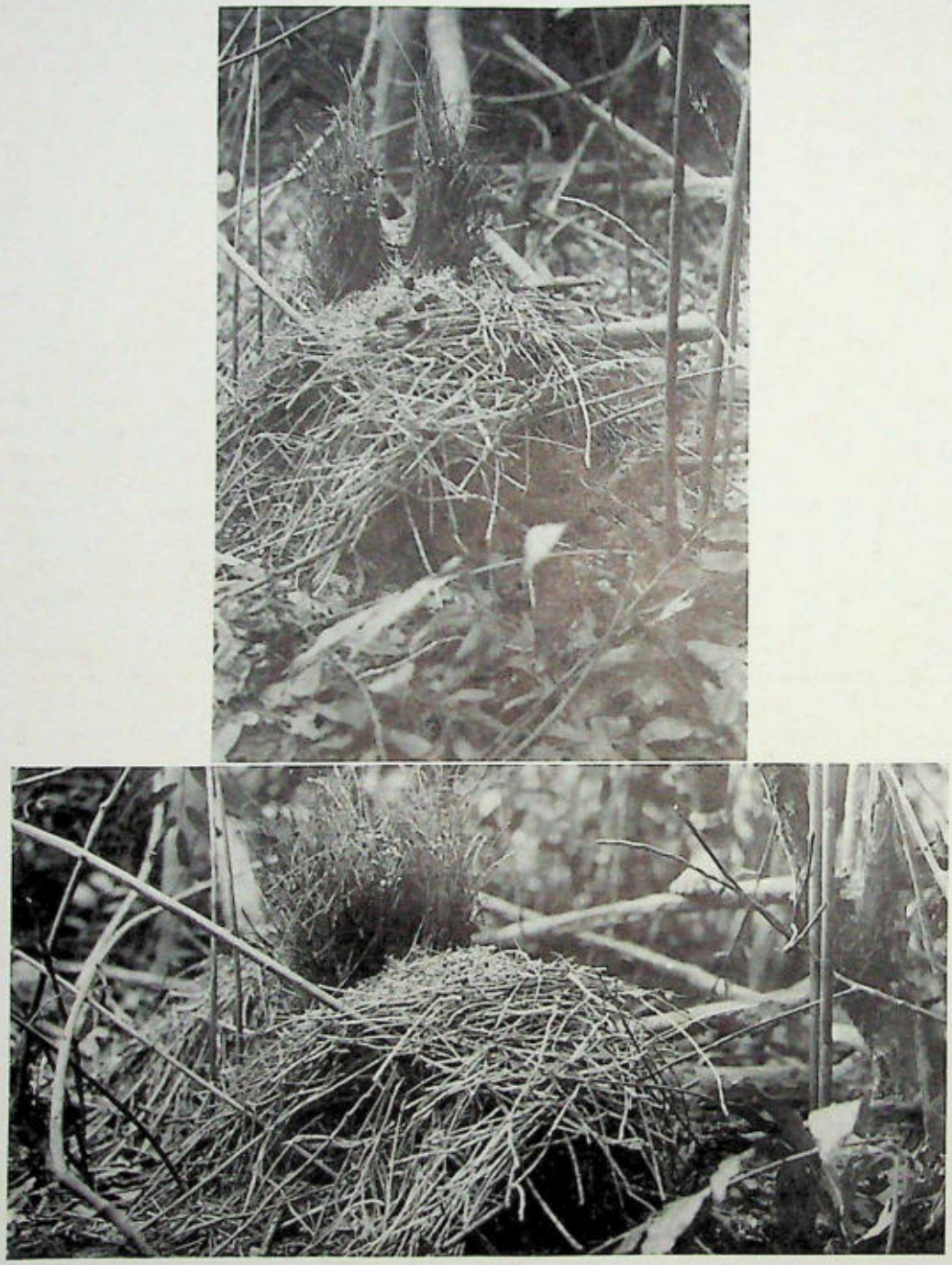
Since that time, except for short gaps, we have had a bower to exhibit continuously, and many thousands of visitors have had opportunity to observe the strange ability of this bird, as well as his ludicrous courtship antics. The gaps that have occurred appear to be caused by an irregular periodicity in the builder's interest. I do no know whether or not this takes place in the wilds, but with us there are times, apparently not connected with the molt, when the bird allows the bower to become neglected. The twigs are then invariably carried off by love birds and other inmates of the aviary. These lapses usually occur between January and June, and may endure a month or even more. Since the beginning of the Australian winter comes within this period, we may find the explanation there.

Bower-birds are not content with the mere erection of the structure but add various decorations as well. The fawn-breasted, which I observed in New Guinea, trims the platform at the front of the bower, as well as the tips of the twigs themselves, with small green berries of several kinds. The satin, as far as I know, never adds ornaments to the walls of the bower, but places them near one entrance or on the floor. He moves them about frequently, often holding one in his beak while dancing through and about the bower. Any small object will do but there seems to be no doubt that he has a decided perference for blue.

I once tried one of our birds with bits of colored yarn, hung in a row in the wire of his aviary. There were several pieces of red and of gold, with light blue in the minority. The bird took all of the latter to his bower, first, then one piece of gold. The red he would not touch. When offered small feathers, he chose first blue, then yellow, then blue-and-red. The pure red ones he would not have.

I have noticed, many times, that when the satin bird is dancing, the lovely, violet-blue eyes are invariably widely opened, even bulging. There may very well be a connection between the coloration of the eye and the shade of the ornament the dancer chooses. Our own birds make use of such playthings as they can find—usually a marble or two of blue glass (furnished by indulgent keepers!), blue feathers, even peanut shells or dried bits of fish, filched from the food tins of cage-mates. A bower of a wild bird, which I examined in the National Park, near Sydney, Australia, in 1928, contained, as ornaments, blue tail feathers of the Pennant parrakeet, some bits of blue and white crockery, a peanut shell, and several small, yellowish-green blossoms. There was nothing red.

The "painting" habit of the satin bower-bird, referred to by Mr. Barrett, is a most remark-



Upper. Bower of the fawn-breasted bower-bird. 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 playhouse. 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. **Photograph by Lee S. Crandall, made in New Guinea.**



Immature male satin bower-bird showing the plumage in an early stage of development. It has been stated by some authorities that the plumage does not attain its full color until the bird is in its seventh year. Observations made by Mr. Crandall, however, indicate that further investigation is required before the problem can be solved with certainty. Photograph by F. Lewis, Chief Inspector, Fisheries and Game Department of Victoria.

able one. In February, 1922, a keeper called my attention to the antics of a satin bower-bird, which followed him about the aviary, nibbling at the soft wood of a sieve the man was using. I watched the bird for some time, and finally discovered that the particles of wood were "chewed" until they had become thoroughly mixed with saliva, and that the resultant paste was then smeared on the twigs that lined the inner walls of the bower. A piece of dry, rotten wood was then placed in the cage and an orgy of plastering followed. When the deposit had become dry, we found that most of the inner twigs were well covered with a thick, grayish coat, of crumbly consistency. Each stick was treated separately, none adhering to its neighbor. I believe no theory in explanation of this habit has been advanced and I am unable to suggest one. There was no evidence of smearing in the bower I saw in the National Park.

In our earlier experiences with satin bower-birds in the Zoological Park, we kept male and female together. When the first bower was built, the work was done entirely by the male, the femal showing no sign of interest. After it was complete, however, I several times saw her poking about it, always during the absence of the male. On one occasion, she went so far as to pick up a loose twig and clumsily insert it, small end down, in the walls of the bower. She fled in haste when the male appeared. He made a quick examination, as though suspecting some damage, immediately spotted the offending twig and promptly removed it. No doubt the shape of the twig betrayed it, for the male seems always to set the thick end at the bottom.

It was not long after this when the male attacked his mate with such violence that she had to be removed from the aviary. We supposed this assault to have been the result of a passing whim and later returned the female to the cage. All went well for a time but one morning a keeper arrived just in time to save her again from the fury of the male. This disappointing ending of a long and laborious courtship no doubt was caused by some frustration of the completion of the cycle. We now keep only bachelor males, which seem to find sufficient amusement in the construction and care of their bowers.

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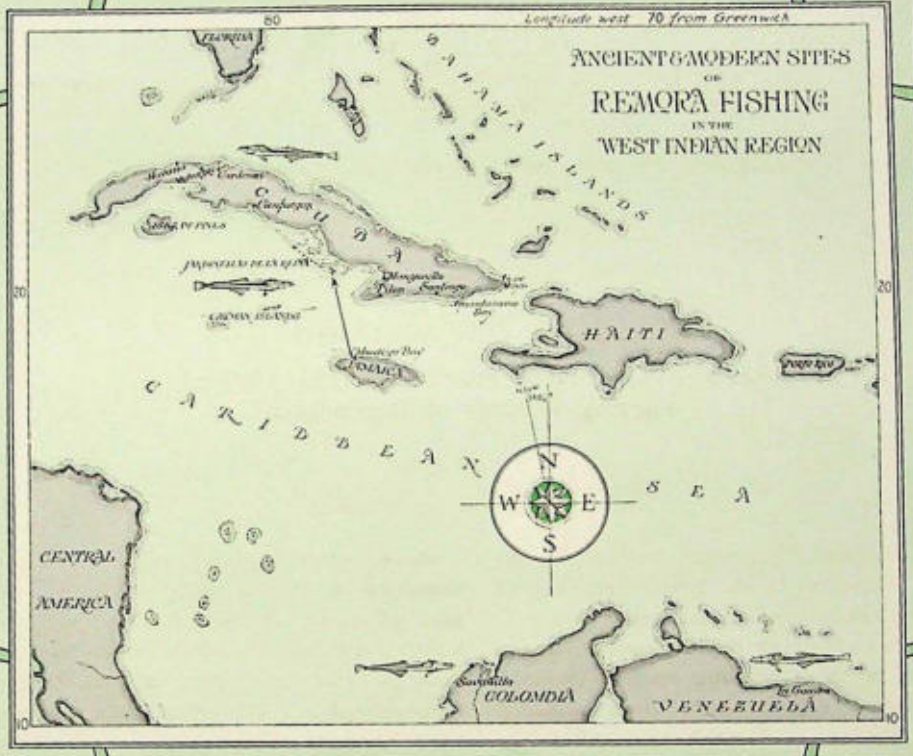
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Localities in the West Indian Region Where Remora Fishing Is Still Pursued.

The Remora or sucking-fish, *Echeneis,* used by the Caribs as a living "fish-hook" for catching fish and turtles, is pictured on the above map near the sites where this custom is used at the present time. The arrow-line from Jamaica to Cuba shows the course taken by Columbus to the islands where Remora fishing was observed and recorded for the first time in the history of man.

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Animal Associations

The Living Together of Fishes and Other Animals in Varying Degrees of Dependence

E. W. Gudger

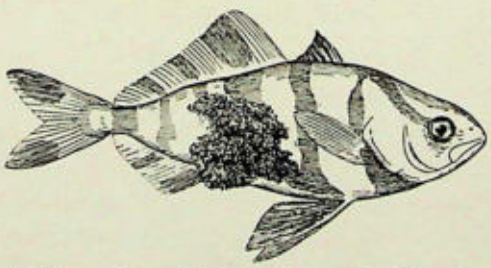
Bibliographer and Associate in Ichthyology
American Museum of Natural History

ONE of the most fascinating subjects in the realm of nature is the living together of the lower animals by twos in varying degrees of dependence on each other on the one hand; or, on the other, in their forming socialistic communities, wherein each rank or class or caste has its set tasks as its share in the community life. We all know that the buffaloes (bisons) of North America and the antelopes of Africa go in herds for association and for protection against their enemies, that the whales and the fish of the seas go in schools drawn by the fundamental attraction of food and the equally fundamental desire to avoid enemies. But what most of us do not know is that among the lower animals are found associations between two animals generally in varying degrees of dependence from complete and perfect independence to the most complete parasitism.

Since I know most about fishes I am going to define these varying degrees of dependence, and illustrate, so far as I can, each kind with examples of what I or others have discovered among fishes.

Symbiosis or Mutualism
Living Together to Mutual Advantage

When two different organisms live in an association from which each gains benefit, then there is the highest type of association, one comparable to the mutualistic organization one finds among the social insects. The best known and most easily observed illustrations are: (1) the living together of algæ and fungi to form the things (not plants) called lichens; (2) the green or other colored algæ found embedded in the cells of the green hydra of fresh water, and in the cells of the sea anemones. Here the algæ take in the co_2 and other wastes given off by the cells of the hydra, break up the co_2, incorporate the carbon and mineral salts into their own cells and give the oxygen back to the hydra — a double-barrelled action covered by our term Symbiosis (*syn*—together, *bios*—life).



Symbiosis: Carangoid fish, with an attached colony of hydroids. After J. W. Fewkes.

Another fine type of association is between animals and a plant, between ants and their host plant—bush or tree. The botanist, Spruce, long ago described from the Amazon Valley the re-

markable symbiosis between certain fierce biting ants which live in the enlarged basal cavities of the thorns found on certain trees. The tree gives the ants homes, and if man or lower animal jostles or shakes the tree, the ants ferociously attack the invader and protect their host.

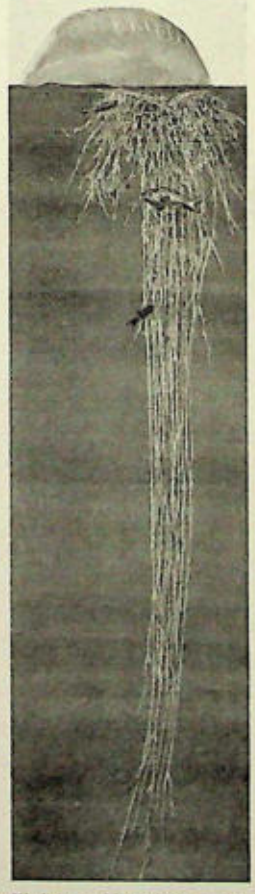
Instances of symbiosis between invertebrate animals are rather common— i. e., a sea anemone resident on the hard coat of a crab or on the sea snail shell inhabited by a hermit crab. The crabs gain a certain protection and the anemones get transport to regions where food may be more abundant. However, I can recall no case of true symbiosis between fish and fish (of different kinds). This relationship is frequently designated as that between the shark and the sucking fish or the little banded pilot fish, but if one analyzes the relationship critically it will surely fall under Commensalism.

In fact I am hard put to it to find a case of mutualism between fishes and invertebrates even. However, out of my bibliographic experience, I collected and brought together some years ago instances of marine hydroids growing affixed on to the scales and spines of fishes. These hydroids were attached to the fishes by their root-like processes, just as they would have been to a wooden or cement pile or to an iron post. Here the hydroids give the fish a certain amount of protection, and the fish translocates the colony of hydroids to fresh pastures; thus both parties to this strange association benefit, it is a case of true symbiosis.

Inquilinism
The Seeking of Lodgings

The root from which this word is derived is the Italian—*inquilinus*, a tenant, and the idea is that this tenant comes and goes without the payment of any rent. My introduction to this curious mode of life in fishes was had when I read that in 1908 a German zoologist named Plate, while resident in the Bahama Islands, had found that certain small perch-like marine fishes, which he called *Apogonichthys strombi*, lived in the mantle-cavity of the huge sea snail, *Strombus gigas*, found abundantly in West Indian waters. When I read this I became tremendously interested and wished that I could some day have the good fortune to study such an association, which the author offhandedly remarks "might easily be cleared up at the biological station [of the Carnegie Institute of Washington] at the Tortugas [Florida]."

By good fortune I was a guest at this station for several seasons beginning with that of 1912, and this problem was one in mind for study. However, since no one was studying conchs (the common name for this great snail), and since everyone was busy with his own problems and keeping our boatmen and engineers busy supplying the needs for other material, few conchs came in and none contained fish. Furthermore, these helpers, Bahama and Southern Florida-born, knew nothing of this remarkable association between fish and sea snail.



Inquilinism: Nomeus amid the tentacles of the Portuguese man-of-war. *From American Museum.*

However, by good fortune in 1914, there came to the station an investigator studying conchs. His needs brought in large numbers of these snails and I kept a sharp eye out, but not a fish relieved my anxiety. However, late in July our boat, the Dohrn, anchored off Marquesas atoll, 20 miles west of Key West, and I went with the conchologist and the men over the eelgrass flats hunting for *Strombus*. The men waded and dived in the glassy-clear water for the snails, the conchologist received them and I poled the launch along keeping up with our amphibious helpers. One great snail was laid aperture up on a seat near

me. And presently to my vast surprise I saw swimming in the water which filled the aperture a little fish. So interested and excited was I that I nearly ran the launch on a nearby coral head.

No other conchs with fishes were found but my specimen furnished the data for a short article on this curious association, which was published by the New York Zoological Society in its journal *Zoologica*. Later two investigators for the United States Bureau of Fisheries, Hildebrand and Ginsberg, found a kindred fish in conchs taken at Key West, Florida, and published their findings in the *Bulletin* of the Bureau.

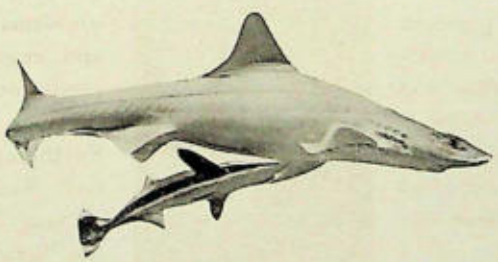
Another form of this curious habit of lodging, but one hardly on the same level, is where small fishes inhabit sponges. This, which was first described in 1917, for a fish found in a sponge off the coast of North Carolina, has been found in various parts of the world. But it was left for William Beebe to describe it most fully and illustrate it with an excellent figure in his delightful book, "Beneath Tropic Seas."

Other such tenancies are:—fishes living inside the shells of pearl oysters; inside the bodies of holothurians (sea slugs) or among the spines of sea urchins; small fishes living under the umbrellas of jellyfishes; and others living inside the bodies of huge tropical sea anemones. One might multiply instances almost indefinitely.

Before leaving this subject, it must be confessed that no explanation is at hand for these associations save that the fish find lodgings and protection. One cannot conceive that the conch or the sponge or jellyfish or sea anemone or sea slug gains anything by this—one-sided—association.

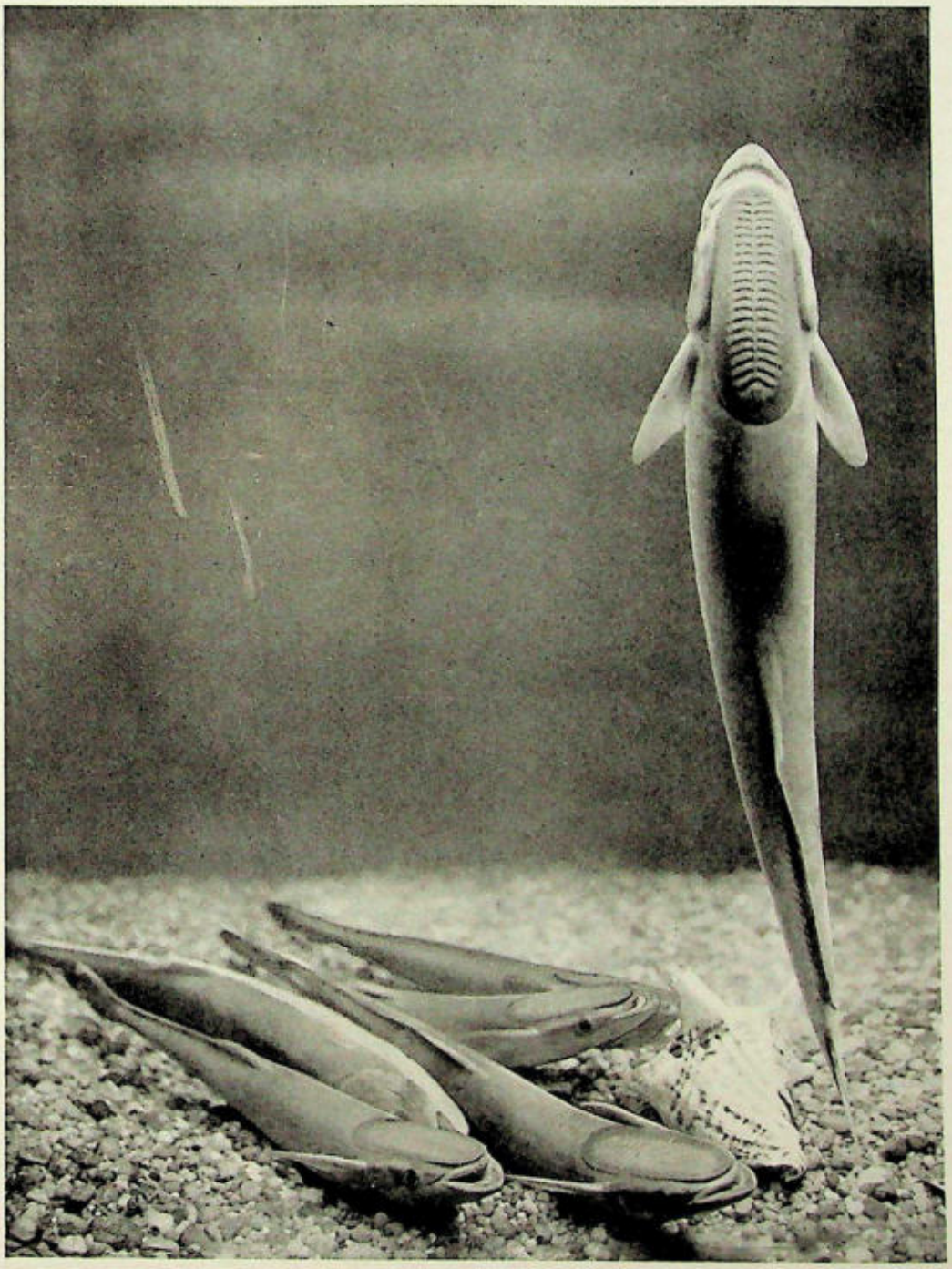
Commensalism
Living at a Common Table

On a slightly lower level is the association coming under this designation, whose derivation is from the Latin, *com*—together, *mensa* — table. Perhaps the most commonly known case of this phenomenon is the association between the echeneis or remora, the shark-sucker, and its friendly shark. This fish, as is known at any rate to zoologists, has its spiny dorsal fin converted into a remarkable sucking disk which has been translocated forward until it has come to rest in the shoulder region and on the back of the head of the fish. This elliptical disc has a circumferential rim of soft fleshy material, while extending right and left across the disc, like the slats of a Venetian blind, are cross partitions of fleshy tissue beset with fine tooth-like spines. The sucker lays this disk flat against the shark's flank and by muscular action raises the rim and slats, thus creating a partial vacuum. And thus by atmospheric pressure plus the pressure of the water the sucking-fish is held fast to the shark. Furthermore, if one pulls backward on the tail of the fish, the little spines in the "slats" stick into the epidermis of the shark and aid in the firm holding-fast.



Commensalism: Shark with attached sucking-fish. When the shark seizes its prey, the *Echeneis* feeds from the fragments. *From American Museum.*

But, the reader says, "I can see that the remora gets free transportation, but what makes him a commensal with the shark, how does he eat at the same table?" In answer let us say that most sharks have sharp, pointed tearing, or broad serrated chopping teeth—and that with these they tear or cut their prey in pieces sufficiently small to pass down the cavernous gullet into the capacious maw of the shark. In this process smaller pieces are torn off and float about in the water. The remora, relaxing the muscles of his sucking disc, lets go of the shark, snaps up these fragments of food, and affixes himself again to the shark. Thus he feeds at the shark's table, without, however, taking any food that the shark cares for.

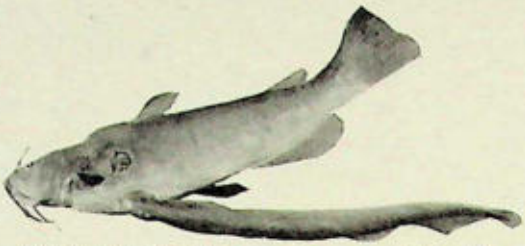


This photograph, taken in the New York Aquarium, shows in some detail the arrangement of the shark-sucker's disc. The disc functions as a sucking cup when the fish adheres to its host and by muscular action creates a partial vacuum by raising the edges of the disc. The successive transverse folds (lamellae) on the disc contain teeth which are directed backward and help grip into the surface of the host-animal, turtle, shark or manatee as the case may be.

PARASITISM

Feeding on the Body of the Host

Some years ago Captain C. F. O'Keefe sent me from the Coosa River at Rome, Georgia, what he wrote were some "parasite sucking fish." When the package came I found in it seven silver lamprey eels. These parasites are called cyclostomes (Greek *kyklos* — round + *stoma* — mouth) because of their circular mouths. Within these funnel-like round mouths made of a circumferential fold of soft tissue provided with papillæ are two horny tooth-plates beset with rasping teeth. Sucking itself fast to its host-fish, the lamprey rasps through skin and scales and into the flesh where it taps the blood vessels and drains away the life of its host.



Parasitism: Cyclostome parasitic on a catfish. The parasite has rasped one hole in the fish's side and is now cutting another. *From American Museum.*

These "round mouths" are widespread and their evil habits are well known to zoologists and to the fishermen of the regions where they abound (i. e., our Great Lakes and the smaller lakes of New York state). Visitors to the Fish Hall of the American Museum have seen the display of cyclostome fishes among which is a lamprey attached to a catfish. Naturally these "round mouths" can operate better on scaleless fishes. Thus Captain O'Keefe wrote me that while he got only one "sucker" off a bass he found five attached to one catfish.

If time and space permitted, other cases might be noted. Thus I have studied the sucking and rasping mouth structures of certain very small South American catfishes which live in the gill cavities or on and in the bodies of their hosts — particularly the giant (scaleless) catfishes of those waters. Then there is the curious parasitism of the male on the female of certain deep sea anglerfishes, in which the male becomes firmly attached to a papilla of the skin of the female. In fact he becomes "grown fast" to her tissues and lives by osmosis of food materials transmitted through the tissues from her blood vessels to his.

Many such other stories might be recounted of these curious associations between fishes and other animals, ranging from the "Damon and Pythias" form of Symbiosis noted above clear down to the lowest and most repulsive forms of Parasitism. In fact a whole number of the BULLETIN would hardly suffice merely to list them under their proper headings. But my intent is to incite the natural history appetite of the reader and not to satiate it, so I shall stop now and here since, as Mr. Kipling would say, each of these constitutes "another story."

Fishing with the Fisherman Fish in West Indian Waters

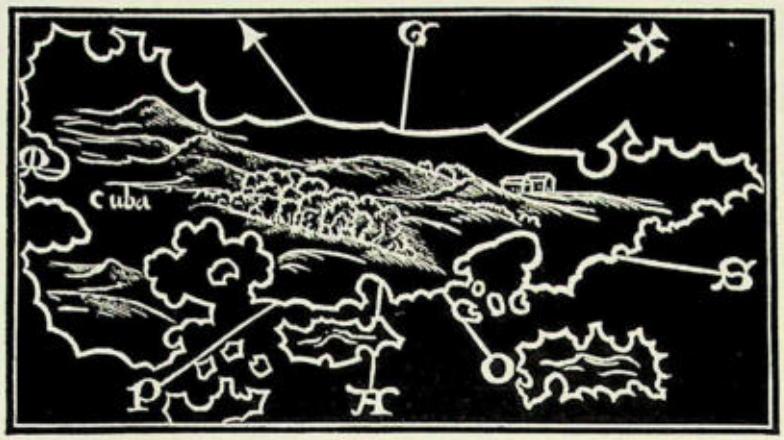
An account of the use of the sucking-fish or remora for catching turtles and fish in Cuban and Colombian waters from the discovery of America to the present day, by C. Ralph De Sola

The illustrations in this article are from photographs in the collections of the New York Zoological Society and of Dr. E. W. Gudger, who has permitted the reproduction of several plates appearing in his papers. The photographs of live specimens were made in the New York Aquarium by Dr. C. H. Townsend and Elwin R. Sanborn.

INTRODUCTION

IT is well established that fishes called remoras or shark-suckers are the hitch-hikers of the seven seas. The various species of remora, (the louse-fish or barracuda remora, the shark remora, the off-shore or turtle remora, the swordfish remora, the spearfish remora, etc.), fasten themselves to the surface of their hosts and are carried through the seas for considerable distances. Such an attachment to a shark is shown in the series of plates in this BULLETIN.

This attachment is effected by means of a large, laminated sucking-disc which covers the top of their heads and which is a modified spinous dorsal fin. The shark-suckers do no



This old map of Cuba, published in 1527 by Bordoni, shows the hazy and distorted ideas concerning the New World that were prevalent among the cartographers of his time. The chart was originally intended to illustrate the location of the remora fishing incident observed by Columbus and is said to show its site, the Jardinellas de la Reina (Queen's Gardens) to the south of Cuba. Up to the present time, modern writers have been in doubt as to the exact location of this group of islands.
From E. W. Gudger after Bordoni.

harm to their hosts except to retard their motion. Transportation and increased facilities for food-getting are the desiderata of remoras.

A shark, a ray, some large bony fish, a turtle, or even a whale will answer to the first requirement—transportation. The feeding habits of such creatures as sharks, barracudas, and turtles, i.e., biting and tearing at their prey, leave much debris of the meal ready for ingestion by their hangers-on, the remoras.

But much more interesting than the louse-like habits of these adhesive fishes, is the use man has put them to. At Cape York (northern Australia), Singapore, Zanzibar, northern South America, and Cuba, primitive man early discovered the habits of the group of discocephalid fishes and applied them for his own benefit: he fished with the remora for small marine mammals, fishes, and turtles.

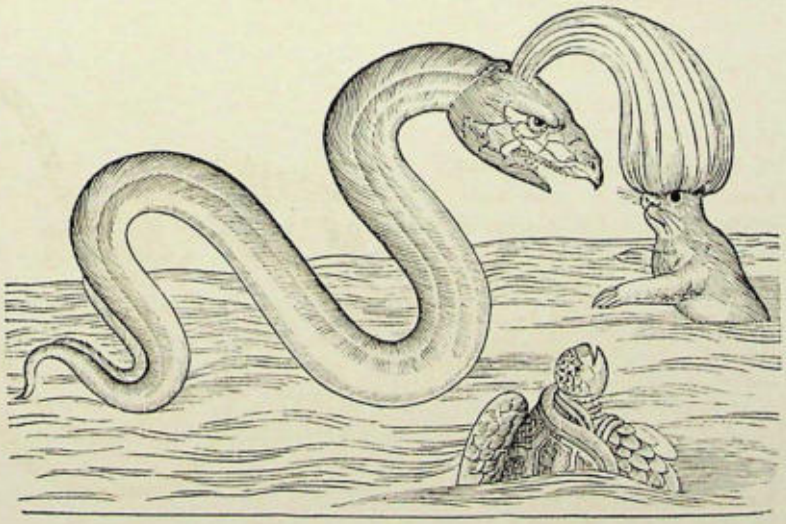
The technique of remora fishing is essentially the same the world over. Professor Haddon's figure tells the story in the form of a primitive drawing made by a native of the Torres Straits region who fished with the remora and used it as his fish-hook. A former British Consul at Zanzibar, Mr. Frederick Holmwood, gives an illustration from that region showing how the remora is prepared for fishing.

My own observations have been made in West Indian waters. The text that follows concerns itself with that region alone.

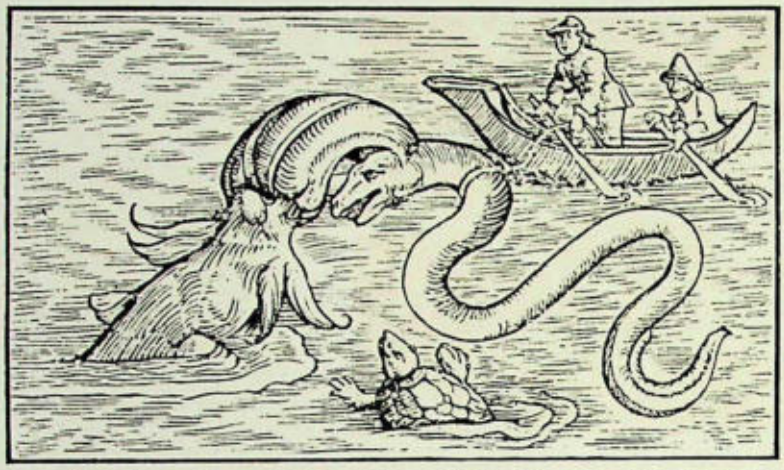


Remora Fishing in the West Indies

More than four centuries ago Christopher Columbus, on his second voyage to the New World, reported for the first time in the history of man one of the strangest and most interesting customs—that of employing a sucking-fish for fishing. Although this custom has been known and recorded in other parts of the world since that time in localities so remote as Zanzibar, Singapore and Cape York, Australia, no record of a personal observation in West Indian waters has been found from the time of its discovery in 1494 to 1885, when another tropical voyager, Lady Anne Brassey, recorded



In 1613, Aldrovandi, a famous writer on ichthyology, repeats part of Gesner's original figure. He gives some attention to the correctness of detail in the prey of the sucking-fish—the manatee and the sea turtle, but heightens and intensifies the exaggerated notions then extant of the ship-holding and fish-pursuing remora.
From E. W. Gudger after Aldrovandi.



The earliest known figure depicting fishing with the fisherman fish is from the works of Konrad Gesner, who was one of the great encyclopedists of the Renaissance. In 1558 he published this quaint wood cut illustrating Peter Martyr's account of the strange fishing custom observed by Columbus in the New World. The reversus or remora (a shark-sucker) here represented as an eel, in keeping with Martyr's account, is throwing its hood over the head of a manatee while a sea turtle looks on in amazement. The fishermen, strangely enough for Carib Indians, are dressed in the European attire of those times. *From E. W. Gudger after Gesner.*

the same custom from nearby Venezuelan waters. However, in 1929, direct evidence, substantiated by personal observation, proved that the ingenious custom of a primitive people is still practised on the very site where it was first seen by the Great Admiral and that it is known today to the Indian tribes of northern South America.

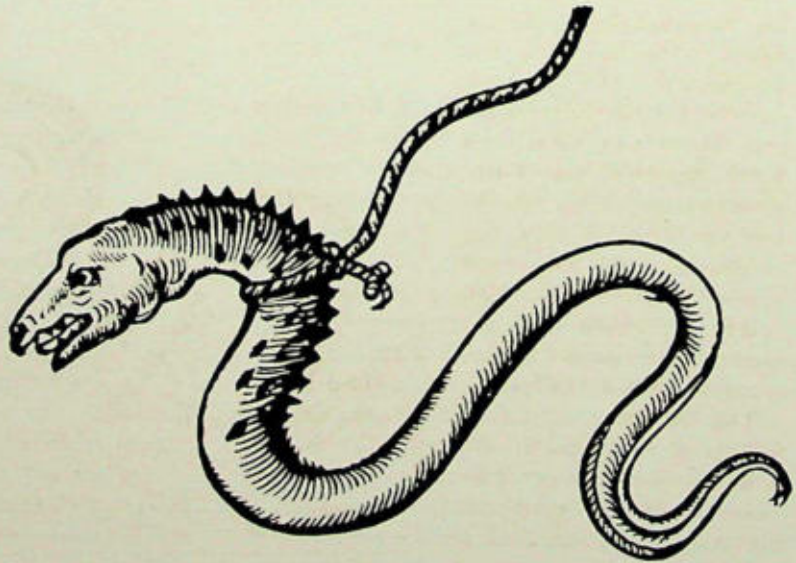


Historical Summary

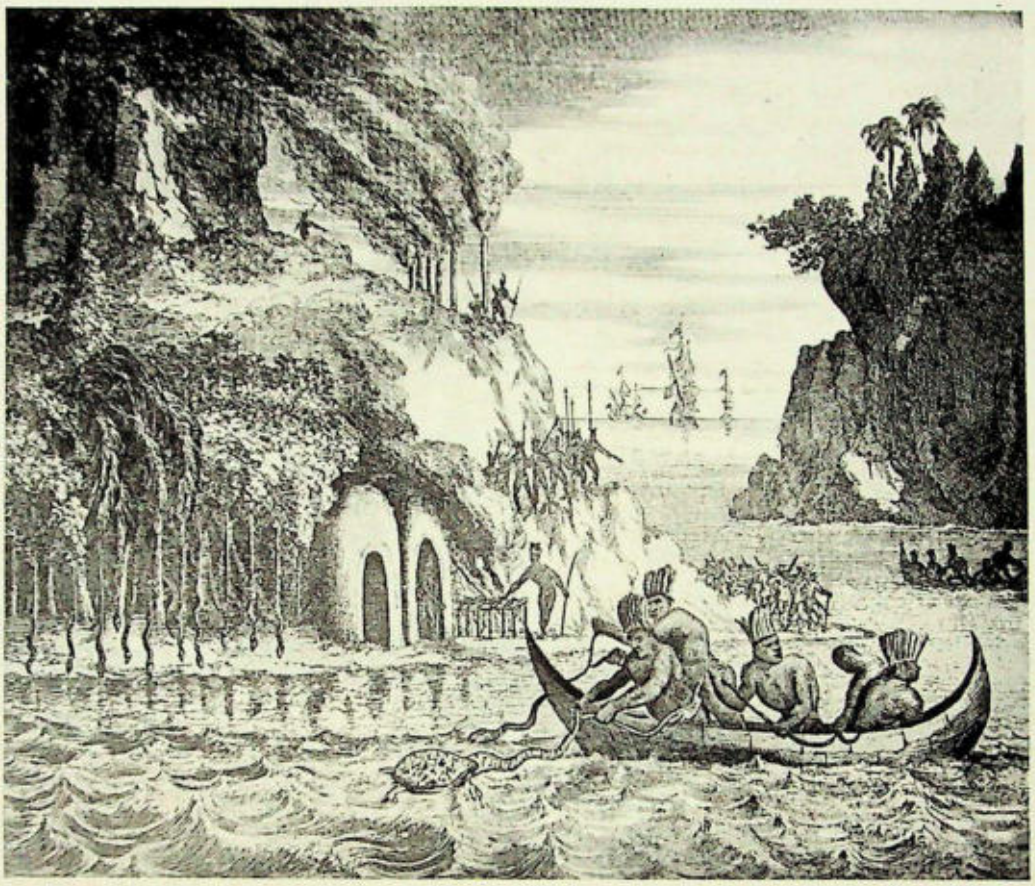
The principal accounts dealing with remora-fishing in West Indian waters have been collected by that indefatigable research worker in the bibliography of ichthyology, Dr. Eugene Willis Gudger, who kindly permits the use of his interesting material in this paper.

Perhaps the earliest and best written of the accounts furnished by Columbus and his crew is that of Peter Martyr, an attaché and writer in the court of Ferdinand and Isabella. MacNutt's excellent translation of his "Decades" follows:

> Everybody has assured me that they have seen fishermen use this fish just as commonly as we chase hares with French dogs, or pursue the wild deer with Mollossians. They say this fish makes good eating. It is shaped like an eel, and is no larger. It attacks fish larger than itself, or turtles larger than a shield; it resembles a weasel seizing a pigeon or still larger animal by its throat, and never leaving go until it is dead. Fishermen tie this fish to the side of their barque, holding it with a slender cord. The fish lies at the bottom of the barque, for it must not be exposed to the bright sun, from which it shrinks.
>
> The most extraordinary thing is that it has at the back of its head a sort of very tough pocket. As soon as the fisherman sees any fish swimming near the barque, he



The "Historia Naturae" published by Nieremberg, a professor in the Royal Academy of Madrid, in 1635, shows Gesner's influence except where his (or his artist's) imagination ran loose and included a saw-toothed mane on the dorsal region of the eel-like fisherman fish. This delineation was the first to appear omitting the hood described by Martyr in lieu of the sucking-disc as we know it today. *From E. W. Gudger after Nieremberg.*



Ogilby's classic, "America: Being the latest and Most Accurate Description of the New World" appeared in 1671 with this fascinating figure of his conception of the sucking-fish or remora employed as a fish-hook. Two remoras are being used in the foreground of this scene. One of them is catching a sea turtle by taking its head in its mouth. Between the palm-topped land masses of the background, the three caravels of Columbus are visible. *From E. W. Gudger after Ogilby.*

gives the signal for attack and lets go the little cord. Like a dog freed from its leash, the fish descends on its prey and turning its head throws the skin pouch over the neck of the victim, if it is a large fish. On the contrary, if it is a turtle, the fish attaches itself to the place where the turtle protrudes from its shell, and never lets go till the fishermen pulls it with the little cord to the side of the barque. If a large fish has been caught (and fishermen do not trouble about the small ones), the fishermen fasten stout cords to it and pull it into the air, and at that moment the hunting-fish lets go of its prey. If, on the contrary, a turtle has been caught, the fishermen spring into the sea and raise the animal on their shoulders to within reach of their companions. When the prey is in the barque, the hunting-fish returns to its place and never moves, save when they give it a piece of the animal, just as one gives a bit of quail to a falcon: or until they turn it loose after another fish. . . . The Spaniards call this fish Reverso, meaning one who turns around, because it is when turning that it attacks and seizes the prey with its pocket-shaped skin.

The name "reverso" really has reference to the reverse or upside-down appearance of the remora when attached to a shark or turtle. Its lower jaw extends beyond its upper jaw and unless one knows that its disc is on its dorsal surface the natural conclusion is that the fish is upside-down—hence "reverso."

Patient comparison of many accounts and figures proves the "Reverso" fish of the Spanish sailors to be the widely known discocephalid—

Echeneis, the remora or sucking-fish. Five species are known to occur in the warm waters of the West Indies and northern South America.

The fish's name, *remora,* is a word well incorporated into the Spanish language and the dictionary of the Spanish Academy lists it as of Greek origin and meaning: hindrance, obstacle, cause of delay. The sucking-fishes belong to the order *Echeneidae,* an ichthyological term taken from the Greek and meaning, *echo,* to hold; *neus,* a ship.



Location of the Queen's Gardens

The location and site of this fishing is given by Bernaldez, an Archbishop of Andalusia, who entertained Columbus and received papers and journals from him dealing with his second great voyage of discovery. In a manuscript written by Bernaldez before 1500 and treasured in the Royal Library of Madrid until 1856 when it was printed in Granada, we find the following account of the Jardinellas de la Reina (Queen's Gardens) where Columbus saw the remora-fishing that he related to his friend, Bernaldez, and that was first recorded in print by Peter Martyr as already given. "The Admiral set sail (from Jamaica) with his three caravels, and sailed 24 leagues toward the west, as far as the Gulf Buen Tiemps . . . Whitsunday, 1494."

Inasmuch as the "Gulf Buen Tiemps" does not appear on any available chart and many authors are at a variance as to the location of these islands it is appropriate to check the course of the caravels of Columbus and accurately determine the position of the first remora site known to European man.

A glance at any chart of the West Indian region leaves one with the impression that from the foregoing account Columbus arrived twenty-four leagues to the west of Jamaica and when this route is checked with dividers and parallel rules one finds a spot in the Caribbean Sea far distant from any islands. Making allowances for the discrepancies of navigation as known to Columbus, and taking into account that his maps were, at best, his own rough sketches of unmapped territory, and that he had no knowledge of the local magnetic variations or even the deviations aboard his vessel, nor of the currents and their speeds, one must reconstruct his voyage and determine what course he made to reach the islands.

Twenty-four leagues reduced gives a sailing distance of 115.2 nautical miles. Using Montego Bay, Jamaica (this being the northernmost port of that island) as a point of departure, and extending dividers to a distance equal on the Hydrographic Office chart of the West Indies to 115.2 nautical miles, the arc described will fall in the Bight of Manzanillo (Cuba) where islands called the Jardines de la Reina are located. This method gives us a course from Jamaica to these celebrated islands of 348½ degrees or North by West.

While it is true that the arc just described cuts the east end of Cayman Brac, it must be borne in mind that the Cayman Islands are a sandy and almost treeless group of three islands, while the Jardinellas de la Reina (Gardens of the Queen), as their name implies, are well wooded and consist of over four hundred cays. Bernaldez writes:

> On Whitsunday, 1494, they stopped at a place which was uninhabited—but not from the inclemency of the sky, or the barrenness of the soil—in the midst of a large grove of palm trees, which seemed to reach from the sea shore to the very heavens. . . . As the number of islands in this region was so great that he could not give each a separate name, the Admiral called them all by the common name of the Queen's Garden.

Aboard the steamer *Cananova* en route to Cienfuegos from Manzanillo, the writer passed these islands and can testify to their tropical luxuriance of foliage and to the vast numbers of royal palms that surmount the lush landscape. De la Torre and Aguayo in their Cuban Geography say (author's translation):

> From Cape Cruz to Port Casilda:—in this region of the littoral are two gulfs: that of Guacanayabo and that of Ana Maria. The coast line is low and broken up with more than 400 cays, which form, the archipelago discovered by Columbus, called the Jardines de la Reina.

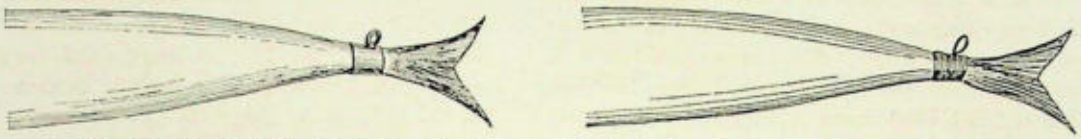
It has been the impression of many writers that the islands were Hispaniola (Haiti) and Jamaica but I feel from the foregoing that no further doubt can exist as to their location being on the south coast of Cuba and within the Gulf of Guacanayabo.

Illustrations depicting remora fishing date from 1558 when Konrad Gesner, one of the great encyclopedists of the Renaissance, published in his "Liber IIII, De Piscium et Aquatilium Animantium Natura" of his great History of Animals, a figure showing this strange custom after Peter Martyr's account. The reversus or remora here represented as an eel, in keeping with Martyr's description, is throwing its hood over the head of a manatee while a sea turtle looks on in amazement. The source of this figure "IIII tabula" has been diligently sought by Dr. Gudger but never has been found.

Later, in 1613, Aldrovandi, a natural history encyclopedist even greater than Gesner, repeated his figure and facts, giving considerable attention to the correctness of detail in the prey of the sucking-fish—the manatee and in the onlooking sea turtle. However, he so intensified the false notions then extant concerning the ship-holding and fish-pursuing remora that his figure today is an interesting curiosity and commentary on seventeenth century natural history.

In 1635, Juan Eusebius Nieremberg, a professor in the Royal Academy of Madrid, published in his "Historia Naturae," a delineation of the remora that was the first to omit the hood described by Martyr in lieu of the sucking-disc as we know it today.

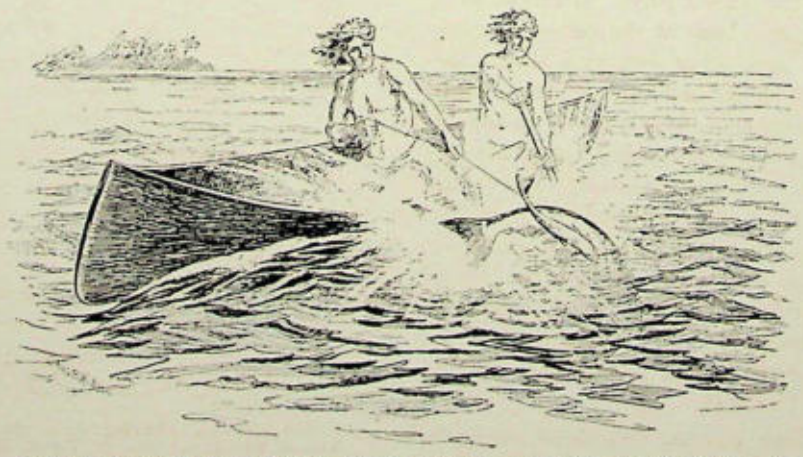
In Ogilby's "America," which appeared in 1671, there is an illustration showing two remoras being used by Carib fishermen. One of the remoras has caught a sea turtle by taking the turtle's head in its mouth. Between the palm-topped land masses of the background, probably meant to represent the Garden's of the Queen (Jardines de la Reina), the three caravels of Columbus are visible.



Left: Tail of sucker-fish with band and ring. *Right:* Tail of sucker-fish with loop and servings. Methods used by the native fishermen of Zanzibar. *After Holmwood.*

The more recent writings of Hudson, Holder, and Ober, are illustrated with remora fishing scenes. The illustrations of Hudson and Ober are based on a knowledge of the aforementioned classics and are the product of their artist's imagination. On the other hand, Charles Frederick Holder, an authority on the fishes of the Florida Reef, made personal observations. His own words taken from "Stories of Animal Life" (1905) suffice to illustrate the point:—

> I experimented with the Remora but the fish invariably refused to dart after the turtle, preferring to find shelter under the boat. One tossed to a shark was seized by the latter, that doubtless thought it a votive offering. Possibly something was wrong;



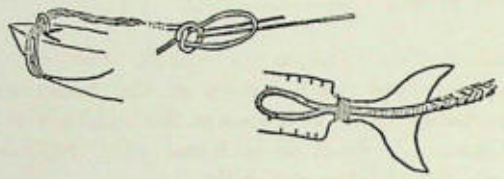
Hudson's "Curious Bread Winners of the Deep" contains this spirited picture of natives fishing with the shark-sucker, *Echeneis*. This appeared in 1893 in the Cosmopolitan magazine. *From E. W. Gudger after Hudson.*

our remoras may have been stale; they surely were not ship or turtle stayers.



Remora Fishing Today

Nearly four centuries elapsed without any mention being made of a definite remora fishing observation in West Indian waters. While it is true that such recent writers as Gosse, Hudson, Holder, and Ober have repeated the Columbus



Native drawing illustrating the method of attachment of the sucker-fish to the canoe in Torres Straits.

story of the sucking-fish in books on the animal life and natural history of this region, their works are but repercussions of the earlier tales set forth by Martyr, Bernaldez and others.

The only first hand information published in modern times comes from the pen of Lady Anne Brassey, who, in her yacht the *Sunbeam* which lay at anchor off La Guayra, Venezuela in 1885, wrote as follows:

> . . . in one of the Indian canoes which we passed we noticed a sort of sucking-fish (*Echeneis remora*), which is used in catching other fish. Arrived at the field of operations, the fisherman lets go an anchor and puts the sucking-fish, attached to a long line with a buoy at the end of it, overboard. It sees other fish at a great distance, darts after them, and attaches itself to them by means of the sucker on top of its head. The Indian easily raises his little anchor, paddles leisurely after the remora, removes the captured fish into his canoe, and repeats the operation until he has caught as many fish as he wants. Thus, one of the ugliest and most incapable-looking creatures is made by savage instinct to become of some use in procuring food for the superior animal.

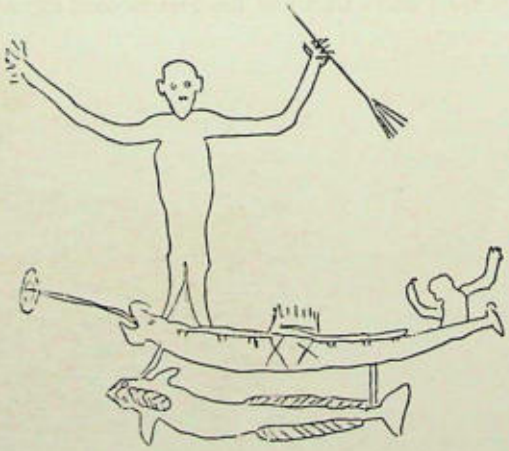
The foregoing account has been considered by many as incredible. Thirty-five years later, however, in 1920, Dr. S. De Sola, on the coast of Colombia, less than six hundred miles to the west of the adjacent Venezuelan site of Lady Brassey's account, says (personal communication):

> "On the beach at Salgar, near Savanilla (Porto Colombia), my attention was called to some native fishermen and Tubara Indians who were fastening ropes of *majagua* bark about three feet in length and from one-eighth to one-quarter inch in diameter to the tails of sucking-fish. These remoras are used to catch the edible and tortoise-shell turtles found along the coast. The custom of using these fish for fishing is restricted to a few Indians and is not widely known. This is significant as there are many fishing villages along this region of the Colombian coast."

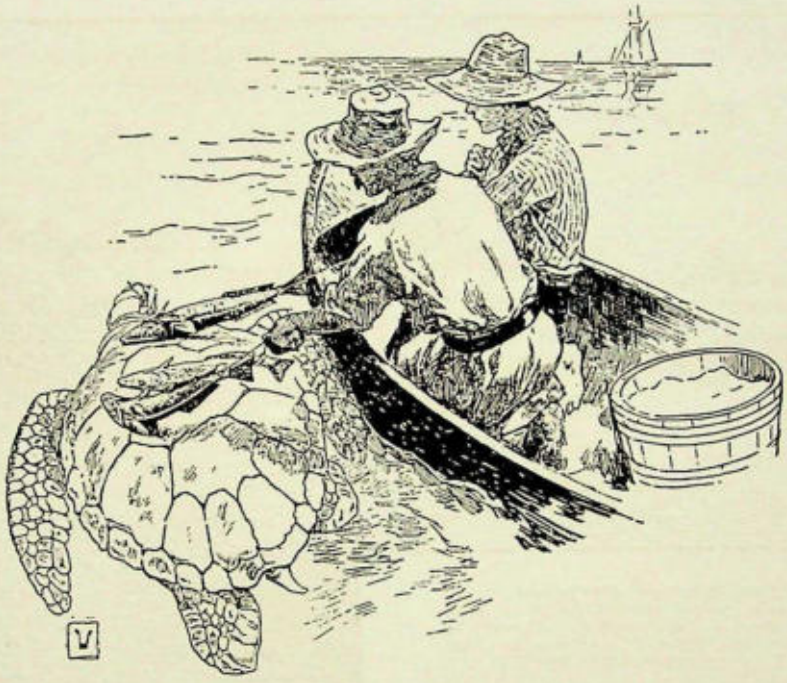
His statement should definitely confirm the existence of the custom in the seas of northern South America and thus corroborate the long disputed veracity of the earlier account written by Lady Brassey.

Observations made by the author near the first recorded site of remora-fishing in the West Indies were carried on recently while conducting some herpetological work in Cuba.

On Sunday, April 14, 1929, it was my pleasure to go on a fishing trip with the American Consul, Mr. Warren C. Stewart, and a party of Cuban friends from Matanzas. We set out from the *marina* at daybreak and motorboated



Native drawing showing how the sucker-fish is leashed by the natives of Torres Straits. In this drawing one of the natives, the canoe and the sucker-fish are represented the wrong way round. *After Haddon.*



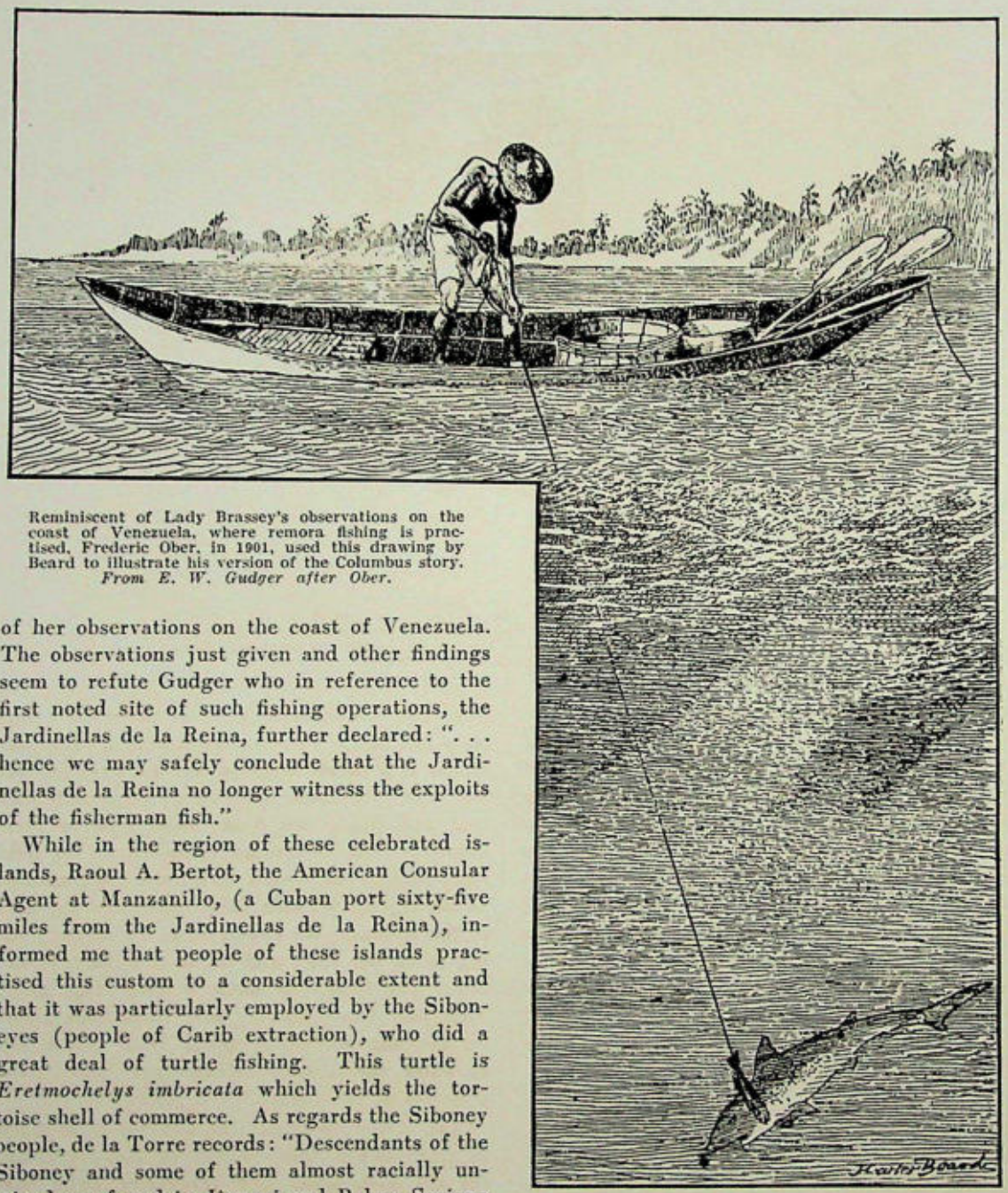
Holder, an authority on the fishes of the Florida Reef, refers to the Columbus story of the sucking-fish and gives in his "Stories of Animal Life," published in 1899, this modern figure to illustrate how the remora is used to catch sea turtles. *From E. W. Gudger after Holder.*

from Matanzas Bay to a village between that point and Cardenas. Here we got into several small carvel type row boats and went out off the sandy beaches with native crews. Along the under side of the craft a pair of *pegapegas* or *pegadores* ("stickers" as sucking-fish are called in Cuba) were attached with their discs firmly holding to the planking and a thin lanyard of *majagua* bark making them secure to the boat. This *majagua* bark is a pliable, long-fibred liana, which lends itself admirably to primitive rope making. In other parts of Cuba I saw it used as a lasso in the capture of crocodiles.

Once clear of the sandy shoal water we sighted a sea turtle basking on the surface. Our boatman immediately headed in its direction and gave us instructions to fasten the *majagua* lanyards that held the remoras to a coil of rope that was faked down in the bow. At this moment the turtle may have sensed our presence for it began to make off leisurely. The fisherman seized the sucking-fish by their heads, thus loosening their grasp from the boat; tossing them in the direction of the sea turtle which was about two points on our starboard bow, they swam rapidly in its direction. The lines ran out of the bow quickly and, using our hands as a check, we soon felt the lines go taut and the vibrations that came back indicated that our living fish-hooks were fast to their quarry. The fisherman implored us to hold tight and by no means to let the lines slacken as the tighter we held them the better the hold of the remora. We rowed up to the turtle, pulling in on our lines and found it to be a hawk-bill. The fisherman made a noose fast to its neck and front flippers and with some effort we got him amidships in the boat. Once out of water, the remoras relaxed their hold on the plastron of the turtle.

The native boatman all the while indulged in much gentle talk concerning his friendship for the *pega-pegas* and reassuring them that they would be well fed and cared for on their return home. The other members of the party in their boats had the same experience except that one of them bagged two turtles during the course of the morning.

Gudger writing in 1919 stated that in the West Indian region, remora-fishing had not been recorded since 1885 when Lady Brassey wrote



Reminiscent of Lady Brassey's observations on the coast of Venezuela, where remora fishing is practised, Frederic Ober, in 1901, used this drawing by Beard to illustrate his version of the Columbus story. *From E. W. Gudger after Ober.*

of her observations on the coast of Venezuela. The observations just given and other findings seem to refute Gudger who in reference to the first noted site of such fishing operations, the Jardinellas de la Reina, further declared: ". . . hence we may safely conclude that the Jardinellas de la Reina no longer witness the exploits of the fisherman fish."

While in the region of these celebrated islands, Raoul A. Bertot, the American Consular Agent at Manzanillo, (a Cuban port sixty-five miles from the Jardinellas de la Reina), informed me that people of these islands practised this custom to a considerable extent and that it was particularly employed by the Siboneyes (people of Carib extraction), who did a great deal of turtle fishing. This turtle is *Eretmochelys imbricata* which yields the tortoise shell of commerce. As regards the Siboney people, de la Torre records: "Descendants of the Siboney and some of them almost racially unmixed are found in Jiguani and Palma Soriano (on the Cuban Railroad between Santiago and Manzanillo), Yateras (near Guantanamo Bay), El Caney (near Santiago), and Baracoa (near Cape Maysi on the northeast coast)."

In conversation with Dr. de la Torre of the Havana University, who is the acknowledged dean of Hispanic naturalists, I was told that fishing with the remora was a hand-me-down from the Carib people and was widely practised in regions of Cuba where their descendants were to be found. The scarcity of accounts from this region is probably due to the decimation of these native fisherfolk, as the majority of Cubans are not a water loving race; in fact, all shipping is handled, operated and manned by Spanish sailors from Galicia.



Echeneis naucrates, the remora or shark-sucker, lifting a pail of water weighing 21 pounds. This experiment photographed by its author, Dr. C. H. Townsend, proves the feasibility of remora fishing.

A few interviews on the subject of the existence of the custom in Cuba follow, as by this time I was very curious to find out everything possible concerning it.

At Ensenada de Mora (Pilon), Charles Mason, sub-manager of the Cape Cruz Sugar Company, said that fishermen on Hicacos Point used the remora as their fish-hook. At Santiago de Cuba, Emilio Portuando, a local naturalist, told of the strange custom and showed a picture he had sketched depicting the fishing operation. At Guantanamo Bay (Caimanera), I was invited to go on another fishing party but time did not permit witnessing the exploits of Echeneis. These fishermen had a pair of sucking-fish secured under the stern of their row boat. The fish attached themselves with their cephalic sucking discs to the underplanking and were attached with lanyards secured to the caudal region of their bodies and made fast to the stern ring of the boat. At Nipe Bay (Antilla), George Curtis of the United Fruit Company told of the custom and showed me the fish that fished. The specimens (*Echeneis naucrates*) were alive and tethered by their tails to a fishing jetty.



Experimental Evidence

Dr. C. H. Townsend, Director of the New York Aquarium, proves the feasibility of remora fishing by the following experiments.

1. To test the holding powers of a sucking-fish he took a two-foot specimen and holding it by the tail lifted a pail with water weighing 21 pounds. A second specimen, somewhat longer was used and supported a pail with water weighing over 24 pounds.

2. A more pertinent experiment with direct reference to our West Indian custom is given in his own words:

> By way of testing its fish-catching capacity, a shark-sucker sixteen inches long was liberated in one of the tanks of the Aquarium containing fishes. It took hold at once, and by hauling on the cord fastened to its tail a good-sized grouper was brought to the surface of the water, although it could not be lifted out of the



A somewhat larger remora lifting a pail of water weighing 24 pounds. *Photograph by C. H. Townsend.*

tank. When the fish began to struggle the shark-sucker let go. When tried on a fifteen pound sea turtle, the latter could easily be drawn to the surface.

There can be no doubt that with a line attached to a large remora a much larger sea turtle could be hauled in without difficulty.

He quotes Mr. L. L. Mowbray in his article as believing that "with such weights of water as used in the above tests the fish *cannot* relax the grasp of its disk."

Mowbray's belief is sustained by the admonitions of the boatman mentioned in the Matanzas account who implored us to hold the line taut so as to help the remora. I have picked specimens out of the water and examination of the lamellae on the disc convinces me that this is not a local superstition but a physical fact.

Gudger gives a method of calculating the "pull" that a remora might withstand when employed as a fish-hook and deduces that a fish with its sucking-disc 7¼ x 2⅔ inches having an area of 13½ square inches could easily sustain a pull up to ninety-nine pounds.

Jordan in his monumental work on fishes, says:

> "The commonest species (of sucking-fish), *Echeneis naucrates*, called pega-pega or pegador in Cuba, reaches a length of about two feet and is almost cosmopolitan in its range, being found exclusively on the larger sharks, notably on *Carcharias lamia*.

The specimens used near Matanzas, Cuba, measured thirty-one and thirty-five inches in length, being of the same species mentioned by Jordan. At Cardenas, on the afternoon following our remora excursion, I saw turtles brought in from pound nets with remoras firmly attached to their plastrons and upon inquiring whether they had anything to do with the fishing I was informed that, on the contrary, the turtles were frequently taken with remoras attached to their undersides. It is well known that they also attach themselves to manatees, porpoises, large oceanic fishes and occasionally to the hulls of ships.

As regards their swimming powers Breder has an interesting comment:

> That fishes of such natatorial powers possess such a highly specialized organ as the cephalic disc is interesting for they have apparently suffered no particular degeneration of their power to care for themselves in a locomotor sense, for of course they must first catch their shark. In this connection, their square tail is of special significance as short spurts of speed are naturally requisite.



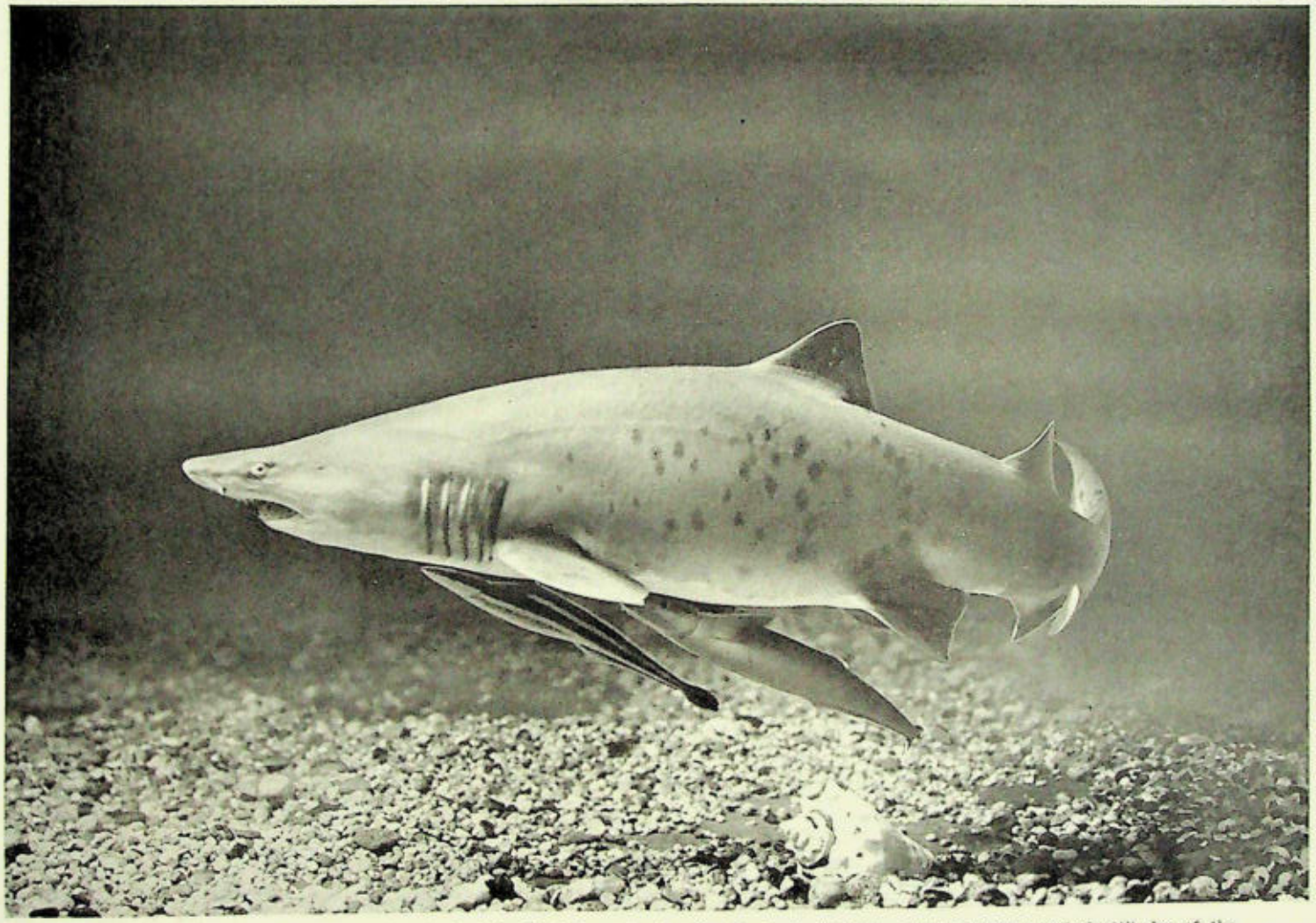
Conclusions

1. The first site of remora-fishing known to European man, the Jardinellas de la Reina, is located in the Bight of Manzanillo on the south coast of Cuba.
2. Remora are still used as living fish-hooks upon the original site observed by Columbus over four and a third centuries ago.
3. With the possible exception of Matanzas the remora fishing localities in Cuba are near or at places where descendants of the Carib people reside.
4. Thirty-five years have elapsed since observations were made on the South American coast from the time of Lady Brassey (1885) to that of Dr. De Sola (1920). The custom is probably still in existence in Venezuelan waters.
5. The fisherman-fish of the West Indies is not found exclusively on the larger sharks but is also seen on sea turtles and other large marine creatures.
6. Owing to the arrangement of the lamellae on the sucking-disc it is impossible for the remora to relax its hold when tension is exerted backward on its horizontal axis.
7. From experimental evidence and observations there can be no doubt that the remora is capable of seizing on to sea turtles of considerable size and weight.

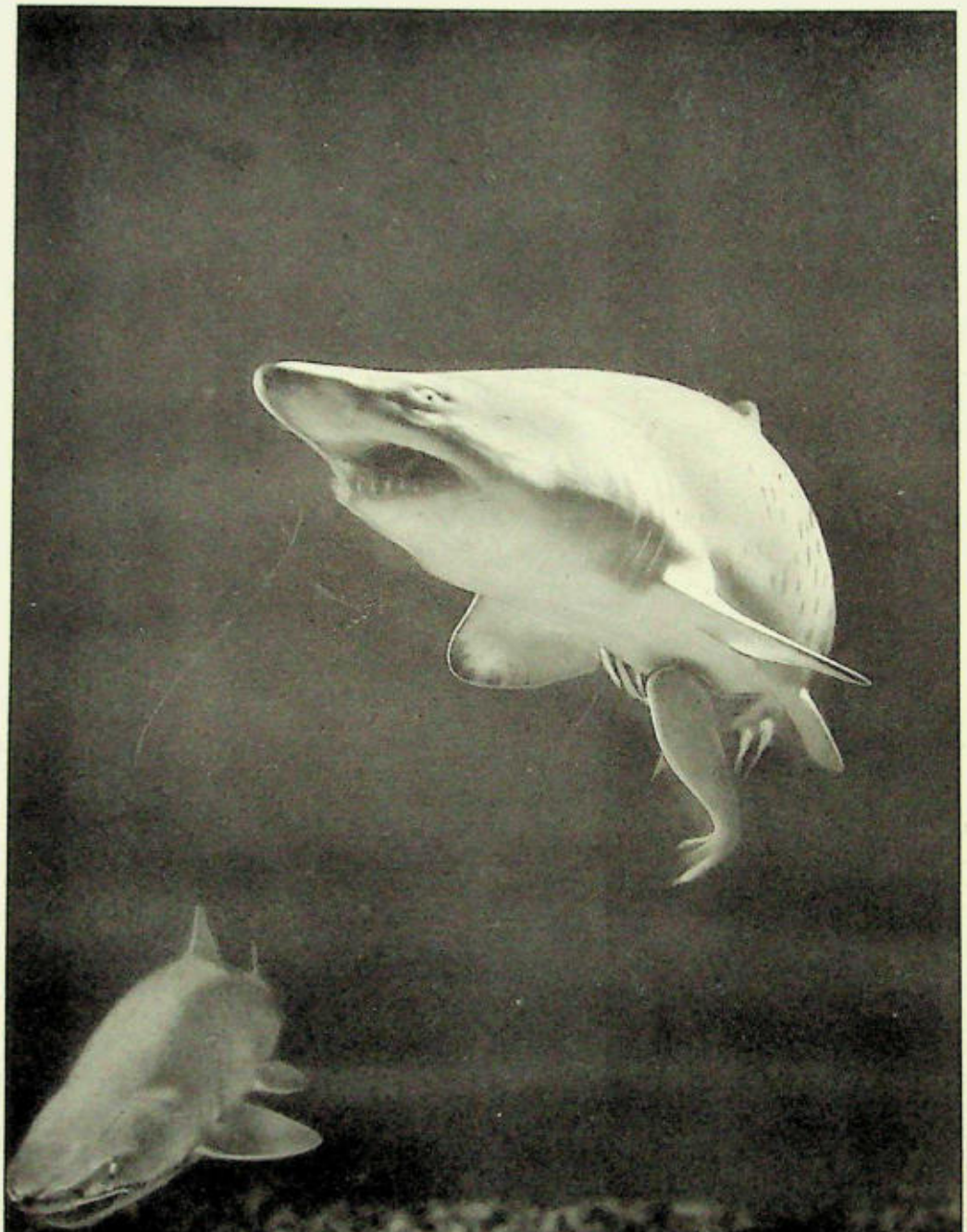


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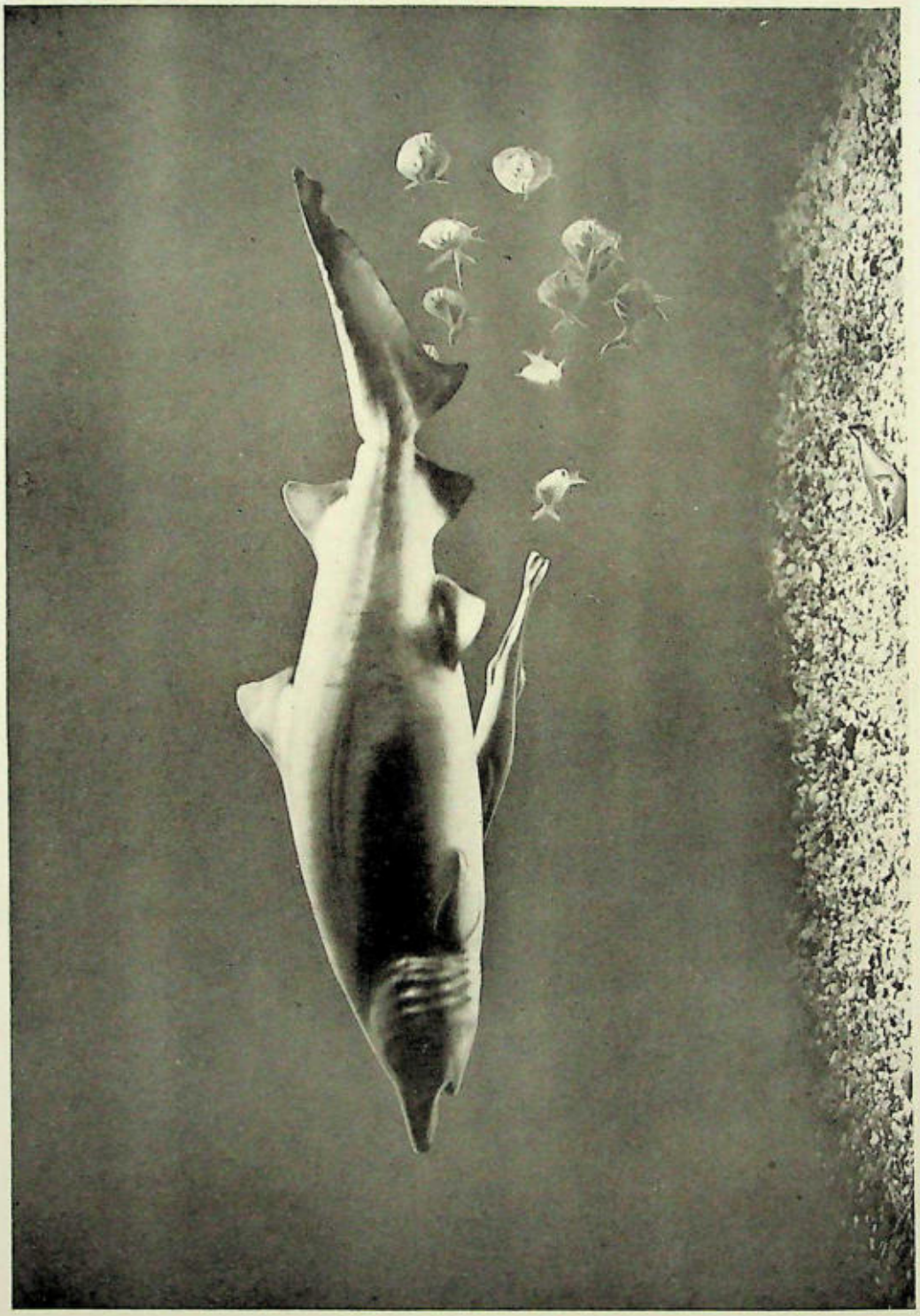
The author wishes to express his gratitude for the critical analysis extended by Dr. E. W. Gudger, Bibliographer and Associate in Ichthyology at the American Museum of Natural History, and for the use of his negatives. Dr. C. H. Townsend, Director of the New York Aquarium has rendered similar services as well as the editor of the Bulletin, whose photographs of sucking-fish are reproduced herein.



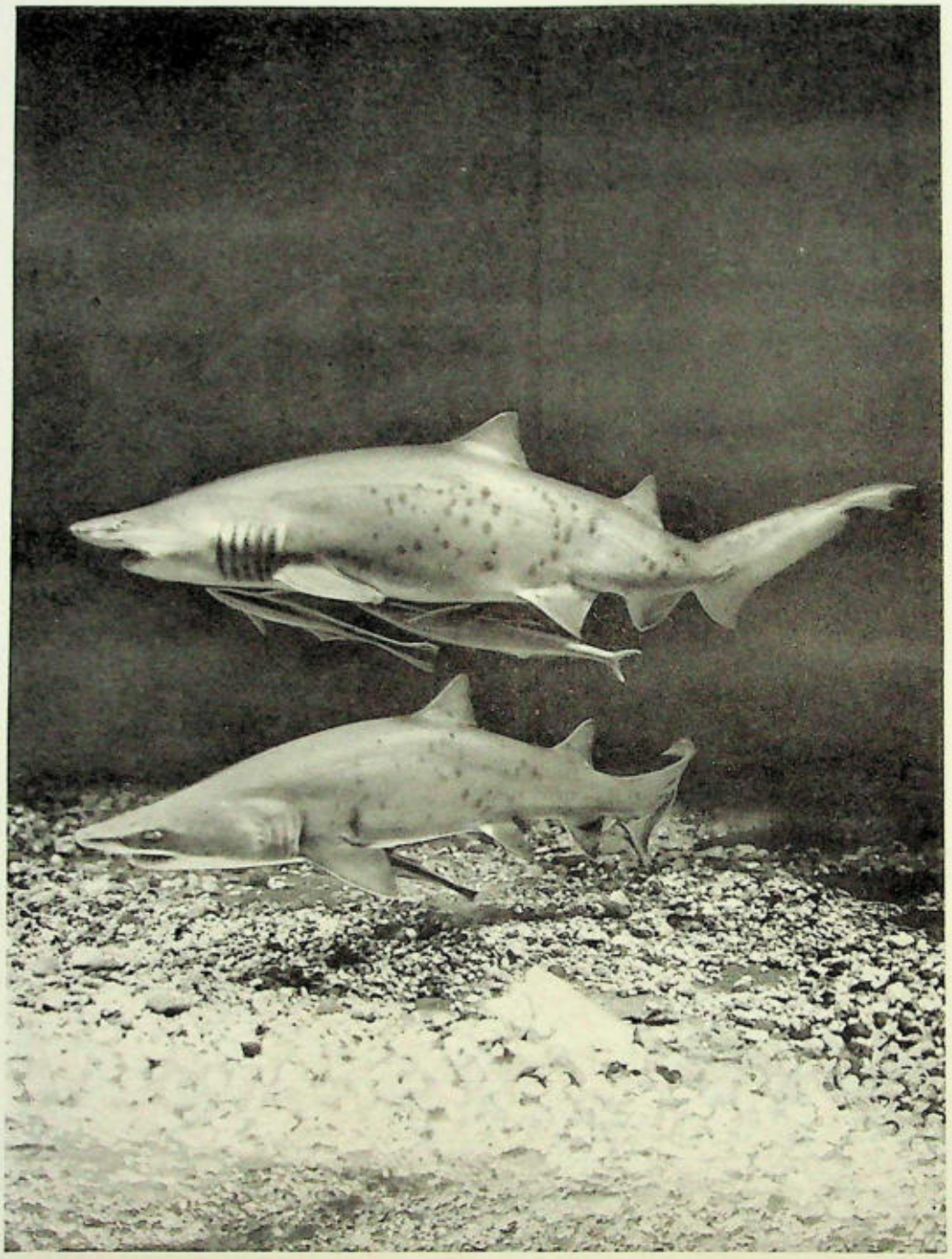
The photographs that follow were taken in the New York Aquarium by Mr. Elwin R. Sanborn. They illustrate typical attitudes of the sucking-fish in association with the larger sharks. Special photographic lighting equipment had to be devised in order to secure these photographs. Ingenuity, patience and skill were required on the part of the photographer. The evaluation of these results is left to the reader.



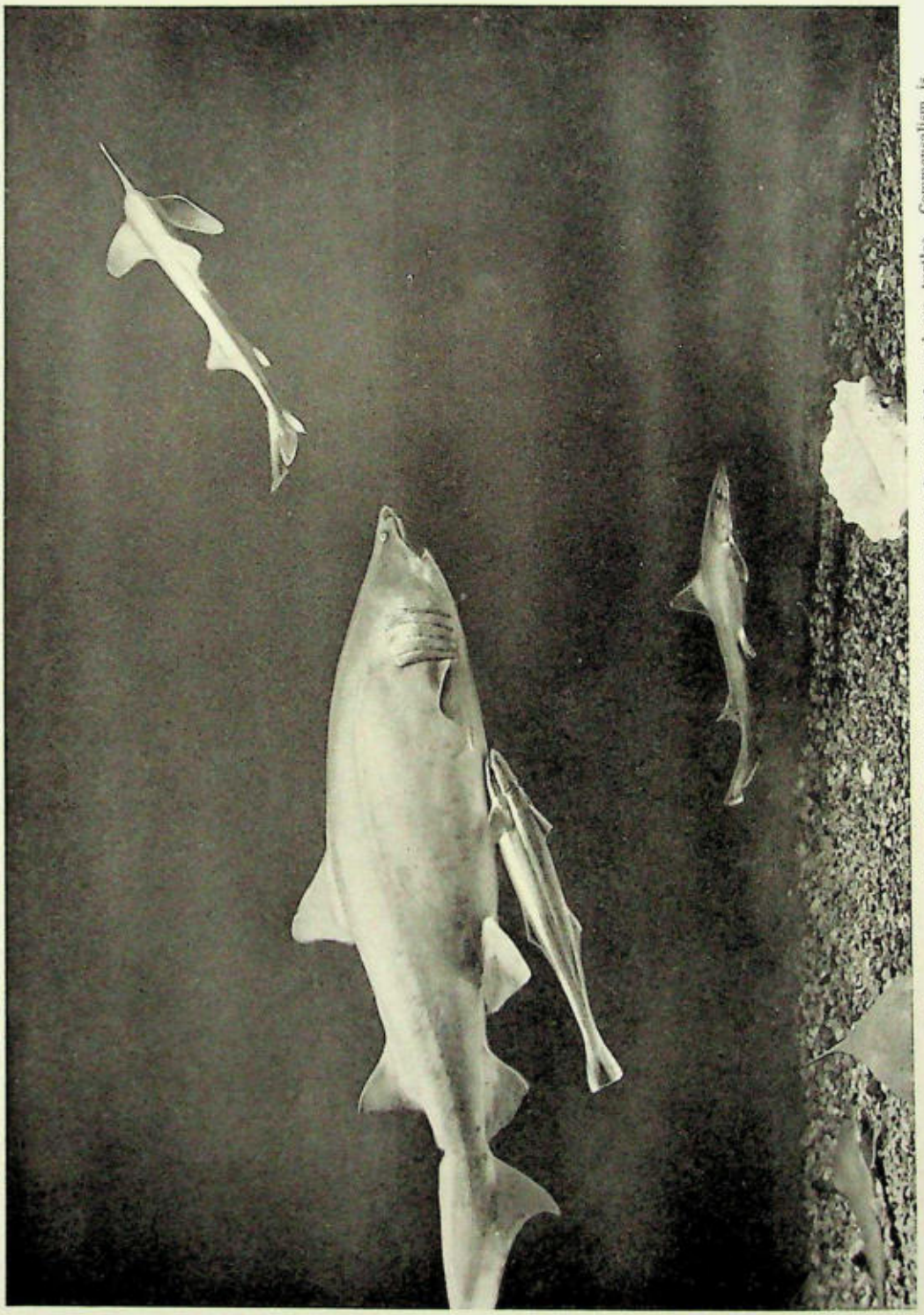
Remora attached to the belly of the large sand shark. The series of pictures illustrating this interesting companionship of two different marine forms represent a task of many nights of close application, and hours of patient waiting for the sharks to cruise into the proper position to photograph the under side. The sharp, penetrating rays of the flashlight in no way disconcerted the subject, the shark swimming on his course entirely unconcerned.



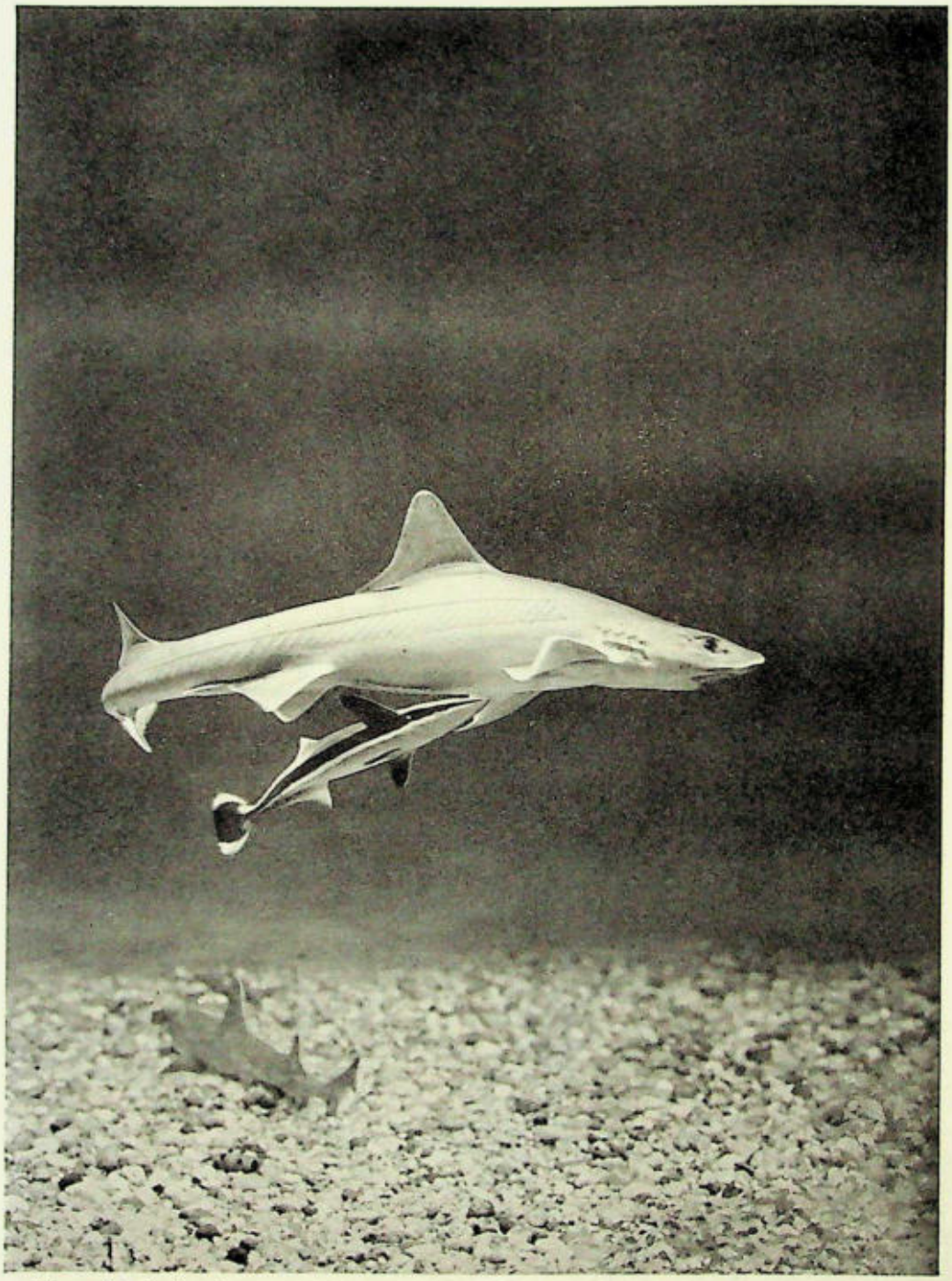
This shows the sucking-fish attached to a sand shark in one of the tanks of the New York Aquarium. This is a typical and natural group found to be common in the seas in many parts of the world.



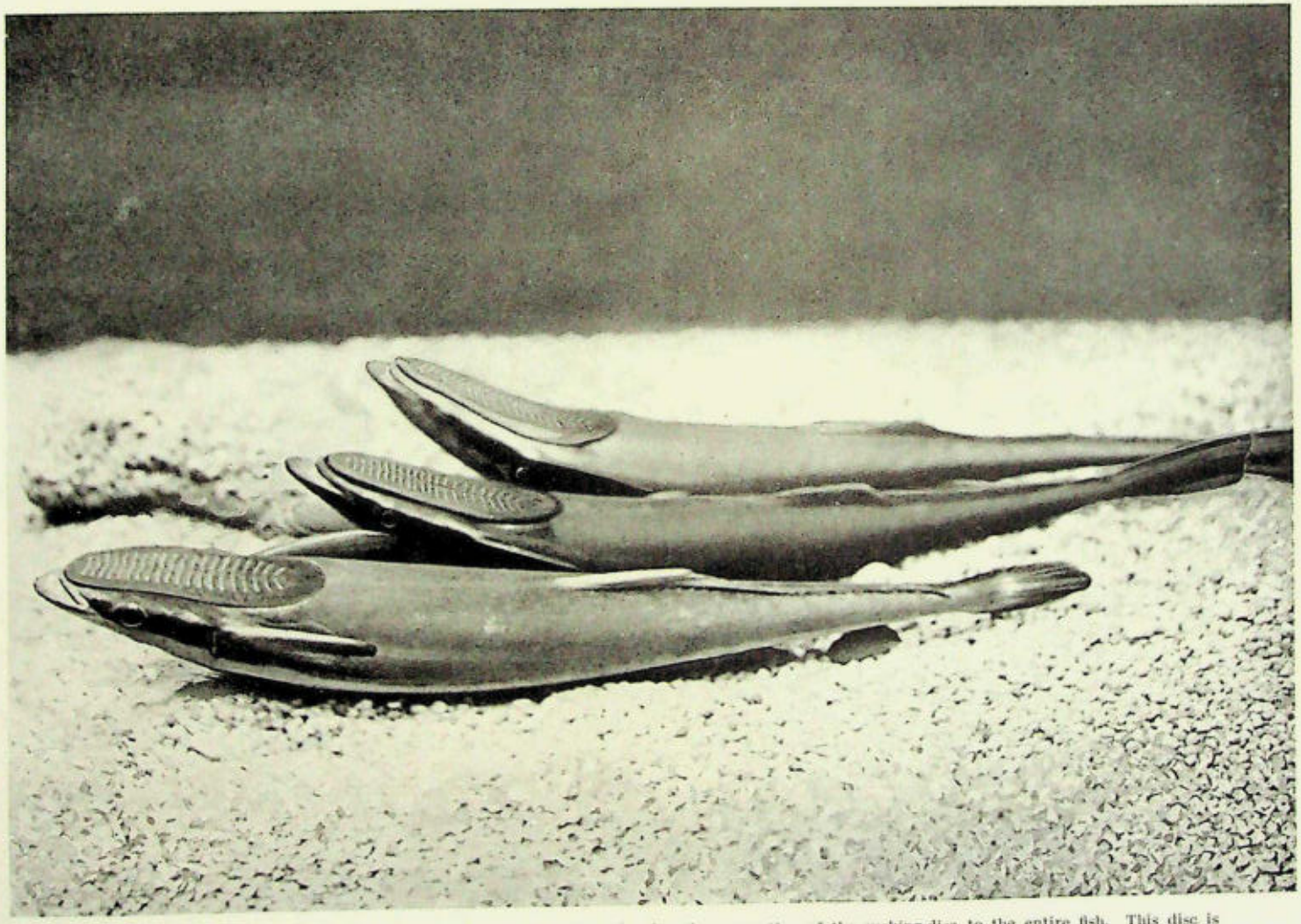
The fisherman fish, *Echeneis naucrates*, like many other marine fishes, has the power of making instantaneous changes in its markings. In this view two color phases of the same species are shown.



The remora or sucking-fish is a commensalist and is usually found associated with the larger sharks and sea turtles. Commensalism is the term used when the lodger (in this case the remora) obtains food with the assistance of its host (the shark).



The smaller sharks, whose movements were rather swifter than the larger specimens, were not always good hosts. When they became annoyed by the drag on their speed by the attached remora, they dropped to the bottom of the tank, where the contact with the pebbles forced their unsought companion to sever his connection. Speed in swimming had no effect on the remora, but the rough drag on the floor of the tank was a certain means of discouragement.



A group of remoras photographed in the New York Aquarium showing the proportion of the sucking-disc to the entire fish. This disc is an evoluted dorsal fin. Their strong, square tails, so useful in pursuit of their host, are also shown.

Items of Interest — Zoological Park

The Snake Island: An island area, surrounded by a water-filled moat, and stocked with a variety of North American serpents, is now an important exhibit of the Park and attracting keen attention. This installation was carefully planned, both as to construction and attractiveness, and is particularly satisfactory. It is fifty feet long and twenty-five feet wide. The outside wall is of cast cement panels, of pale hue, ground to smooth finish. Interspersed with the panels are piers of special brick to conform to construction details of the nearby Reptile House. The island has grassy slopes and an elongated rock ledge, with shelving crevices. Over fifty snakes, of six species have been liberated in the area. The snakes frequently enter the water and swim about the island.

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Young Animals: The spring and early summer months have brought a number of interesting births among the mammals. Two of these have been very rarely recorded in the history of zoological collections. The exceptional specimens are a baby kudu and a brindled gnu. It also happens that both are singularly attractive types. They are also vigorous and developing rapidly. While not rare among recorded births, two of the most interesting infants in the Park are rhesus monkeys, born only a few days apart. Among the other young animals are a yak, American bison, fallow deer, Dybowsky's deer, two axis deer, three red deer, two white-tailed deer, two tahr and four aoudad.

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Nest of Galapagos Tortoise: A most unusual event occurred in June, in the yard occupied by one of our colonies of Galapagos tortoises. A one-hundred pound tortoise dug a deep nest and deposited eggs, then carefully filled the cavity and tamped it down with her shell. As far as we know this is the first record of actual observation of the nesting habits of these giant tortoises. The female concerned was one of four presented to the Park by Mr. W. K. Vanderbilt in March, 1928. Mr. Vanderbilt had conducted an expedition to the Galapagos Islands and captured the four specimens on Duncan Island. The species concerned is scientifically known as *Testudo ephippium*. There have been several indications of breeding among these specimens. Late one afternoon this larger example of the two females was seen to be busily digging until she had a cavity about two feet in diameter by eighteen inches deep. The rear portion of the tortoise tilted into the cavity and the digging was done with her hind feet, by a sweeping motion, which brought the earth to the surface. She finally came to rest in this position and as night came on and we did not wish to disturb her with artificial light, we left her to the nest building. In the morning, the cavity had been filled and shell markings indicated that she had tamped the earth firmly. A careful investigation with a trowel revealed several eggs, apparently four. We did not critically make further examination for fear of damaging the eggs, and therefore our investigating crevice was refilled. From the meager notes about eggs of smaller tortoises, we estimate these eggs should hatch about October. If we obtain freshly hatched Galapagos tortoises and have a chance to rear them, the resulting notes will be unique in the history of zoological observations.

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Interesting Arrivals: Through Mr. Ross Freeman's interest in zoological collections, an extensive series of Sumatran mammals, birds and reptiles arrived in New York, July 10th, on the Furness Withy liner, *Javanese Prince*. The specimens are being distributed among several zoological gardens, the greater number going to Washington and New York. Our portion of this shipment was composed entirely of reptiles. We received three salt-marsh crocodiles, three large monitor lizards, a twenty-foot python, three "blood" pythons, four mangrove snakes, a king cobra and a tree viper. The king cobra is about eleven feet long. The "blood" pythons, *Python curtus*, were of particular interest as the species in the past, has been extremely rare in collections, even in preserved form, in the museums. It has previously been described as of red coloration, but the specimens brought by Mr. Freeman are of yellowish hues. It is proportionately an extremely stout snake, with a small head. An example a yard long is approximately three inches in diameter.

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Growth of the Gorilla: Our young female gorilla is developing in a most satisfactory manner and is now a really impressive exhibition



FRANK KNIGHT STURGIS

IN THE PASSING OF MR. STURGIS, THE ZOOLOGICAL SOCIETY SUSTAINED A GREAT LOSS. AS A MEMBER OF THE BOARD OF TRUSTEES SINCE 1907, OF THE EXECUTIVE COMMITTEE SINCE 1910, AND AS VICE PRESIDENT SINCE 1915, MR. STURGIS' DEVOTION TO THE INTERESTS OF THE SOCIETY AND THE CHARM OF HIS PERSONALITY ENDEARED HIM TO ALL HIS ASSOCIATES. HE GAVE MOST GENEROUSLY OF HIS TIME AND MONEY TO THE WORK OF THE SOCIETY AND THE PARK, AND AS CHAIRMAN OF THE ART COMMITTEE THE SPLENDID GALLERY OF WILD ANIMAL PAINTINGS IN THE ADMINISTRATION BUILDING IS LARGELY DUE TO HIS WORK AND PLANNING.

Photograph, Underwood and Underwood.



ERECTED IN MEMORY OF
PHILIP MESIER LYDIG
AND
CATHERINE SUYDAM LYDIG
BY THEIR DAUGHTER
FLORENCE LYDIG STURGIS
A.D. 1903

THESE LANDS BECAME
THE HOME OF
THE LYDIG FAMILY
A.D. 1802
AND BY THEM THESE FORESTS
WERE PRESERVED AND
PROTECTED UNTIL ACQUIRED
BY THE CITY, A.D. 1888

INSCRIPTIONS ON THE OPPOSITE SIDE OF THE ARCH

animal. She occupies one of the commodious cages in the southerly section of the Primate House. From the time of her arrival, her inseparable companion has been a chimpanzee of approximately her age. The frequent play of these young specimens is a source of the keenest interest among our younger visitors. The gorilla is now about five years old. She arrived at the Park in October of 1928. On arrival she weighed seventeen and a half pounds. In December of 1929 she had grown to a weight of thirty-nine and three-quarter pounds, and a year later (1930) to forty-five pounds. She was weighed in July of the present year, when the scales registered her development to seventy-six pounds.

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Anthropoid Ape Records: It appears that the Park is establishing some exceptional records as to the longevity of captive anthropoid apes, of which we have reared several from extreme youth to maturity. It is indicated that sexual maturity occurs about the eighth year. Following are records from our card index, of the period we have exhibited several examples, which continue in thriving condition: Chimpanzee Susette, fourteen years; chimpanzee Fanny, sixteen years; chimpanzee Boma, seventeen years, and a female orang-utan, Gabong, sixteen years.

R. L. Ditmars.

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The Legendre Gift:—A fine and valuable collection of birds from French Indo-China, the gift of Mr. and Mrs. Sidney J. Legendre, was received at the Zoological Park on May 10, 1932. The birds were collected by the Legendre Indo-China Expedition and arrived here in excellent condition, due to the painstaking care they had received from Mr. T. Donald Carter, Assistant Curator in the Department of Mammals at the American Museum of Natural History. Mr. Carter accompanied Mr. and Mrs. Legendre on the expedition and having completed his duties in the field, could not resist the opportunity to do the Zoological Park a good turn. Included in the gift of the Legendres were two Javan peafowl, one Germain peacock pheasant, six Siamese fireback pheasants, two of the curious hybrids between the Javan jungle fowl and the domestic fowl, and a pair of the extremely rare white-winged duck (*Asarcornis scutulata*). Very few representatives of this shy and secretive duck have been kept in captivity, and none has previously been seen in this country.

In Saigon, contact was made, by the expedition, with Monsieur Jean Delacour, an Honorary Member of the New York Zoological Society. M. Delacour added to the collection a further pair of Javan peafowl, as his own gift to the Society.

At Singapore, Mr. Carter secured two pairs of great Argus pheasants, and a female Malay crested fireback pheasant, all of which he presented to the Society.

European travelers to far distant places have long made a practise of bringing home unusual specimens for local Zoological Gardens, many rare species having made their first public appearance by this means. This custom has never become as popular as it should among Americans but we may hope that the example of the Legendre Indo-China Expedition will be followed by others.

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New Birds of Paradise:—The recent purchase of three male birds of paradise—a greater, a lesser and a red—brings our collection of these lovely birds to a total of thirty-seven individuals, representing seventeen forms. Once birds of paradise have become thoroughly acclimatized with us, they usually begin their annual molt in spring, so that they are not again in full plumage until autumn. Newly introduced birds, however, may have their first molt at almost any time. At present, our older birds, including those brought from New Guinea in 1929, are in complete disarray but the two male Emperor of Germany's birds of paradise, the two males of Rothschild's gorgetted, purchased last year, and the recently arrived lesser, are all in full color. This is a fortunate chance, for birds of paradise undergoing the molt are not objects of great beauty. We do not expect these birds now in color to molt again until the spring of 1933, when all will then be on the same schedule.

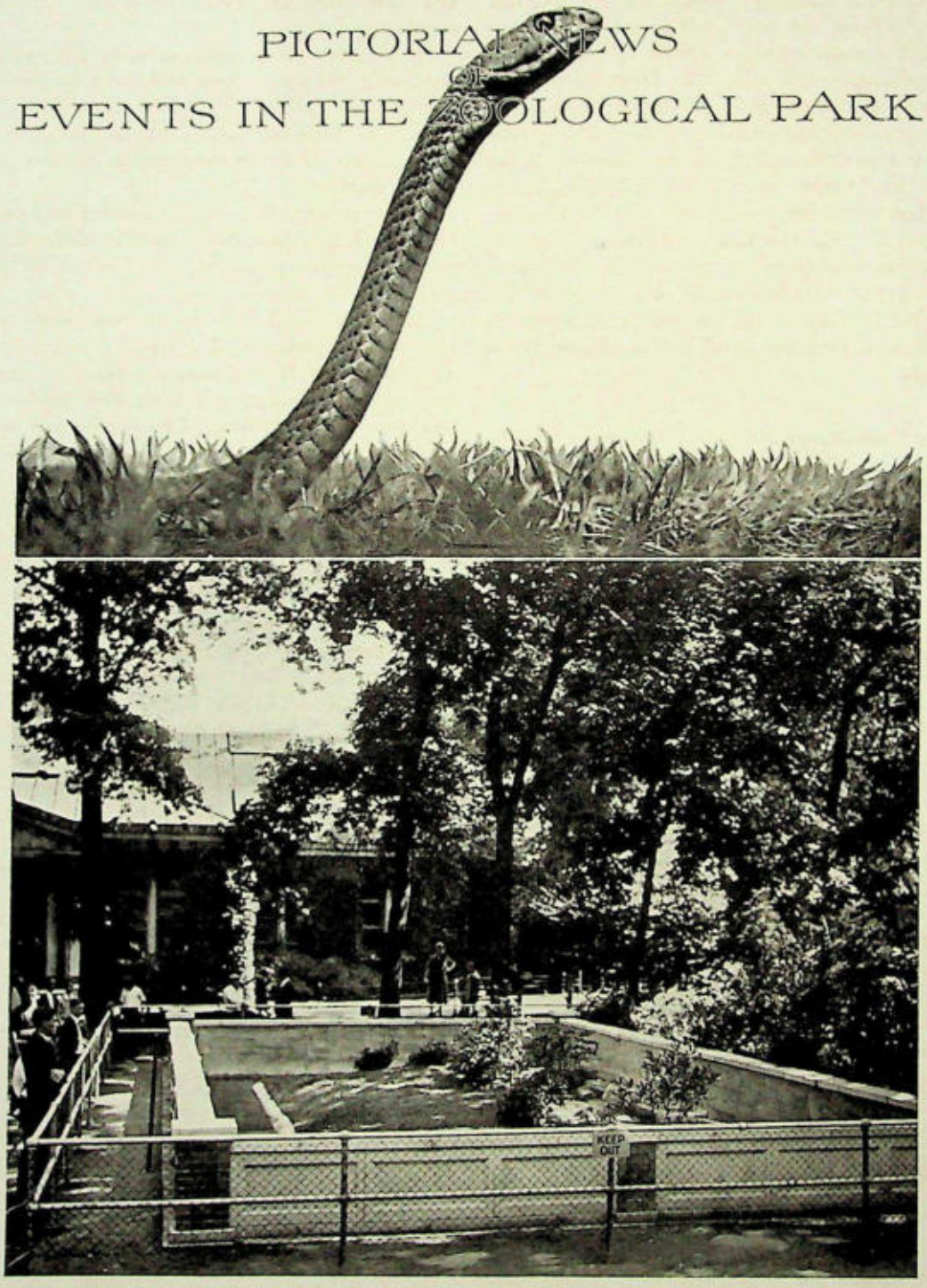
—L. S. Crandall.

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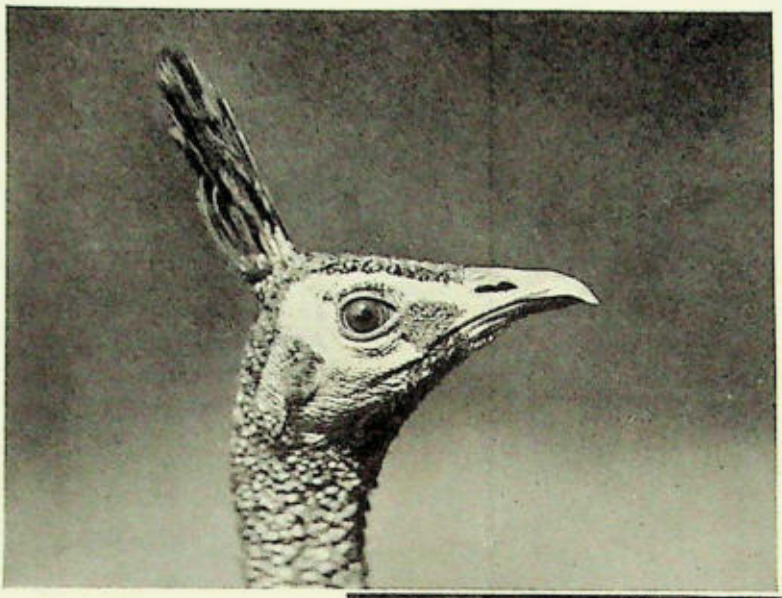
Endowment

The Endowment Fund of the Society has been increased by the bequest of $50,000, from the estate of the late Mortimer L. Schiff. This sum has been deposited in the Schiff Endowment Fund.

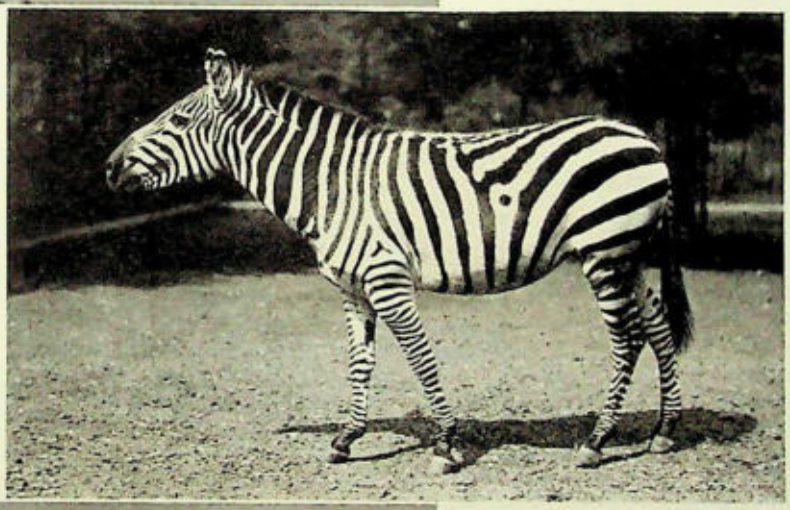
PICTORIAL NEWS OF EVENTS IN THE ZOOLOGICAL PARK



A new installation in the Zoological Park for the out-door exhibition of several species of harmless serpents. It has been aptly termed "Snake Island," and is briefly described in this issue.



Visitors to the Zoological Park are almost certain to have their attention attracted to our pea fowls, which have a free run of the Park, either through seeing the gorgeous display of the males or by hearing their raucous voices. Thanks to the generosity of the Sidney H. Legendre Expedition to Indo-China, and to M. Jean Delacour, we now have, in addition to our Indian and white pea fowls, four specimens of the Javan form. This species is somewhat larger than the common pea fowl, the crest is longer and the neck and underparts are green instead of blue.



The collection of zebras in the Zoological Park is an exceptionally fine one and we have been successful in raising the offspring of most of the mated pairs. To keep the herd in good condition it is sometimes necessary to secure young animals from outside sources. This recently acquired two-year-old Grant zebra thus replaces a much older animal.



This fine specimen of the chacma baboon from South Africa is the largest baboon ever exhibited at the Zoological Park. The chacma lacks the violent red and blue coloring which adorns the West African drill and mandrill, and also the colored ridges on the nose of the latter. It is fairly intelligent, perhaps more so than other baboons, and can be taught various tricks. It is the baboon sometimes seen in acts at the circus.



This brown bat was brought to the Park by a visitor as a possible addition to our collections. Less is known concerning the habits and life histories of bats than of any other group of our common mammals and they are always of considerable interest to anyone privileged to examine them in the light of day. This mother bat was of special interest because of her two young, which may be seen clinging tightly to the fur on her abdomen. The family was photographed and released.



The coati or coati-mundi is native to Central and South America. It is a southern representative of the raccoon family, and like that more familiar animal, is a tireless and industrious hunter. Coatis are gregarious and small bands thoroughly comb their territory in the search for food. This young coati is the first that we have received. They usually do not survive the sea voyage to this country.



The great ant-eater is one of the world's strangest mammals. We have been fortunate in being able to maintain this animal in captivity for a relatively long time. Our last specimen was on exhibition for eight years. Ant-eaters, in captivity, of course can not receive their natural food of ants and other insects, so a substitute has been devised. This consists of a mixture of ground meat, eggs and milk.



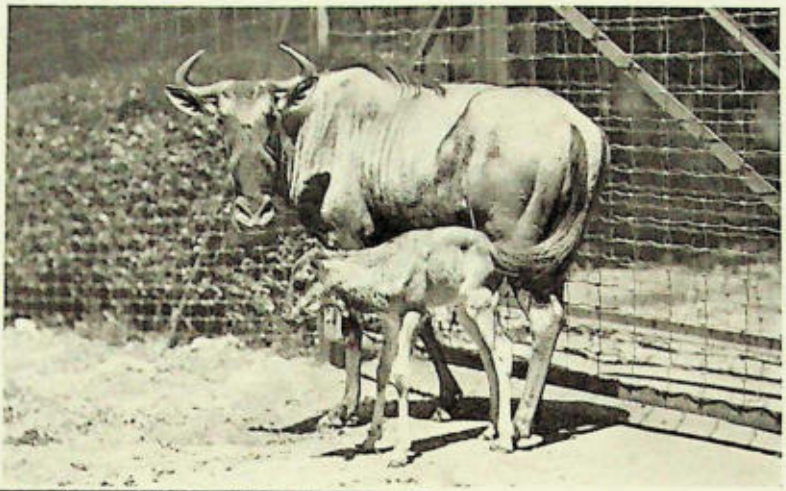
While North American porcupines are more or less arboreal, South American representatives of the group are climbers to an even greater degree, so much so, in fact, that they have developed prehensile tails, very similar to those possessed by the typical South American monkeys. This specimen is the spiny tree porcupine, never before represented in our collections.



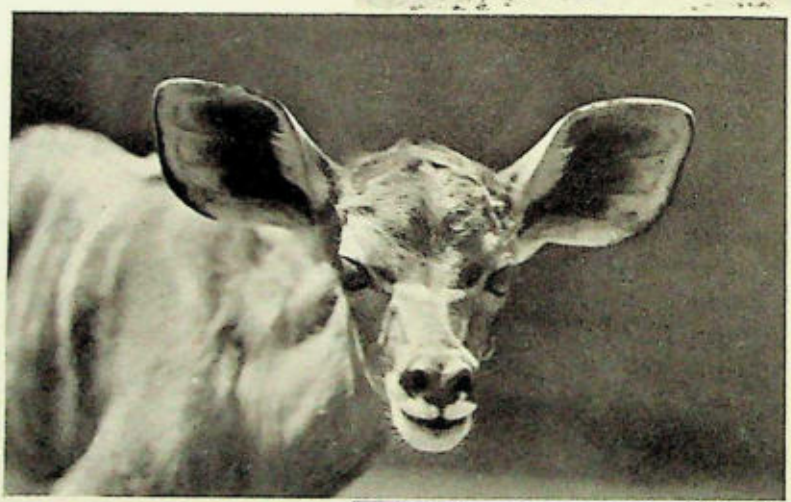
The Himalayan tahr holds its own extremely well in the climate of New York City and, despite the high temperatures and humidity of the summer months, our herd has no apparent difficulty in raising the young produced on Mountain Sheep Hill. The tahr is the largest of the Himalayan wild goats. The hunting of this animal, due to the rugged type of country which it inhabits, is one of the world's most dangerous sports, although from a sportsman's viewpoint the horns are rather small.



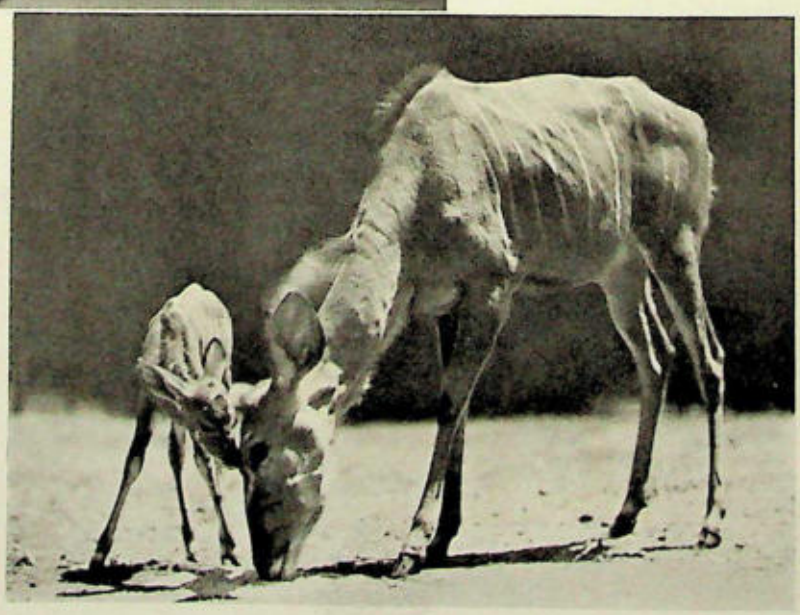
The Zoological Park herd of yaks is famous. The original pair was sturdy and prolific. Not only were they the forebears of our present large herd, but their increase has started other herds in "Zoological Parks all the way from Boston to Melbourne." Our present herd leader is a magnificent animal, five feet high at the shoulder.



Our pair of blue or brindled gnus, acquired only last year, presented us with a sturdy young female on June 28, the first gnu ever to be born in the Park. Gnus bring all of their odd looks and much of their activities of the wild into captivity, and since they take so kindly to life in the Zoo, they make excellent exhibits.



Apparently this is the first young kudu to be born in captivity in this country. This newcomer is one of the handsomest of our young Park animals, and like in a well-marked, adult male, the perpendicular white stripes stand out strikingly from the reddish-brown ground color of the body.



The greater kudu is regarded by many persons as being the handsomest of all the African antelopes. We have always tried to have this species represented in the Park collections and several years ago we obtained a young male specimen as a mate for the female then on exhibition. On June 18 this pair bred for the first time and presented us with a fine young female.



Markhors are, after all, nothing more than goats with horns gracefully turned and spirally coiled in a cork-screw-like fashion. In the Astor markhor, the spire is open, the horns being loosely coiled. In the Suliman race, the spire is tightly closed, forming, in effect, a straight horn with spirally coiled ridges. This newcomer to the Park collections belongs to the Astor group and is native to the eastern Himalayas.



The Zoological Park herd of bison became famous in 1906, when the New York Zoological Society presented fifteen bison to the United States Government as a nucleus for the Wichita bison preserve, the first preserve designed to save the bison from extinction. Our bison herd is still vigorous and healthy. This photograph shows the latest addition to the herd.



The most picturesque animal on Mountain Sheep Hill is the Aoudad. Native to the arid and desert regions of North Africa, it nevertheless does exceptionally well in the climate of New York City. The males possess a mane of long hair on the dew-lap and an apron or pantalettes of long hair on the forelegs. Three or four young aoudads are born to the Zoological Park herd every year. Our own native mountain sheep from the Rocky Mountains find the New York climate to be utterly unsuited to them and efforts to maintain them in the Park have been so unsuccessful that we no longer try to exhibit them.

Educational work:—During the last year, the activities of this department have been concerned chiefly with extending the use of our visual instruction materials, lantern slides and motion pictures, to the public schools of the city. A modified form of docent service, in which visiting groups of students are taken behind the scenes and given a more intimate view of Park specimens and administrative details, has been used successfully, especially with groups of older children. Talks concerning the Park collections and local birds and mammals have been given upon several occasions in school and college.

During the year 744 groups of school children and other organizations visited the Park. These groups comprised a total of 27,888 children. The financial depression had its adverse effect upon these visiting groups and the number of such visitors was some 5000 under that of last year.

As reported by teachers, our lantern slides of birds and mammals have been seen by 22,393 children. One new series of slides has been added during the year—"Reptiles of the Eastern United States." This series contains characteristic photographs of reptiles of the region, and since such material is not generally available, the slides have been in steady demand.

Our motion pictures were shown to 7000 children during the year. One subject has been printed on 16mm. film and this has been so successful that more will be added as soon as possible.

The department stands ready to do whatever it can to help teachers and others in their study of natural history.—*Claude W. Leister.*

—o—

The Library: Additions to the library in recent months include a number of important and interesting books which have been acquired by purchase and by gift. Some of the volumes are to be found in the main library in the Administration Building and others have been placed in the departmental sections for the use of the Curators.

The outstanding acquisition was the purchase of a set of twelve volumes called the Smithsonian Scientific Series. The volumes contain a wealth of material based almost entirely on the collections of the Smithsonian Institution and its allied institutions. The text matter is entertainingly and authoritatively presented and the illustrations and colored plates in many cases are exceptionally fine.

Thus far eleven volumes have been issued, as follows: I The Smithsonian Institution, by Webster Prentiss True; II The Sun and the Welfare of Man, by Charles Greeley Abbot; III Minerals from Earth and Sky, by G. P. Merrill and W. F. Foshag; IV The North American Indians, by Rose A. Palmer; V Insects: Their Ways and Means of Living, by Robert W. Snodgrass; VI Wild Animals In and Out of the Zoo, by William M. Mann; VII Man from the Farthest Past, by Carl Whiting Bishop; VIII Cold Blooded Vertebrates, by S. F. Hildebrand, C. W. Gilmore and Doris M. Cochran; IX Warm Blooded Vertebrates, by Alexander Wetmore, Gerrit S. Miller, Jr. and James W. Gidley; X Shelled Invertebrates and the Past and Present, by Ray S. Bassler and others; XI Old and New Plant Lore, a symposium by various authors.

By gift the library has received a four-volume set of "Les Oiseaux de l'Indochine Francaise" by J. Delacour and P. Jabouille. Although bound in paper, the books present a fine example of book making in the matter of type and color plates. The latter are the work of H. Grönvald, who also made some of the color plates for The Pheasant Monograph by Dr. William Beebe. The text is in French.

Other gifts included the presentation by the United States Geological Survey of the imposing two-volume work by Professor Henry Fairfield Osborn on "The Titanotheres of Ancient Wyoming, Dakota and Nebraska." Prof. Osborn presented to the library a copy of his "Fifty-Two Years of Research, Observation and Publication." Further gifts by the respective authors were "Thirty Years War for Wild Life" by Dr. W. T. Hornaday and "The Physiology of the Large Reptiles" by Dr. Francis G. Benedict. Through Mr. Madison Grant, President of the Society, the library received "Conservation in the Department of the Interior" by Ray Lyman Wilbur and William A. DuPuy, and Volume XXI of "The Geographical Review."

Two other notable bird books recently purchased are "Florida Bird Life" by Arthur H. Howell of the U. S. Bureau of Biological Survey, and "Birds of Minnesota" in two volumes

by Dr. Thomas S. Roberts, Director of the Museum of Zoology of the University of Minnesota. Both volumes are illustrated by fine color plates and present in a very comprehensive manner the bird life of the states mentioned.

Not technical in character but containing much information of interest and value is C. Emerson Brown's "My Animal Friends," having to do chiefly with the animals in the Philadelphia Zoological Gardens, of which Mr. Brown is Director.

While the Zoological Society's library is used chiefly for reference and research purposes, it is open to members of the Society. Those wishing to avail themselves of the privilege should make inquiry of the Director's secretary regarding the rules governing the use of the books.

——o——

Accessions: The collections of the Zoological Park are added to by purchase, by births, by gifts, and occasionally by exchange with other zoological parks or gardens. The purchases are important from the standpoint of the monetary value or the rarity of the specimens acquired, the births are always interesting, and the gifts are appreciated and acceptable.

Because of the present economic situation the Zoological Society has adopted the policy of not expending any large sums on the purchase of animals except when a specimen may be needed to fill a gap in the existing collections. The only important purchases within recent months have been an unusually large chacma baboon, a female Grant zebra shipped direct from Nairobi in South Africa to New York by way of Rotterdam, and a young Astor markhor, a species which has not been represented at the Park for many years.

The most important addition to the bird collection was the purchase of three birds of paradise, one Greater, one Lesser and one Red, making the present collection of birds of paradise in the Zoological Park superior to any to be found anywhere.

The additions to the reptile collection were the most numerous and consisted chiefly of the common snakes, turtles and tortoises.

The earliest births to be recorded for the year 1932 were two aoudad which arrived early in February. By far the most interesting births were two rhesus monkeys, one in April, the other in May. The father, two mothers and two babies live amicably in the same cage. The babies have developed splendidly and it affords a most entertaining spectacle to watch their playful antics and to observe the patient care and solicitude of the two mothers for their respective offspring.

Another giraffe baby made its appearance in March, but unfortunately an infection which apparently was present from birth brought about the untimely death of the calf after only two weeks. This was the fifth giraffe to have been born in the Antelope House.

On Mountain Sheep Hill two more aoudad lambs were born later in the spring as well as a mouflon and six Himalayan tahr. The gamboling lambs and kids appear to enjoy their home on the rocky hillside.

In the deer ranges one white-tailed, one Dybowski, one Barasingha, two fallow, three red and four axis deer fawns have increased the deer population to that extent during the first six months of the year.

In the Antelope House a number of unusual animal babies have been born in the past. Aside from the giraffes this building has been the birthplace of anoas, nilgai, blackbucks or Indian antelopes, and in June of this year a kudu and blue gnu were added to the register of births. Both little animals are growing nicely and it is hoped that they may be reared to maturity.—*Edith H. Franz.*

——o——

New Members of the New York Zoological Society

Elections from January to July, 1932

Annual

Mrs. B. Mayer
Mrs. Robert R. Titus
George N. Reinhardt
Mrs. Walter S. Mack
Mrs. Roswell Miller, Jr.
W. Y. Peters
Clifton P. Williamson
Dr. W. Ridgely Stone
Mrs. Harlow Brooks
Miss Ruth Walker Brooks
Miss Eleanor M. Mellon
Mrs. Margaret A. Gude
Thomas A. Keck
Mrs. Mary L. Peck
James W. Atz
Miss Dorothy Oak
Dr. C. Monford Cole
Carlton L. Pyetell
Thomas Mitchell Chance
H. Y. Barrow
Harold L. Taylor
Mrs. Sanford D. Foot
Mrs. William R. Biggs
Paul McMichael
Dr. Charles V. Morrill
L. R. Gale
Mrs. Richard T. Merrick
Mrs. Alburtus J. Ogden
Mortimer Landsberg
Mortimer Marcus

Life

Sidney J. Legendre
T. Donald Carter

Fellow

James P. Chapin

Changed from an Annual Member to Life Member

Mrs. George A. Helme

Vol. XXXV, No. 4.

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The Nourmahal ..... Photograph by Morris Rosenfeld *Cover*

BULLETIN

New York Zoological Society

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FLAMMEO

FROM FAKARAVA, TUAMOTU ISLANDS. THE PARTICULAR SPECIES OF THE GENUS *FLAMMEO* HAS NOT YET BEEN DETERMINED. WE OBTAINED SPECIMENS OF *FLAMMEO SAMMARA* WHILE WITH THE *U.S.S. ALBATROSS* AT MAKEMO IN THE TUAMOTUS IN 1899. IT MAY BE THE SAME. THE NATIVE NAME IS NOT AVAILABLE, BUT IT BELONGS TO THE GROUP KNOWN AS SQUIRREL FISHES IN THE TROPICAL ATLANTIC. THE COLOR PHOTOGRAPH WAS MADE IN THE AQUARIUM BY MR. B. R. SHERWOOD.

BULLETIN
NEW YORK ZOOLOGICAL SOCIETY

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Fishes from Pacific Coral Reefs

CHARLES HASKINS TOWNSEND

Illustrations made from photographs taken in the New York Aquarium by S. C. Dunton, unless otherwise noted.

WHEN Mr. Vincent Astor's yacht, *Nourmahal,* returned from the Galapagos Islands in 1930, she brought to the Aquarium a large collection of fishes, many of which are still living. Mr. Astor recently made important additions to the exhibit of Pacific fishes. This year he took the *Nourmahal* far beyond the Galapagos to the Marquesas, Society and Tuamotu Islands.

The first collection was noteworthy, as 265 fishes reached the Aquarium after a 3000-mile voyage—the longest one for live fishes in our experience. The journey made by the second lot broke all records, eighty-six fishes arriving alive after a voyage of more than 6,000 miles.

The carrying of this sort of live stock is not a simple matter of freight transportation as the uninformed person might suppose. Fishes must not only be carried in a plentiful supply of their natural element, but the water in the tanks must remain pure at all times. This means the operation of electric pumps and a flow of sea water day and night, to say nothing of mechanical aeration in the fresh water of the Panama Canal where sea pumps could not be used. Daily feeding is necessary, lest hungry fishes harass each other. When a gentleman undertakes a troublesome job, such as transporting live fishes, for the benefit of the public, it is a pleasure to assure him that the act is appreciated.

The *Nourmahal* called at Cocos Island and the Galapagos, making some additions to the list of fishes secured in 1930. The balance of the collection was secured at Nukuhiva in the Marquesas Islands, Tahiti and Bora Bora in the Society Islands, and at Fakarava in the Tuamotu Islands.

Most of the fishes were taken in wire fish traps of the pattern used by fishermen in Florida and the West Indies. The writer became acquainted with Pacific coral reef fishes at these same localities many years ago during the oceanographic investigations of the U.S.S. *Albatross.* The fishes then secured are in the National Museum at Washington in the unattractive form of alcoholic specimens. It is delightful to renew acquaintance with them as living things here in New York.

These fishes from the tropical Pacific are fascinating creatures with their amazing colors and odd shapes. Since their arrival in April, more than a million visitors have enjoyed seeing them.

Mr. Astor states that Chief Officer Carlson gave the collection his personal attention while it was on the *Nourmahal,* and Captain Klang and officers and crew participated in making a success of the effort. We personally observed, during the first voyage, the fine spirit with which things are done on board the *Nourmahal.*

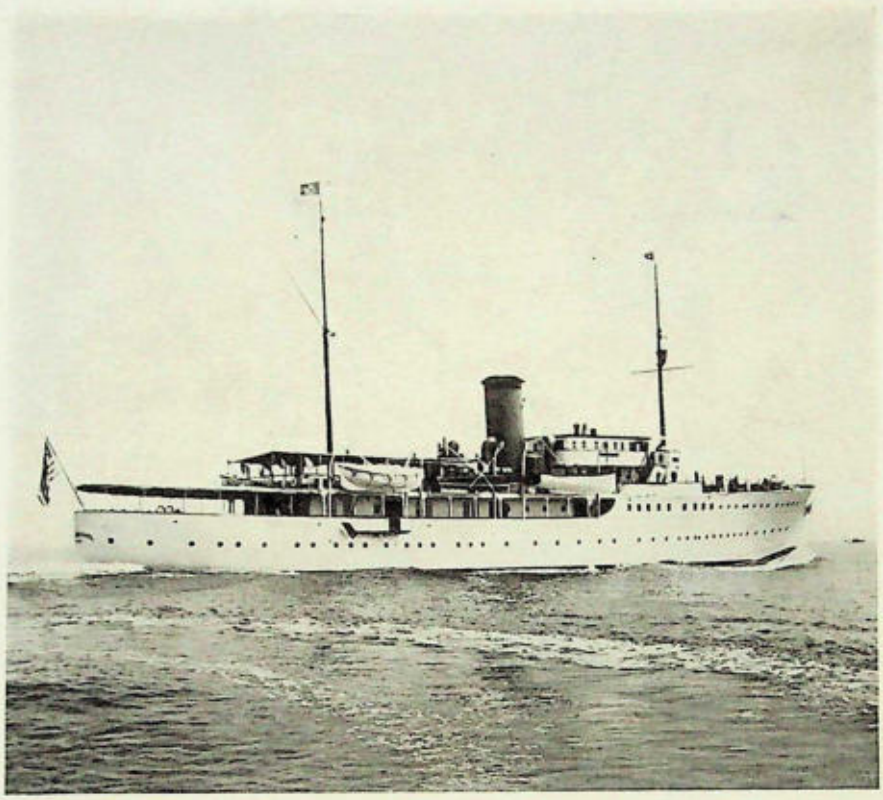
Our photographer has been so successful in making pictures of these new occupants of the tanks, that many are presented in this number of the BULLETIN for the benefit of persons who have not yet seen them.



MR. VINCENT ASTOR.

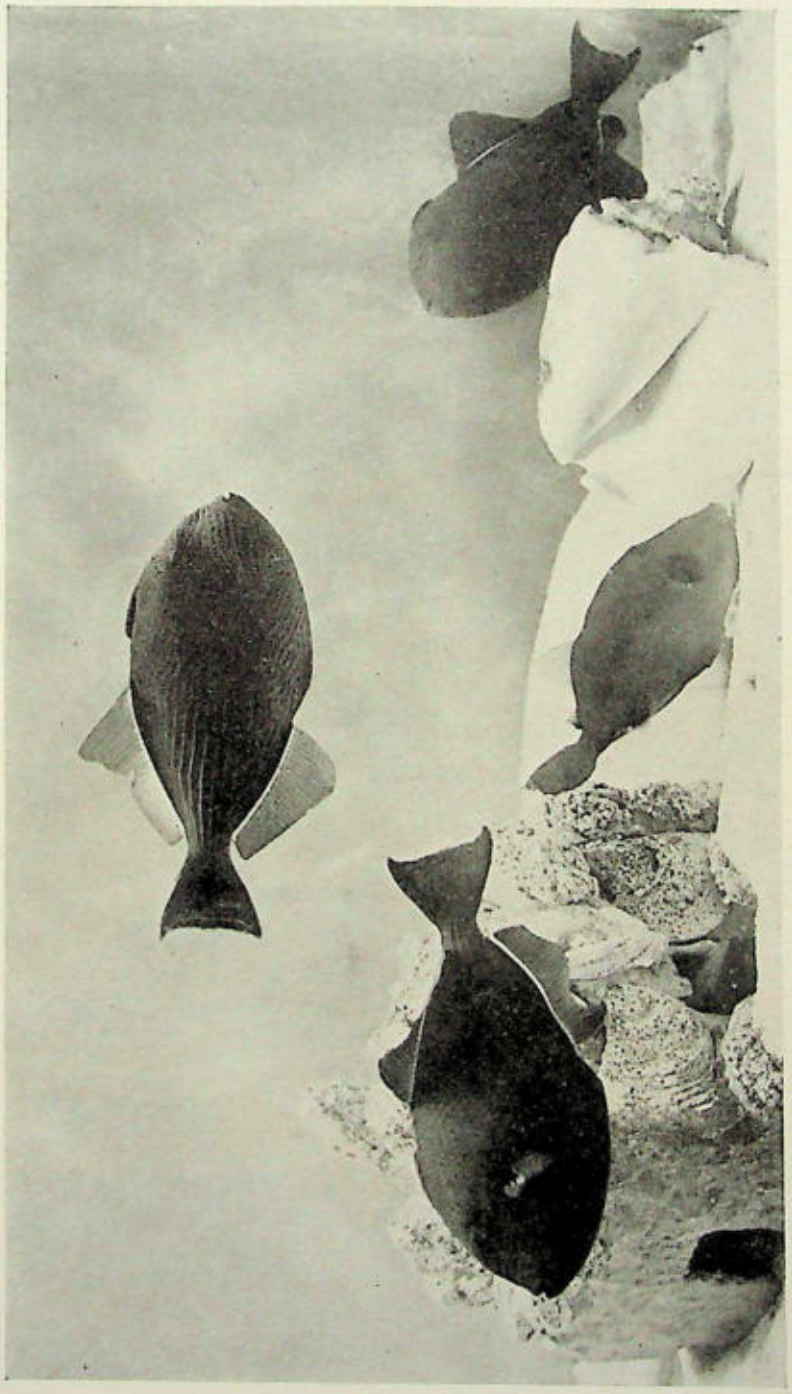
MR. VINCENT ASTOR, OWNER OF THE *NOURMAHAL*, HAS RENDERED MUCH VALUABLE SERVICE TO THE AQUARIUM IN THE MATTER OF OBTAINING MARINE SPECIMENS FROM DISTANT LOCALITIES. HE IS NOW A MEMBER OF THE BOARD OF TRUSTEES OF THE NEW YORK ZOOLOGICAL SOCIETY.

From a photograph by Blank and Stoller, Inc.

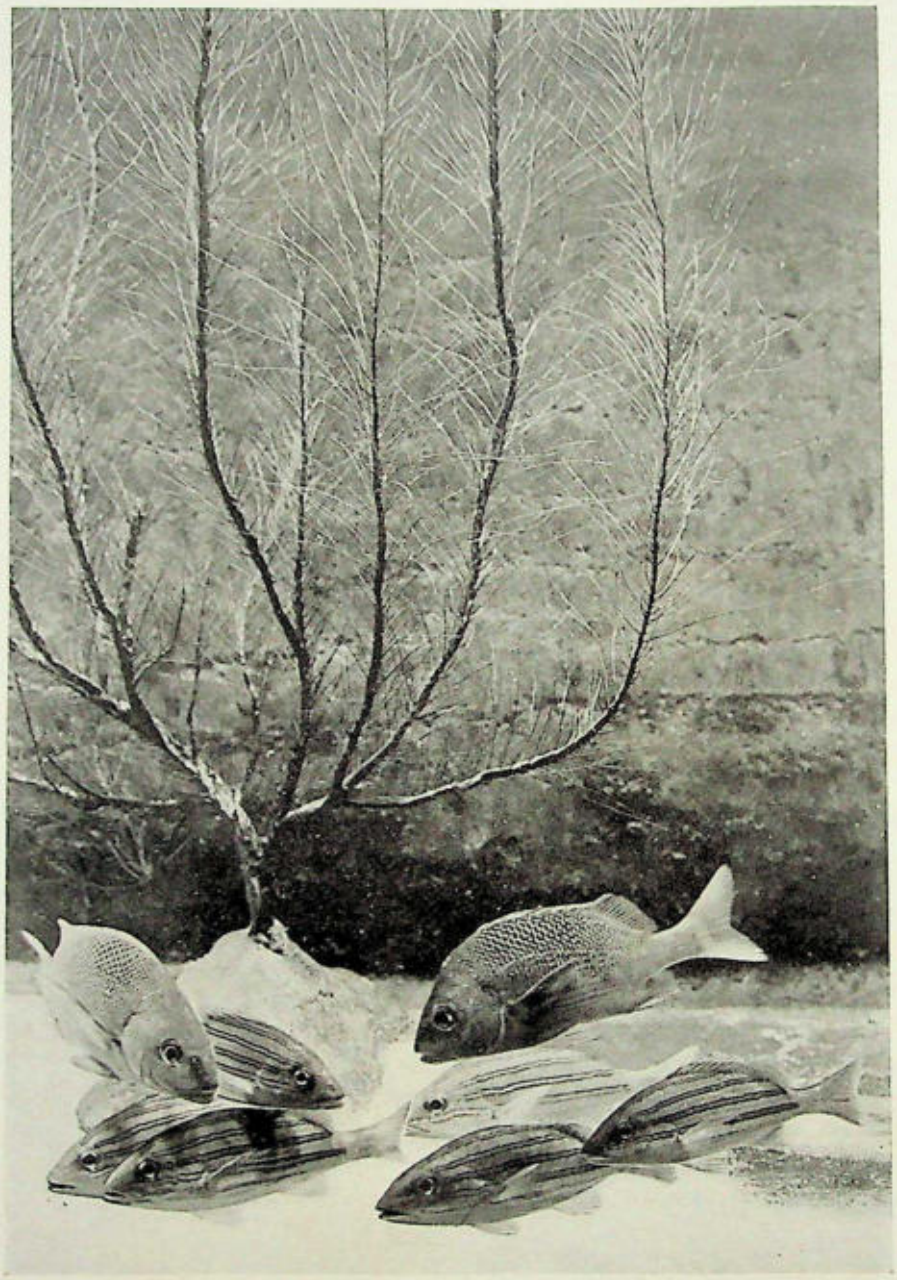


THE *NOURMAHAL*. A SHIP WHICH HAS BROUGHT MANY BEAUTIFUL THINGS TO THE AQUARIUM. THE VESSEL HAS RECENTLY BEEN FITTED WITH SEVERAL METAL TANKS FOR THE TRANSPORTATION OF FISHES AND OTHER MARINE FORMS OF LIFE.

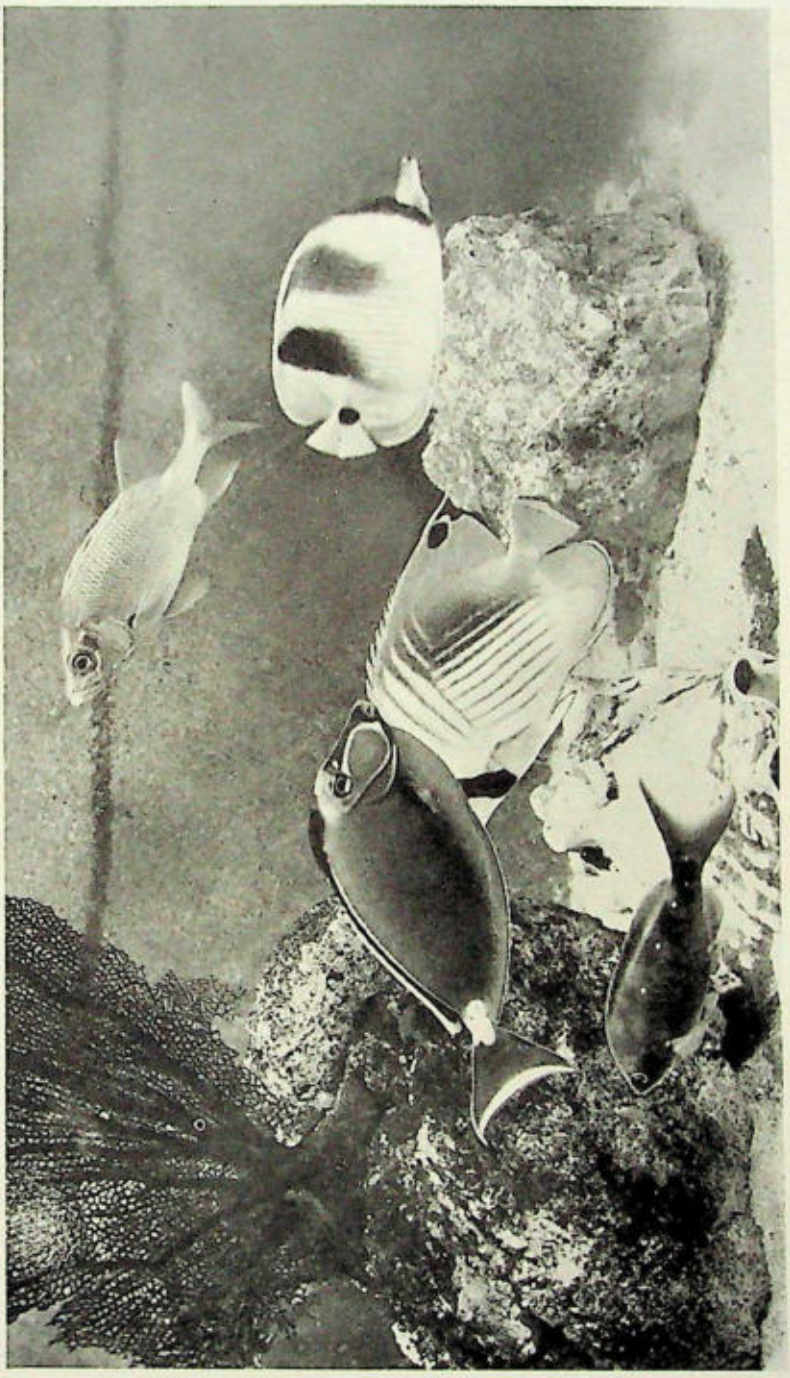
From a photograph by Morris Rosenfeld.



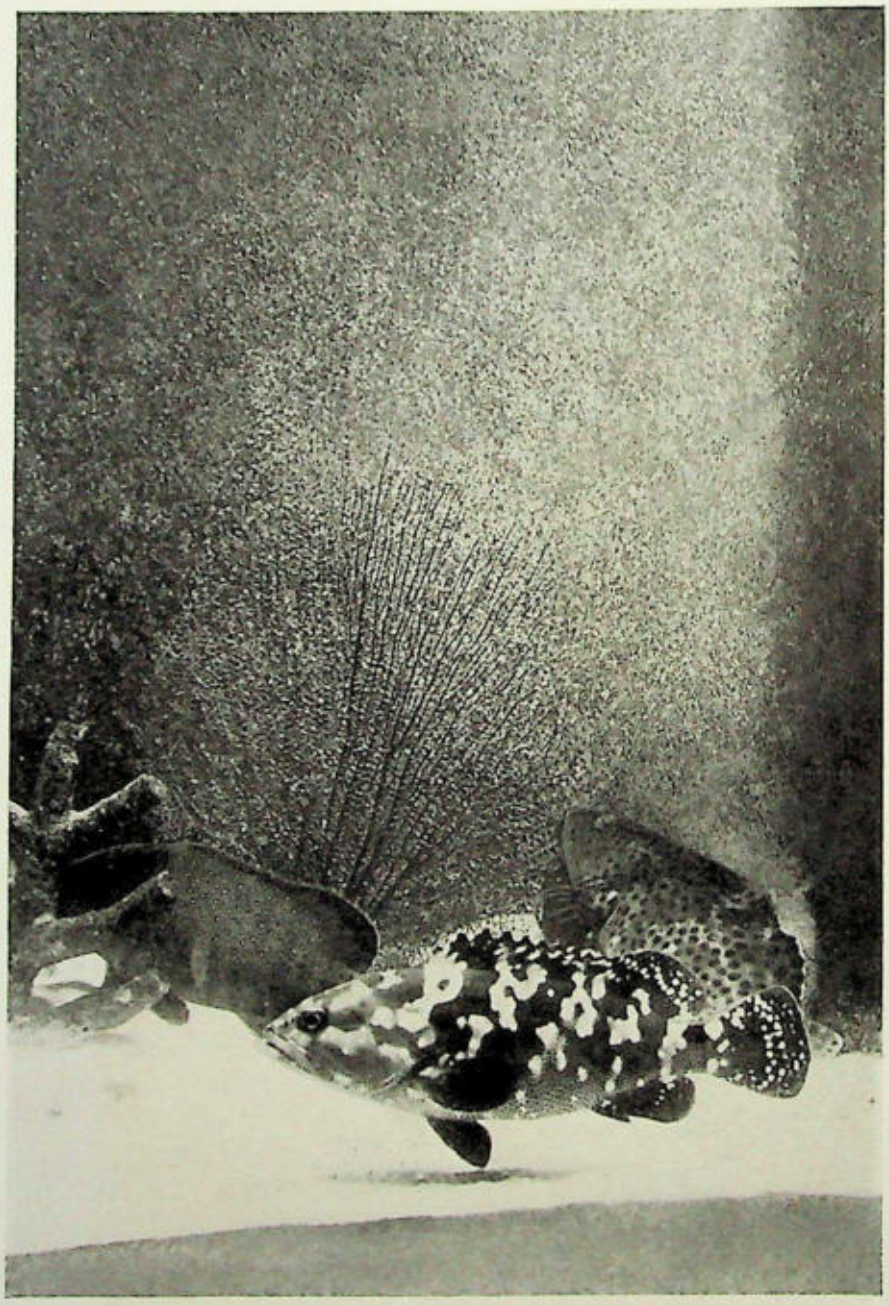
Two Pacific species of Trigger Fishes; *Melichthys radula* and *Balistis* sp. Lower right. The first mentioned species is nearly black for most part but brilliantly marked along the bases of the dorsal and anal fin, with a scintillating "electric" blue line. They are particularly hardy fishes; most of those brought from the Galapagos Islands in May 1930 are still living.



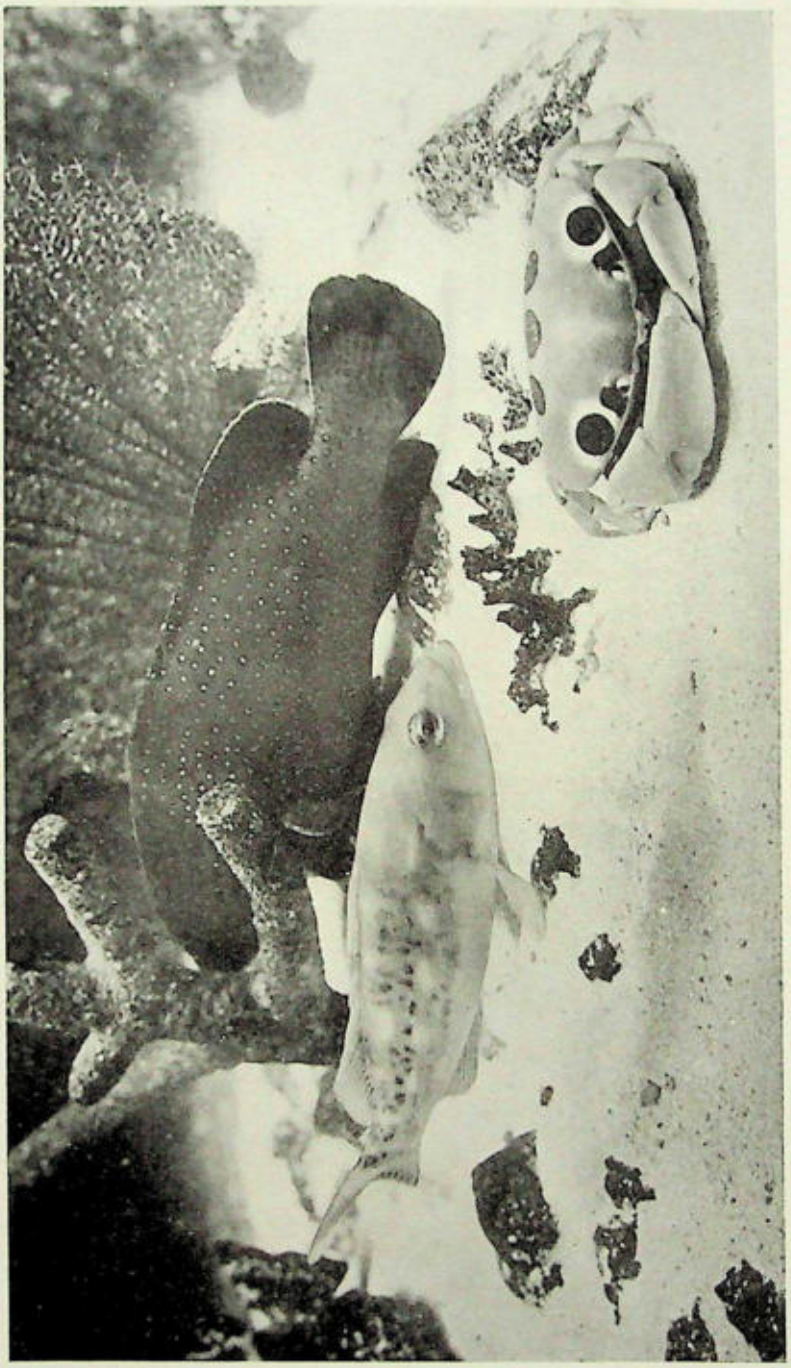
Yellow-striped snappers, *Evoplites viridis*, and Grunts *(Haemulon)*, from Cocos Island.



An assortment of reef fishes from the South Seas. These have been taken near and about Tahiti by the second *Nourmahal* expedition.



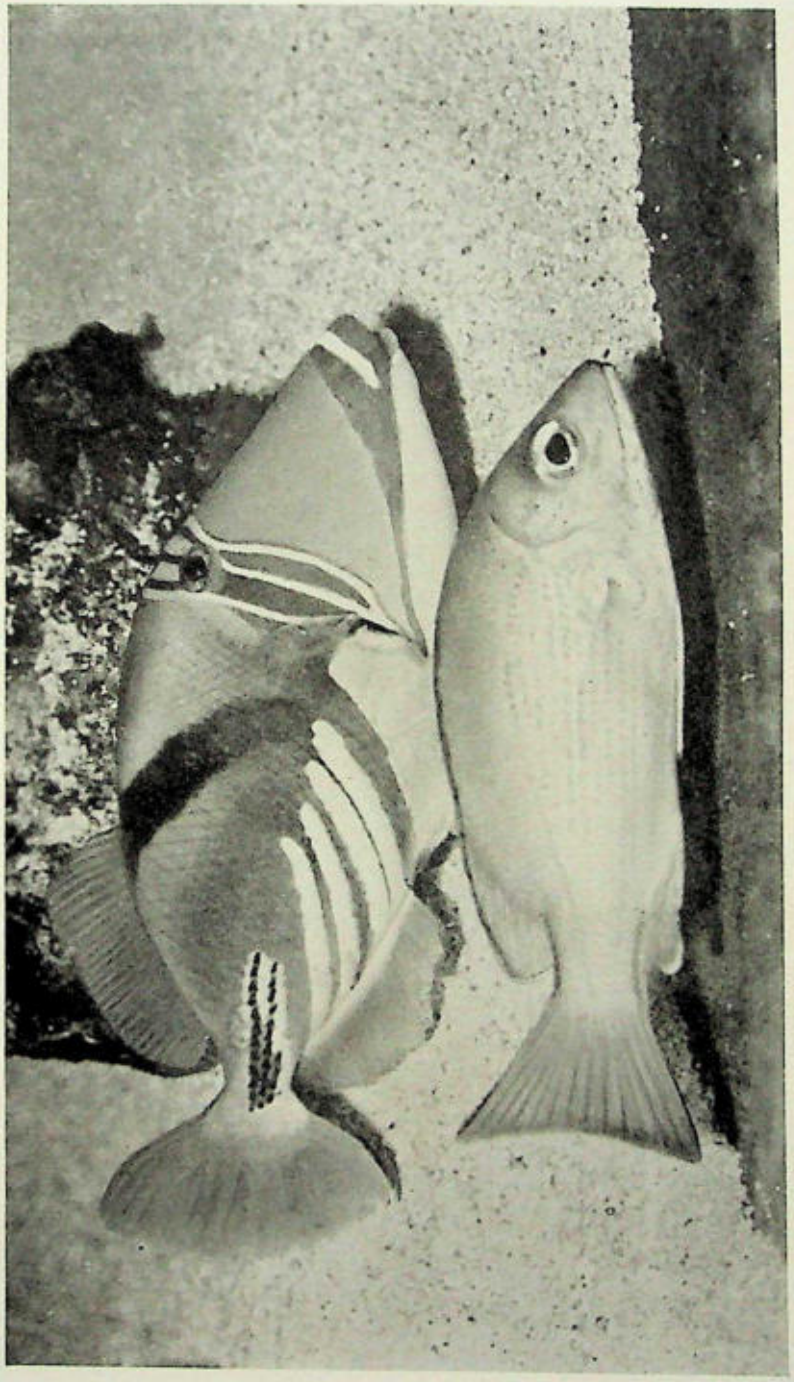
South Sea Groupers: *Cephalopholis argus* (rear); *Epinephelus* (front).



A peculiar "eyed" crab from the South Seas, and two Groupers: *Cephalopholis argus* (rear); *Paralabrax maculatofasciatus* (front). The real eyes of the crab are between the two conspicuous spots which resemble eyes. This crab is from Tahiti, Society Islands.



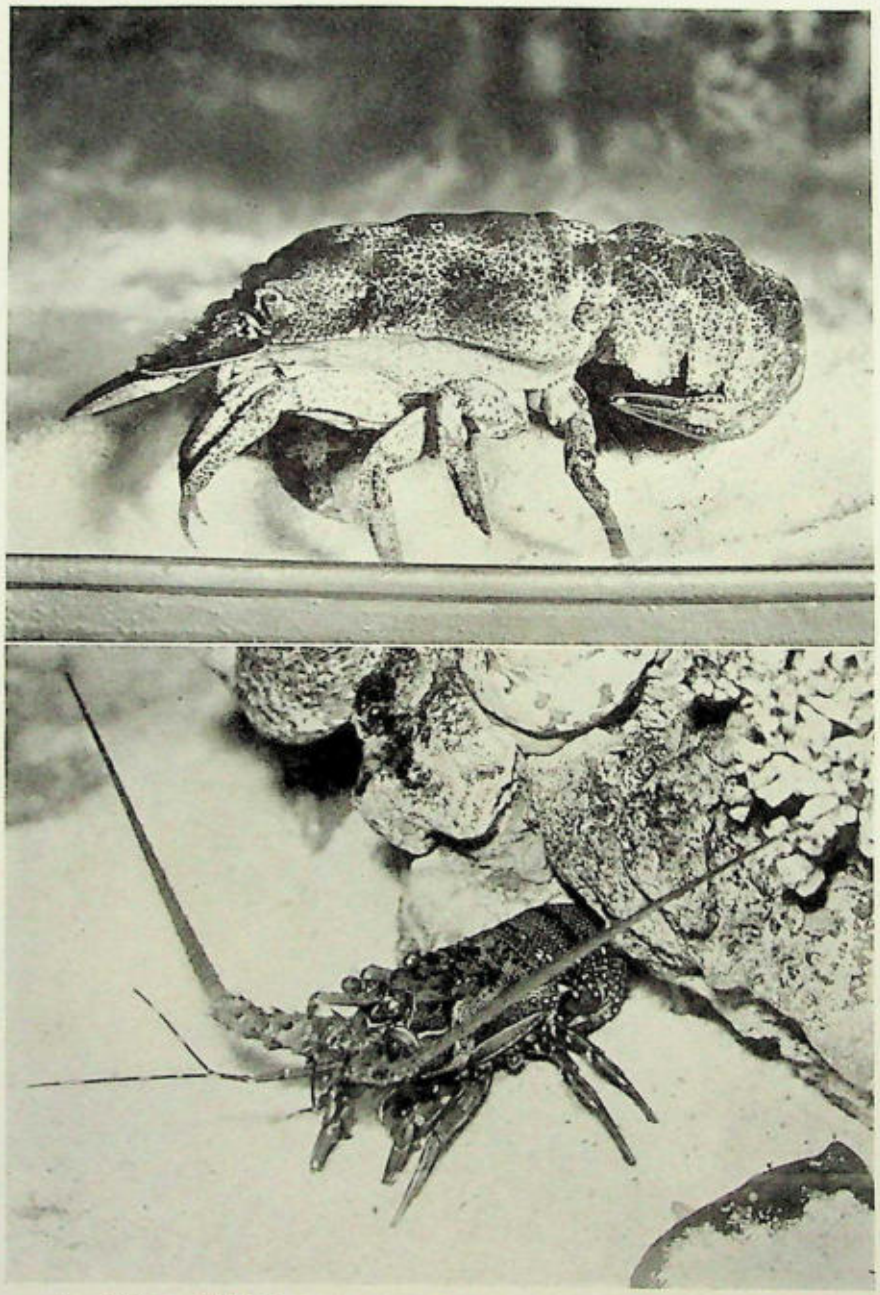
A Galapagos and a Tahiti Grouper: *Epinephelus* sp. from Tahiti (rear); *Paralabrax maculatofasciatus* from Galapagos (front).



Two Tahiti fishes: *Balistipus aculeatus* (upper); *Lutianus* sp. (lower). The *Balistipus* is found in many parts of Polynesia. From a photograph by P. W. Kearney.

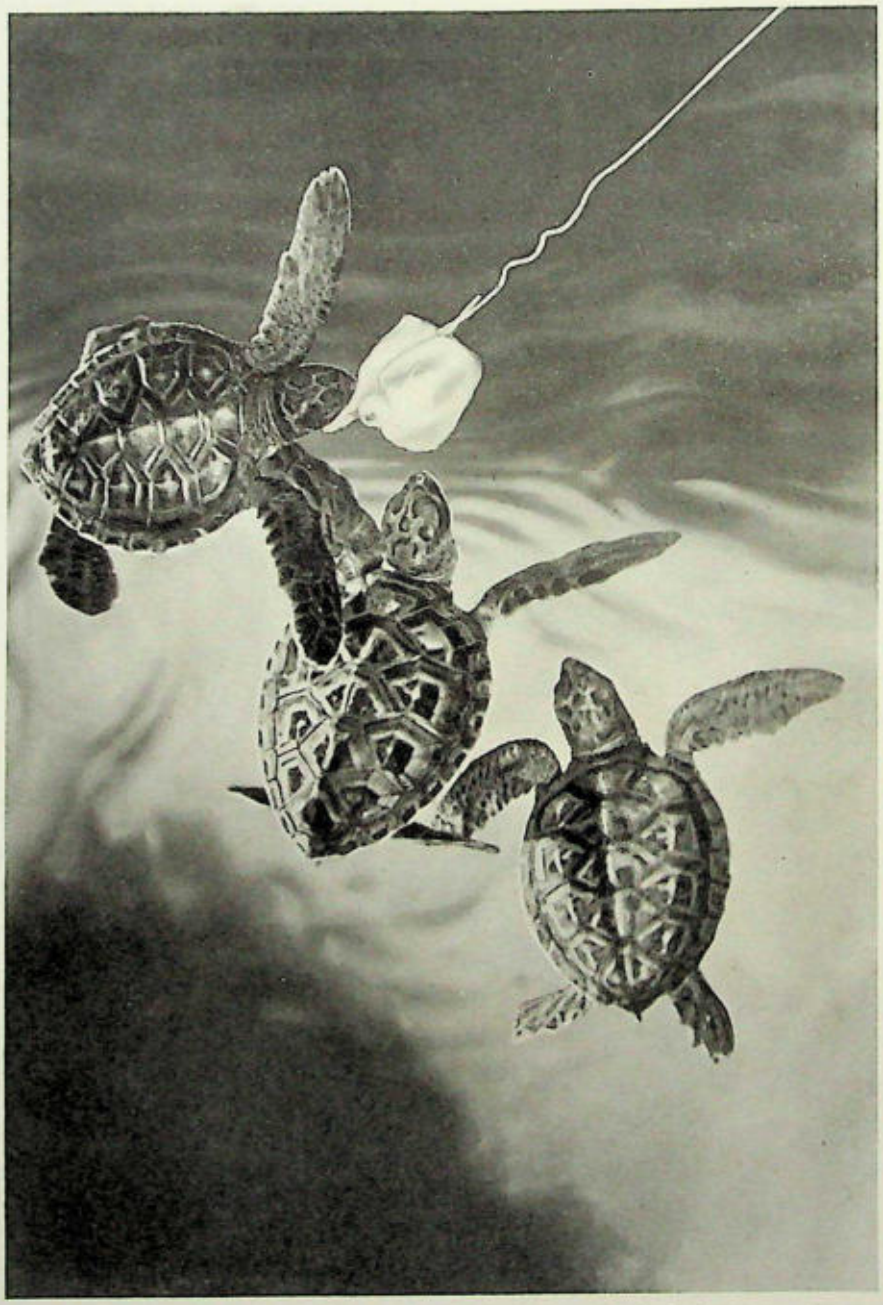


A group of South Sea fishes. *Flammeo* (two fishes center); *Holocentrus* (extreme upper left); *Myropristes* (upper left). The three preceding species are all brilliant red for most part. *Xesurus* (lower center); *Chaetodon setifer* (center right rear); *Epinephelus* sp. (lower right).

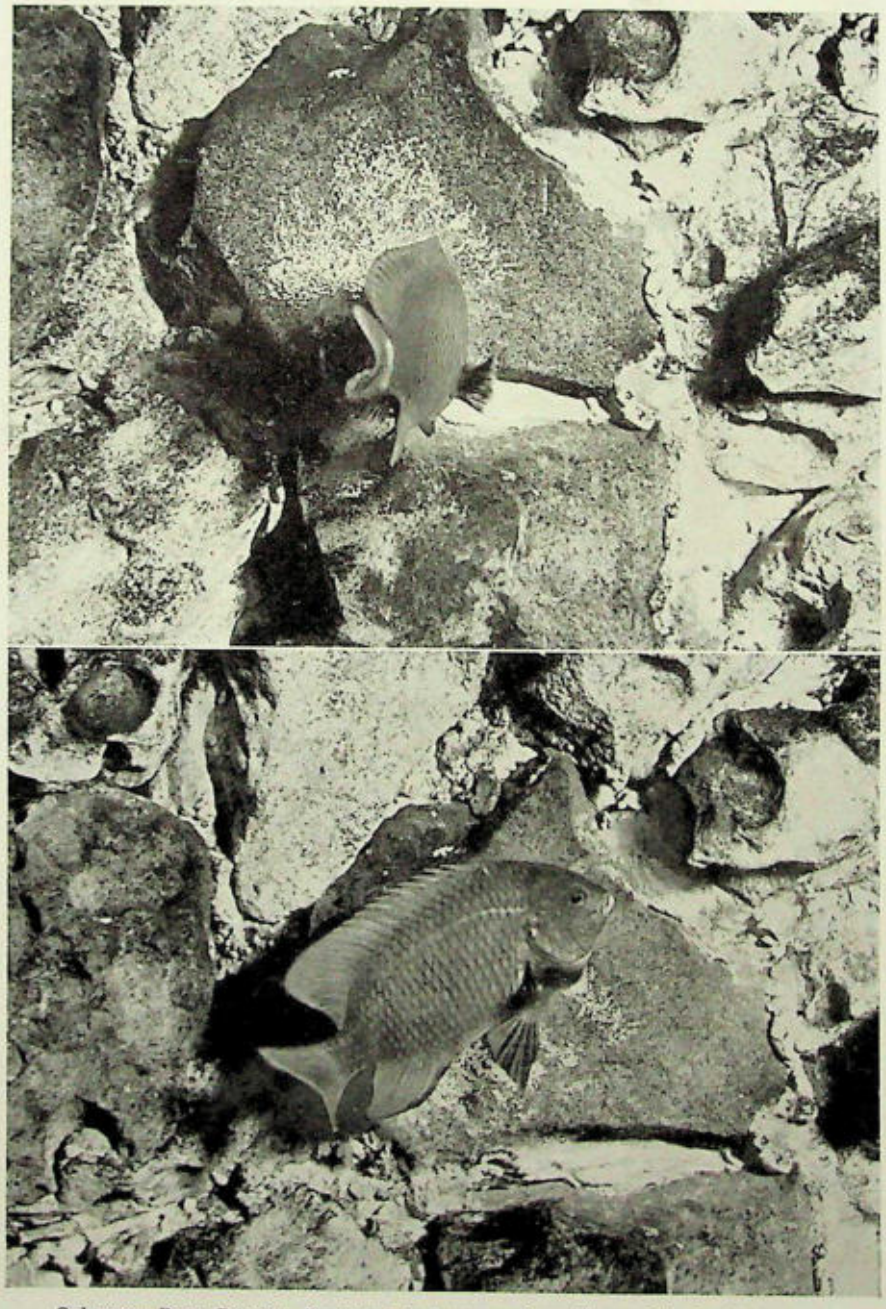


Locust lobster *(Scyllarides)*, from the Galapagos Islands. Possibly an undescribed species.

Tahitian spiny lobster. This species differs from the Atlantic *Panulirus* and Pacific *Panurus* by being predominately a dark green instead of reddish.
From a photograph by P. W. Kearney.



Young sea turtles from the Island of Bora Bora, Society Islands. It is necessary to suspend the food of these small turtles at the surface of the water as the surest means of their getting what they require.



Galapagos Beau Gregory, *Pomacentrus leucorus*, from Tower Island, picking over its eggs which may be seen adherent to the rock in back of it.

The same fish as shown in the preceding illustration fanning its pectoral fin to insure a change of water on its eggs.



Pulling a fish trap, Tagus Cove, Albemarle Island, Galapagos Archipelago. The traps are made of wire and one is shown on the stern of the dory. Most of the specimens brought back by the *Nourmahal* on her first trip to the Islands were procured by this method.

East Indian Reef Fishes: The Aquarium has just received a small collection of remarkable East Indian reef fishes. The most striking among them are the clown fish *Premnas percula*, a peculiarly patterned species crossed by alternate bands of bright yellow and white, the junctures of which are margined with black. Judged by the comments of visitors these bid fair to be the most popular species on display. Their companions, pale green shoal fish, *Chromis*, and black and white *Dascyllus*, distinctly accentuate the gaudy boldness of the tricolored harlequins. These fishes are rarely imported by dealers because of the difficulty of maintenance without flowing sea water.—*C. B.*

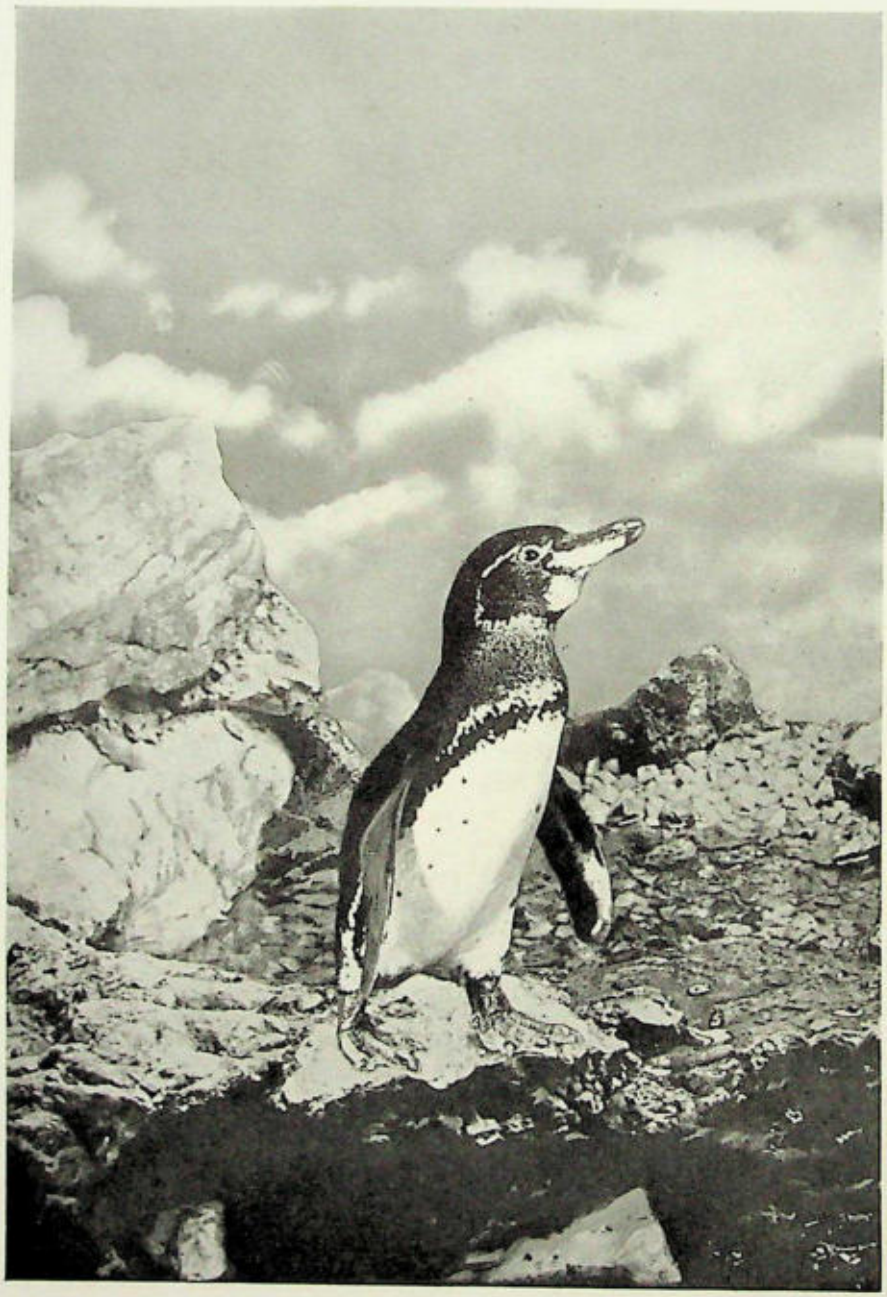
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Breeding of the Beau Gregory: The two accompanying illustrations show the care given to the eggs by the Galapagos Beau Gregory (*Pomacentrus leucorus*). These fishes were brought to the Aquarium on the first *Nourmahal* expedition, May 2, 1930, and as they proved to be exceedingly quarrelsome they could only be kept satisfactorily in pairs.

The photographs are of the second spawning, July 3, 1932. The upper one shows the male circulating water over the eggs by a peculiar rocking motion of the body. The eggs are adherent to the rock behind him. The lower shows him picking off the dead eggs. Both spawnings failed to produce young, as after a time the parents devoured them. This is a common happening in aquaria when fishes are disturbed. Since this spawning took place in an exhibition tank, and drew much attention from visitors, we believe this is responsible for the behavior noted. —*C. B.*

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Galapagos Tortoises in Bermuda: Among the tortoises brought from the Galapagos Islands in the spring of 1928 by the writer, were ten young ones varying in weight from three to nine pounds. The total weight of the lot at that time was sixty-six pounds. They were located in Bermuda, forming the twelfth colony of Galapagos tortoises then established in mild climates by the Zoological Society. Later on two locations were abandoned, the tortoises now being in ten colonies. The one in Bermuda has thrived and has had no losses. The total weight of this group on August 10, 1932 was 370 pounds. Their individual weights now vary from thirty to fifty-three pounds. These tortoises



The Galapagos Penguin. The two specimens brought by the *Nourmahal* are of great interest to visitors. This is the only species of penguin found in the tropics. From a photograph by B. R. Sherwood.

have been under the care of Mr. L. L. Mowbray, Curator of the Bermuda Aquarium and formerly of the staff of the New York Aquarium. They occupy a grassy range adjacent to the Bermuda Aquarium and have been fed some vegetables in addition to the food they get by grazing.

We are now adding to this promising colony six baby tortoises that have been kept at the New York Zoological Park. They go to Bermuda on Mr. Astor's yacht *Nourmahal*. Their growth has been negligible owing to necessary housing in winter and the lack of a grassy range in summer. These animals from islands under the equator cannot lie at night on rain-dampened ground in our climate without acquiring pulmonary troubles.

The other colonies in the south have also thrived. The total weight of the young tortoises located in the south, increased from 1800 pounds in 1928 to nearly 6000 pounds in 1931. Later reports are not at hand. Very rapid growth was made in some localities and slower growth in others where conditions proved to be less favorable.

As some of the tortoises in Florida now exceed one hundred pounds in weight, we may reasonably expect that the unknown breeding age is not far off.—*C. H. T.*

The Life History and Control of a Destructive Fish Parasite at the New York Aquarium

R. F. Nigrelli[1]

SINCE 1926, the New York Aquarium has been seriously troubled with a parasite that has been causing severe injuries to and often death of many of the marine fishes. This parasite was described by Dr. G. A. MacCallum (1927) as a new species *Epibdella melleni*. It belongs to that group of animals commonly known as flatworms, a group which includes the cestodes or tapeworms and the trematodes.

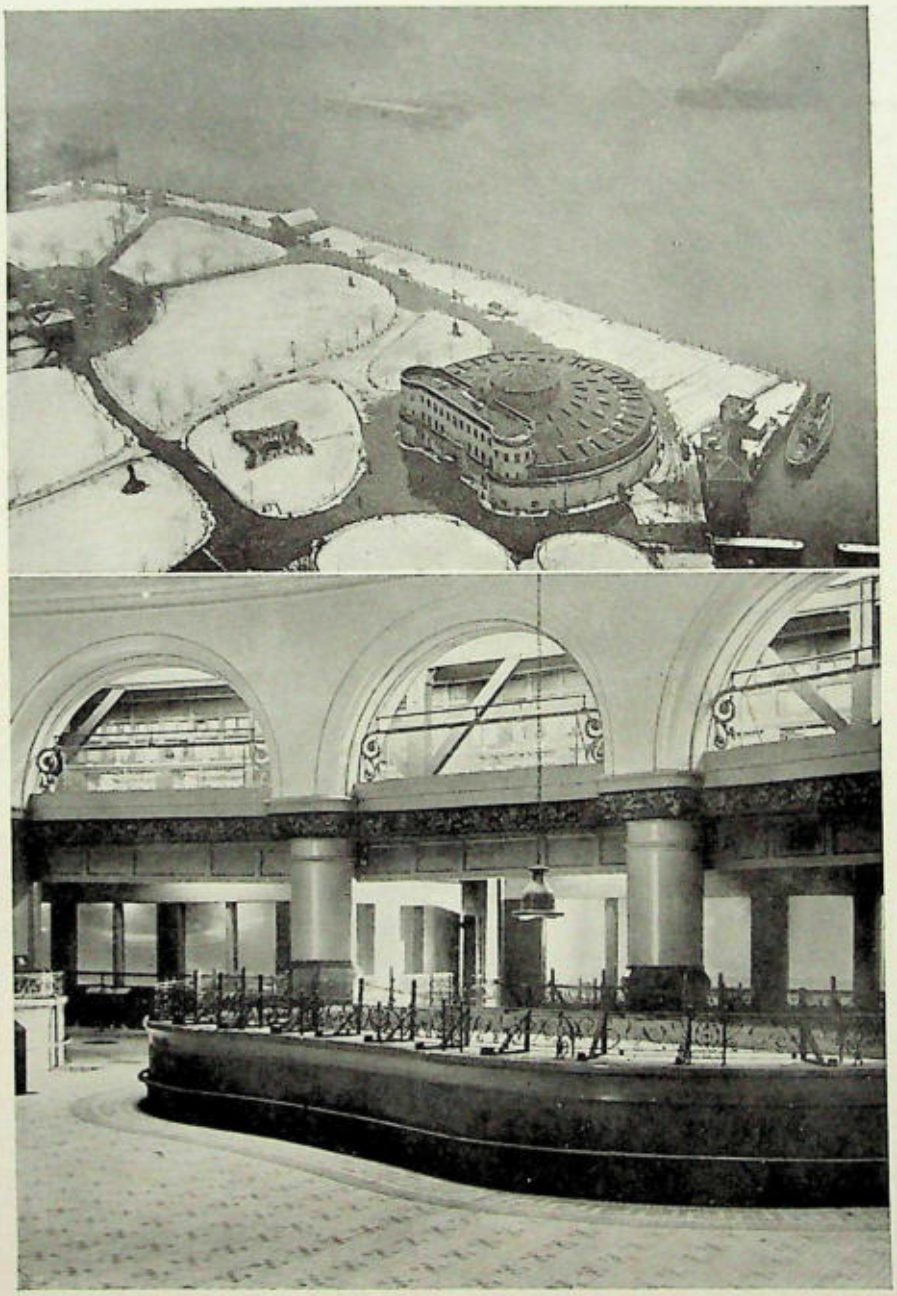
Epibdella melleni is a trematode and more specifically a member of the group known as the monogenetic trematodes in contradistinction to another class called the digenetic trematodes or flukes. The latter forms are invariably internal parasites and are often superficially classified according to the organs in which the adults are found. Thus, they may be intestinal, lung, liver, or blood flukes. These forms have a life-cycle in which two or more hosts are involved. The mature stages produce eggs—each of which contains a microscopical ciliated organism. This larva becomes free-swimming, enters the body of some invertebrate animal (often a mollusk), undergoes metamorphosis to form a sporocyst, and by a series of parthenogenetic generations produces tailed forms called cercariae, larvae of an entirely different type. These second larval forms leave the mollusk, or whatever the intermediate host may be, and directly or indirectly reach the original vetebrate host where they become sexually mature.

The monogenetic trematodes, on the other hand, have a relatively simple life-history as compared to the above forms. No intermediate hosts are involved. The eggs develop directly into adult-like organisms on or in a single host. They are, with but few exceptions, external parasites on fishes and other aquatic animals and are found on the gills, eyes, or scattered over the entire body surface, usually between the scales in the case of fishes. A few, however, are internal parasites living in the oral, nasal or cloacal cavities.

Although the life-histories of the monogenetic trematodes are apparently much simpler than those of the digenetic forms, they have been less extensively studied. Of the five hundred or more species described from fresh-water and marine vertebrates, the life-cycles of but three were known prior to the investigation of Jahn and Kuhn on *Epibdella mellini*.[2] These were *Gyrodactylus, Diplozoon paradoxum* and *Polystomum integerrimum*. The first two are parasites on fishes while the third form is found on the gills of tadpoles in the larva stage and in the urinary bladder of frogs in the adult.

[1] This account is illustrative of one of the problems attacked in the Aquarium laboratory. The advantage of cooperating with special students, in this case the parasitologists of N. Y. University, is evident.—*C. M. Breder.*

[2] This is a report of the work done by Dr. T. L. Jahn and Mr. R. L. Kuhn during the summer of 1930, details of which appear in the Biol. Bull. M. B. L. (1930) Vol. LXII.



The Aquarium in winter. A view of Battery Park from the top of the Whitehall Building. From a photograph by the staff of the *N. Y. American* by courtesy of Mr. Arthur Brisbane.

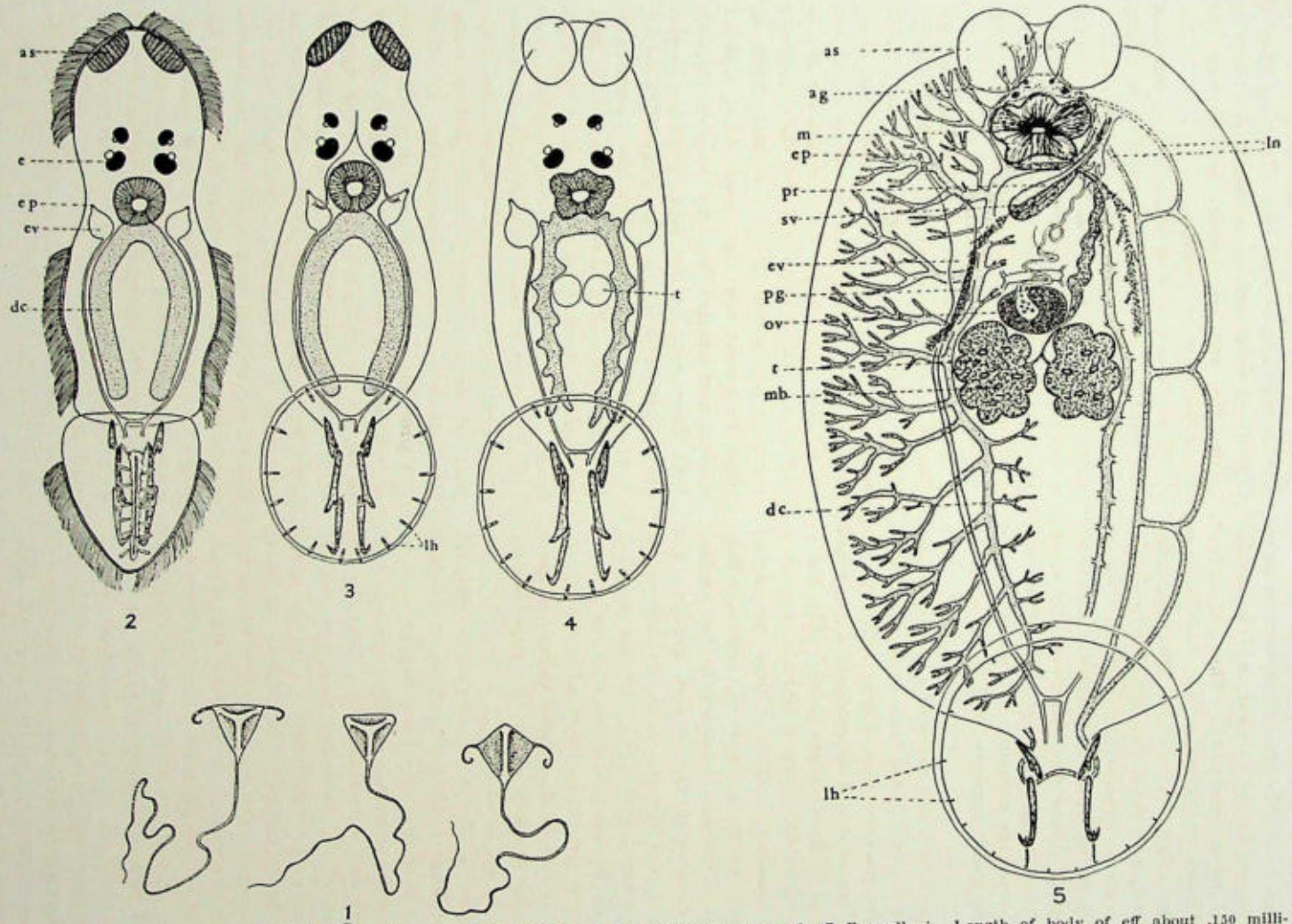
A general view of the recently-opened large aquaria. These two tanks are much larger and deeper than any glass-fronted aquaria hitherto used at this institution. They are back of the floor pool in the foreground.

The mature *Epibdella* vary in size from one to five millimeters in length. They are elliptical in shape with a convex dorsal and a concave ventral surface. The oral sucker lies just behind the two anterior sucking discs and is ventral in position. The genital pore is also on the ventral surface, to the left of the oral sucker. There are two large testes in the middle of the body and a single ovary which lies between but in front of the testes. The intestinal caeca ramify throughout the body and between the rami are found the vitellaria or yolk glands. There is a large round posterior sucker possessing hooks of chitinous material. The excretory system consists of branching channels which unite into longitudinal trunks that pass anteriorly to end in an excretory pore where the waste products of metabolism are emitted. Units of this system are known as "flame cells" the pattern of which is considered a specific character. The excretory pattern was determined and mapped out in detail by Jahn and Kuhn in their study of young stages of *Epibdella*. The nervous system consists of a large crescentic mass in front of the oral sucker. In this mass are embedded four eyes, each of which possesses a black pigment and a crystalline lens. Nerve branches pass from the brain mass to all parts of the body.

Like all monogenetic trematodes this parasite is hermaphroditic but cross-fertilization is necessary. The eggs produced are tetrahedral in shape and bear three filaments—one long and two short lateral ones. The lateral filaments are curved to form hook-like structures. Jahn and Kuhn have found that the eggs hatch in about five to eight days at room temperature. The larva emerges as a ciliated organism, measuring about .225 x .060 millimeters and possesses a posterior sucker that is folded in such a manner as to be non-functional. The animal is, in general structure similar to that of an adult except that the digestive and excretory systems are simple and the reproductive organs are as yet not developed. At this time the organism swims about in the water until it comes in contact with a susceptible fish. If it meets a fish it attaches itself by means of the sucking pads. Within a few hours the larva loses its ciliated covering and the posterior sucker is unfolded and the hooks become oriented in such a manner as to become functional. All these details are shown in the accompanying plate. The parasite then buries its hooks into the softer parts of the host, feeds and grows. During the growth process certain internal changes occur. The sucking pads become definite suckers, the digestive system becomes branched, the posterior sucker becomes larger, and finally, the reproductive system develops. The animal matures and begins to lay eggs.

The life-cycle of *Epibdella melleni* just described differs from that of *Gyrodactylus* in that the latter is vivaparous. In *Gyrodactylus* the remarkable phenomenon is observed that the embryo, while still within the body of the parent worm, develops another embryo in its interior and this again develops a third. It also differs from *Diplozoon paradoxum* in that this parasite, which also has a ciliated larval stage, the young animal does not become sexually mature until two have become permanently united with one another. The direct development of the ciliated larva of *Epibdella* into the adult seems to be more closely related to the type of development described for *Polystomum integerrimum*, except that it is not dimorphic as has been reported for this amphibian parasite. *Epibdella* affects such a variety of fishes that it is much easier to list those that are never parasitized by it. They are as follows: All Elasmobranchs, morays, killifishes, seahorses, black grouper, gag, striped bass, blue fish, blue-striped snapper, gray snapper, grunts, Pacific salema, sheepshead, spot, black drum, Pacific beau gregory, spiny boxfish, shark-sucker, and toadfish.

The injury produced to a susceptible fish is usually quite considerable and if the infection is not treated death often results. The trematodes attach themselves to the epidermis and in most species of fishes they migrate and become concentrated on the eyes. The relative ease with which nourishment can be obtained from the soft tissue of the conjunctiva as compared with the difficulties met with in the coarser substance between the scales seems to be a plausible explanation as to why such a concentration does occur. In such cases, if the infection is not treated, destruction of the eyes invariably follows and the animal eventually dies of starvation. If the infection is very heavy, the epidermis suffers such severe injury that the scales fall off exposing large naked areas of connective and muscular tissues, which usually become sec-



Stages in the development of the fish parasite *Epibdella melleni*. 1. Most common type of eff *E. melleni*. Length of body of eff about .150 millimeters. 2. Free-swimming larva of *E. melleni* shortly after hatching. Size of specimen about .225 millimeters. 3. Larva which had been isolated when ciliated and maintained under a sealed coverclip for forty-five minutes, during which time the ciliated epithelium was shed and the posterior sucker opened. 4. Young individual obtained from infected fish. Size of specimen about .320 millimeters. 5. Fully matured adult ag. anterior nervous ganglion; as. anterior sucker; dc. digestive caecum; e. eye; ep. excretory pore; ev. genital sinus; lh. larval hooks; ln. longitudinal never trunk; m. mouth; od. oviduct; oes. oesophagus; ol. oral lips; os. oral sucker; ov. ovary; pog. post-oral ganglion; t. testis; yd. yolk duck; yr. yolk reservoir. From Kuhn and Jahn.

ondarily infected with bacteria causing death of the host within a few days.

Although most fishes are susceptible to an infection by *Epibdella melleni*, a few develop some sort of an immunity. Thus, in 1930 a group of black triggerfish became heavily parasitized but after a short time the trematodes dropped off, and since then the fish have been entirely immune against the infection. In another case, the group of Runners was also heavily infected. These were given several treatments with sol-argentum and since then have been free from the parasites even in times when there were great numbers of *Epibdella* in the tanks.

The extent to which fishes of a certain family or even of a single genus seem to be immunized against the parasite also differs quite considerably. This is well demonstrated in the genus *Epinephelus* of the Grouper family. The black-grouper, yellow-fin grouper and the gag show a natural immunity and at no time had any of these fishes become parasitized, although they have been continually exposed to the worms. On the other hand, the Nassau grouper, the red grouper and the red hind are always infected to some degree. The Jewfish or giant grouper, of the closely related genus *Promicrops*, become parasitized only when the trematodes are present in the water system in great numbers and at such times the eyes become the center of the infection.

Unfortunately, the most susceptible ones are among the Aquarium's best exhibition fishes—such as the spadefish, angelfish, hogfish, coneys, graysbys, and yellowtails. These are so readily attacked and are so suitable a host for the propagation of the parasites that they had to be placed in a separate system. That the above fishes are important to the continual existence of the parasites in numbers sufficient to become detrimental can readily be shown. When such are removed to a separate circulation, the percentage of other parasitized species and the numbers of parasites themselves are markedly diminished. This is true to the extent that at the present time they have become almost negligible. Removing these fishes to a separate circulation has beome one of the most effective means of controlling the parasites. Whether this reduction in numbers can be maintained by continuing the segregation of these fishes from the regular circulation cannot be foretold, because the host-parasite relationships of these trematodes are so variable. That is, since a variety of fishes are susceptible to an attack by *Epibdella*, any one species may become the focus for a future epidemic.

Other means of controlling and eradicating the parasite have been attempted. For a long time the best method of removing the parasites from the infected fishes was by placing them for a few minutes in a one-seventh of one per cent. solution of solargentum in fresh-water. This requires so much tedious labor that other methods have been tried.

The most successful chemical method employed was one worked out by R. L. Kuhn, which consisted of raising the density of sea-water with salt. In the first experiment along this line pure sodium chloride was used. It was found that by adding a sufficient amount of this salt to raise the density to 1.035, the trematodes turned white within fifteen minutes. After an hour the worms lose their hold at the anterior suckers and project from the body of the fish, held there only by the large posterior hooks, apparently unable to disengage themselves.

After three hours the parasites become free from the fish. The fish may be left in such solution for about eight hours without apparent harm. Later it was found that by using rock salt, the reaction was stimulated to a surprising degree, great numbers of the parasites dropping off within a few minutes. Before using this salt it had been supposed that the effect was probably due to the inability of the parasites to adjust themselves to changes in density as rapidly as the fishes. The rock salt apparently contains something which makes the effect more pronounced. One of the advantages of this method is that an entire tank may be treated and then allowed to mix with the general circulation without doing more than raising the salinity a little. With the use of the salinostat, a mechanism worked out at the Aquarium for controlling the chemical equilibrium of salt water, the increased salinity is lowered automatically.

The increased density, applied for a sufficient time to rid the host of the worms, had no effect on the eggs. Experimentally it was found, however, that subjecting the eggs to the increased density for a longer period





Bullheads guarding their nest of eggs in the Aquarium. The entire grayish patch between the two fishes is a mass of some thousands of eggs.

Bullheads rounding up their brood of young in the Aquarium. The dark oval area between the two fishes is composed entirely of coal black young fishes. A few near the lower edge may be seen silhouetted against the lighter rocks.
From photographs by S. C. Dunton.

(twenty-four hours or more) caused a complete cessation of development of the eggs and consequent death of the embryo. Since the eggs hatch four to seven days after laying, repetition of this treatment every four days upon all susceptible fishes would be an effective method in ridding the Aquarium of the parasite. But this method was impractical since it required a very long period of exposure which proved detrimental to the fishes.

Other methods of eradication of the parasites were employed with more or less success. Thus treating the fishes with a three-tenths per cent solution of Eosin, more frequent cleansing of the filters to remove the eggs caught in the meshes, exposing parasitized fishes to ultra-violet rays or placing them for some time in tanks containing bay water were employed. All these methods, however, give only temporary relief since the parasites will reappear just as soon as conditions in the tanks again become normal, for it is almost impossible to rid the circulation of all the eggs. In addition, the parasites are continually being reintroduced into the tanks by new shipments of fishes from Nassau and Key West from where they originally came.

There can be no doubt that the parasites were present in the aquarium prior to their discovery in 1926, but the reason why they have not been observed before lies in the fact that *Epibdella melleni* will not survive very long exposures to acidulated water. Before adequate methods were developed for maintaining the normal alkaline nature of the sea water the parasites did not present a very serious problem. When this detail was worked out it improved the health and longevity of the fishes in a satisfactory manner. However, it happens these conditions are also optimum for the propagation and development of the parasites, which since then have appeared in great numbers.

The Breeding of Bullheads in the Aquarium

C. M. Breder, Jr.

UNUSUAL activity in the gallery tank of bullheads (*Ameiurus nebulosus*) on August 12, 1931 suggested to the attendant that an urge to reproduce their kind was present in some of the individuals. In order to encourage them as much as possible, two days later a few rocks were so arranged as to form a shelter to which they might retire. Almost at once they began to investigate the structure and apparently being satisfied with it cleared away all the gravel under the most sheltered part down to the bare concrete base of the tank.

On the morning of August 18, a large mass of creamy-white eggs were to be seen occupying nearly the entire cleared area. They were about one-eighth of an inch in diameter, adhering to each other and the cement substratum. Both parents were tending them. One, supposedly the male, spending most of time fanning and otherwise causing a current to flow over the eggs; the other, acting for most part as a guard, defending the nest against depradations of other tank mates. These showed such a desire to raid the nest that they were removed, thereby giving the parents every opportunity to attend the eggs. Frequently both parents would work over the eggs at the same time. They are shown thus engaged in the accompanying photograph.

At times parts of the sticky mass of eggs would be taken up in the mouth and churned about, apparently for the purpose of more thorough aeration. This activity tended to reduce adhesiveness and they became scattered about the tank. When it is recalled that the related marine gaff-topsail catfish (*Felichthys felis*) carries its eggs about in its mouth throughout incubation, the behavior of the present species suggests a clue as to how the very specialized habits of the gaff-topsail catfish may have arisen. This constant attention was maintained throughout the period of incubation. The parents would leave the nest for little else than the purpose of feeding.

The eggs hatched on the morning of August 24. The new arrivals were a creamy-white at first but rapidly took on pigment so that when they first began to leave the nest they were coal black. At this time most of the large yolk sac had been absorbed and they were well able to navigate clear of the bottom. The leaving of the nest by the young first took place in a definite way on September 3. Both parents were very attentive to their offspring and herded them about preventing any great dispersion of the closely compacted school. The second photograph shows the parents so engaged. The



Three of the large electric eels at the Aquarium. (*Electrophorus electricus.*)

nearly solid black oval between the two adult fish is a solid "ball" of infant catfish. So black, and light absorbing are they, that the detailed elements of the school are not photographically differentiable. At the edges of the mass, however, a few of the scattered individuals stand out clearly against the lighter rocks.

As time went on the little fish became more and more venturesome and on the average tended to form schools at the surface of the water. In this they were usually thwarted by the parents which persisted in attempting to round them up near the bottom. Finally, however, they became sufficiently agile to elude this herding by the attentive adults and became scattered generally throughout the aquarium. At this time the mature fish seemed to redouble their efforts and thrashed about the tank in a manner that tumbled the young over and over. At this same time these began to die rapidly so that in a few days, by September 15, all were dead. It is not entirely clear as to whether this frantic activity on the part of the parents was responsible or not. In a state of nature, however, the young are usually allowed to form a school at the surface. In local ponds this species breeds at a much earlier date. The reason for delay in this aquarium spawning is not evident. According to various observers, the male alone generally looks after the eggs, as is rather common with a considerable number of unrelated species of fishes. Cases are on record, however, of both sexes showing parental solicitude as in the present one.

Aquarium Notes

Electric Fishes: One of the truly amazing things in nature is the possession by certain fishes of living batteries capable of giving electric shocks. Anatomists say that the living battery shows all the qualities of magnetism and even affects the magnetic needle.

Electric fishes are few in number. The best known are the electric eel of South America, the electric ray of all warm seas and the electric catfish of Africa.

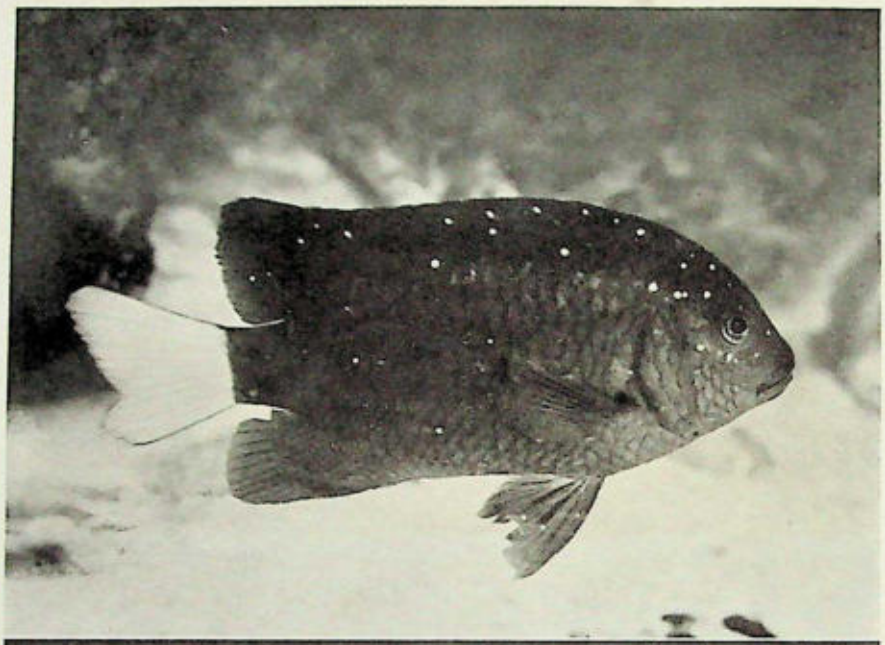
We can dimly comprehend that some ancient fishes had to develop lungs or perish when gills became useless because of lack of water, but the need of electrical equipment is not understandable. Somewhere, however, in the long course of evolution these fishes got it and continue to use it in the capture of prey and for defense from enemies. Man did not master the uses of electricity until some millions of years later.

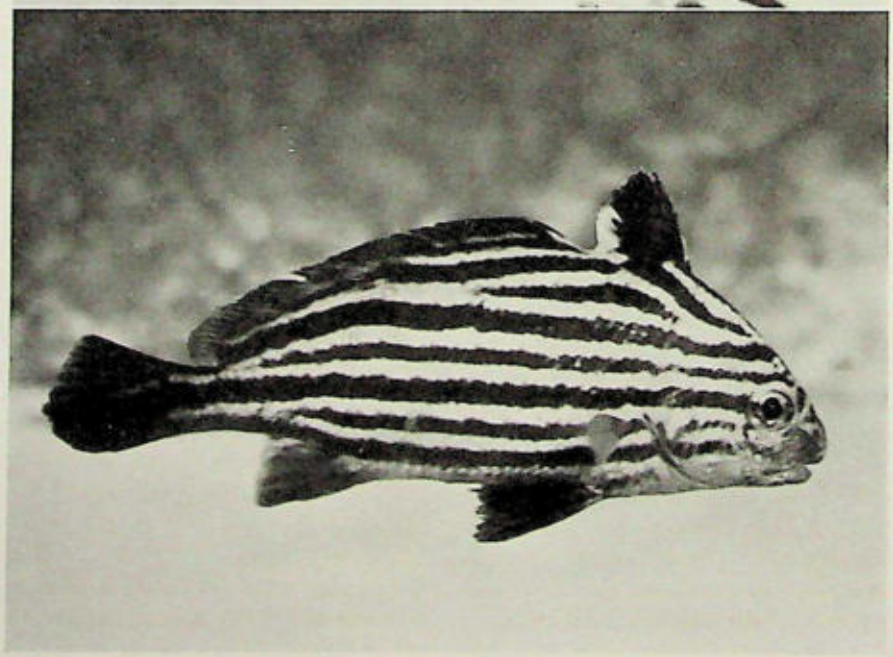
The electric eels in the Aquarium, some of them nearly six feet long, swim quietly toward the fishes thrown to them for food and stun them by a discharge before seizing them. When the attendants have occasion to move them with nets they wear rubber gloves.

The battery of the electric ray is not so powerful. When at the Naples Aquarium years ago we saw visitors touch some that were kept in shallow water. The shock was light as the attendants had previously reduced the discharge by other means. At the seashore the shock is communicable through a spear. It is even felt through a stream of water poured on the fish when dragged ashore. The power of the fish battery is soon exhausted but is regenerated after rest. The anatomy of this animal battery, different in structure and position in the different species, is well known, but the method of discharge is not understood.

The derogatory expression "the poor fish" is manifestly unfair. In the "battery," developed from his own tissues, the electric fish stands alone. No other member of the animal kingdom invented anything like that.

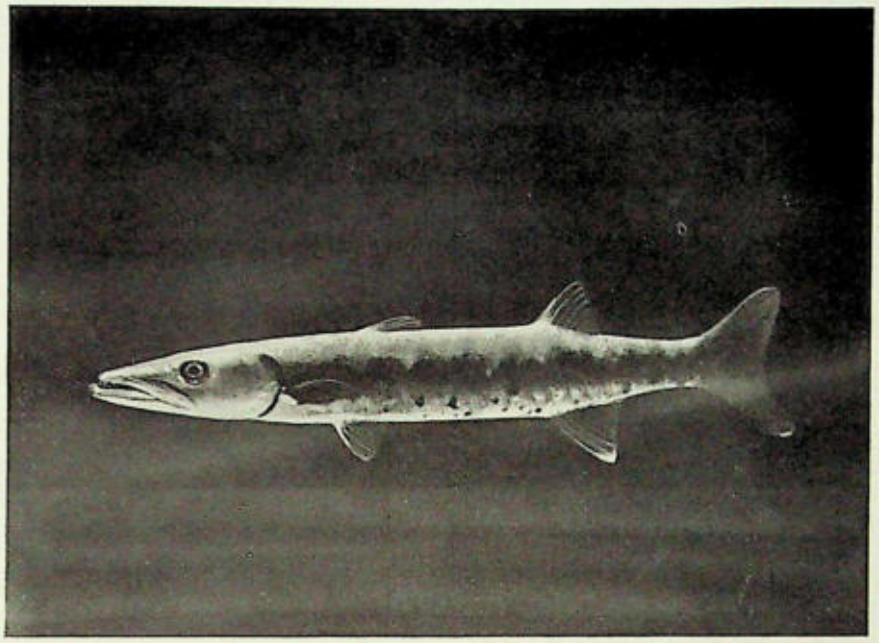
In make-up the electric eel is mostly tail. We measured one five and a half feet long. Its head is five inches long and its body six. All the rest of the fish is tail, or about five sixths of the total length. There is no dorsal but the anal runs the full length of the tail. Much of the thick and heavy tail is devoted to the large electrical organs. These are in two pairs, one along the back and the other along the anal fin. They consist of an enormous number of minute cells. In the electric eel the nerves leading to these organs are much larger than those passing from the spinal cord for any other purpose. The battery is more powerful than in any other electric fish. The electric eel has whitish eyes of surprisingly small size. In most of the Aquarium specimens





The Golden-tail, *Microspathodon chrysurus*. A small but brilliantly marked reef fish that is unusually difficult to capture.

The Cubbyu, *Eques acuminatus*. A coral reef relative of the weakfish and croaker. Seldom seen in aquaria.



The Barracuda now living at the Aquarium. This fish has retained all the well-known ferocity of its kind, taking its food avidly and attempting, at times, to capture the pointing fingers of visitors on the other side of the aquarium glass.

the throat and belly are colored rather a brilliant red. Its scientific name is *Gymnotus electricus.*—*C. H. T.*

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Floor-pool Dwellers: The seven large floor pools in the Aquarium have until recently been supplied with water pumped from the harbor. The marine animals living in them from time to time, were lung-breathers such as seals, manatees, porpoises and sea turtles. Years ago there was little difficulty in keeping them. One sea lion lived nineteen years. It may have died of old age as a post-mortem examination failed to reveal the cause of death. Sea turtles have also been long-lived. Latterly the lung-breathers have not thrived. Chemical analysis showed this water supply to be unsafe because of increasing pollution. A year ago it became necessary to fill most of these pools with fresh water, when conditions immediately improved. Sea birds such as pelicans and cormorants having done well in fresh water, the Aquarium has now added sea lions and may be able to keep other large lung-breathers. There is little difficulty in keeping sea fishes as the glass-fronted tanks in which they live are supplied with pure stored sea water from a large reservoir. Strangely enough the big sea turtles have apparently not suffered from the gases our chemists found in the harbor water. Most of them have been here more than twenty-five years. These cold-blooded reptiles remain unaffected by conditions the warm-blooded mammals and birds could not endure. Constant chemical control of stored sea water has of late given the New York Aquarium the lead over other aquariums in this country, in the matter of safety for the occupants of the tanks. The enlargement of the tanks has also been a factor in this respect. Losses have been reduced to the minimum. Never in the history of the Aquarium have the living exhibits been as extensive and varied as at the present time. There are on view not less than 400 species and 8000 specimens.—*C. H. T.*

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The Barracuda: A young barracuda is now well established in the Aquarium, the first in many years. This species is rather difficult to transport. Part of the reason for this is its extreme ferocity and the injury that it is consequently apt to suffer at the hands of justifiably cautious fishermen. Many of the attacks on swimmers credited to sharks have been shown to be referable to the barracuda. It is clearly, by far, the

most dangerous species of fish in the West Indies. A length of about six feet is reached, at which size this fish is no mean antagonist. A similar species occurs on the coast of California. The accompanying photograph represents the specimen now living at the Aquarium which gives promise of a long life and has already shown a considerable growth.—*C. B.*

"Kamongo"; the Lung-Fish
(*Protopterus aethiopicus*)

C. H. Townsend

THE Aquarium has some African lung-fishes. The largest are eighteen inches long, but lung-fishes reach a length of over six feet. They were brought from Lake Victoria in Africa by Dr. Homer Smith of the New York University Medical College, who went there especially to get them for scientific experiment.

There are three genera of lung-fishes, *Protopterus* of Africa; *Lepidosiren* of South America and *Ceratodus* of Australia. The Aquarium also has a specimen of *Lepidosiren*.

Lung-fishes wherever they come from are fishes which have almost lost the use of gills, with which other kind of fishes manage to extract from the water the limited amount of oxygen they require. They have developed lungs and must frequently come to the surface for whiffs of genuine atmosphere. The acquisition of lungs by these few kinds of fishes took place millions of years ago. That trick saved them from the wholesale extinction that swept away fishes less adaptive to changes that made a strictly aquatic life impossible. We know them now only as fossils from sedimentary rocks. There are also fossil lung-fishes that did not persist down through the ages.

Existing lung-fishes are among the few survivors of ancient types that found no escape. They burrowed deep in the mud when waters disappeared and managed to get enough air for their salvation until returning waters liberated them. Recurring periods of dryness gradually led to increase of lung power among these adaptive fishes and less use of gills. Wherever lung-fishes are found today they continue to survive dry periods by burying themselves and providing a mud tube to the surface for air. In waters that do not dry up they avoid the necessity of mud life, but their gills are atrophied and they must needs seek air at the surface.

The fish with lungs is one of the "links" with animals of the past that is not "missing." Dr. Smith's book on the lung-fish* is an illuminating account of how this remarkable creature lives in Africa. The first specimens he collected were either *drowned* because they were entangled in nets, or drowned in unsuitable vessels where they could not rise to breathe. After he discovered that they needed more air and less water his troubles were over. Waters happened to be high at Lake Victoria and Dr. Smith did not get half-dormant lung-fishes in their dry mud cocoons which make transport easy, but he brought active ones in shallow water to New York without any losses. In his laboratory some were allowed to form cocoons in American mud. One has been in dry mud for three years and is still sleeping. Its breathing is detected with a microphone.

"Kamongo" is not merely a book for naturalists. It is also a discourse on the meaning of life and the processes of evolution. The book is a readable story throughout, not only of active investigations in Africa, but of a voyage through the heat of the Red Sea that is told with the art of a real story-teller.

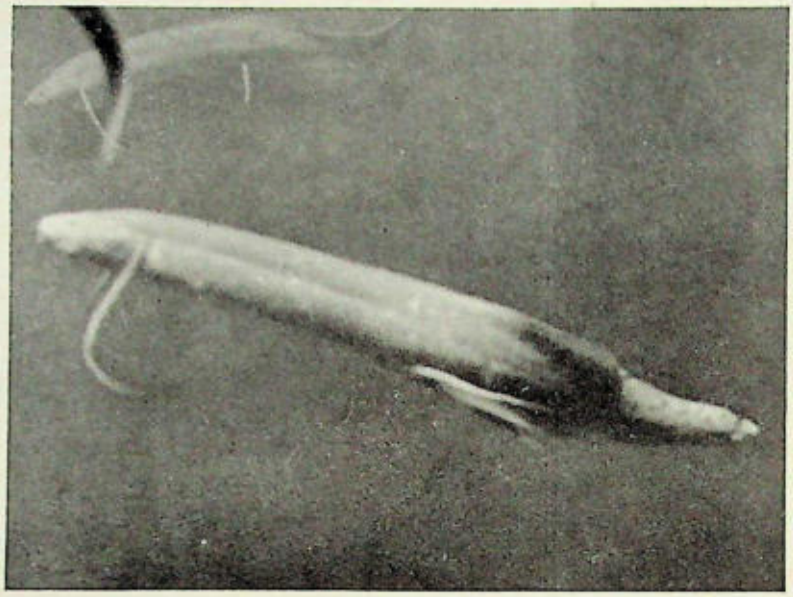
An Early Account of the Killer Whale

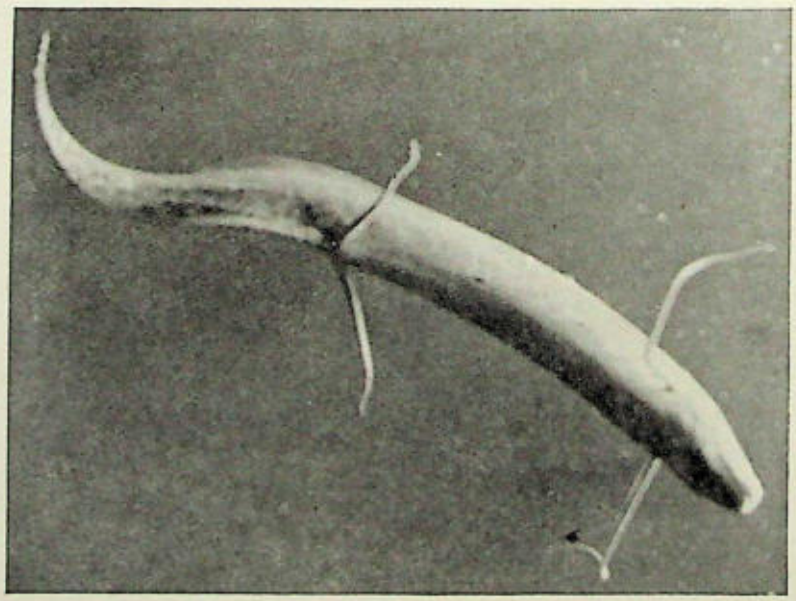
MR. MADISON GRANT sends a copy of History of the Wars[1] by Procopius of Caesarea, and calls attention to what may be the earliest description of the ferocity of the Killer (*Orca gladiator*). Procopius was a Byzantine historian, born about the year 490 A.D.

". . . It was at that time also that the whale, which the Byzantines called Porphyrius, was caught. This whale had been annoying Byzantium and the towns about it for fifty years, not continuously, however, but disappearing sometimes for a rather long interval. And it sank many boats and terrified the passengers of many others, driving them from their course and carrying them off to great distances. It had consequently become a matter of concern to the Emperor Justinian to capture this creature, but

* Kamongo. Homer W. Smith
The Viking Press, New York. 1932.

[1] History of the Wars. Book VI. The Gothic Wars. Chapter XXIX.





African Lung-fish. *Protopterus æthiopicus*. A peculiar eel-like remnant of a numerous group known mostly from fossils. This fish breathes atmospheric air and summers in the solidified mud on the recession of the water.



JOHN EDWARDS HOLBROOK
1794-1871
From a portrait in oils made in 1856 by Daniel Huntington (1816-1906). Painting in the collection of the late Thomas B. Clarke, New York.

he was unable by any device to accomplish his purpose. But I shall explain how it came to be captured in the present instance. It happened that while a deep calm prevailed over the sea, a very large number of dolphins gathered close to the mouth of the Euxine Sea. And suddenly they saw the whale and fled wherever each one could, but the most of them came in near the mouth of the Sangarius. Meanwhile the whale succeeded in capturing some of them, which he swallowed forthwith. And then, either still impelled by hunger or by a contentious spirit, it continued the pursuit no less than before, until, without noticing it, it had itself come very close to the land. There it ran upon some very deep mud, and, though it struggled and exerted itself to the utmost to get out of it as quickly as possible, it still was utterly unable to escape from this shoal, but sank still deeper in the mud. Now when this was reported among all the people, who dwelt round about, they straightway rushed upon the whale, and though they hacked at it most persistently with axes on all sides, even so they did not kill it, but they dragged it up with some heavy ropes. And they placed it on wagons and found its length to be about thirty cubits, and its breadth ten. Then after forming several groups and dividing it accordingly, some ate the flesh immediately, while others decided to cure the portion which fell to them. . . ."

There can be no doubt about the species discussed by Procopius. It is the only whale destructive to other whales and hunts in packs like the wolf, killing also porpoises and seals. It is of world wide distribution. The size of the specimen described by Procopius, about forty-five feet by fifteen feet, is exaggerated. Killers, as known to naturalists today, seldom reach a length of thirty feet.

In the January-February number of the BULLETIN for 1930, we published a colored plate of the Killer, from a painting by Charles R. Patterson. An illustrated account of it will be found in the BULLETIN for November, 1925.—*C. H. T.*

A Portrait of Holbrook

Naturalist, 1796-1871

CHARLES HASKINS TOWNSEND

AMERICAN naturalists are indebted to John Edwards Holbrook for the first comprehensive work on the reptiles and batrachians of this country. He published also an important first volume of a work entitled "Southern Ichthyology." The writer is not aware of the existence of any previously published portrait of this naturalist. The photograph from which the accompanying reproduction was made, was presented by the late Thomas B. Clarke of New York, who owned the original. It was painted by Daniel Huntington in 1856. It is evident that in Holbrook the artist found a decidedly manly subject for a very attractive portrait. We have seen the painting. There is no information at hand respecting the personality of the man, but zoologists are well acquainted with his work on reptiles and fishes.

The "American Herpetology, or a Description of Reptiles Inhabiting the United States," was published in Philadelphia in 1842, while Holbrook occupied the chair of anatomy in the Medical College of South Carolina, a position he held for thirty years. This is a notable work in five quarto volumes, with lucid descriptions of species and excellent colored plates. It was highly commended by Agassiz and by European scientists. Holbrook's "Southern Ichthyology, or a Description of the Fishes Inhabiting the waters of South Carolina, Georgia and Florida," was, after the appearance of the first volume in 1847, brought to an end by the outbreak of the Civil War, when the author became head of the South Carolina examining board of surgeons. This work was a volume of 205 pages and 28 plates.

Holbrook was born in Beaufort, South Carolina, in 1794, and died at Norfolk, Massachusetts, in 1871. He graduated from Brown University in 1815, the Medical School of the University of Pennsylvania in 1818, and began the practice of Medicine at Charleston, South Carolina in 1822. Holbrook studied for two years in Europe and published other ichthyological papers in addition to the one listed above. Most of the species of reptiles of the United States that he described as new are still recognized, twenty-two of them being listed by Stejneger and Barbour in their recent catalogue of reptiles and amphibians.



Arctocephalus townsendi, the fur seal of the California Islands.
Modeled by James L. Clark.

New York Zoological Society

The Park and Aquarium

EXCHANGING MARINE FISHES: Mr. Vincent Astor will sail for Bermuda on the *Nourmahal* in September, accompanied by the Director of the Aquarium. The object of the trip is to bring to New York a collection of Bermudian marine life, including both fishes and invertebrates. At the request of Mr. L. L. Mowbray, Curator of the Bermuda Aquarium, a collection of local marine fishes has been taken to Bermuda. Mr. Mowbray is interested in trying to establish certain mainland species in Bermuda waters. The progress of this experiment will be of considerable biological interest, especially concerning problems of acclimatization. To insure the safe transportation of the collections, Mr. Astor has temporarily installed a series of large shipping tanks on the *Nourmahal*.—*C. B.*

DR. TOWNSEND HONORED: At a recent meeting the Board of Managers of the New York Zoological Society presented to Dr. Charles Haskins Townsend a gold medal in commemoration of his thirty years of service as director of the New York Aquarium. At the same time they presented a bronze statuette of *Arctocephalus townsendi* Merriam, the fur seal of Guadalupe Island, discovered by Dr. Townsend in 1892.

There are only two museum specimens of this seal in existence. The statuette was modeled by James L. Clark from the mounted specimen in the American Museum of Natural History. The other seal is in the National Museum of Mexico. The species was long supposed to be extinct. An account of its reappearance was published in Zoologica: New York Zoological Society in 1931.—*E. R. S.*

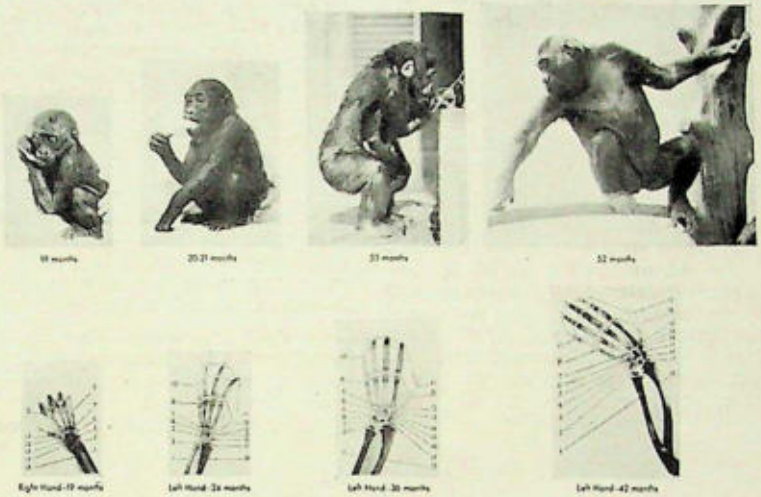
EDUCATIONAL ACTIVITIES: This department has just completed a motion picture entitled "Wild Animals in a City Park," which is now available for school use in New York City. It includes scenes showing various birds and animals that may be observed in most of our larger city parks. Among the birds, robins, barn swallows and song sparrows are shown feeding and taking care of their young. Squirrels, chipmunks and cotton-tail rabbits represent the mammals.

Few persons realize what a variety of animal life persists in a large city wherever it is protected to any extent. All of the scenes were taken within the boundaries of the Zoological Park. The pictures will be available in both 35mm. and 16mm. widths.—*C. W. L.*

"DEEP SEA COLLECTING: For three years now the Bermuda Oceanographic Expeditions of the New York Zoological Society under the leadership of Dr. William Beebe have made collections of deep-sea animals in the same region nine and a quarter miles south south-east of Nonsuch Island, Bermuda. That these collections must be becoming very complete as representative of the deep-sea fauna in that area is shown by a recent publication (*Zoologica*, 13, No. 3), which gives the lists of hauls made during May-November in 1931. Up to the present date, 1350 collections have been made at all depths down to 2000 fathoms in mid-water, the majority being at the surface and between 500 and 1000 fathoms. The fruitfulness of these collections is already shown by two further publications in the same periodical (13, Nos. 4 and 5). In the former Dr. Beebe describes nineteen new species of deep-sea fish, and in the latter the same author and John Tee-Van record six new species of shore fish from that region. It is by such continuous collecting that the sparsely distributed members of the pelagic deep-sea fauna will become better known, and we hope that more material will be accumulated; for until the many unknown forms have been fully classified and described the study of their life histories is impossible."—From "Nature," No. 3271, Vol. 130, p. 63; July 9, 1932.

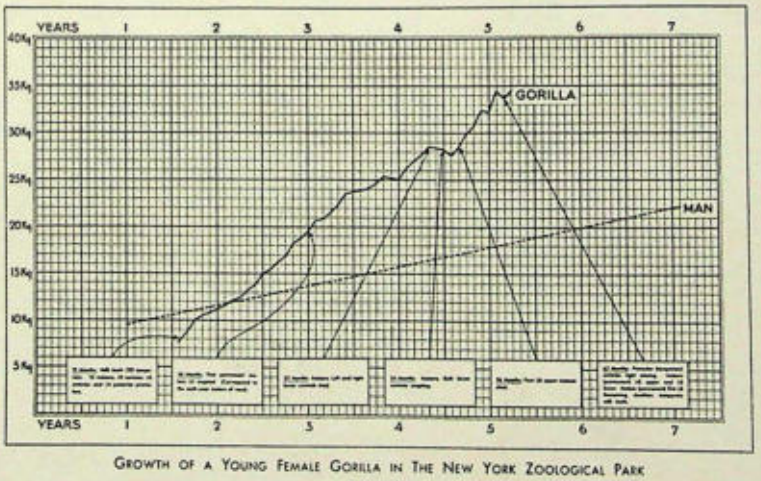
GORILLA GROWTH-CHART: The growth of the Park's young gorilla from the time of her arrival, October 31, 1928, to the present is graphically shown on the accompanying chart. This chart four by six feet was exhibited by invitation during the Third International Congress on Eugenics at the American Museum of Natural History.

The improvement in the physical condition of the gorilla, Penserosa, may readily be seen by referring to the series of scale-photographs at the top and to the weight curve at the bottom of the chart. Her sitting height during November 1928, was fifteen inches and her weight was



RADIOGRAPHS OF GORILLA'S HAND. DORSAL ASPECT

1. Ulna. 2. Distal epiphyses of ulna. 3. Lunatum. 4. Pisiform. 5. Triquetrum. 6. Hamatum. 7. Capitatum. 8. Distal epiphyses of 2-3-4-5 metacarpal bones. 9. Proximal epiphyses of first phalanx 1-2-3-4-5. 10. Proximal epiphyses of second phalanx 2-3-4-5. 11. Proximal epiphyses of third phalanx 1-2-3-4-5. 12. Proximal epiphyses of first metacarpal. 13. Multangular major. 14. Multangular minor. 15. Centrale. 16. Navicular. 17. Distal epiphyses of radius. 18. Radius.



GROWTH OF A YOUNG FEMALE GORILLA IN THE NEW YORK ZOOLOGICAL PARK

as increased by

Weight, Dentition and Development of Carpal Bones between 19 to 63 Months of Age

Compiled by Dr. Charles V. Noback

©1932

seventeen and one-quarter pounds. At the present time the sitting height is thirty inches and the weight eighty-two pounds. Her sitting height doubled in four years while her weight increased almost five-fold. The weight is recorded in kilograms (1 kilo. = 2-1/5 pounds).

The rapid development of her wrist bones (carpals), four were present when she arrived and eighteen months later had increased to nine, the appearance of her first permanent molar during the third year of her life, and her marked increase in body weight, indicate a more rapid rate of growth, than that of man over the same period. The first permanent molar in man usually appears during the sixth year and is commonly known as a six-year molar.

—*Charles V. Noback.*

Vol. XXXV, No. 5 September—October, 1932

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Headquarters of the 16th Expedition of The Department of Tropical Research of the New York Zoological Society. A cottage used as a laboratory by Dr. Beebe and his Staff through the courtesy of the Bermuda Biological Station for research of shore waters.

BULLETIN

NEW YORK ZOOLOGICAL SOCIETY

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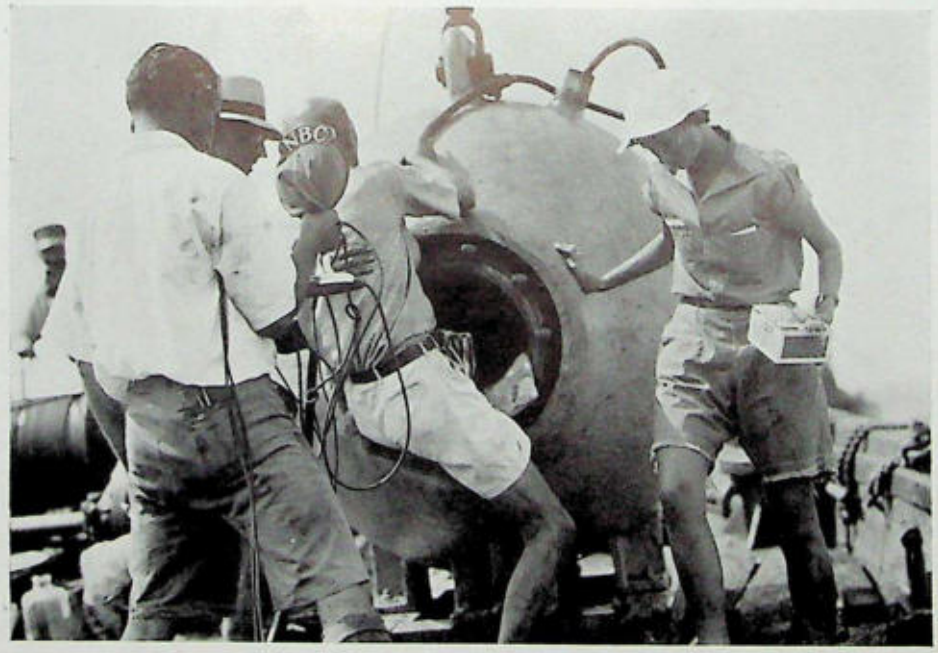
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Members of the Zoological Society are entitled to all Publications, Reports, Bulletins, Zoologica, etc. (Zoologica mailed by request only) and no effort will be spared to ensure their delivery. Changes of address, forwarding points and non-delivery of mail should be stated promptly. Contributions pertinent to the objects of the Bulletin cordially welcome. Stamped and return envelope should accompany communications.
Editorial and Subscription Offices, Zoological Park, New York City. Elwin R. Sanborn, Editor.

DEPARTMENT OF TROPICAL RESEARCH

Operations of the Department in 1932

THE Fifteenth Expedition of the Department of Tropical Research was made possible by the courtesy of Colonel Edwin M. Chance, who invited Dr. Beebe and Miss Hollister for a month's cruise among the Leeward Islands in his yacht "Antares." Such little known islands were visited as Union, Tobago Cays, Barbuda and Saba, and considerable collections and notes were made of native fish. Descriptions of new species and other results are now ready for publication. The Sixteenth Expedition of this Department left New York for Bermuda on August 13th and returned on November 23rd. It consisted of the regular members of the staff, William Beebe, John Tee-Van, Otis Barton, Gloria Hollister and Jocelyn Crane. In Bermuda Mrs. Tee-Van joined the party, and Vincent Palmer for two weeks. The Bermuda Biological Station for Research was used as headquarters, a laboratory being installed in a five room cottage (page 141). For this courtesy we are indebted to the President Prof. Edwin G. Conklin and the Director Dr. J. F. G. Wheeler. Seven dives were made in the Bathysphere and considerable work completed on the life histories of Bermuda fish. The Bathysphere was brought back for a thorough overhauling and for exhibition at the American Museum and the Chicago Exposition.



The Zero Hour:—At exactly 1.40 P.M. on September 22nd, with the microphone recording every sound, William Beebe and Otis Barton climbed into the Bathysphere for what proved to be a record dive of 2200 feet. In this photograph McElrath of the broadcasting company is holding the microphone, Tee-Van standing next, Beebe entering the sphere and Hollister holding a box of instruments. Sixteen minutes later the Bathysphere splashed beneath the surface, and two hours and twenty minutes after, it was again safe on deck.

BULLETIN
NEW YORK ZOOLOGICAL SOCIETY

Published by the New York Zoological Society

VOL. XXXV September—October, 1932 No. 5

A Half-Mile Dive in the Bathysphere

Shown in a Series of Pictures, from Photographs made by the Staff of the Department of Tropical Research.

WILLIAM BEEBE

Director, Department of Tropical Research

IN the Bulletin of the New York Zoological Society for November-December 1930 we described in detail the dives made in that year, and in a future number I shall similarly present all the facts concerning this year's dives. This account is merely a preliminary review of the chief points of interest.

Up to the present time, in company with Mr. Otis Barton, I have made six deep sea descents in the Bathysphere, as follows:

800 feet—	open	ocean,	10	miles	south of Nonsuch.
800 feet—	"	"	5	"	" " "
800 feet—	"	"	6½	"	" " "
1426 feet—	"	"	5¾	"	" " "
1000 feet—	"	"	3½	"	" " "
2200 feet—	"	"	5	"	" " "

The first four were made in 1930, and throughout a period of fourteen days. The two last were in 1932, and from first to last required a period of waiting of thirty-eight days.

We had this present year to contend with four threatened hurricanes, one of which came within fifty miles and exposed us to wind velocities of ninety-six miles an hour. We went to sea seven times but except on two occasions were prevented from diving by various reasons: by a dangerous leak in the hull of the tug; by two implosions, around the packing, first of a quartz glass window, and second, of a steel window plate; and finally by such waves and cross swells as would seriously have endangered our lives and apparatus.

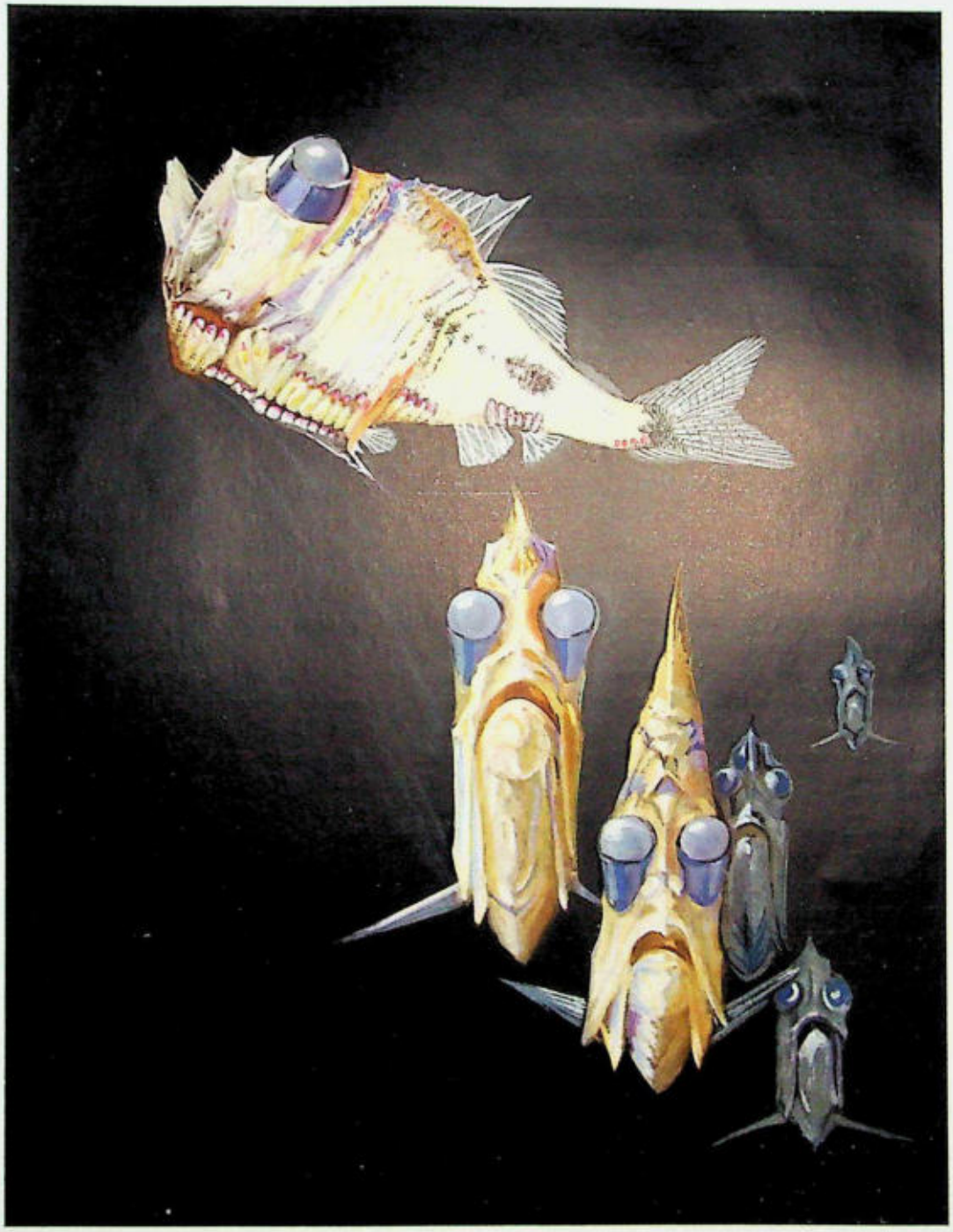
On September twenty-second under stress of great haste owing to approaching darkness, and extremely unfavorable conditions of wind and swell, we succeeded in reaching a depth of twenty-two hundred feet.

Sixteen days later, on October eighth, a few hours of quiet weather enabled us to make a second dive for observation and photography to one thousand feet. Immediately afterward I sent Mr. Barton and Miss Hollister down to an equal depth, to enable Barton to complete his photography and to have some of my observations checked up by an independent observer.

During two half-hour periods of the twenty-two hundred foot dive the National Broadcasting Company brought their delicate microphones to bear on the work. From 1:30 to 2:00 P.M. they stood close to the Bathysphere as we were preparing to enter, and from 3:00 to 3:30 they tuned in on the telephone wire over which Miss Hollister and I were talking, and succeeded in getting the vocal interchange from a depth of fifteen hundred to that of twenty-two hundred feet.

The absence of any financial consideration between the National Broadcasting Company and the New York Zoological Society made it possible for me to insist on only indirect communication, by which I mean that we did not say a single word in the presence of the microphones which would not have been said if these instruments had not been present. We have to thank the broadcasting men for aiding in every way in this unusual, and quite atypical, radio method.

The complete absence of first hand observational knowledge of this underworld of the sea



Silver Hatchetfish. Many of these strange fish (*Argyropelecus hemigymnus*) were seen from the windows of the Bathysphere. In the darkness only their lights were visible, but in the electric beam every detail stood out. Their eyes are enormous and look straight upward. From in front they have a singularly human aspect.
Painted by E. Bostelmann.

may be realized from the fact that the lowest depth hitherto reached by a living human being is five hundred and twenty-five feet, attained by a German in a jointed diving dress in a fresh-water lake. Submarines have never reached even this depth, and at best they offer almost no opportunities for observation. I have sat at the periscope of the submarine V-1, as she sank beneath the waves and have watched eagerly out of her tiny ports, but no form of life, nothing but the green water of the upper layers, was visible.

On September twenty-second Mr. Barton and I reached a depth of twenty-two hundred feet. At seventeen hundred feet my spectroscope and photometer showed no glimmering of light, and to the unaided vision the sea outside was wholly black with no hint of blue. So my principal object in making these dives was attained at this depth, that of reaching a point below the level of visible light. From this level down, except during the rare use of the electric light, everything seen was perceived by the light of the animal itself or reflected from other illuminated creatures in the surrounding water. The abundance of organisms, their unexpected activity, combined with the knowledge of the shortness of my period of observation, made concentrated record a very difficult matter.

My classification of lights showed pale blue to be the most abundant, next pale green and only a few times did I see a reddish or a rosy tinge.

The distinctness of the lights was very marked; each one, large or small, whether a sudden flash or a continued illumination, stood out sharply outlined, with no haze or penumbra or halation effect. Twice we saw flashes which can only be described as blinding. For several seconds afterwards I was conscious of the lasting effect on my retina.

The heat of our bodies and the occasional use of the 1000 watt electric lamp kept the internal temperature at about 70 degrees, but outside it was 53 degrees and the walls of the Bathysphere felt cold and clammy to the touch.

The pressure at 2200 feet, or 366 fathoms, could only be grasped intellectually. There was nothing outside or in to make it real to us. On every square inch of my fused quartz window was a weight of 993 pounds or a total of 14 tons on the entire glass through which I looked. The pressure of water on the whole Bathysphere was 5120 tons.

On almost all of my deeper dives one of the most interesting phenomena was the presence of deep sea fish at levels much higher than we ever take them in our nets. In this same area we have pulled 1350 nets from the surface down to 1200 fathoms, so we feel that we know the general distribution fairly well and our Bathysphere observations have correspondingly greater value.

Several concrete identifications will show the value of these observations. Four times I saw large eels, almost always in pairs, very definitely *Serrivomer*. This fish has no light organs, yet each time I could see the outline of the jaws, head and body. This must have been from illumination of very minute creatures in the water stirred up by the passage of the eels, although nothing like separate sparks was detectable. These eels were seen at 260 and 280 fathoms. Our trawling records show that of one hundred and fifty specimens of *Serrivomer*, only ten per-cent have been taken above 300 fathoms, with the maximum at twice that depth.

Of the giant, scarlet crustaceans *Notostomus* and *Gnathophausia*, the maximum occurrence, as shown in our trawling records, is 800 fathoms with only two individuals as high as 600 fathoms, whereas the six which I saw from the Bathysphere were at 260 fathoms.

The explanation must lie in the imperfections of our modern trawling apparatus. The silk nets can be drawn at a speed of only two knots an hour, and in the upper levels there is apparently sufficient diffused light to enable all the larger and more active fish and invertebrates to detect the approach of the net and to avoid it.

The abundance of Pteropods or flying snails is evident on every dive, which is reasonable when we realize that the bottom of this restricted area presents the only pteropod ooze to be found anywhere in the north-eastern Atlantic.

Twice during our deep descent we saw an indefinitely shaped, but very large body of some sea creature pass in the distance through the beam of light. It was pale in color, apparently a grayish white, but whether squid or some giant fish we cannot tell.

The most obvious result of this deep dive was the ease with which accurate identifications could be made. Given a sufficient number of dives and

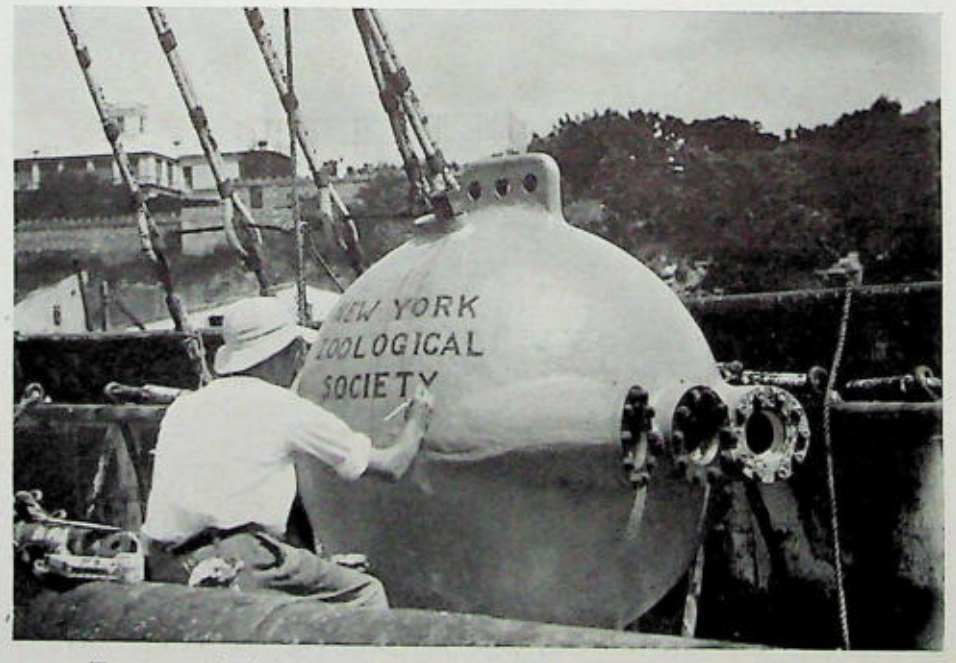
long enough duration of observational periods, and a very accurate picture could be obtained of the abundance, activity, and illumination of a great many known deep sea fish and invertebrates, and recognizable descriptions made of new, unnamed forms. This is amply attested by the many observations on which I am working at present.

I am deeply grateful to the generous contributors to this year's Bermuda Oceanographic Expedition by members of the New York Zoological Society, and to the splendid trio of fellow workers on my staff, John Tee-Van, Gloria Hollister and Jocelyn Crane, each of whom has an indispensable share in every phase of this and all other activities of our expeditions.

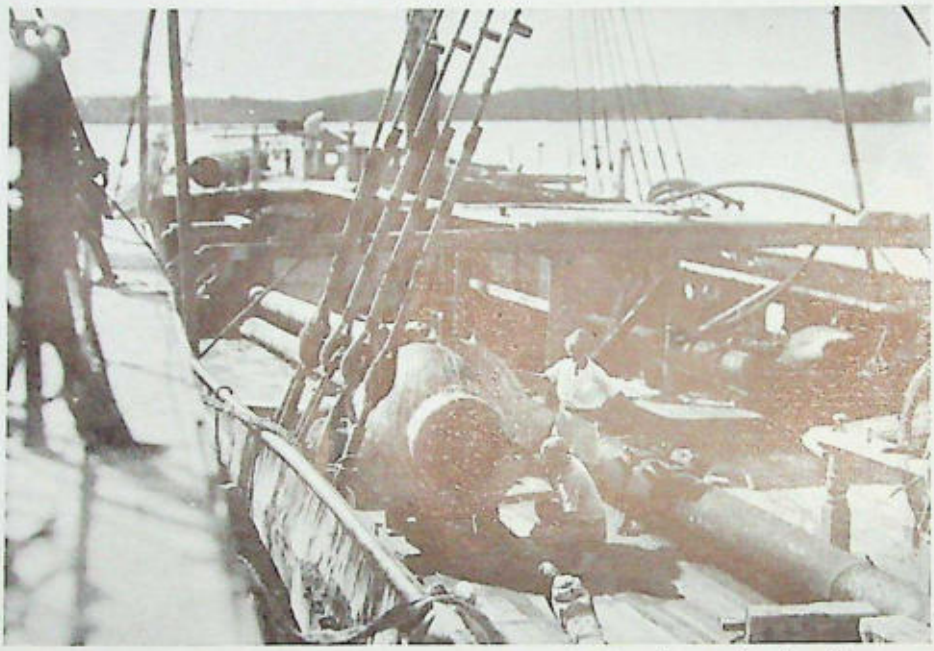
A Half-Mile Dive in the Bathysphere

Shown in a Series of Photographs

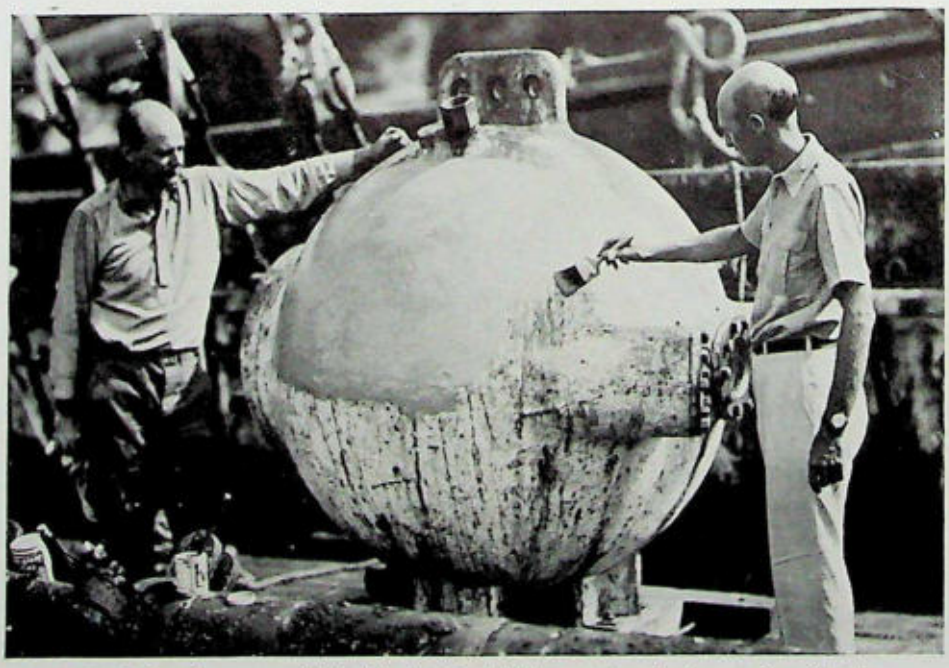
PREPARATION



The grease-stained sides of the Bathysphere were covered with a thick coat of new paint, and the name of the New York Zoological Society placed on one side. The white lead can be seen around the recently installed, farthest quartz window. It was an excess of this which caused the first leak.



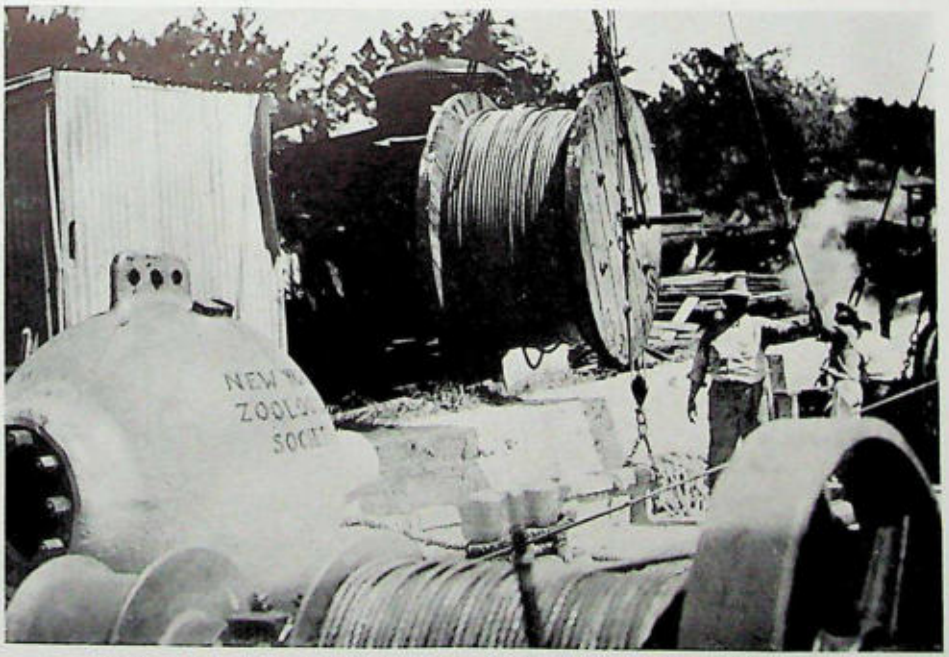
While giving the Bathysphere her first thorough overhauling, she was placed on the deck of a famous old four-masted wreck—the *Taifun*.



The Bathysphere was painted white in 1930, but this year in order to camouflage it and make it less conspicuous to timid deep sea fish, we gave it a thick coat of dark marine blue, hiding the streaks of grease.



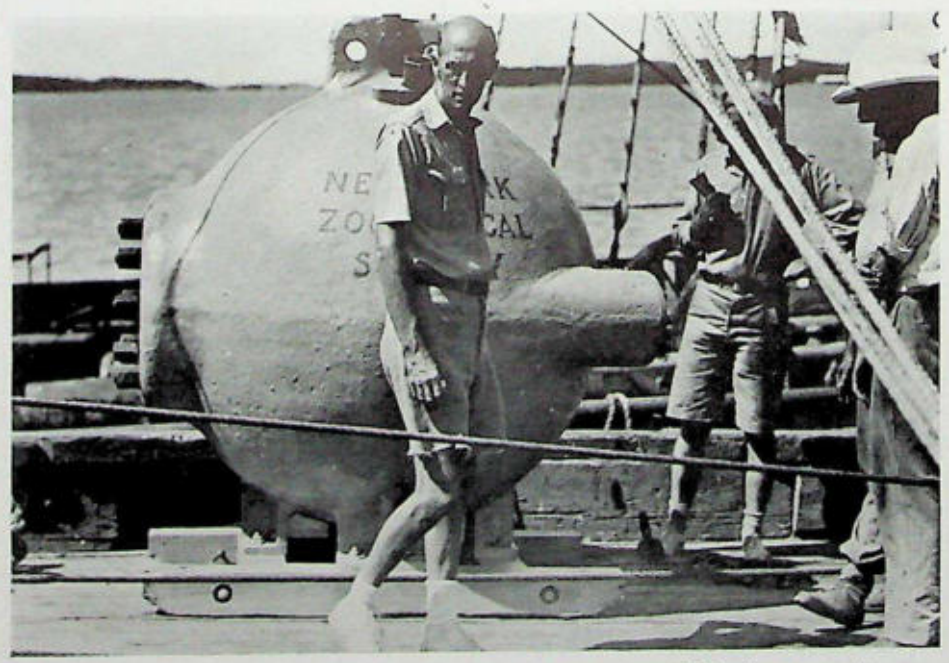
When cleaned of a year's accumulation of rust, and dressed up in its fine new coat of paint, we hoisted the Bathysphere on board the mother ship, the *Freedom*, Beebe and Barton riding on her and guarding the quartz windows from harm.



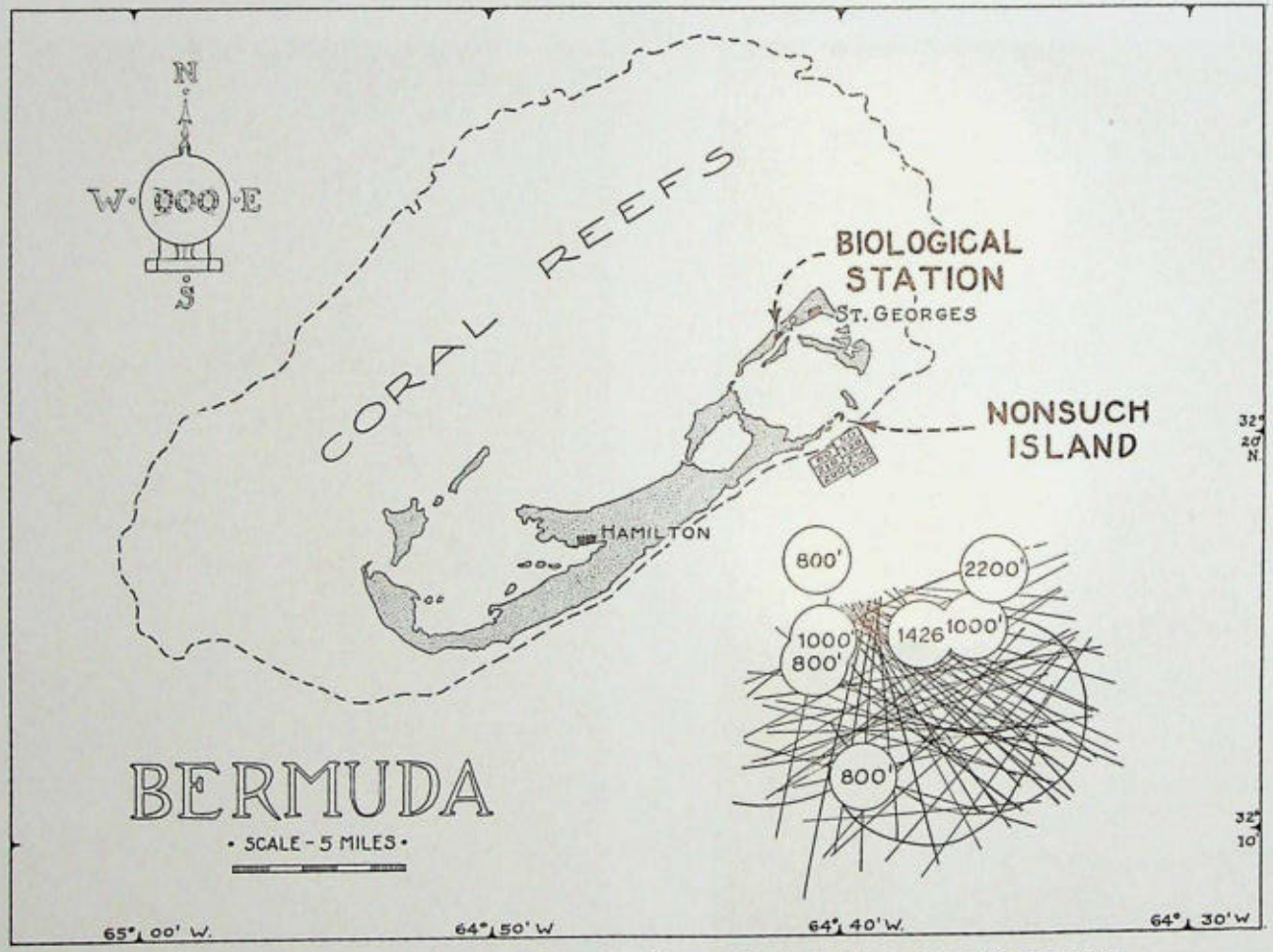
We are now at the wharf where the Bathysphere, the winches and miles of cable have lain in their house for a year and a half. The 3000 feet of rubber hose, enclosing the telephone and electric light wires, are just coming aboard.



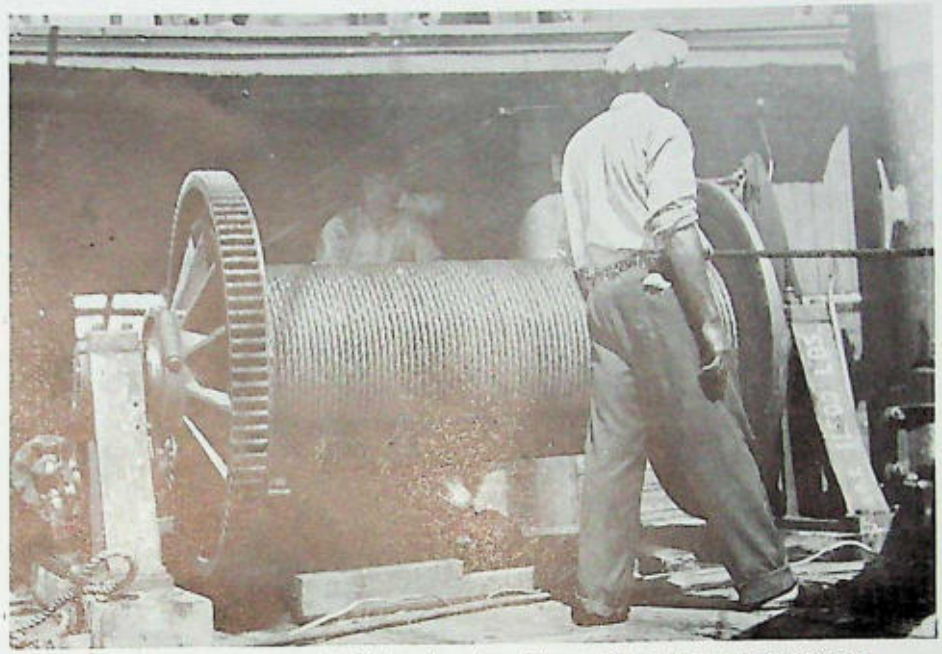
We see the Bathysphere on the deck of the *Freedom*, and the enormous yard, brought especially from last year's boat. The low bulwarks and wide expanse of deck make this craft ideal for our work. But she proves to be anything but sea-worthy.



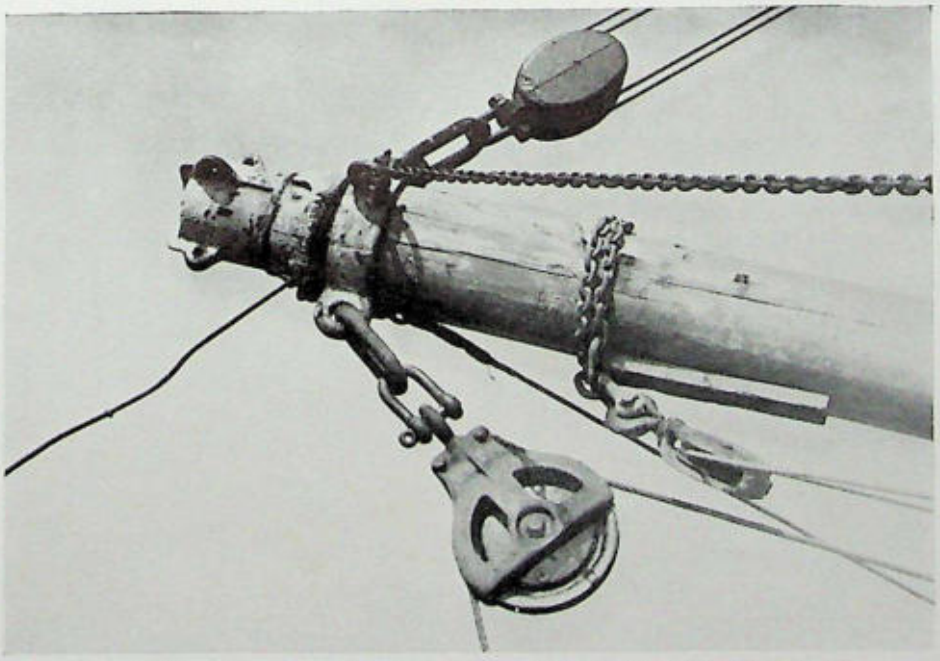
Our first concern is with the steel cable, but when a quarter-mile has been run out we find it as strong and clean of rust as when new. It has a breaking strain of twenty-nine Bathyspheres, so we cease to worry on this score.



Map of Bermuda, showing Nonsuch Island; our trawling area for the last three years with its maze of daily hauls all in a roughly circular area eight miles across; also the position of the several Shore Contour Dives in the Bathysphere, and the deeper dives in the open sea. Drawn by John Tee-Van.



The seven-ton *Arcturus* winch is in place, the cable wound tightly ready for slow or rapid reeling or unreeling. This cable is seven-eights-inch, with a steel core and about one hundred strands, made especially for this purpose by John Roebling.

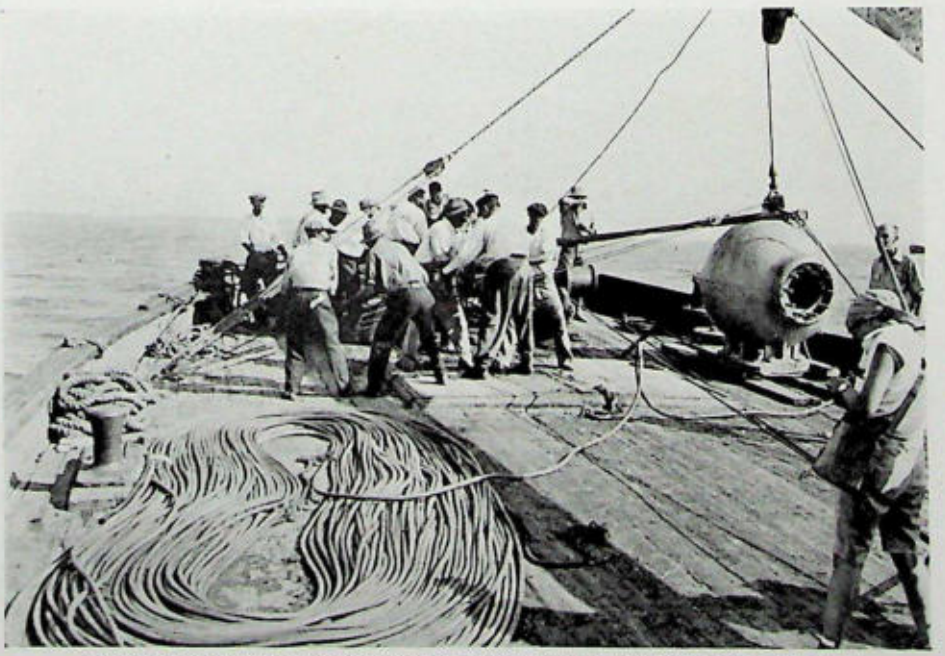


The giant steel sheeves have been in use for seven years, yet show no signs of wear, and perform their important job smoothly and well.

AT SEA



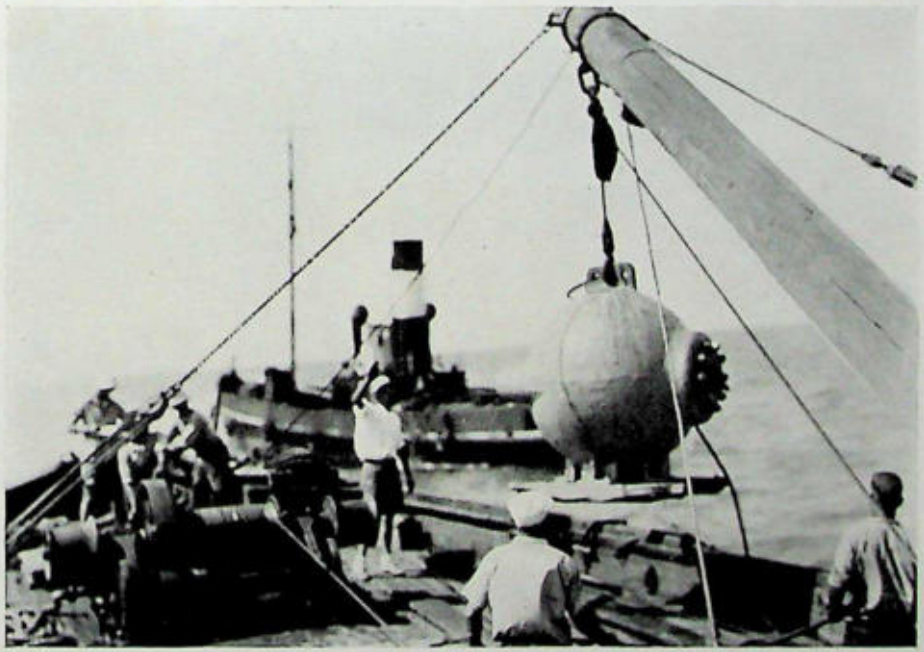
The *Freedom* has performed yeoman service in Bermuda for more than twenty years, and she does all that we ask of her. But with our heavy load, in rough seas, she discovers leaks of which she was wholly ignorant, and the first day we have to steam full speed to shore with the water almost at the level of the engines.



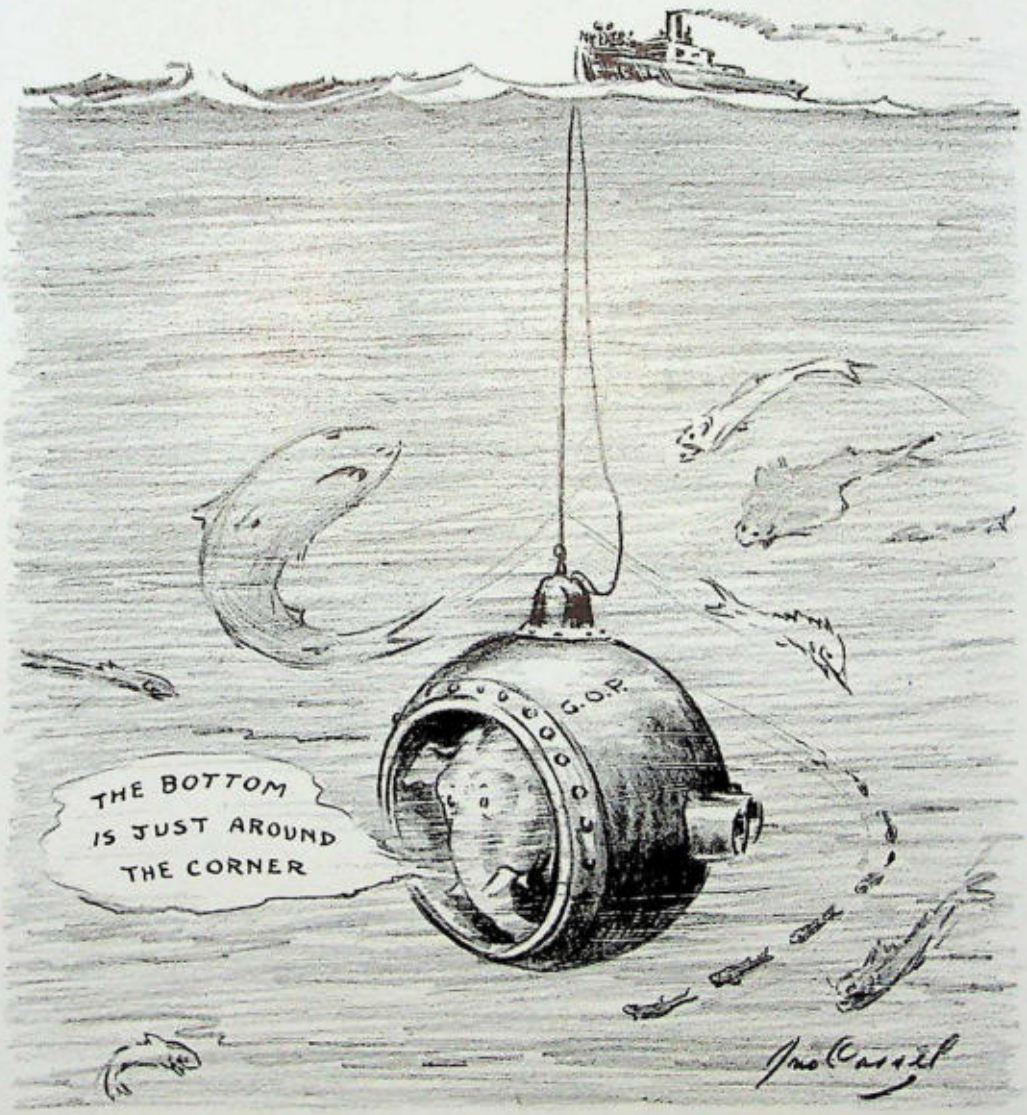
The half-mile of solid rubber hose has now been unwound from its spindle and coiled loosely on deck. One weak spot has been cleverly spliced by a wireless man, and the four internal wires work perfectly, transmitting sound and light. A squall has just threatened, making diving impossible, and the Bathysphere is being lashed to keep it from rolling about.



Before a human being goes down in the Bathysphere it must be sent down for a test dive, deeper than the final descent. The 400-pound door is swung into place and fastened on.

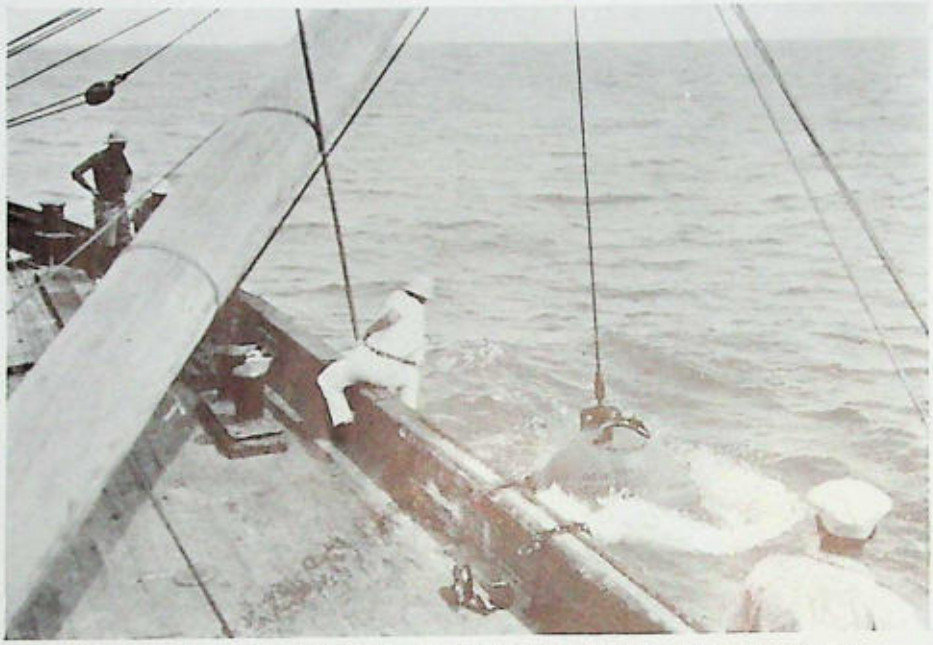


The signal given, the great hollow mass of steel is lifted into the air and overboard. A large tug, the *Powerful*, is seen, standing by in case our boat should again spring a leak.

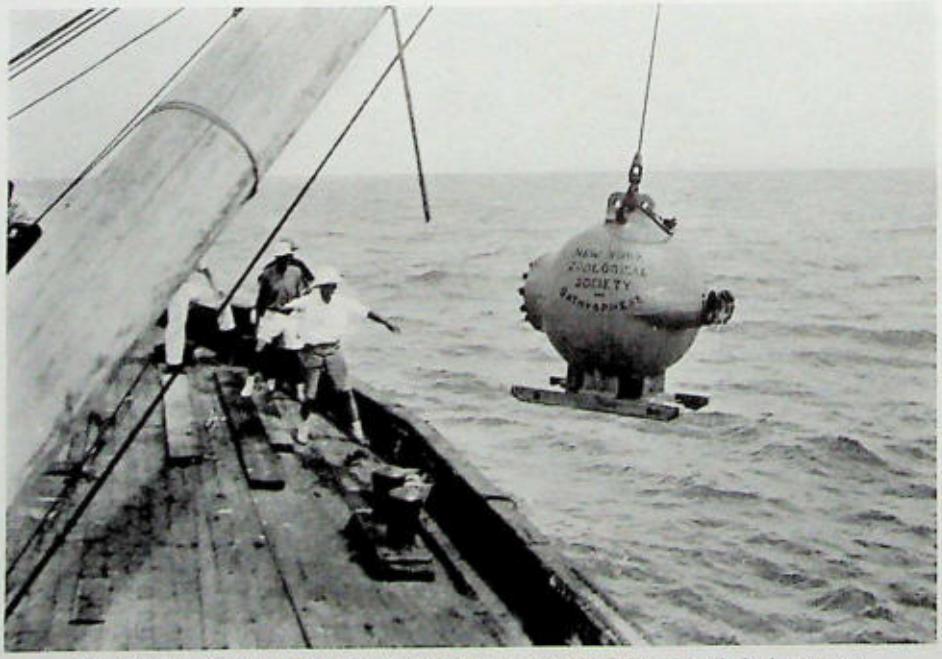


The Political Bathysphere. The Zoological Society's Bathysphere has become such a nationally known word that it is used in cartoons such as this. Courtesy of John Cassel and the Brooklyn Daily Eagle.

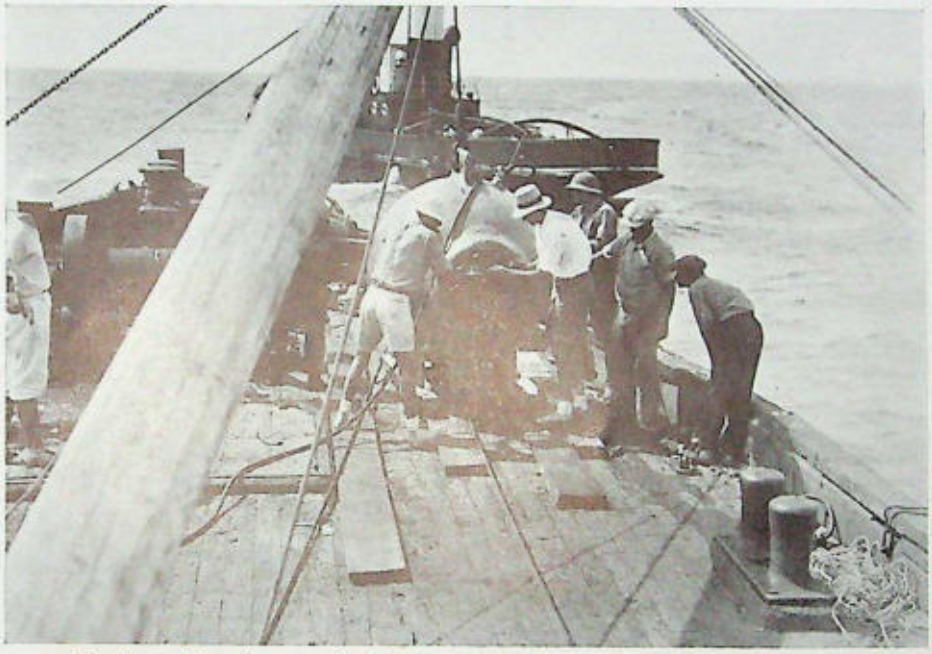
TEST DIVE



After being lowered to 3000 feet, the Bathysphere is brought up again. One hundred feet from the surface it becomes visible, the ultra-marine appearing pale turquoise. When lifted into the air, the creaking and straining of the machinery shows that something is wrong; the sphere is twice as heavy as it should be.



Straining at its cable, the Bathysphere swings heavily inboard and during a momentary lull between swells, is brought to rest on the landing boards. A glance at the new quartz window shows that a leak has started and that the Bathysphere is filled with water; not from an explosion, but an implosion.



For the first time in our work with the Bathysphere something has gone wrong. The steel sides are cold, and a low hissing sound can be heard. Those in the photograph are Beebe, Tee-Van, Barton, Blagdon and our favorite deck-hand known as OKay.



The central wing bolt is loosened and slowly turned, and almost at once water begins to drip out, the hissing increasing.



Standing far back, with fingers just touching the wing bolt, the Director gives it a last push and, like a shell from a cannon, it flies across the deck and crashes against the steel winch thirty feet away, making dents half an inch deep in the brass. The compressed air and water turn to steam, clouding the entire forward deck.

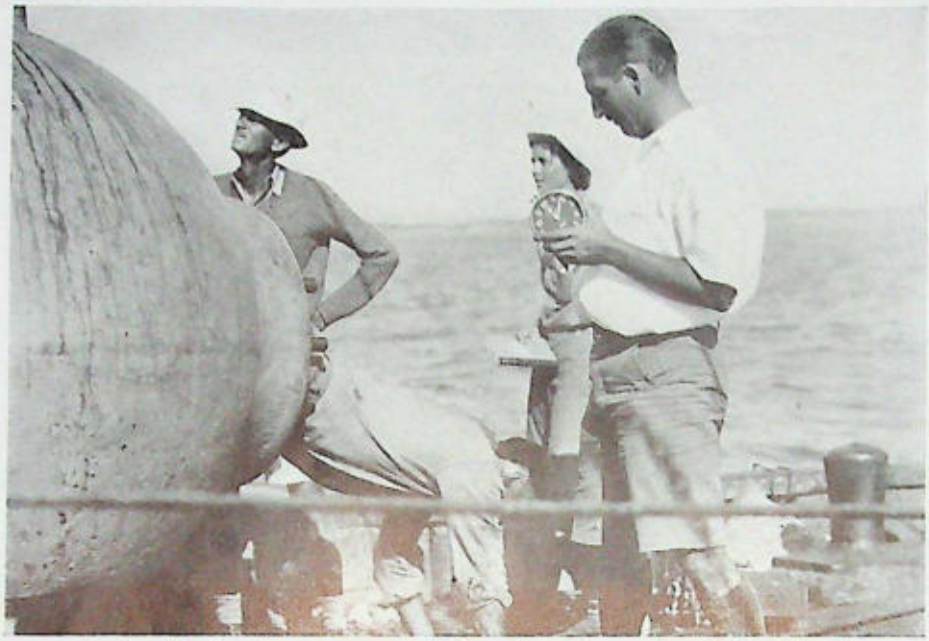


As the wing bolt turns, more and more water escapes, and the hissing rises to a high scream. On the chance that the pressure might be dangerous, the deck is cleared of people, and the photographer placed far to one side.



When the rush of water, air and steam ceases, the Bathysphere is left half full of water. This feels icy cold to the fingers and a thermometer registers fifty-six degrees, indicating that the break took place at least 2000 feet down.

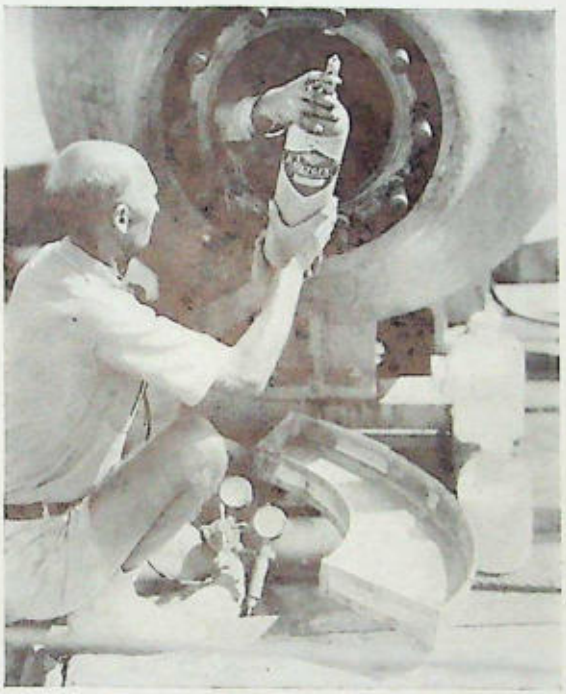
THE HALF-MILE DIVE



Another test dive is necessary, and this is made on the morning of September 22, a clock being sent down, the ticking audible over the telephone wires until 12:09 P.M. when the clock stopped at 2500 feet. The sphere comes up dry. At the moment of this photograph we are examining every detail of the sphere and watching the weather to decide on the possibility of making the broadcasting and our deepest dive. At 12:55 I decide to risk it.



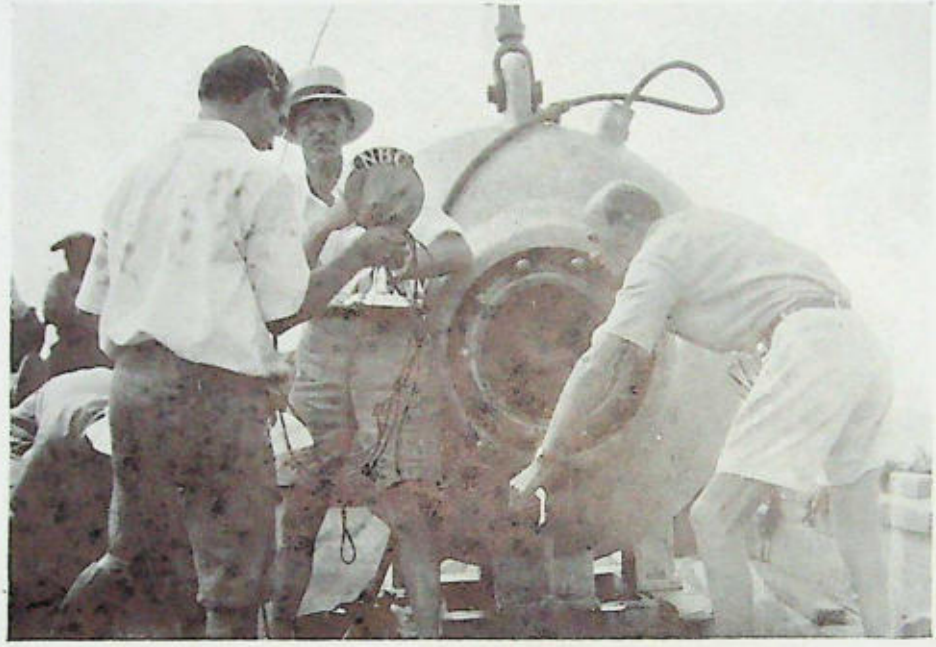
Here we have five minutes to wait before the zero hour, when the broadcasting begins over the United States and Europe. From left to right Tee-Van, Beebe, McElrath and Barton.



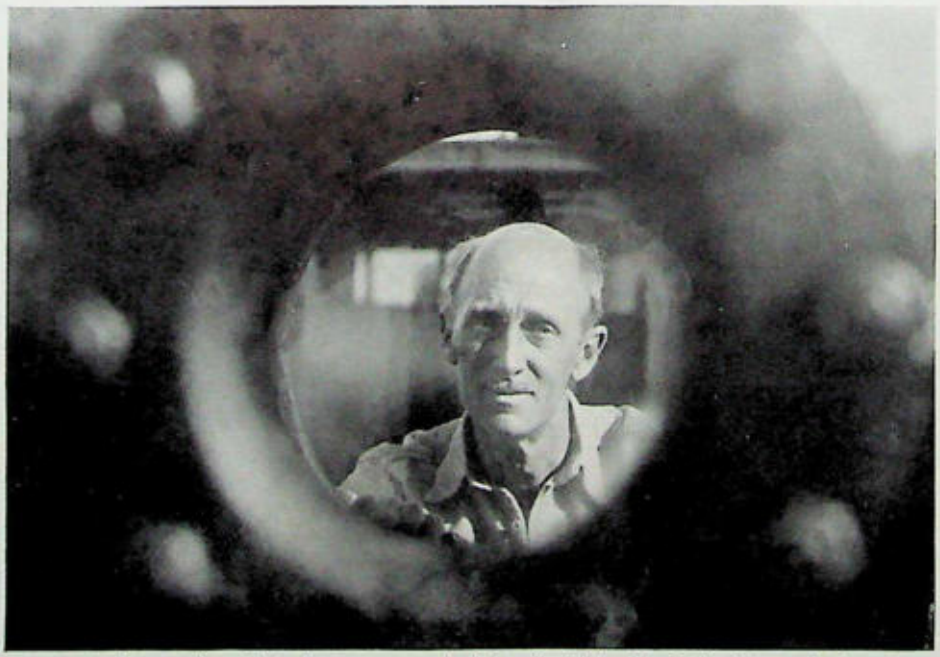
More rapidly than ever before we begin loading the Bathysphere, tightening the stuffing box, attaching the chemical trays, filling them and installing the oxygen tanks.



Perhaps most important is the adjustment of the oxygen valves, which must be perfectly clean and must give out two litres of oxygen every minute—no more, no less.



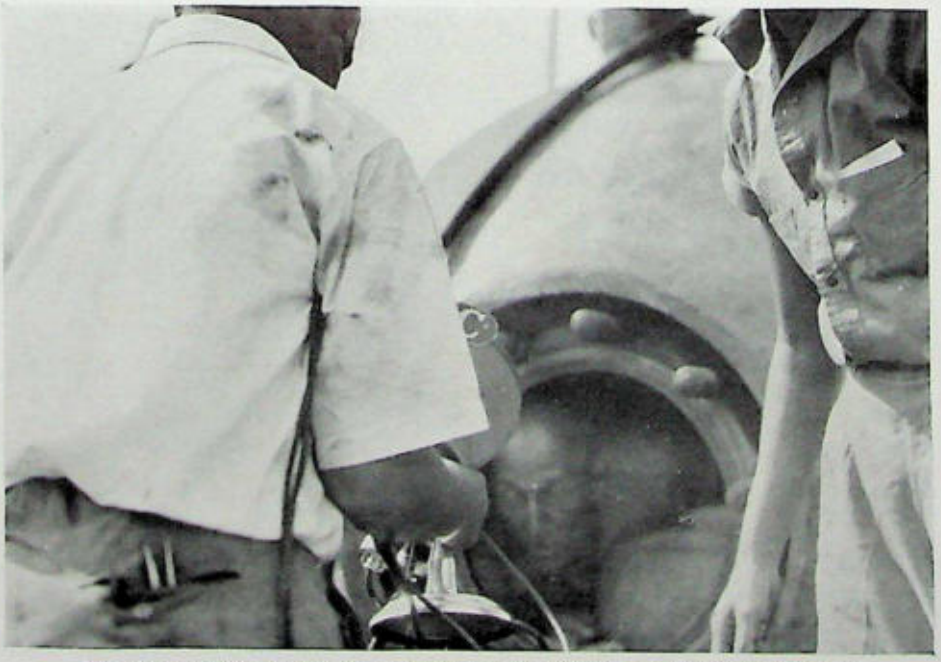
At 1:30 P.M. the broadcasting begins. This simply means that the microphone is brought close to our group about the Bathysphere, and our general directions and preparations are heard.



A photograph made just as we are about to climb into the Bathysphere, all the apparatus having been installed. The clarity of the fused quartz windows is evident.



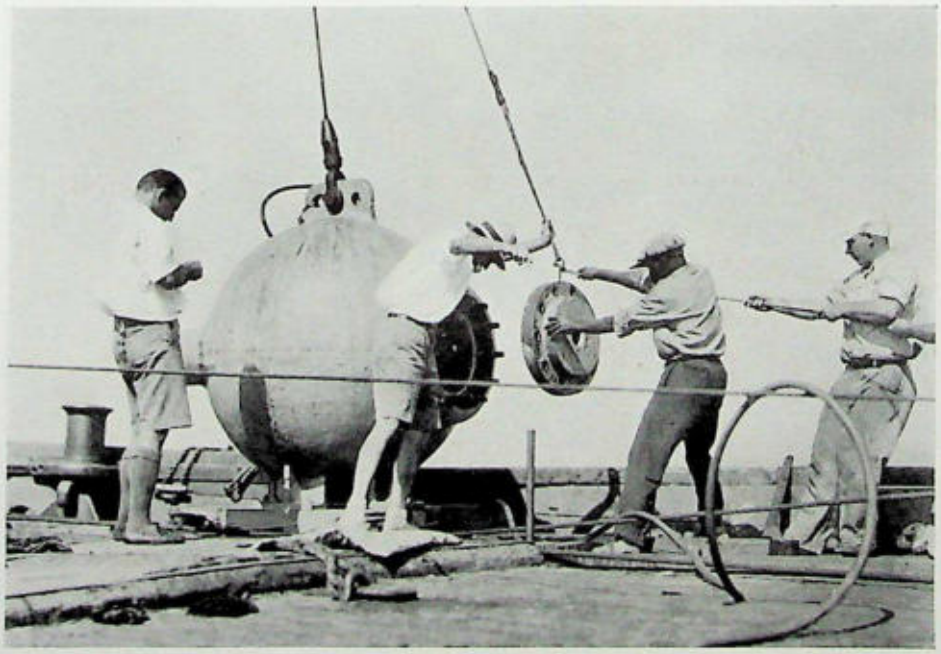
Beebe and Barton in Bathysphere for the deep dive. Earphones are on but connection is not yet made. Final examination of the windows.



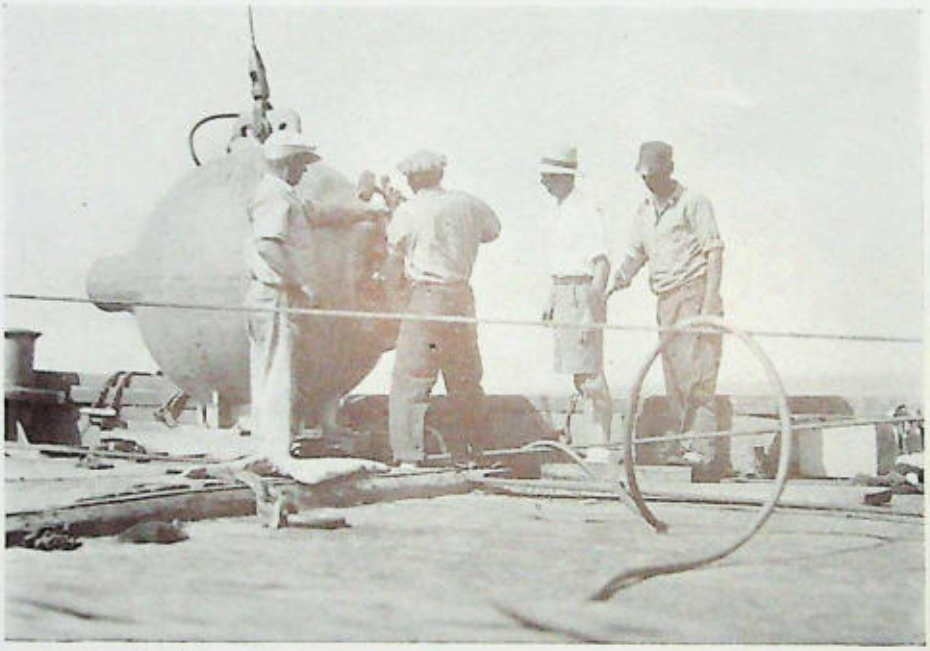
Both divers inside, giving final instructions and agreeing on emergency signals in case the telephone should cease working.



A thin coating of white lead is placed on the flange of the door to make the junction of steel with steel as perfect as possible.



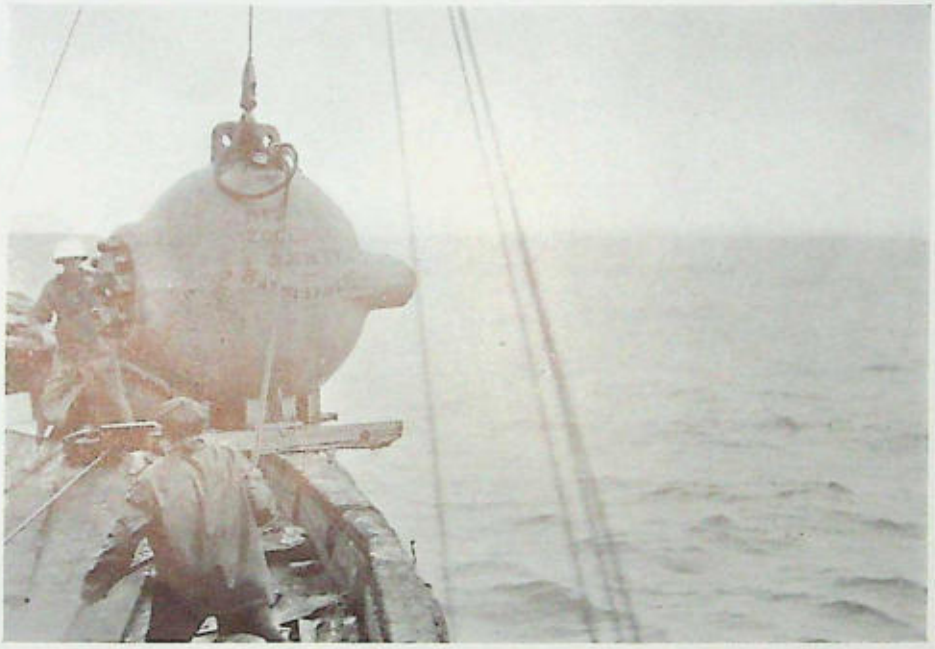
The 400-pound door is now lifted and swung gently over the ten great bolts, and the mass of steel clangs home.



The mighty brass nuts are screwed into place, each one numbered and fitted to its particular bolt.



The central wing bolt has been screwed tight and now the wrench is pounded with a sledge hammer, so that the wing bolt and all ten nuts seem as if they were a single piece with the whole welded body of the Bathysphere. The noise is terrific on our eardrums as we sit curled up inside.



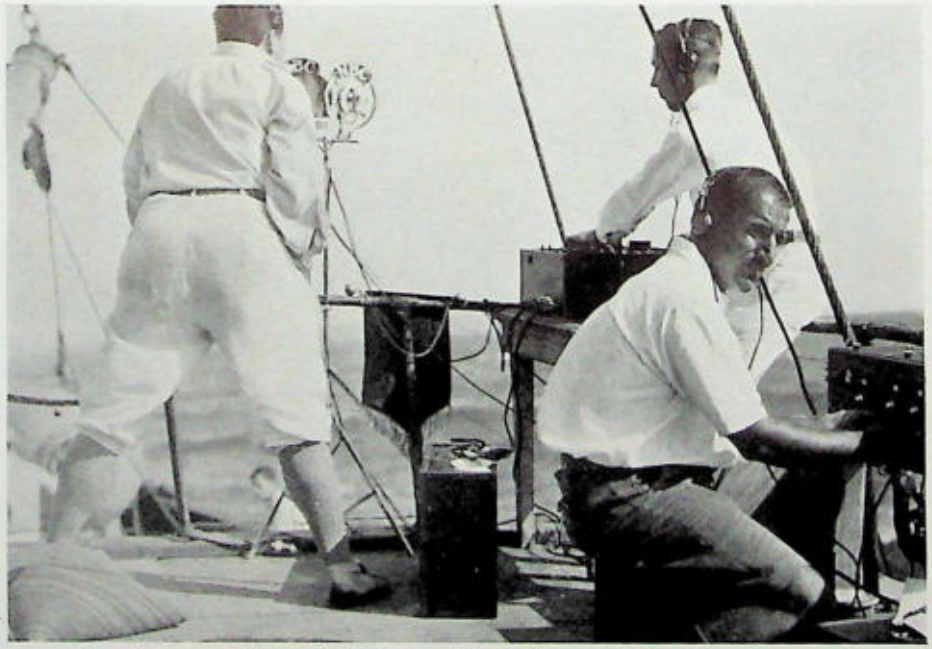
The door is sealed tight, the signal given, and the two-ton steel ball rises gently, clears the rail and is swung outward.



This is the moment of greatest worry to Tee-Van and Sylvester, who are in charge of the deck machinery. A sudden swell may set the Bathysphere swinging like a pendulum; then a second wave counteracts the movement, and in this propitious second, it must be dropped beneath the surface.



The most delicate part of the operation of the descent is the paying out of the solid rubber hose containing telephone and electric light wires. This must not be bent or rubbed, and every 100 feet is tied to the wire cable with a rope tie.



The divers are inside the Bathysphere and the radio men, after waiting for a month through hurricanes and mishaps, are at last in full swing. Ford Bond is announcing, while Resides and McElrath (in charge of the N.B.C. outfit) are watching the mass of delicate and complicated machinery which is sending our voices over half the world.



The dive has begun, and Barton begins his ceaseless watch for trouble at the door, oxygen valve, chemical racks and packing of the hose. Beebe becomes one large eye at the window, trying to see and interpret every possible thing that appears. The ear-phones are in place and hardly a second passes between communications that the phone is not tested for a possible break.



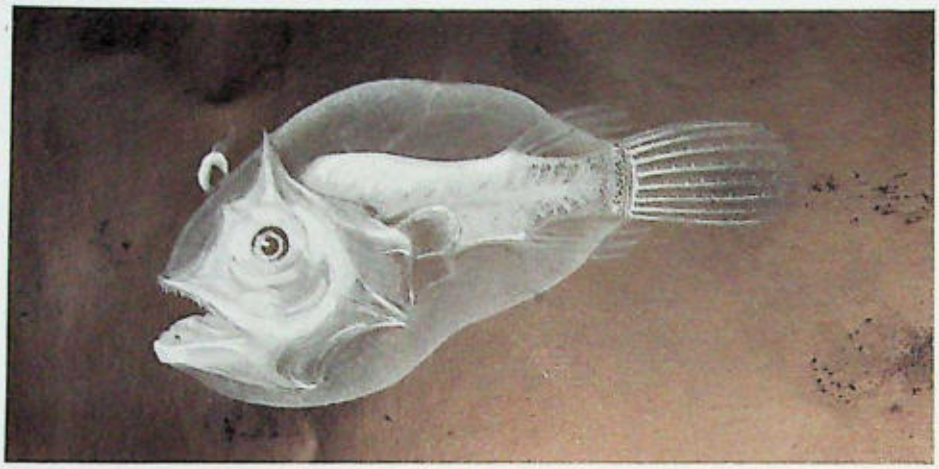
On deck, near the winch, Gloria Hollister is one large ear, recording every exclamation, every fact, answering questions as to depth or speed, passing orders on to Sylvester, the man at the winch, and dictating to Jocelyn Crane the time, depth and position.

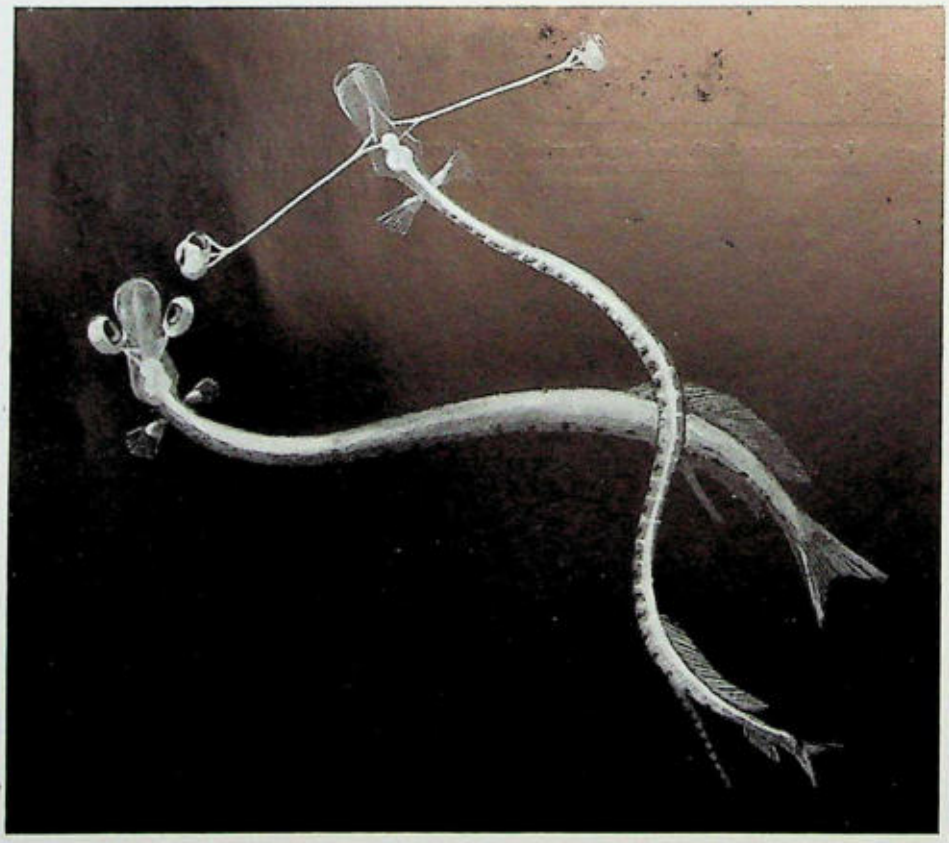


At 1000 feet Miss Hollister made this photograph with her camera, showing dimly the strong electric beam shattering the darkness which had been unbroken by human-made illumination for two billion years.



A photograph of the waters of the sea at great depths shows only complete blackness, with a scattering of sparks and lights from the bodies of the fish.

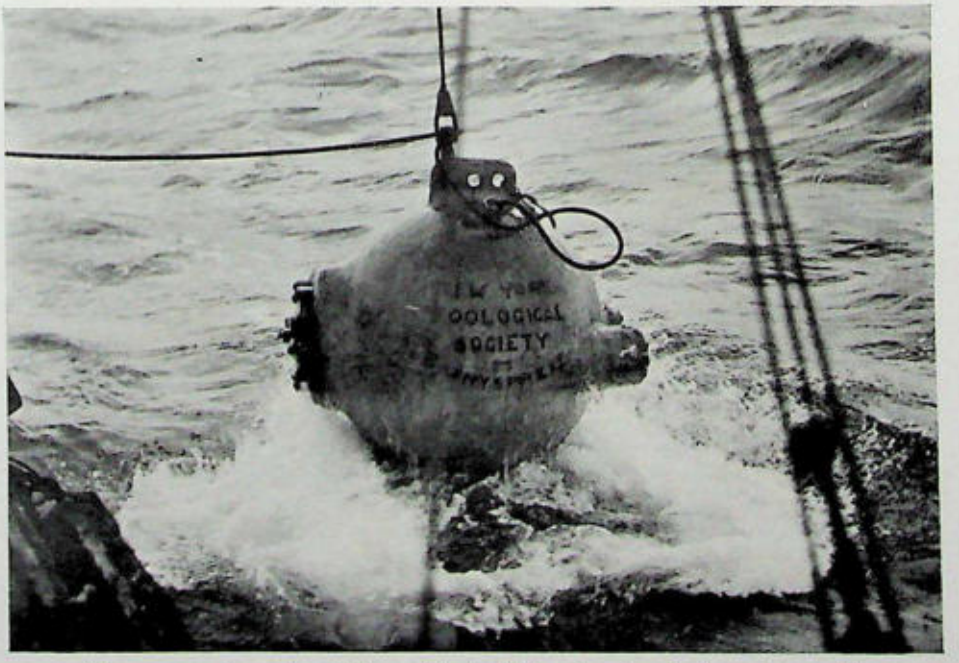




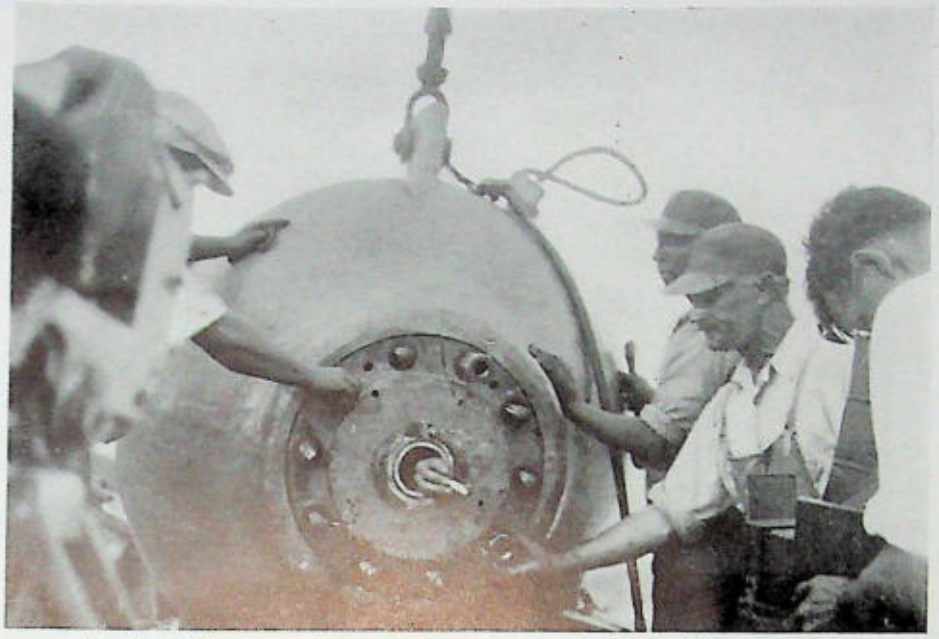
What the camera cannot portray at these depths the human eye can dimly perceive, and remember and fit to the specimens which the trawls of the past three years have brought to the surface and to the artist.



The greatest depth has been reached and now the Bathysphere is on its way up. To save time the rope ties between cable and hose are quickly cut, so there is scarcely a moment's delay at each 100 feet.



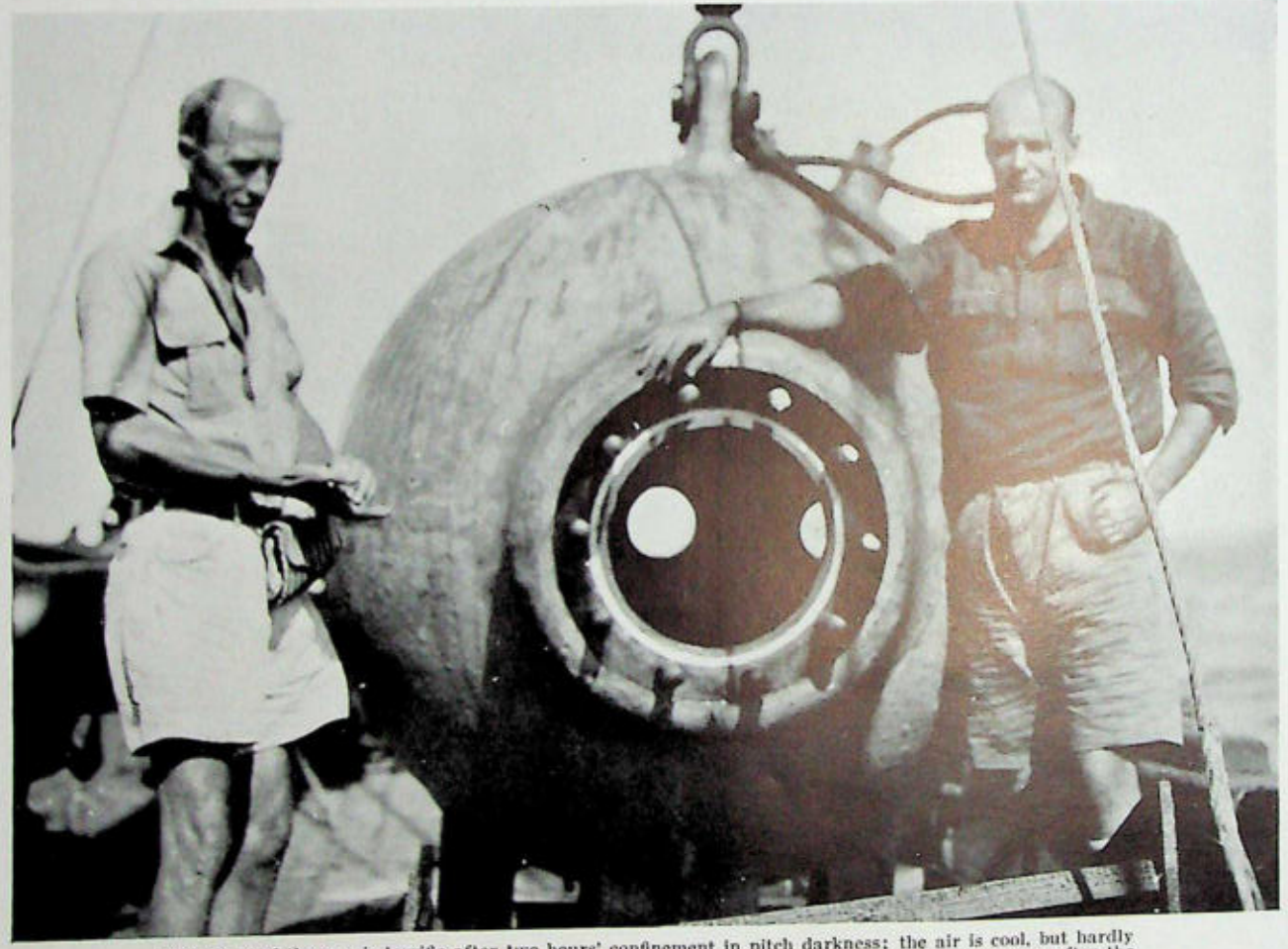
Like some great creature of the sea the dark blue sphere breaks the surface, and is held there until there comes a moment of complete steadiness when it is drawn rapidly up, swung inboard and landed.



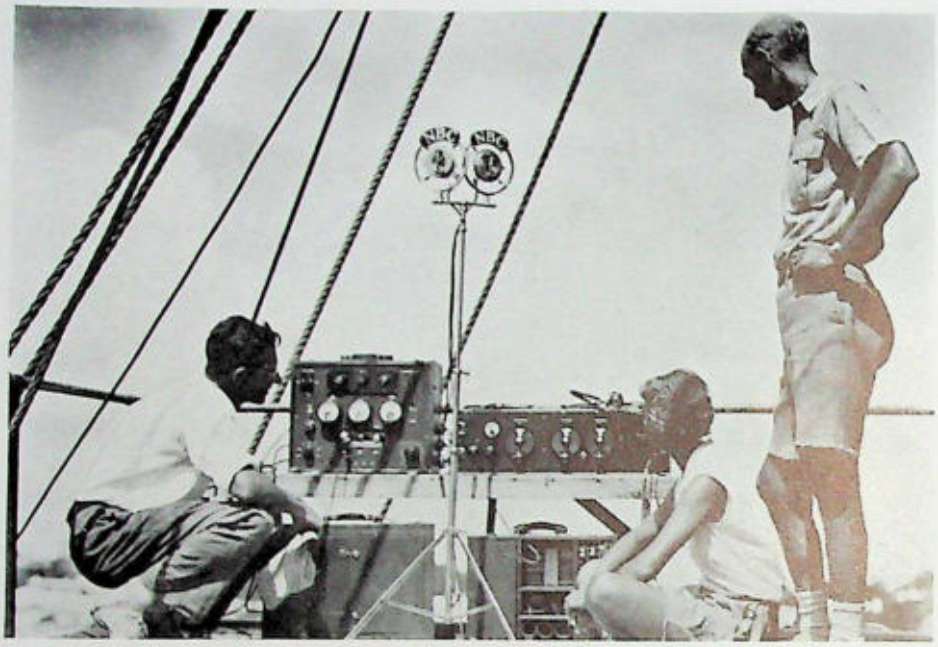
The wing bolt is unscrewed, very slowly at the first, when the slightly compressed air hisses out. Through the hole, the more delicate instruments are handed out.



The most painful part of the whole dive for the divers is when they emerge, tired and cramped, with feet asleep, and haul themselves out of the fifteen-inch opening of the door.



The glare of the sun is terrific after two hours' confinement in pitch darkness; the air is cool, but hardly fresher than the oxygen-fed atmosphere of the Bathysphere. The horizon seems very far away after the four-and-a-half-foot radius of our recent home. As we look out over the face of the ocean we realize that we know, as no other human beings do, some of the secrets of the creatures which live a half mile beneath our feet.



Station ZFB—1 Freedom. The elaborate wireless machinery was set up on the upper deck of the Freedom, out of the way of harm from people, from unnecessary noises and from flying spray.

The Bathysphere Broadcast

GLORIA HOLLISTER

SEPTEMBER 1932 marks the first time in history that radio engineers have travelled beyond territorial waters of the United States to broadcast a program back to home stations. The Bathysphere of the New York Zoological Society made a record plunge to 2200 feet below the surface of the sea on the twenty-second of September. The dive was made about eight miles southeast of St. Georges from the mother ship *Freedom*. This was the occasion for the field staff of the National Broadcasting Company to set up two complete transmitters and two receiving stations on the upper deck of the *Freedom*. Here was established a special radio station which was called ZFB-1, after the station in St. Georges which is ZFB. Through the courtesy of the Imperial and International Communication Company a license was granted to operate in territorial waters off Bermuda, and its officials cooperated in every way to facilitate the broadcast of this dive. An elaborate technical setup of radio geer was required to transmit to listeners throughout the United States and foreign countries the preparations of the Bathysphere on deck and observations made during the dive to 2200 feet. The engineers considered the problem of transmission from Bermuda to the United States relatively simple. But the installation aboard the *Freedom* of the short wave transmitter to be operated at sea, and the reception facilities on shore, required considerable labor and weeks of preparation. Static, which is often prevalent in the vicinity of Bermuda, had to be combatted.

The broadcast was divided into two thirty minute periods. The first half hour, from 1.30 to 2.00 P. M. described the scene of tense activity on deck preparing and sealing the Bathysphere with its human cargo. Two sound microphones, mounted near the Bathysphere and the big winch, caught the clanging of the sledge hammers tightening the nuts of the door, and the grinding of the winch as it released more and more cable to lower the Bathysphere into the deep. During the second half hour, 3.00 to 3.30 P.M. Dr. Beebe was heard describing what he saw between 1500 and 2200 feet. While at my end of the telephone on deck I recorded his observations and gave him what information he wished as to depths, etc.

Dr. Beebe's voice was carried through 3000 feet of telephone cable from the Bathysphere to the deck of the *Freedom*. On deck the voices



Miss Gloria Hollister immediately after a dive of 1000 feet.

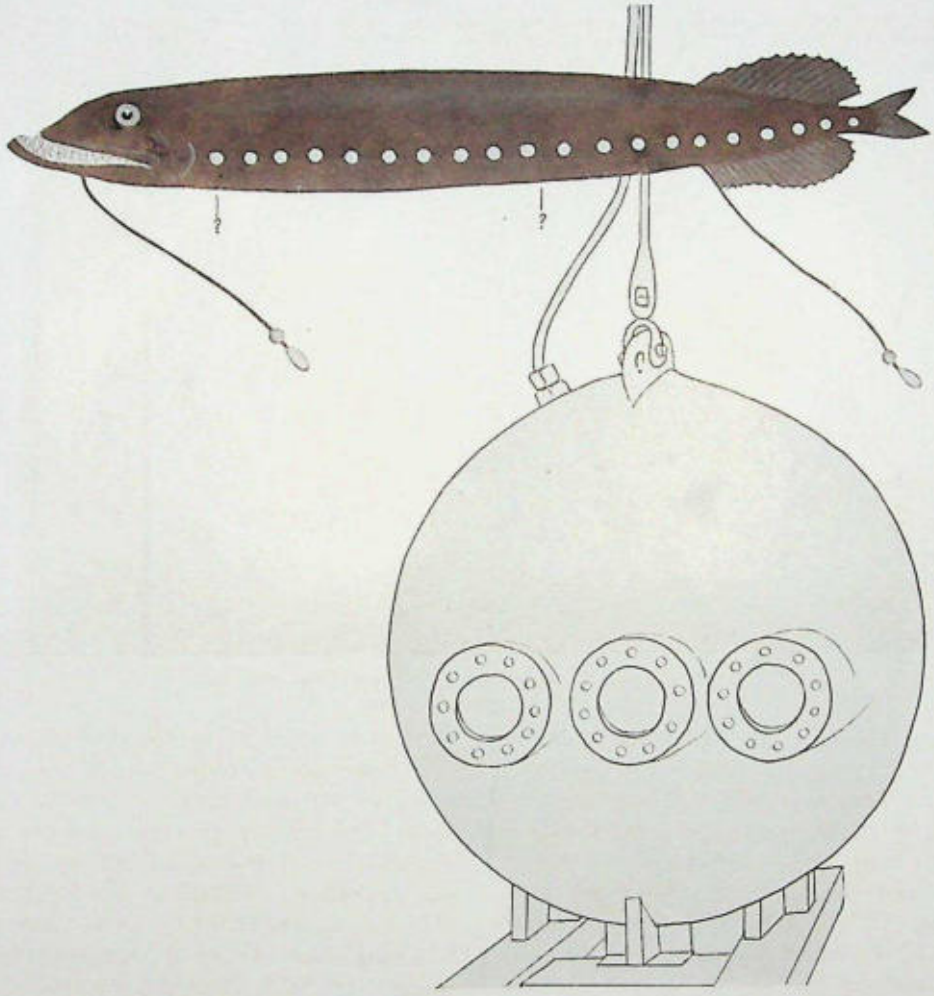
were picked up from the telephone wires and sent over a portable 50 watt radio transmitter (which had a frequency of 2390 kilocycles—125 meters) by short wave to the receiving station at the Flatts. From here it was sent over a special telephone cable circuit to the St. Georges radio transmitter, ZFB (10335 kilocycles, about 30 meters). ZFB's signal was sent over the radio telephone and received at the A. T. & T. Company's receiving station at Netcong, New Jersey and then sent over the telephone circuit to the studio of the National Broadcasting Company at 711 Fifth Avenue. From here it was distributed over the existing networks of telephone circuits of associate long and short wave stations which rebroadcasted the dive on the air for radio listeners from the Atlantic to the Pacific coasts over a combined network of NBC stations, WEAF, and WJZ. It was also sent to England by short wave to be rebroadcasted over networks of the British Broadcasting Corporation.

Cues and instructions from the United States were received over the two radio receiving sets which were tuned to stations WZXL in Boundbrook, New Jersey (NBC), and WNB in Laurenceville, New Jersey (AT&T).

The weather was constantly against us. Rough seas all during September and four threatening hurricanes forced us to abandon the first, then the second scheduled day for the deep dive and broadcast. It is of interest to realize the extent of the Bathysphere Broadcast and the numbers of cities with their outlying districts to which it was distributed throughout the United States. This was accomplished by radio stations in the following cities, in spite of having only two hours notice: New York, Hartford, Boston, Worcester, Providence, Schenectady, Buffalo, Detroit, Cleveland, Montreal, Toronto, Philadelphia, Baltimore, Washington, Richmond, Pittsburgh, Ashville, Columbia, S. C., Jacksonville, Miami, Tampa, Nashville, Birmingham, New Orleans, Shreveport, La., Cincinnati, Chicago, St. Paul, St. Louis, Kansas City, Davenport, Des Moines, Oklahoma City, Tulsa, Denver, Salt Lake City, Butte, Portland, Ore., Seattle, Wash., Spokane, Wash.

During the first half hour of the broadcast fourteen stations in the United States sent out the program. During the second period forty stations sent out the program.

Radio waves travel 7½ times around the world per second. It took 1/20 of a second for the broadcast to travel to New York and back to radio listeners in Bermuda—a distance of 1400 miles.



A New Deep-Sea Fish, by William Beebe. Drawn by Helen Tee-Van.

A New Deep-sea Fish

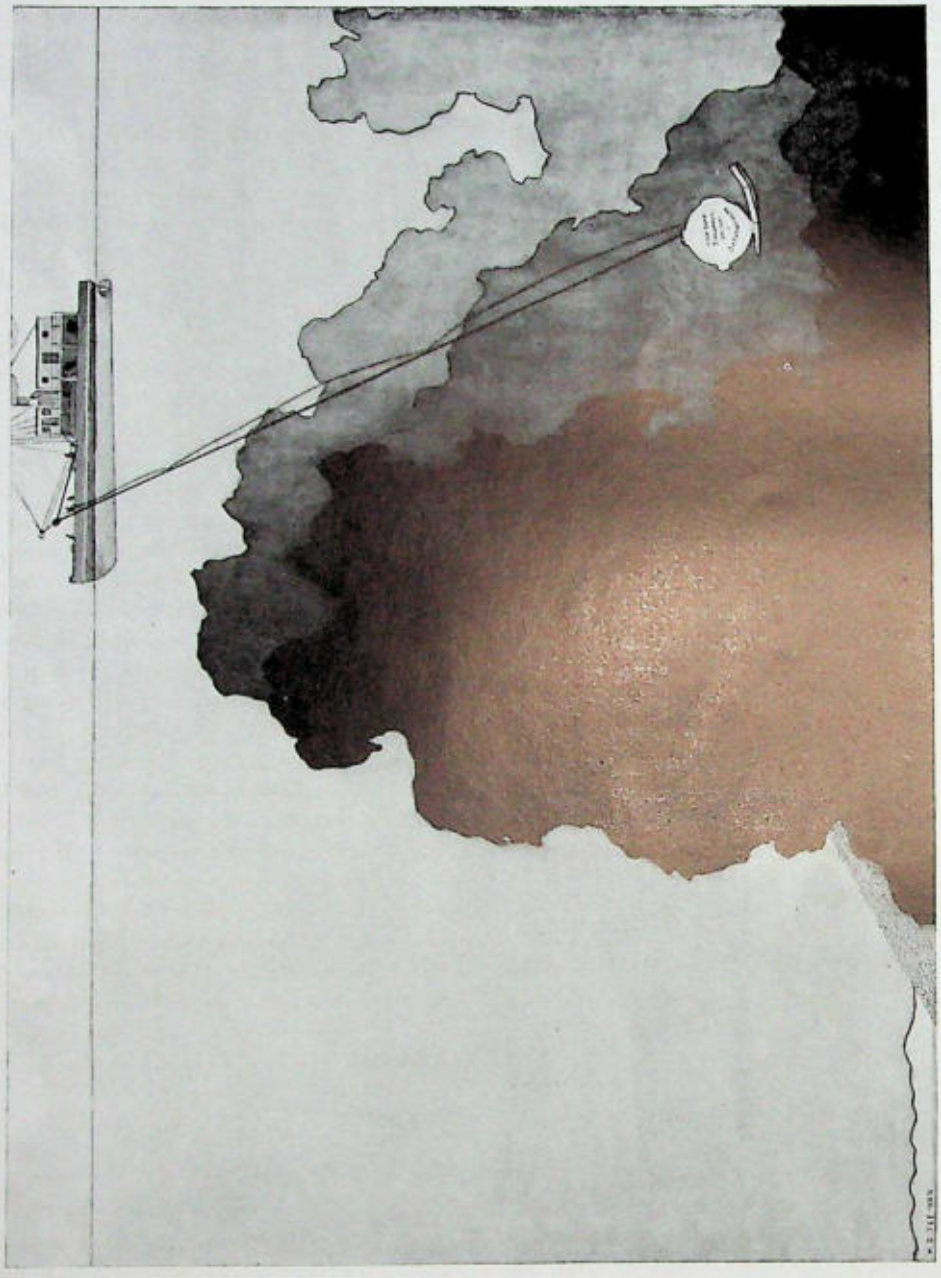
William Beebe

ON the twentieth dive in the Bathysphere, at a depth of 2100 feet, we saw two large, elongate, barracuda-shaped fish, which twice passed within eight feet of the windows, once partly through the beam of our electric light. These were at least six feet in length.

No direct lights were visible on the head, yet the rather large eye and the faint outline were distinct. There was a single row of strong, pale blue lights along the side, large and not far from twenty in number. The mouth, with strongly undershot jaw, and numerous fangs was illumined either by mucous or indirect internal lights along the branchiostegals.

The fish reminded me in general of barracudas, with deeper jaws open all the time. Posteriorly placed vertical fins were seen when they passed through the electric beam. There were two ventral tentacles, each tipped with a pair of separate, luminous bodies, the superior reddish, the lower one blue. These twitched and jerked along beneath the fish, one undoubtedly arising from a mental base, the other so far back that its origin must have been at the anal fin. Neither the stem of the tentacles nor paired fins were distinguishable.

I assume from the position of the vertical fins and the general facies, that the position of the fish must be somewhere near the Melanostomiatidae, but the single line of large, lateral photophores and the two ventral tentacles set it apart from any known species or genus.



The Bathysphere seen just before being rapidly drawn up, barely in time to clear the summit of the submerged range. Beyond is seen the glacial beach. Drawn by Helen Tee-Van.

The depth was 2100 feet, the date September 22nd, 1932, the position 32°17′ No. Lat., 64°36′ West Long., 5 miles southeast of Nonsuch Island, Bermuda.

Relying on this recognizable diagnosis I propose for it the name of *Bathysphaera intacta*, the Untouchable Bathysphere Fish.

Contour Shore Diving

WILLIAM BEEBE

IN addition to the deep vertical dives in the open sea, I had hoped for worth while results from descents near shore. These have been realized in the course of seven dives, ranging from 50 to 350 feet.

The method evolved out of initial experience is as follows: A day of perfect calm with a slight off-shore breeze is a necessity. With the bottom well in sight, at a depth of nine to ten fathoms, the Bathysphere is lowered to within two fathoms of the reefs. An elongate rudder of wood orients the sphere and directs the windows forward, and the shackle, shifted to the posterior hole, tilts the whole apparatus slightly downward in front.

With all these conditions met and my assistant at the other end of the telephone standing close to the winchman, I progress slowly seaward, now and then ordering a fathom or two of elevation to escape a projecting coral crag, or descending as the bottom drops slowly away beneath.

Visibility is usually excellent, except for a few days after a severe storm or hurricane, when cloudiness puts an end to the work. When the water is clear I can make out and identify all coral and algal growths, and fish down to two inches in length. After three years work in diving helmet I am familiar with the fauna down to six and eight fathoms. Below this, a mile or more from land, there is an increase in size of many common fish, such as angelfish, chubs, surgeons, parrots and jacks. Now and then a fish is seen larger than any of its kind ever taken in Bermuda, and this in spite of the fact that angling is carried on down to 90 fathoms.

Certain species of mid-water fish offer unexpected problems. The two most abundant are the Blue Chromis, *Chromis cyaneus*, and the Smooth Sardine, *Sardinella aurita*. The former holds a place on the Bermuda list solely on the basis of a single doubtful record of seventy years ago, while the Sardine is very seldom seen near shore. Yet on these shallow dives I see school after school of each, hundreds of Chromis swimming loosely, and tens of thousands of Sardines in dense formations. When the latter sight the Bathysphere they turn downward, as one fish, and pour past like elongate, silvery rain drops. In the West Indies in July I saw these two species in vast numbers about the shallowest reefs near shore.

Another phase of observation is the physical geography. I have been able to describe and map over a mile of bottom seen from five to twenty feet elevation, traversing it steadily seaward. It is however, all important to keep a constant watch ahead. On my last dive on October 25th there loomed suddenly through the green water a steep, fifty foot crag dead ahead. Fortunately Miss Hollister transmitted my order so instantaneously that we were swiftly raised in time, missing the top by inches.

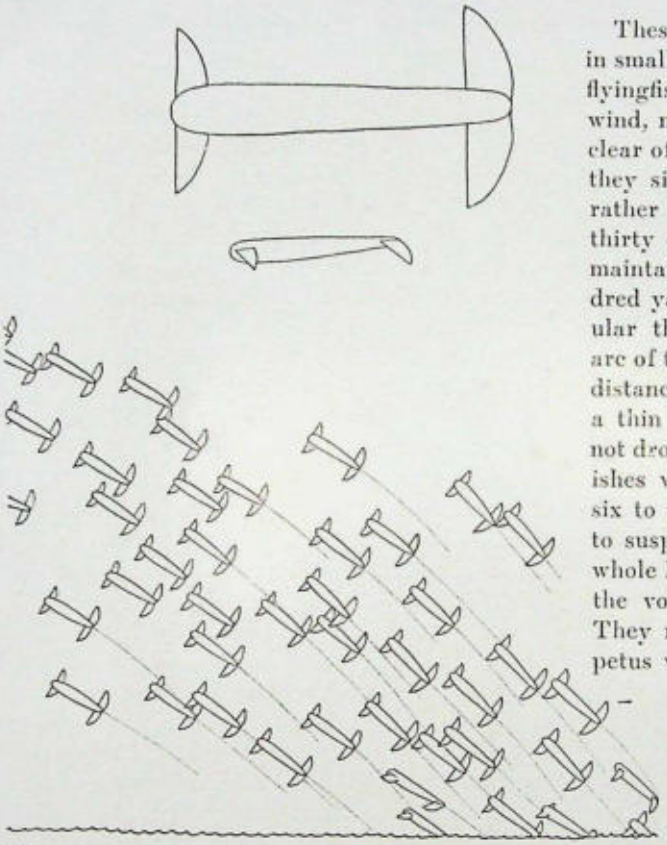
After passing a great loop of the trans-Atlantic cable, all visible life ceased, and we traversed a wide expanse of desert, with no fish or plumes or living coral. Then, after more jagged crags and cliffs, there appeared what must be the sea beach of the last Glacial Age in Bermuda—long beaches of water-worn shells and pebbles sloping down to white sand, marked with deep furrows.

I have never succeeded in following the bottom lower than 350 feet. Increasing cloudiness of the water and greater obscurity have made it impossible to distinguish anything, and the danger of getting hung up and snapped off on some projecting cliff is too constant to progress blindly. At high noon on some calm, brilliant day I hope to be able to continue my seaward travels, and to see for the first time the actual transition between the shore life with which we are familiar, and the organisms of the mid-depth bottom, which at present are as unknown as any inhabitant of Mars.

Flying Squids

WILLIAM BEEBE

ON a trip to British Guiana in 1924 I made my first notes on what seemed to me a wholly new type of flyingfish, which for convenience I called the Biplane Torpedos. Six or eight times since then I have seen them, but not until July of the present year when cruising through the Leeward Islands in the yacht *An-*



Flying Squids. From a pen drawing by Helen D. Tee-Van

teres, did I have the opportunity of watching them at closer range. Again, on August fourteenth, when halfway between New York and Bermuda, Miss Hollister and I saw a school of forty rise close on the starboard bow.

I am now certain that what I have been considering as flyingfish are, in fact, squids, so amazingly like fish that only observation of many hundreds has convinced me. My descriptions have been checked by five people who have seen them with me.

They average six to eight inches in length, are faintly bluish above and silvery below, and shaped like a cigar or torpedo, progressing thick end foremost. There are two pairs of wings, rather small, and so far separated that no hint of a head or tail is visible beyond them. The anterior pair is clear and slightly the smaller, the posterior pair sometimes shows a distinct brown tinge. In some individuals this pair is a full third larger than the forward fins. Miss Hollister is certain that she has detected scallops along the hinder edge.

These mysterious creatures appear suddenly in small schools of twelve to fifty, and, unlike all flyingfish, they invariably rise directly into the wind, never having to change their course when clear of the surface. There is no initial wriggle, they simply appear, rising swiftly and curving rather sharply upward, attaining a height of thirty or forty feet, when they flatten out, and maintain this elevation for as much as one hundred yards. Their formation is much more regular than that of flyingfish, the direction and arc of trajectory being identical in all. For some distance above the surface there trails after each a thin stream of water, almost thread-like, yet not drops, but a solid line, which breaks and vanishes when they have attained an elevation of six to ten feet. It was this which first led me to suspect their cephalopodic identity. On the whole I should consider them as better flyers than the volant fish, in all except actual distance. They never renew their flight or gain new impetus while still in the air, but disappear with little or no splash on a slight downward trajectory.

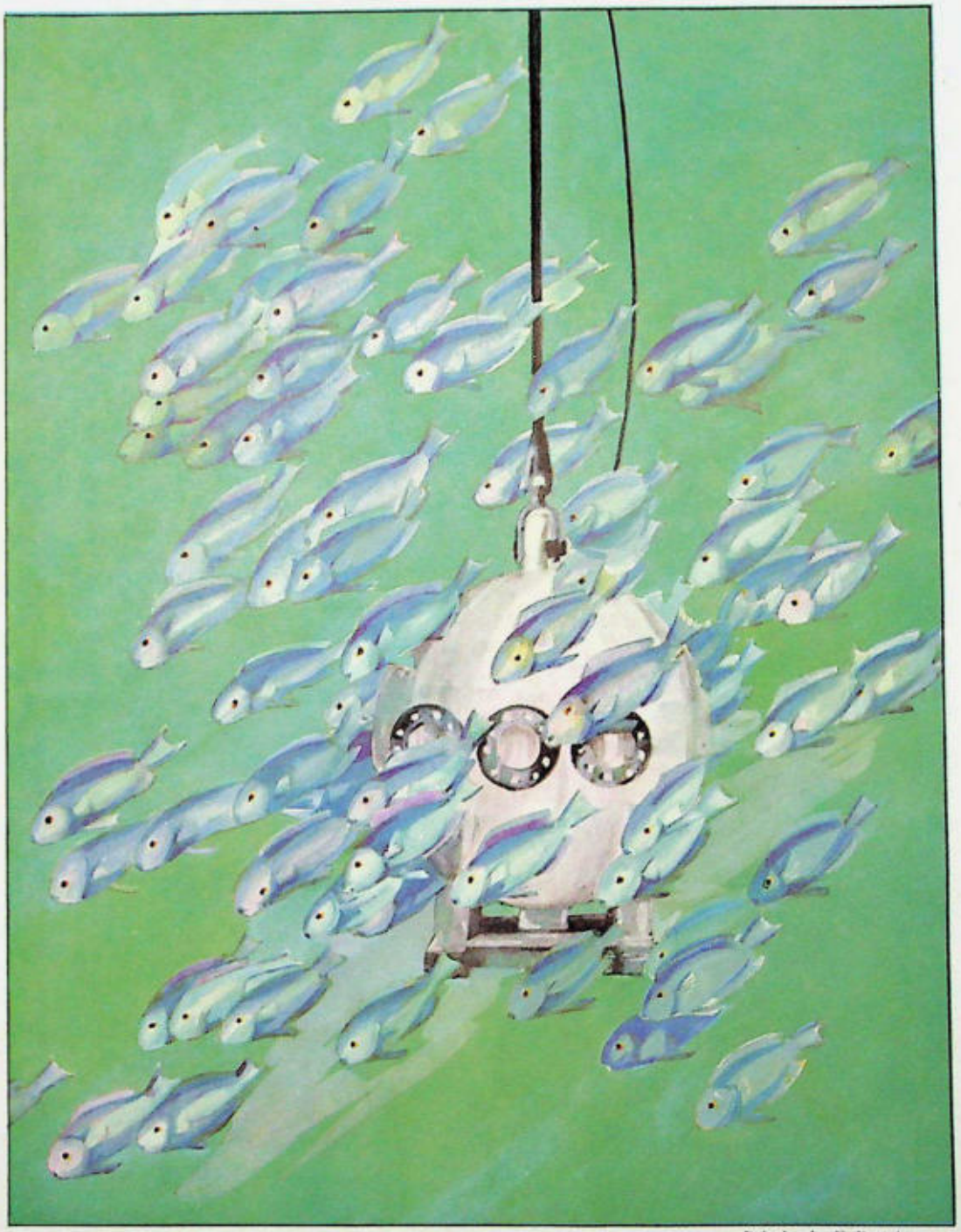
If, as seems certain, these are flying squid, they progress through the air backward, with the caudal fins spread stiffly, while at the opposite end the arms must be so exactly fitted to one another that they give no evidence of being other than a second, larger, but equally homogeneous fin, wide spread to the wind. This cohesion is perhaps aided by the webbing which probably is stretched between the cerus. The impetus is evidently derived from an expulsion of water through the siphon, as in the usual swift, submarine progression.

Dr. G. C. Robson of the British Museum writes me, "squids do not, as far as we know, fly. They seem merely to shoot out of the water if by chance they are swimming very near the surface in rough weather. Their jumps may be quite extensive but are not really flight." Dr. Paul Bartsch tells me he has seen squid leap fifteen feet out of the water, only to fall back again at once. Admiral Fitzgerald relates that when he was Captain of H.M.S. *Inconstant*, sailing from St. Helena to the Cape Verde Islands, a shoal of flying squid came through the ports twelve feet above the water.

As in the case of the fish, these squids should be credited with a gliding, not a true flight.



Mid-water Fish. Schools of Blue Chromis and Smooth Sardines seen from the Bathysphere a mile off shore. These are almost unknown near shore. From a drawing by Helen Tee-Van.



Painting by E. Bostelmann

While Beebe and Barton were contour diving a mile off shore and forty feet down, a school of many thousands of Giant Blue Parrotfish (*Scarus caeruleus*) swam past the window of the Bathysphere, headed for the deeper, cooler depths of the ocean.

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BULLETIN

NEW YORK ZOOLOGICAL SOCIETY

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The first herd of pronghorns on exhibition at the New York Zoological Park. Photograph taken in 1901. The pronghorn is shown here against a leafy background which differs considerably from its native open plains. In recent years encroaching civilization has forced the animal to abandon its former habitat in favor of more difficult wooded country where it is apparently increasing considerably in numbers.

BULLETIN
NEW YORK ZOOLOGICAL SOCIETY

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The Pronghorn of North America

A brief discussion of its zoological characteristics and the influence of changing environment upon the habits and future of the species.

Claude W. Leister

Curator, Educational Activities, Zoological Park.

Illustrations from photographs made in the Zoological Park by Elwin R. Sanborn, except where otherwise noted.

APPROXIMATELY 400 years ago Francisco Vasquez de Coronado set forth from Mexico on his expedition which explored the vast and unknown territories lying to the north as far as the plains of what is now the state of Kansas. The historian of that expedition recorded seeing flocks of goats or deer, spotted with white, and which, upon the approach of the cavalcade, disappeared over the surface of the plains with great rapidity.

That is probably the first account of the pronghorn having been seen by white men. In the years that have passed since that time, the acquisitive and destructive civilization of the white race has almost entirely removed the pronghorn from the picture. Once free to roam some millions of square miles of primitive North America, it now can be found only in scattered localities over that vast area; and its numbers, then counted by the millions, can now be reckoned only in thousands.

Of all the mammals native to North America, only one, the pronghorn, can be regarded as a real native American. All other mammals show fairly close affinities to representative forms from other parts of the world and have reached the North American continent through the migrations of prehistoric ancestors, very little different from their present-day descendents. The pronghorn is no mere importation and it has no living near relatives anywhere on the face of the earth. An animal, almost identical with the present-day form, lived in the early Pleistocene, and it is easy to believe that our pronghorn has come down through the ages and evolved from some deer-like antelope, native to the soil of North America.

The pronghorn, prong-horned antelope or, simply, antelope differs so much from other hoofed mammals that zoologists have given it the distinction of placing it in a family all by itself, the Antilocapridae. No other hollow horned ruminant has horns possessing a branch or prong. Unlike these other ruminants, the pronghorn sheds and renews the sheaths of its horns every year and in addition, the horns are placed directly above the eyes. The animal has become so perfectly adapted to a life on the plains that there are no dew-claws and all traces of the bones of the lateral digits have disappeared.

The pronghorn possesses several other interesting characteristics which are shared by other ruminants. Thus, like the deer, it has a coat of more or less cellular hair with an under woolly coat, and its shedding of the horn sheaths is more or less comparable to part of the process of antler growth and shedding; like the goat, it possesses a system of scent glands; and, in having only two hoofs to each foot, it is like the giraffe. In addition to the above characteristics, it possesses an area on each buttock covered with hairs of varying lengths and which are capable of being erected by a muscular contraction, thus flashing into two conspicuous discs or rosettes of

white. In bright sunlight these serve as especially noticeable flashing devices to convey danger signals to the rest of the herd.

Zoologists are interested in the pronghorn mostly because of its physical characteristics but early hunters and explorers, upon their first acquaintance with the animal, discovered that its psychological make-up was likewise unique and different from that of other forms of game with which they were familiar.

Practically all of the old time hunting accounts mention the intense (and usually distressingly fatal) curiosity of the animal. It was a common thing for the hunter to lure nearby bands into range by lying flat on the ground and waving back and forth a piece of cloth, or any handy article of clothing, tied to the ramrod of his gun. Another expedient was for the hunter to lie on his back and kick his heels in the air. If these efforts were persisted in long enough the animals were practically certain to come in close to investigate. In later years the pronghorn learned to discount such ruses and they became comparatively ineffective, especially where the animals had been hunted a great deal. Dr. E. W. Nelson had considerable success in collecting specimens for the National Museum by approaching his intended victims under cover of a white sheet, they apparently taking him for some harmless white animal. In this way Dr. Nelson collected the type specimens of *Antilocapra americana mexicana*.

The pronghorn possesses an extraordinary racing complex. It has an irresistible desire to race any mounted person or object paralleling its general course, and after passing, to cross over in front to the other side. This cross-over has frequently been made just in front of the horse's nose. Railroad trains and automobiles too, have been raced upon occasion.

As might be expected of a practically defenseless plains animal, the pronghorn has had to develop fleetness of foot in order to escape its enemies. It has accomplished this with a vengeance and it is generally regarded as being the swiftest of our native American mammals. The pronghorn can get under way and out of sight with a speed that is really amazing and early travelers were astounded thereby. Audubon believed that the animal could do a mile a minute. Since his time, and especially since the coming of the automobile, we have been able to measure the rate more exactly. Now we know that it is seldom able to make more than 35 miles per hour. In comparing its speed with that of some commonly known mammals, Seton puts the racehorse first, the pronghorn second and the greyhound third. On the other hand, Seton quotes Governor St. John, of Kansas, as saying that "It takes a mighty good greyhound to catch a mighty poor antelope". At any rate, the top speed of the pronghorn is more than enough to enable it to escape any of its natural enemies under ordinary conditions.

Because of the great speed and agility at its command the pronghorn can make tremendous leaps, either forward or to the side. One has been seen to jump a twenty-seven foot gully, and another, to leap sideways across a pool seventeen feet in diameter. With the gradual settling of the West and the coming of fences, the pronghorn was forced to develop new abilities, since a new dimension, that of height, was encountered. Here the animals were up against an entirely new proposition. Living on the prairie they had never learned to be high jumpers. The first fences proved to be effective barriers to their free migration and roaming over the plain. Encountering a fence, instead of clearing it at a single bound, they piled up along the near side. In 1907 Seton saw twenty-six different bands (a total of 232) against a new wire fence of the Canadian Pacific Railroad.

In time the pronghorn learned to jump fences but even today it prefers to leap through rather than over the ordinary fence. Years ago the animal could easily be confined by a four-foot enclosure. Today a five-foot fence will not always hold him.

The pronghorn diminished greatly in numbers at about the same time as the bison and through very much the same causes. The gradual advance of civilization drove the survivors to the more remote regions of their former range. Even in the earlier days certain bands could be found in the rugged, partly wooded sections, and today, while the open, more fertile plains, offer no haven to them, the animals in the former localities are thriving and in many cases increasing in numbers. It has been said that they have been gradually changing their habits, forsaking their old habitat, the plains, and taking to the wooded areas. Apparently such is the case, and in the

last few years they have shown a marked increase only in these regions.

On reading recent reports concerning the status of the pronghorn in several of our western states it is plainly evident that the change in habitat, as noted above, has been responsible for a large increase in numbers for the states named. This fact, coupled with the much greater interest now taken at large for the animal's welfare, augurs well for the future.

Today, the various states to which the pronghorn is native are striving to do everything in their power that will tend to keep this interesting animal with us for many years to come. Conservation measures have achieved marked success and in several areas it has been found necessary to dispose of surplus animals. This leads us to believe that the future of the animal will be assured through a sane policy of game management and conservation.

A few years ago it was extremely difficult to obtain anything like a fairly accurate census of the pronghorns still remaining in the country. In 1908 the Biological Survey estimated the number to be less than 20,000 for the United States and Canada. About this time they had probably reached the lowest stage in numbers although the census made by the American Bison Society in 1921 records but 11,279 for the same area. However, at this latter time it was particularly difficult to get full information. In 1922-24 Dr. Nelson made his census for the Biological Survey and with the assistance of various reporting agencies concluded that there were 26,604 in the United States and 1,327 in Canada. Today, the fairly accurate but incomplete census as given on the following pages, places 68,392 in the United States and 2,400 in Canada.

As mentioned earlier in these pages, the outstanding zoological characteristic of the pronghorn lies in the fact that it possesses branched horns and that the horny sheath is shed and replaced each year. This process and the general characteristics of the change have never been fully understood. Farther on in this Bulletin Dr. Charles V. Noback discusses this change in the light of investigations which he has made at the Zoological Park.

Following is a report on the status of the pronghorn herds of those states from which we have received information. A comparison is made with the results of Dr. Nelson's survey in 1922-24.



Census of the Pronghorn

Compiled from figures furnished by officials of Forest and Game Preserves of Canada and the portions of the United States included in the natural range of the Pronghorn.

THE following census of the pronghorn as made by the Bulletin represents an attempt to estimate its numbers as accurately as possible through an inexpensive long-distance survey. In several instances the figures given, represent the exact number of animals in the state at the time the census was made. In general the figures are believed to be reasonably accurate. Several estimates, while official, are apparently too optimistic and should be reduced considerably in order to agree with more conservative reports on the same areas received from other sources.

It should be understood that it is exceedingly difficult to determine with any degree of certainty, the exact numbers in the widely scattered herds ranging over the vast areas of the territory involved.

The fact of greatest interest is, however, that

the pronghorn is increasing; thus its future bears a certain assurance of safety. This is a matter most gratifying to wild-life conservationists.

Appended is a list of the states from which information was received, with extracts from letters concerning the pronghorn herds and their estimated numbers in the state. In each instance a comparison is made with the census figures compiled by Dr. Nelson in 1922-24. States which failed to reply to our communications are not listed in the census.

We wish to thank the following organizations and officials who so kindly cooperated in making this survey.

CANADA

Hon. J. B. Harkin, Commissioner, National Parks of Canada.

UNITED STATES

Dr. W. B. Bell, Bureau of Biological Survey.
C. E. Rachford, United States Forest Service.
Horace M. Albright, Director, National Park Service.
M. E. Musgrave, United States Forest Service.
Leo K. Wilson, Division Fish and Game, California.
R. G. Parvin, Commissioner, Department of Game and Fish, Colorado.
Thoralf Swenson, Commissioner, Fish and Game, North Dakota.
O. H. Johnson, Director, Department Game and Fish, South Dakota.
L. V. Bailey, Department Fish and Game, Idaho.
J. E. Sullivan, Assistant Secretary, Fish and Game Commission, Nevada.
Elliott S. Barker, State Game Warden, New Mexico.
W. B. Cook, Commissioner, Fish and Game, Utah.
Marshall N. Dana, Associate Editor, The Oregon Journal, Oregon.
M. S. McMurtery, State Game Warden, Oklahoma.
J. T. Scott, President, State Game and Fish Commission, Wyoming.

CANADA

DR. NELSON, 1922-24. 1,327 BULLETIN, 1932. 2,400

In Canada a number of small wild herds are found in Saskatchewan and Alberta. Of a total of approximately 2,400 animals about 400 are found in the two National Parks set aside as antelope reservations.

The first sanctuary was established in 1914. This later became known as Wawaskesy Park. It is located in southern Alberta about 75 miles south of Lethbridge and has an area of about 54 square miles. In 1915 the Dominion Government established the second reservation known as Nemiskam National Park. This area is about 25 miles north of Medicine Hat and contains about eight and a half square miles. It is a fenced preserve and it is therefore possible to keep a definite record of the progress made in that area. According to reports, the approximately 400 animals in this Park are, in the main, descendents of the original forty-two animals fenced in the preserve.

"At Wawaskesy National Park, as far as the observations of those in charge of the park show, the antelope which frequent this unfenced reserve are increasing. Concentrations of these animals are noticeably greater throughout the area than previous to the establishment of the park and their future in this part of the province appears assured".

ARIZONA

DR. NELSON, 1922-24. 651 BULLETIN, 1932. 7,500

"There are no antelope refuges in Arizona but those animals have enjoyed full year-round protection for many years and have increased materially in the past ten years. A conservative estimate of the number of antelope in Arizona would be between 7,000 and 8,000 head, about 5,500 of which range on National Forests or along their borders, in places summering on the Forest and wintering on the public domain or private lands.

Through the necessity of self-protection, antelope have changed their habits in the last quarter of a century from a plains to a woodland animal. This does not mean that they do not still inhabit the plains but most of them are found ranging along the edge of forested areas where they can run for cover when danger approaches and we are finding them ranging in comparatively rough areas in the higher elevations of the Transition Zone.

Golden Eagles are perhaps the worst enemy, except man, that the antelope has. Last winter, we found where those predatory birds had killed 8 full grown antelope that had been caught in a snow storm and were unable to reach cover before they were broken down by the big birds.

So far, we have not had any epidemics that have depleted our antelope herds and the future of the pronghorn in the Southwest is very bright".

CALIFORNIA

DR. NELSON, 1922-24. 1,057 BULLETIN, 1932. 8,000

"We have two main areas where antelope are to be found in varying numbers. One herd is concentrated in the Mt. Dome section, in Siskiyou County, and the other is in northeastern Modoc and Lassen counties. In both these sections, the state maintains game refuges for their preservation and protection.

In the Mt. Dome secton, it is estimated that the herd comprises 1000 individuals. In the Modoc and Lassen area, the herd is considerably larger and numbering at the present time approximately 8000 individuals. Understand, though, that during the severe winter of 1931, a large number of these animals migrated from northwestern Nevada to California and in the spring failed to return, thus our supply has been greatly augmented.

During the past 10 years, there has been a material increase in the size of both herds. Apparently there are no prevalent or endemic or epidemic diseases in the herds.

The future for antelope in California looks very bright. As you undoubtedly know, the animals have completely changed their habitat. Whereas they were once to be found only in the open meadows and high mesas and were never found in close proximity to trees, they have shifted their habitat due to the conflict with the pursuits of man, to the juniper areas in the more rugged lava outcropping. This is a niche of no value to man except in those areas which are watered enough for the pasturing of sheep and cattle, therefore, there is very little conflict from an economic point of view".

COLORADO

Dr. Nelson, 1922-24. 1,233 Bulletin, 1932. 2,000

"In addition to twenty-two game refuges in various parts of Colorado, one refuge containing 65,000 acres has been set aside in the northeastern part of Colorado. There are estimated to be about two thousand antelope in the state most of them in northeastern Colorado, although they range south and east to some extent. Settlers on prairie lands have forced the antelope out, and it is only by vigilant effort that we are able to maintain the present herds. They just about hold their own in numbers."

IDAHO

Dr. Nelson, 1922-24. 1,485 Bulletin, 1932. 4,000

"We have eighteen preserves for the protection of all game animals, located for the most part in the national forests. The antelope, however, has state-wide protection, and it is unlawful to hunt or kill this animal in Idaho. A recent check by the Forest Service fixes the number of antelope in the national forests as approximately 2,750 and we estimate that there are probably 4,000 in the state".

NEVADA

Dr. Nelson, 1922-24. Bulletin, 1932. 3,000 (inc.)

Census figures as received for Nevada are incomplete.

NEW MEXICO

Dr. Nelson, 1922-24. 1,682 Bulletin, 1932. 6,000

"A most conservative estimate of the number of antelope in New Mexico at the present time would be 6000 head, and I believe that we have many more than that.

A thorough study of our antelope situation would, I am sure, reveal some most interesting facts and should be made whenever we have the time available. One of the most interesting things in connection with the antelope herds in New Mexico is the fact that in the Black Range country antelope have penetrated right back into the heart of the mountains. You will find down on Diamond Creek, Tom Moore Canyon, and the Black Canyon Region, more than thirty miles from the nearest plains country, small herds of antelope ranging regularly in the timber and comparatively rough country adjacent to small open park areas. Antelope have been seen on the summit of Black Mountain, which is a high timbered area and serves as a lookout station for that part of the Gila Forest, and is located many miles from the nearest prairie land. Each year in the Black Range country deer hunters running onto antelope in the heart of the wooded areas have mistaken these animals for deer and killed them".

NORTH DAKOTA

*Dr. Nelson, 1922-24. 225 Bulletin, 1932. 250

"There is one game refuge in North Dakota on which these animals are found. It is estimated that there are between 200 and 300 antelope in the state of North Dakota in several bands ranging in a number of counties south and west of the Missouri River. The number of these animals has been about stationary for several years".

NEBRASKA

Dr. Nelson, 1922-24. 187 Bulletin, 1932. 13

The only definite information received concerning the number in this state is that 13 are on the Niobrara Reservation.

OKLAHOMA

Dr. Nelson, 1922-24. 23 Bulletin, 1932. 16

There are no wild pronghorns left in the state of Oklahoma. There are two reservations with a total of 16 animals.

OREGON

Dr. Nelson, 1922-24. 2,039 Bulletin, 1932. 9,000

Since part of the Oregon antelope herd ranges south into Nevada and California some of the animals have been credited to those states. It is generally reported that the number is increasing.

"The chief protection for the antelope now is the fact that shooting is forbidden and that they are now in the desert country not much visited. We have intervened numerous times to the United States Biological Survey for assistance in establishing an antelope reserve but have been told that no money is available. The herd which also ranges in northwestern Nevada is, I believe, the largest at the present time in the United States".

SOUTH DAKOTA

Dr. Nelson, 1922-24. 680 Bulletin, 1932. 400

"One antelope preserve under fence, approximately 10,000 acres in area located in Harding County in the northwest extremity of our state. The preserve has been in existence but four years and thus far the annual increase has been about what could be expected from antelope at large.

Up until ten years ago, the antelope were rapidly decreasing, due to the settling up of their range, placing a large portion of the land under cultivation. Adverse conditions have compelled many farmers and ranchers in the northwest corner of our state to abandon their land holdings during the past ten years, resulting in that section reverting to a more or less open range country, and as a consequence wild antelope in the area are showing a marked increase, thus minimizing the necessity of maintaining a preserve".

UTAH

Dr. Nelson, 1922-24. 670 Bulletin, 1932. 800

"Our antelope are very sparse indeed, consisting of three small herds in the western part of the state and one small herd in the northeastern portion. These animals have only been "holding their own"; for a number of years there has been no decided increase and no decrease.

Limited watering places in our western desert makes it possible for us to get a fairly accurate count. We believe that we have in the neighborhood of 800 antelope in the entire state".

WYOMING

Dr. Nelson, 1922-24. 6,977 Bulletin, 1932. 25,000

Mr. J. T. Scott, President of the Wyoming Game and Fish Commission, states: "Twenty-five thousand antelope estimate conservative for Wyoming herd".

An unofficial estimate places the number in the state considerably under the above.

Census—Forest Service: As a matter of information and for comparison with the preceding census, The United States Forest Service states that 12,725 pronghorns were estimated to be on National Forests in 1931. These animals are of course included in the above figures.



An early herd of pronghorns at the Zoological Park. Photograph taken in 1902. The pronghorn is one of the most graceful of all animals and its long, lithe limbs carry it over the ground with a speed that gives it the distinction of being the fastest American mammal. None of the predatory animals can catch it under ordinary conditions, but in the heavy snows of winter it sometimes falls an easy prey to its enemies.

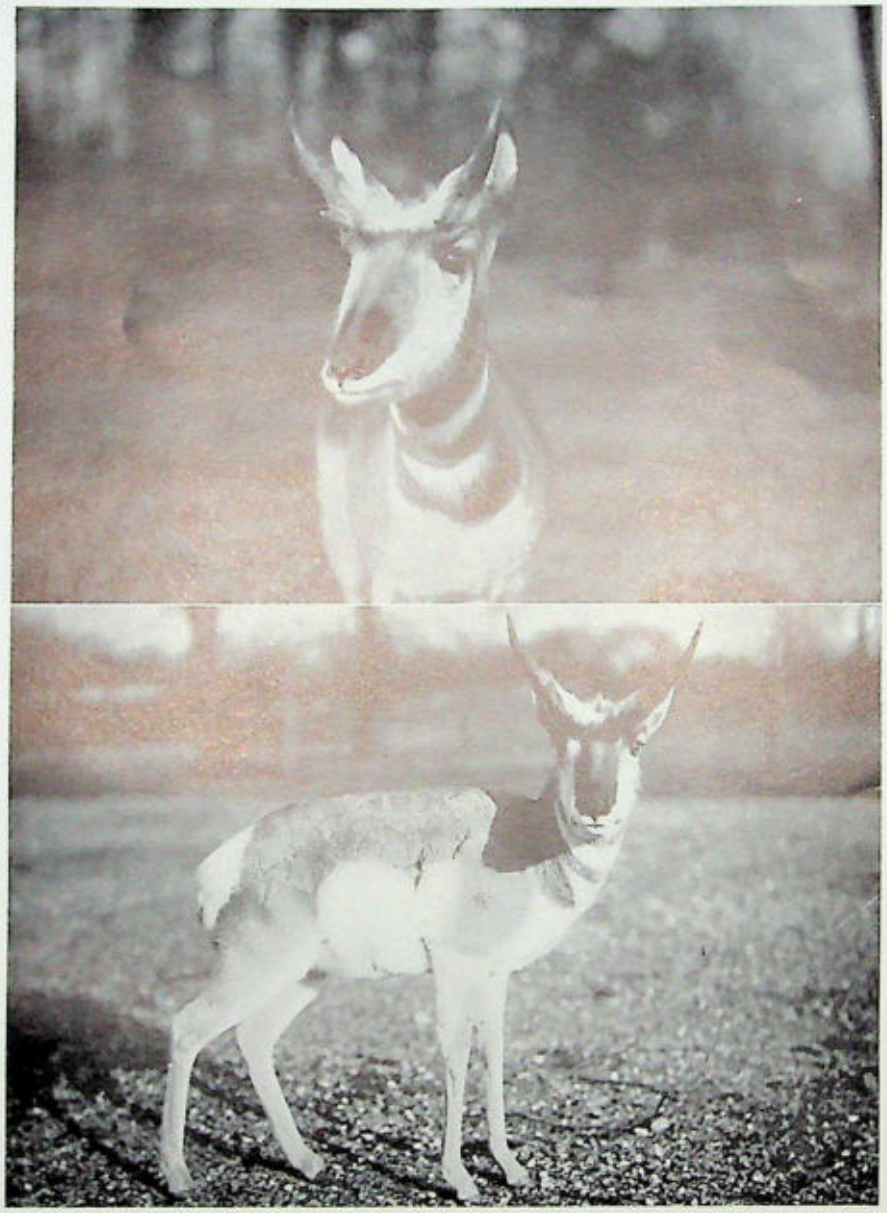


Above. Pronghorn on the Wichita National Game Preserve at the time of establishing the original herd of bison presented by the New York Zoological Society in 1907. *Below.* Another pronghorn from one of the early Park herds. Photographed in 1903.

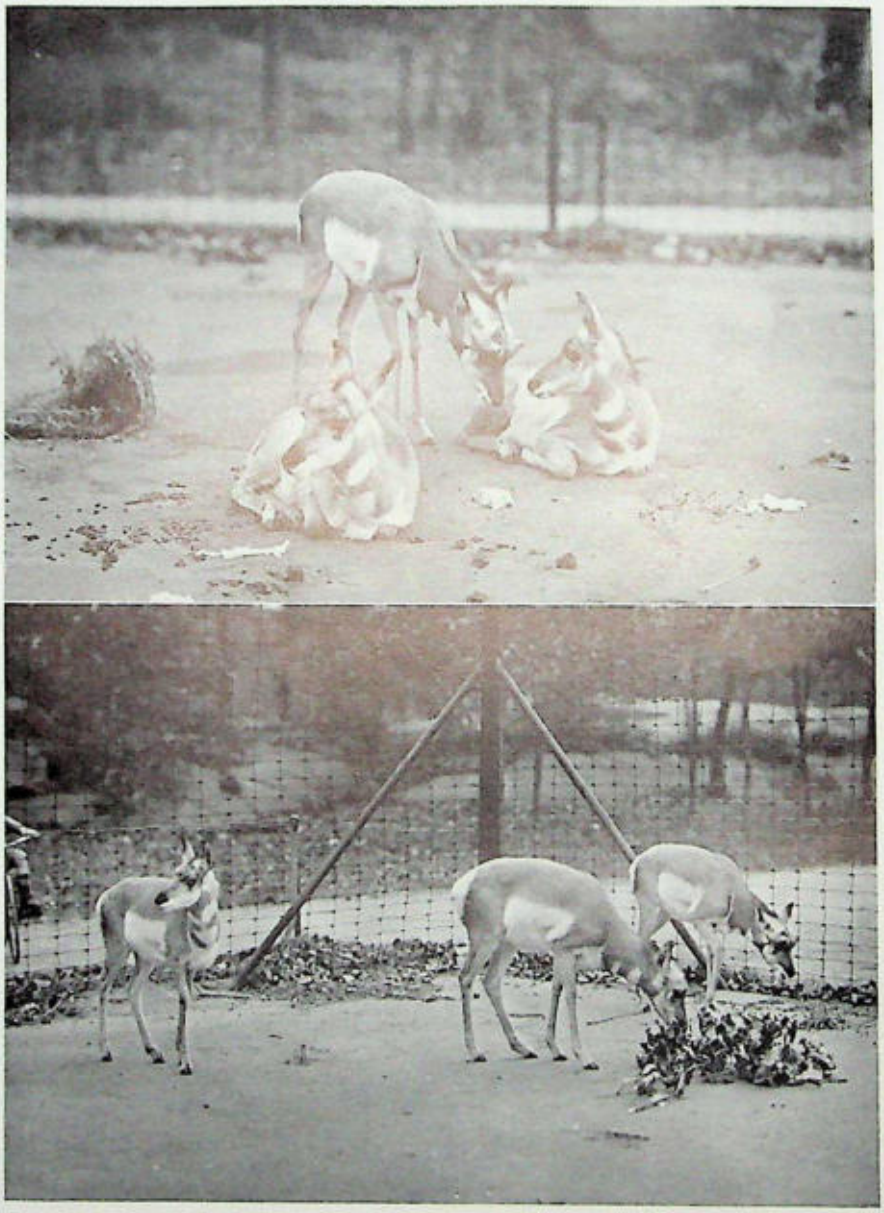


Above. The pronghorn herd in 1902. *Below.* A fine male pronghorn, the leader of the first herd. Note the single prong on each horn. In fighting for herd leadership the male uses the prong as a guard and deftly parries the thrusts of his antagonist. Serious injuries are sometimes inflicted by the sharp point of the horn.

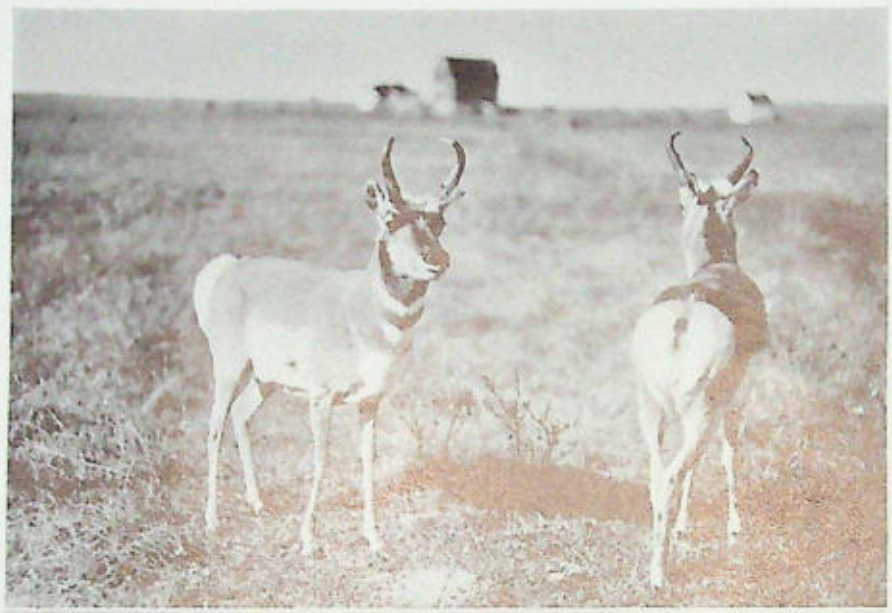




Two male pronghorns from an early Park herd, 1902-05. Because of their nervous temperament pronghorns sometimes suffer ill effects from the long journey to the Park. Apparently these animals can not be acclimatized in the humid, coastal climate of New York City. Efforts to keep them on exhibition have been temporarily discontinued.



The last herd of pronghorns on exhibition at the Zoological Park. Several of the Park herds contained young animals. They are endearing little creatures and in captivity are particularly tame and inquisitive Soon after some young pronghorns were placed on a reserve in the Grand Canyon, a photographer sought to take their picture. He could see nothing on his ground glass and, looking up, found a doe licking his lens.





(*Above*) Pronghorn, Nemiskam National Park, Canada. The male on the right is somewhat suspicious of the process of having his photograph taken, and has slightly elevated his white rump patch, the "chrysanthemum." (*Below*) A trio of young pronghorns in the Nemiskam National Park. Photographs by courtesy of National Parks of Canada through the Hon. J. B. Harkin, Commissioner.



Fig. 1. Head of a mature pronghorn that was exhibited in the Zoological Park some years ago. The photograph is an excellent illustration of the position of the horns on the head, and clearly shows that the prongs project over the supraorbital ridges which are directly above the eyes.

The Deciduous Horns of the Pronghorn Antelope
Antilocapra americana

CHARLES V. NOBACK
Department of Comparative Medicine, Zoological Park

Illustrations from photographs made in the Zoological Park

THE Pronghorn Antelope of North America, though not as widely known as the American bison (Buffalo[1]) is a truly representative American mammal. Fossil remains of prehistoric mammals closely related to the comparatively few living pronghorn antelopes have been found only in western North America and in Mexico. It therefore seems reasonable to consider the American pronghorn as distinctively American both in its origin and habitat. Since the pronghorn antelope possesses branched deciduous horns in addition to other unusual characteristics, zoologists have placed it in a separate family—the Antilocapridae—with but one genus—of which it is the only living representative.

The existence of the pronghorn antelope was probably brought to the attention of Europeans for the first time during the period of the Spanish Conquest of the New World by some of the Conquistadores who ventured into the regions of the Far West. Torquemada, writing in his work "Monarquia Indiana," published in 1723, gives an account of a great hunt, made in honor of Antonio Mendoza, Viceroy of Spain, which took place in the year 1540 in the northwestern part of the state of Hidalgo, Mexico. It took the form of a great drive of game by the Indians, during which, Torquemada states, "600 deer were killed, among which were large stags and those called 'verrendos'." Regarding the verrendos, the author stated that "they not only ran but flew and were unknown in Spain." These, the verrendos, were later to be identified as pronghorn or American antlope. According to Nelson[2] the pronghorn antelope was apparently seen for the first time by Europeans about 1540, as mentioned in the preceding account.

Although the earlier explorers had probably seen and apparently knew of the existence of these unique animals, none of them, however, brought specimens back to the settled eastern states. The scientific world is indebted to Lewis and Clark for the very first specimen of pronghorn antelope brought back to civilization from the Northwest in 1804. Audubon and Bachman (1851) were among the first naturalists who had observed the pronghorn antelope in its native habitat during the summer months. The earlier naturalists recognized that the horns of the pronghorn were branched, which characteristic gave this animal its name. They did not, however, recognize another very important characteristic of this strange mammal, and that was that its horns are shed periodically during the autumn of each year, notwithstanding that soldiers at Fort Union and the natives called their attention to this important fact. (Caton[3]).

This distinctive American mammal is found nowhere else in nature except in its immediate habitat in the western part of North America and in Mexico. Extreme shyness renders it very difficult to study. Its large, clear, dark limpid eyes are alert, keen-visioned and quick to discover any unusual object. Highstrung, nervous and swift, the pronghorn antelope has succeeded in eluding most of its enemies except man with his high-powered rifles and cold steel bullets.

The pronghorn antelope stands about three feet high at the shoulder and a few inches higher at the rump, being not quite as large as the white-tailed or Virginia deer but more compactly built. Its branched horns stand out prominently, the prongs projecting over the supraorbital ridges just above the eyes. (Fig. 1)

Its body is yellowish brown to a dull rufous yellow except for white hair around the rump, abdomen and neck. The white hair of the neck is girdled by a band of tawny-colored hair. The white rump patch stands out very prominently, especially when the pronghorn is excited and, when the antelope is in flight is clearly visible long after the animal is hardly distinguishable.

1 The name "buffalo", commonly used to designate the bison of America, is a misnomer. The bison—of which there are but two species—the American and European (Wisent) is distinguished from the true buffaloes by the hump at the shoulder.

2 NELSON, E. W. Status of the Pronghorned Antelope, 1922-1924. U. S. Dept. of Agriculture. Department Bulletin No. 1346. Govt. Printing Office. 1925.

3 CATON, JOHN DEAN. The Antelope and Deer of America. Hurd & Houghton, Riverside Press, Cambridge, Mass. 1877.

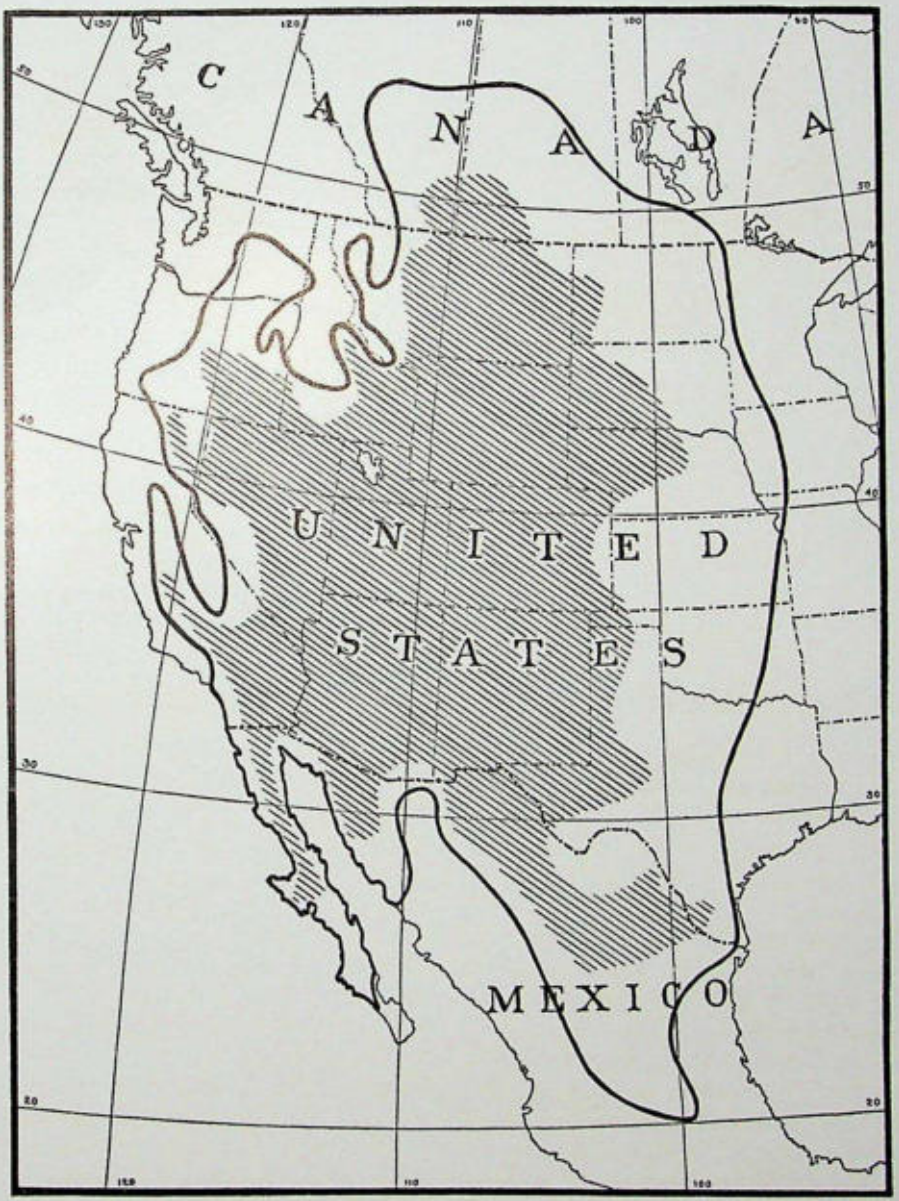


Fig. 2. Original and present distribution of the pronghorn. The black line marks the limits of the distribution before European settlements in America. The shaded portion indicates the area within which antelope are now found (1922-1924) in scattering bands. From Nelson, "Status of the Pronghorned Antelope, 1922-1924."

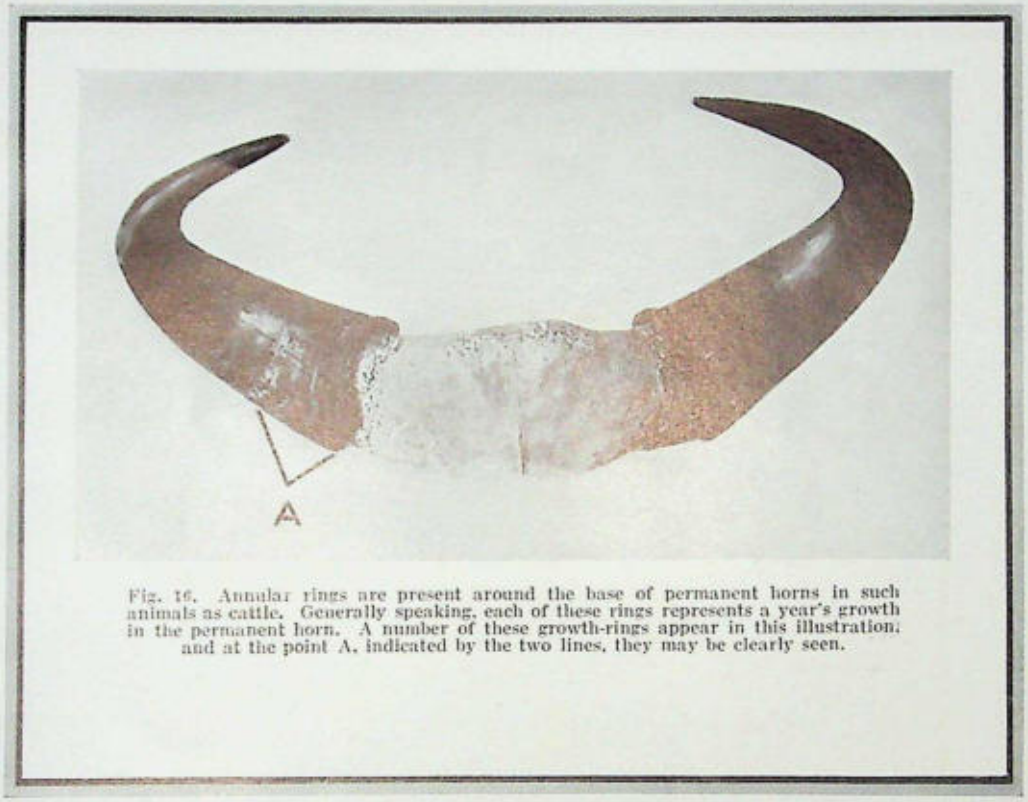


Fig. 16. Annular rings are present around the base of permanent horns in such animals as cattle. Generally speaking, each of these rings represents a year's growth in the permanent horn. A number of these growth-rings appear in this illustration; and at the point A, indicated by the two lines, they may be clearly seen.

With reference to the geographical distribution and the present-day status of the pronghorn antelope, Nelson writes as follows:

"Subsequent occupation of the continent has shown that the pronghorn ranged over an enormous area. (Fig. 2) It occurred over parts of the present provinces of Manitoba, Saskatchewan and Alberta in Canada. In the United States it occupied the country from western Minnesota, Iowa, Kansas, Oklahoma and Texas, reaching the Gulf coast near the mouth of the Rio Grande and west to western Washington, Oregon and the Pacific coast in California. In Mexico it occupied the open plains country of the tableland south almost to 20° of latitude, nearly to the Valley of Mexico; also the western part of Sonora and most of Lower California.

"Through the occupation of its territory by man the pronghorn has become extinct in many of its former haunts, but it has survived in limited numbers over an amazing proportion of its original range in Canada, Mexico and in sixteen of the western states of this country.

"It has been estimated that not less than thirty to forty millions of pronghorns ranged over this original area. The recent census by the Biological Survey shows that only about 30,000 survive today (1922-1924)."

Before describing the process of horn shedding in the American antelope, let us recall that all of the tissues of the mammalian body are developed from three primary layers of cells. These three primary layers of cells are formed soon after the ovum has been fertilized. The outer layer of these cells or the ectoderm, gives rise to skin, hair and nails, which are technically known as ectodermal structures. The middle layer, or mesoderm, gives rise to ligaments, connective tissue and bones, or mesodermal structures. The inner layer or endoderm, gives rise to the lining of the digestive tract and other endodermal structures.

The outer layer of skin consists essentially of a horn-like substance called the corneum or horny layer. The corneum is composed of a hard protein substance, keratin, a scleroprotein, which serves to protect the underlying delicate skin structure. Claws, nails, hoofs and horns are, practically speaking, specialized extensions of the corneum.

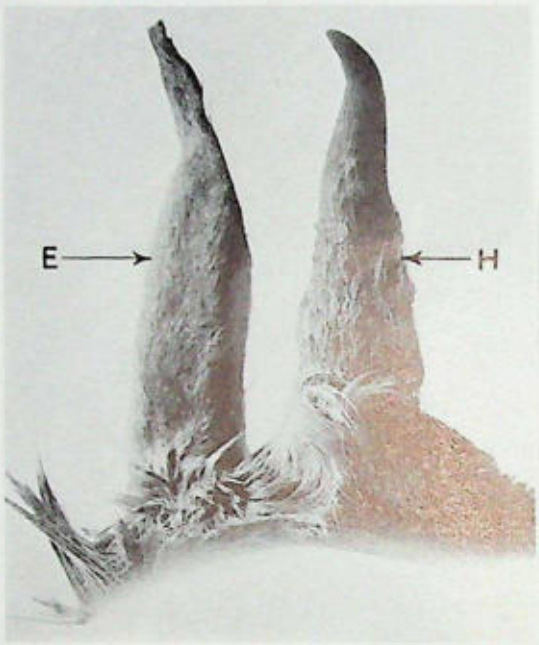




Fig. 3. (*Upper*) The general appearance of the concha or external ear (E) and the horn (H) in a young male pronghorn. The concha and horn project vertically from the top of the head and are parallel. The whorl of hair arising from the skin as it swirls around the base of the horn is quite distinct. Numerous hairs enmeshed in the horn substance are visible in the lower portion of the horn. The budding prong is not clearly visible in this picture. One-half life size. Fig. 4. (*Right*) A close view of the horn of a young pronghorn (as it caps a skin-covered bony pedicle) with the base hidden from view by the whorl of hair is shown at the right. This whorl of hair arises from the skin which covers the pedicle and hides the base of the horn. Life size of horn is four inches, as shown in the illustration.



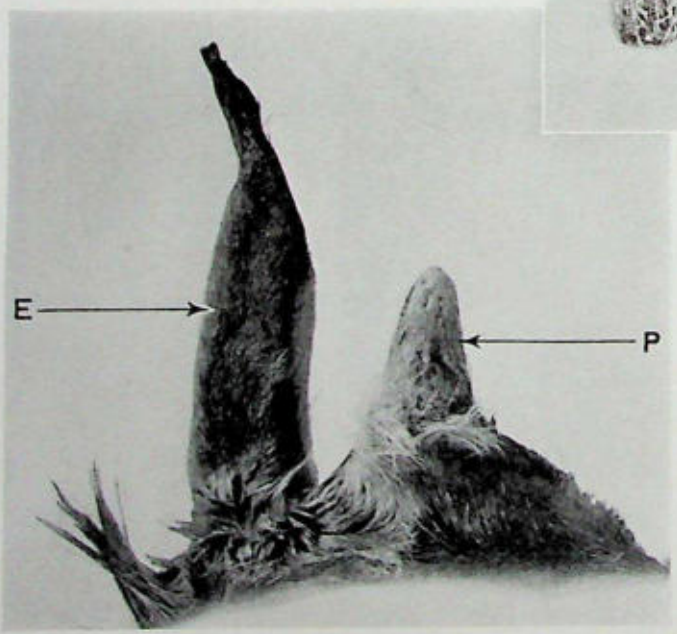


Fig. 5. (*Lower*) During the fall (October) the horn of the pronghorn may be readily separated from the skin which envelopes the bony pedicle. At this stage if the horn is removed by gentle traction, the skin from which it arises is clearly visible. This specialized skin envelops the (P) bony pedicle which is an extension of the frontal bone and is situated over a hollow vault designated the lateral sinus in a succeeding illustration. One-half life size. Fig. 6. (*Right*) The conical-shaped horn with hairs enmeshed in the walls of its base can be seen in the accompanying figure. Its upper solid portion terminates in a tapering tip which gracefully curves backward. The dark knob seen in the upper third of the horn is a budding prong. Life size.

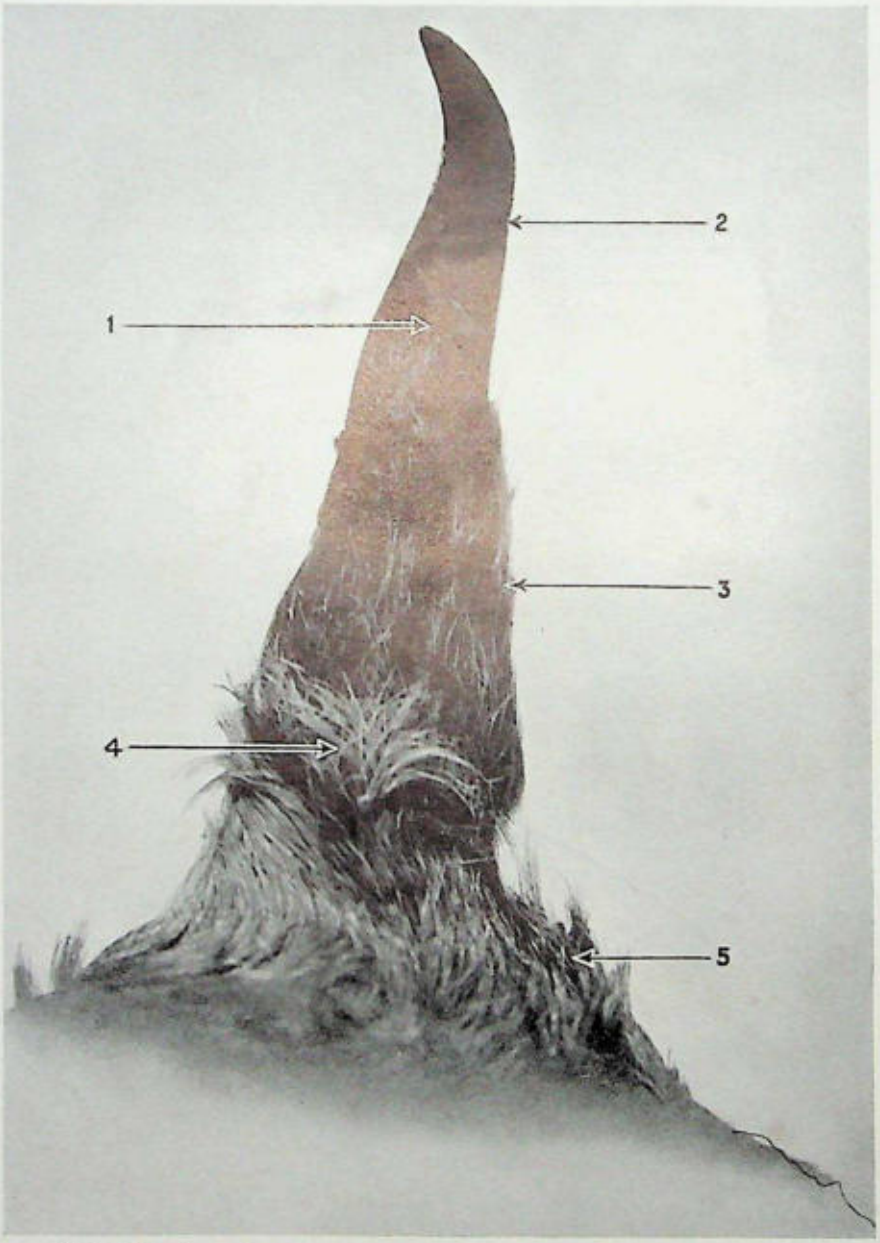


Fig. 7. This figure (external view of the horn and pedicle) and figure 8 are used to show the external appearance of the horn, a sectional view of the interior, and the relation of the horn and pedicle to each other. 1. The knob in the young specimen shows the budding prong, which is fully formed in the adult specimen. 2. The compact smooth tip of the horn which curves gracefully backwards. 3. The lower third of the horn with enmeshed hairs. 4. Whorl of hair around the base of the horn. 5. Hair and skin of the head below which the frontal and lateral sinuses are located. A sectional view of the horn, the specialized skin from which it arises, the bony pedicle and the sinuses below the bony pedicle. See figure 8.

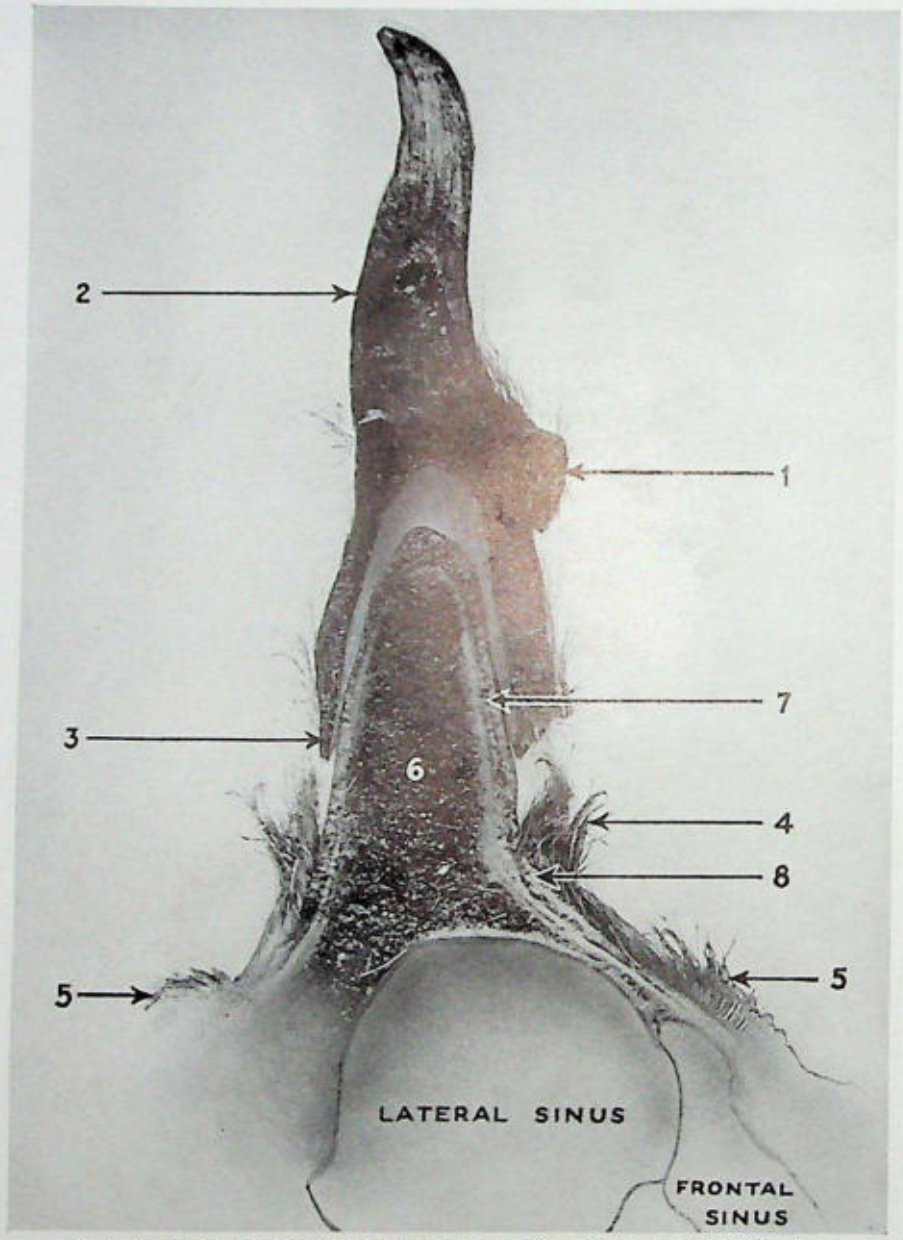
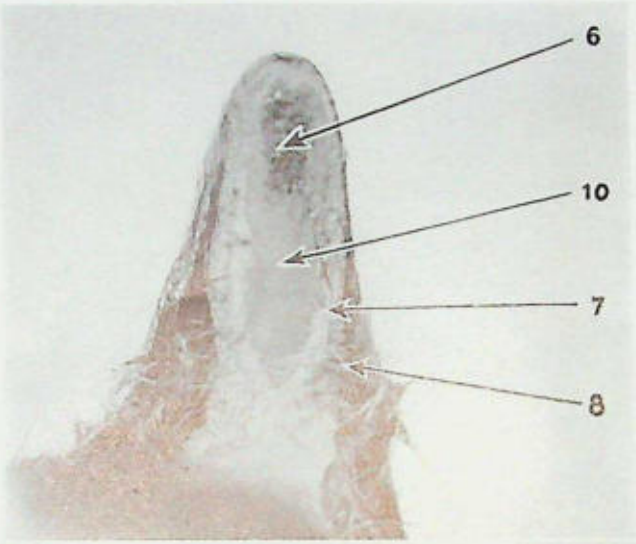


Fig. 8. 1. The horn-knob in an immature horn. 2. The solid upper portion of the horn. 3. The lower border of the horn is here shown because the horn had been raised by gentle traction from the pedicle in order to show its relation to the skin covering the bony pedicle. 4. The skin of the head with hairs which cover the base of the horn. 5. Skin and hair covering the head. This skin does not develop horn. 6. The spongy, relatively soft membranous bone forming the bony pedicle above the lateral and frontal sinuses. 7. The specialized skin from which the horn originates covering the membranous bony pedicle. 8. The skin of the head as it merges in with the specialized skin of the pedicle. The lateral sinus is the spherical cavity below the pedicle while the frontal sinus is just in front of it.



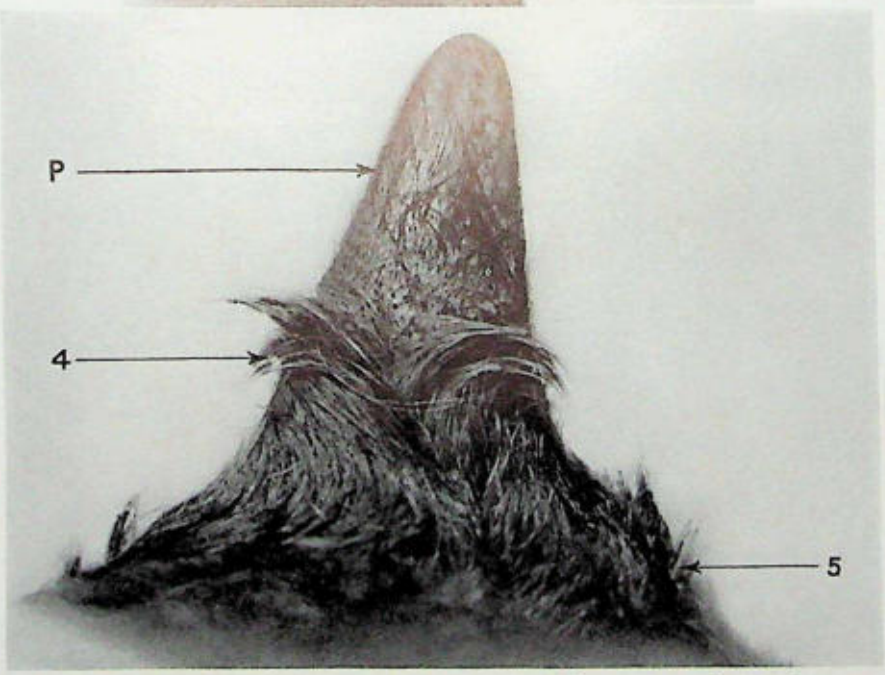


Fig. 9. (*Upper*) Internal appearance of the pedicle. 6. The spongy membranous bony pedicle, internal view. 7. The membrane covering the spongy, bony membranous pedicle, apparently the inner layer of the specialized skin enclosing the pedicle. 8. The skin of the head. 10. The hard outer portion of the bony pedicle. Natural size.
Fig. 10. (*Lower*) The skin-covered pedicle with the whorl of hair around its base. P. This arrow is intended to point to the internal membranous bony pedicle. The skin as shown is the specialized skin from which the horn has been removed. This skin is covered with many fine hairs. It is this hair which apparently becomes enmeshed in the keratin or corneum of the skin as it develops into a new horn. 4. Whorl of hair. 5. Hair on skin of head. Actual size.

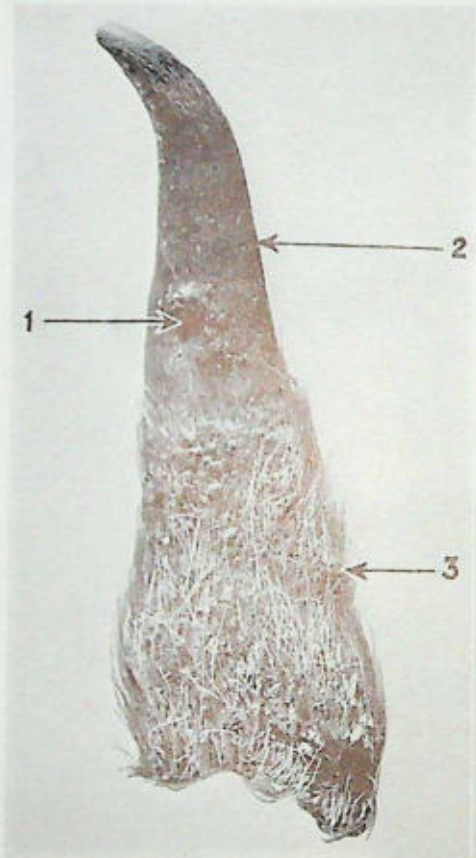


Fig. 11. (*Left*) 1. A knob-like button of horn is the nucleus of a budding prong. Since the specimen from which the horn was obtained was very young it did not develop a fully formed prong such as is seen in adult specimens. 2. The hard, finer grained tip of the horn which inclines backward. 3. Apparently as the horn develops from the corneum of its specialized skin, hairs become enmeshed in it. Life size.

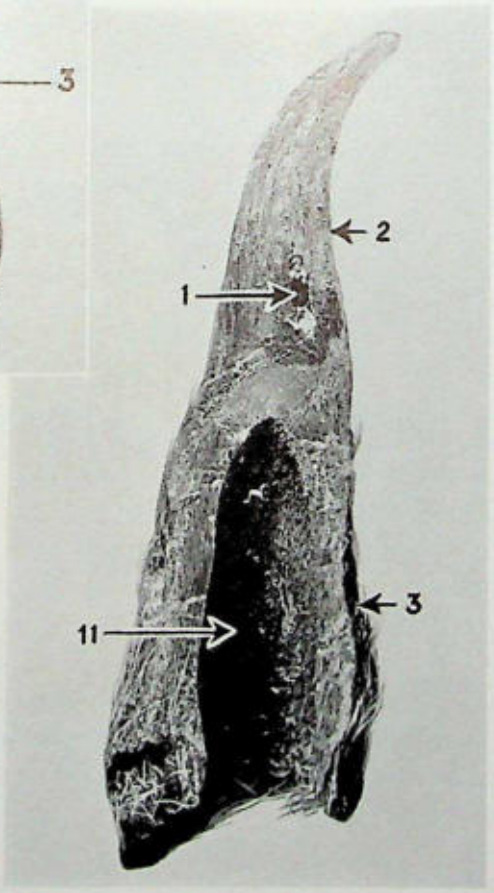


Fig. 12. (*Right*) After the shed horn has been cut lengthwise its internal gross structure is visible. 1. A cavity in the upper third of the solid horn which is just below the knob of a budding prong. 2. The solid portion of the horn. 3. Wall with hairs enmeshed in the horn substance (keratin). 11. The cavity of the horn which fits over the skin of the conical-shaped pedicle. Natural size.



Fig. 13. (*Upper*) Is a good illustration of the mature horns of the pronghorn, showing the full development of the prongs. Fig. 15. (*Lower*) is the same specimen with one horn removed to show the skin cap which covers the bony pedicle. The new horn apparently grows from this skin cap. Fig. 14. (*Center*) Shows the bony pedicle A, the skin cap C and the horn B, respectively. The records of these adult specimens were made in the Zoological Park several years ago by Elwin R. Sanborn.

The horns of the pronghorn antelope are clearly differentiated from those of such other horned mammals as cattle, sheep, goats and antelopes by three characteristics:

1. The horns are branched.

2. The horns do not possess annular rings around the base as do the horns of animals which possess permanent horns, such as cattle or antelope. In observing the permanent horns of cattle, for instance, one can readily see that as the horn grows from the skin at its base a new ring forms at the base each year, forming the annular rings. By counting these rings or ridges one can closely estimate the age of the animal. (Fig. 16)

3. The horns of the pronghorn are shed and renewed each year, consequently no such ring formation takes place. They are relatively softer than those in cattle or antelopes, and do not take on as fine a polish as the finer grained horns of cattle.

It was not until 1855 that the first published record of the fact that the pronghorn sheds its horns periodically appeared as a part of the "Proceedings of the London Zoological Society", in an article by C. A. Bartlett, Superintendent of the London Zoological Garden. Caton in "The Antelope and Deer of America," published in 1877, on page twenty-six reports that Dr. C. A. Canfield of Monterey, California, sent a description of the process of horn shedding in the pronghorn to the Smithsonian Institution in 1848. It was not, however, published by the Smithsonian until 1856, one year after Bartlett's report appeared. Caton further relates on page thirty-three that "the source of this horn is the epidermis. This alone undergoes a change and is converted into horn while the body of the skin remains substantially unchanged."

During the fall of 1928, the writer had the opportunity of observing the deciduous horn of a pronghorn antelope during the process of shedding. The specimen observed was a young male in the New York Zoological Park, hardly more than a year old, whose horns were just beginning to branch because the prong was present as a small bud-like sprouting knob.

The horn, four inches long, stands out from the top of the head parallel to the outer ear or concha (Fig. 3). A whorl of hair, extending from the hair of the head, swirls around the base of the horn so that the union between the lower border of the horn and the epidermis is hidden from view. Fine bristles of hair protrude from the horny matrix in the lower third of the horn. It seems that these hairs become enmeshed in the horn substance as the horn grows and develops from the corneum of the specialized skin and are subsequently drawn up with the growing horn. The upper third, composed of true keratin, completes the conical-shaped horn as it tapers in a fine pointed tip which gracefully curves backward. (Fig. 4)

At the time the specimen in the Zoological Park was observed, it was noticed that the horn could be loosened from its attachment to the skin which covered a membranous bony projection or pedicle. The bony pedicle or bony core is actually a projection from the frontal bone of the skull. It should, however, be noted that the horn itself is an outgrowth of and attached to the skin of the bony pedicle and is not in direct contact with the bone itself. The bony pedicle is referred to as a bone core by Nelson.[3] Since the horn is a keratogenous structure it seems hardly possible that the new horn should develop from bone, as is apparently implied in the following quotation from Nelson[3]: "A new horn nucleus develops on the tip of the bony core, and the horny growth then extending slowly downward until it reaches the base." Flower & Lydekker[4] state that "when the horn is about to be cast off it becomes loosened, and a new one is formed upon the bony core beneath it." From the observations made by the writer and the fact that the horn is a keratogenous substance, it appears that the horn of the pronghorn is in direct contact with the specialized skin which in turn envelops or covers the bony core or pedicle.

The deciduous horn about to be shed was separated from the underlying skin by gentle traction. After the horn was removed a cone-shaped pedicle (Figs. 5-6) came to view. This pedicle has the appearance of a conical peak surmounting a hill-like bulge (lateral sinus) on the side of the head. Later examination revealed that this bulge was formed by an extension of the frontal bones which form the vault of a large lateral sinus. (Figs. 7-8) This sinus serves as an air cushion to protect the brain which is located deep in the skull. The base

[4] Flower, William Henry and Lydekker, Richard. Mammals Living and Extinct. p. 333. 1891.



(*Upper*). One of the dovekies or little auks driven inland during the storm of November 19, 1932, and picked up exhausted in the Bronx. This is one of the fifteen little victims brought to the Zoological Park. It was afterward released on Long Island Sound. Photograph by E. R. Osterndorff. (*Lower*) Three other dovekies found at Jones Beach, Long Island. Mr. William Vogt, director of the Bird Sanctuary, is shown banding a dovekie preparatory to its release. Photographs by courtesy of Dr. Robert Cushman Murphy, American Museum Natural History.

of the pedicle is surrounded by the whorl of hair. The skin enclosing the pedicle or so-called bone core, clings firmly to the bone beneath it and apparently the corneum of its epidermis serves as the starting point (anlage) of a new horn. (Figs. 9-10)

The shed horn, which was photographed separately, as shown (Figs. 11-12) consists of true keratogenous or horn tissue, such as is found in all true horns. Hairs enmeshed in the horn substance can be seen in the lower portion while the upper part is particularly free from hair. A knob-like growth on the exterior part of the upper portion of the horn indicates a budding prong which is more prominent in the horns of an adult pronghorn antelope. (Fig. 13)

A longitudinal section of the shed horn reveals that it is hollow with relatively thick horn walls in the lower two-thirds while the upper part (Figs. 11-12) is solid with the exception of the hollow portion of the budding prong knob.

Photographs made several years ago by Elwin R. Sanborn (Figs. 13, 14, 15) show that essentially the process of horn shedding is the same in the adult pronghorn as in the case of the younger specimen studied by the author, that is, when the horn is shed it is separated from the specialized skin (skin cap) covering the bony pedicle. The new horn develops from this skin.

The shedding of horns by the pronghorn might be confused with the shedding of antlers in the deer, but one clearcut difference between the horn of the pronghorn antelope and the antlers of deer stands out clearly: The horns of the pronghorn are true horns, or ectodermal structures derived from the outer layer of the skin, while mature antlers of deer are not true horn or keratogenous structures, but are bony or mesodermal structures. The bony antlers of deer are shed in the spring while the true horns of the pronghorn antelope are shed in the fall.

The Dovekie Invasion

Lee S. Crandall
Curator of Birds, Zoological Park

Inured to the vagaries of New York weather, Traffic Officer Beckwith was stoically directing the slow movement of long lines of motor vehicles, at Pelham Parkway and Eastchester Road, in the outer reaches of the Bronx. It was early afternoon of the 19th of November, 1932, a particularly wretched day. A wind of but little less than gale force was rushing upon the city from off the sea, driving before it horizontal sheets of torrential rain. Visibility was reduced almost to its minimum; drivers felt their way with caution, each checking his own progress by that of the car directly ahead.

A New York policeman is expected to be prepared to handle any situation that may arise; it is, in fact, difficult to imagine an occurrence that would nonplus him completely. Consequently, when out of a burst of wind and rain, a strange bird dropped suddenly to the pavement at the feet of Officer Beckwith, there was no unseemly excitement. Sharp blasts of a whistle brought all traffic to a stop; all eyes were focussed on the cause of the interrupted flow. With praiseworthy caution, the policeman proceeded with his investigation. After some preliminary feinting, which convinced him that his proffered fingers were not in jeopardy, he picked the bird up and held it in his hands. It rested quietly, without struggling. So far, so good. But now what to do? Waiting motorists, becoming impatient, pressed without restraint upon the buttons of their horns.

Even the wretchedness of such a day could not prevent the formation of a crowd on any pretext, within the confines of New York, and already the usual ring of small boys and idlers had gathered. Quickly selecting two from their number, Officer Beckwith turned the bird over to one of them and bundled them into a westbound car, with instructions to stop at the Zoological Park. A blast of the whistle and the long lines again moved forward with their accustomed smoothness.

A minor incident in a great city's traffic, the dropping of this bird was of the greatest importance to us in the Zoological Park, for it was our first intimation that a major catastrophe had overtaken its race. The bird was a dovekie or "little auk" (*Alle alle*), a species that ordinarily

winters well out at sea. Its arrival at the Park signalized the beginning of a considerable procession of kind-hearted persons bringing rescued birds and a long succession of telephone calls, extending through the remainder of Saturday, all day Sunday and most of Monday. In all, fifteen birds, many of them dead, were brought in. All those who called by telephone were advised to liberate the birds in the nearest body of water, preferably salt, so that a large number of victims of the storm were given a chance to win back to the open sea.

Previously, only one dovekie has ever been received at the Zoological Park. This bird came aboard the old S. S. *New York*, of the American Line, on November 27, 1908, and was delivered to us when she docked here on the 30th. It was very weak and survived for only a day or two.

The dovekie is a member of the family Alcidae, which includes the auks, murres and puffins. It is a small bird, averaging somewhere about eight and one-half inches in total length; the wingspread of one measured here was fifteen and one-half inches. In the breeding season, the upper plumage is bluish black, with the sides of the head, throat and front of neck brownish; below the neck the under surface is pure white. There are narrow streaks of white on the edges of the scapulars, with a thin bar of white across the lower wing. In winter, the plumage is much the same, except that the brown on the head and neck is replaced by white, which extends partly around the nape.

The breeding range of this little bird lies along the coasts of the Arctic and North Atlantic Oceans, and various islands, including Baffin Land, northern Greenland, northern Iceland, Spitzbergen and Novaya Zemlya. It is extremely abundant and is an important source of food supply of the Eskimos, who catch the birds without difficulty in small hand nets, as they fly along the rocky shores.

At the end of the breeding season, the birds begin to work south and by November have reached their winter range. This includes coastal waters of the western Atlantic as far south as Virginia (casually to South Carolina), and of the eastern Atlantic to the Azores and Madeira. Commonly, the birds keep well out at sea, and there is much variation in their numbers, at given points, from season to season. Consequently, there are very few in-shore records; Griscom,[1] referring to the region of New York, states that "There are some twenty records in the last forty years."

Dovekies are hardy birds, ordinarily well able to fend for themselves in rough weather. Occasionally, however, a succession of severe storms may prove too much for them; unable to hold their own against the rush of wind and water, the helpless creatures may be blown inland, most of them to perish miserably.

Such a debacle occurred on the coast of New England on November 15th, 1871[2], during a heavy easterly storm. On that occasion, birds were reported from widely scattered inland points in Massachusetts and Connecticut. There appears, however, to be no record of any dovekie catastrophe approaching that of November, 1932.

This seems to have begun with a severe storm that occurred off the coast of New England, from November 7th to 10th. Dr. John B. May,[3] Director of Ornithology for the Massachusetts Department of Agriculture, reports as follows:

". . . during and immediately after the period literally hundreds of dovekies were reported to this office as seen on inland waters, or picked up exhausted or dead on land. The aviary at Franklin Park received about thirty birds, nearly as many were sent to various humane societies for treatment, sanctuary protectors received many more . . . . The birds were noted from Maine to Rhode Island along the coast, and as far inland as Wolfeboro, New Hampshire, Worcester and Athol, Massachusetts, and west of Providence in Rhode Island. Then on November 19 came another storm from the south or southwest, and once more dovekies were reported by hundreds from Rhode Island, Connecticut, New York, New Jersey, and as far west as the Philadelphia region. This storm also brought records from the Connecticut Valley in Massachusetts . . . . Most of the birds died, either from exhaustion, injury or lack of proper food but a small group survived in the Mystic Lakes from November 11 to at least November 27."

The second storm to which Dr. May refers, as occurring on November 19, is the one which

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1 Griscom, Ludlow. Birds of the New York City Region, 1923. p. 65.

2 Brewster, William. Memoirs of the Nuttall Ornithological Club, No. IV, 1906.

3 Items of Interest, Massachusetts Department of Agriculture, December 7, 1932, p. 2.

caused the dovekie invasion of New York. The month had already brought us some bad weather, but that of the 19th was particularly severe. Official observers of the United States Weather Bureau, situated atop the Whitehall Building in downtown New York, recorded the wind velocity as increasing from thirty miles an hour in the early morning, to fifty-one shortly after noon. Its direction, at first, was from the southeast but it changed later to due south. From 4:00 A.M. to 3:25 P.M., when the rain ceased, the total precipitation was 1.49 inches.

It is reasonable to assume that the birds were blown inland on Saturday, before the wind subsided. A few, of course, were found on that day but more were discovered on Sunday, Monday or even Tuesday. Under ordinary conditions, the dovekie seems unable to rise from the ground, once it is down. At sea, it can take off from the tops of waves, or skitter along the surface for a running start. Mr. George Vogt, of the Jones Beach Bird Sanctuary, on the south shore of Long Island, reports a case in which a bird was carried to a concrete road, and was able to rise when headed into the strong wind. Most of the birds, less fortunate than this one, never took wing again, once they were down. From the large number of birds reported, one is able to grasp the immensity of the holocaust, since for every dovekie that was found, very many more must have escaped notice.

A timely story of the disaster, released by Director Blair, accompanied by a photograph of a living bird and published by the New York papers on the 22nd, was welcomed by many persons who had been unable to identify the birds they had found. It brought us, also, many interesting reports that otherwise might have escaped notice. Among these was a post-card from Mrs. Dorothy Binney Upton, of Fort Pierce, Florida, stating that she had found eleven dead birds and one that was still living, on the beach at Fort Pierce, on December 2. She believed the birds to be dovekies. The only evidence of the occurrence of the dovekie in Florida is a sight record of a single bird in the Indian River, established by C. J. Maynard, "presumably in 1871.[4] Hastily, we wrote Mrs. Upton, urging that some tangible evidence, if only the head or foot of one of the birds, be sent us in order to establish positive identification. In a letter dated December 13, Mrs. Upton replied:

"It is with some misgiving I sent you a box today with two very dead little bird carcasses in it. But as your note to me said you would be glad to have any remains, or even a head or a foot of what I think is the "little auk" found here on our Florida beach, I am taking you at your word and the postmen between here and there can rave all they like about odors and sachets! . . . On December 1, I saw one of these little birds up the Loxahatchee River (about twenty miles north of Palm Beach) alive and swimming . . . The following day here on the beach at Fort Pierce I saw eleven bodies and found one live specimen . . . several fishermen told me of having seen the strangers in the Inlet here or just outside the Inlet, in the ocean."

On the day after Mrs. Upton's letter was received, the box arrived. It contained the remains of two authentic dovekies, both, as we had been warned, quite definitely dead. They have been sent to the American Museum of Natural History, where they will be preserved as definite, if somewhat fragmentary, evidence of the record.

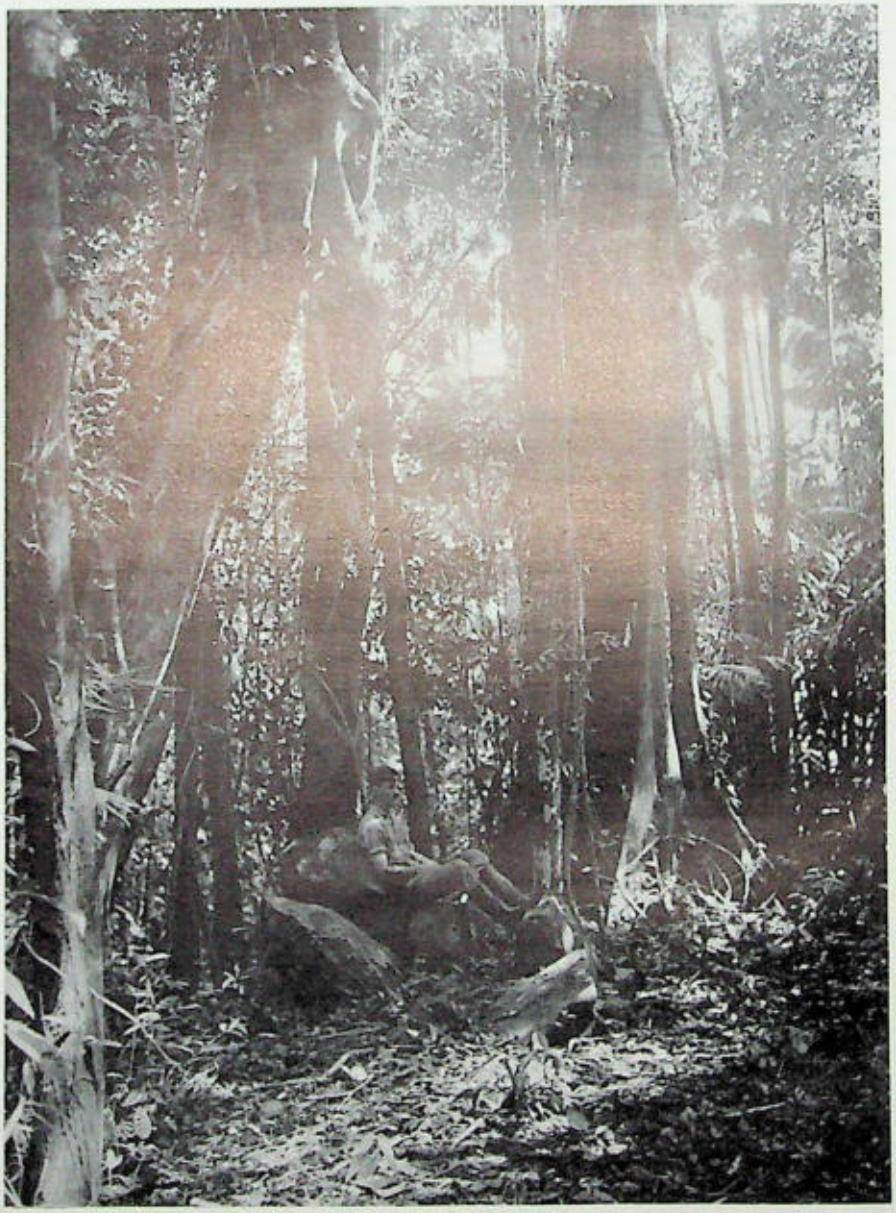
The farthest north of the reports received here came from Miss Miriam E. North, who identified a bird floating on a small pond near Meriden, Connecticut. One, also, was reported from Peekskill, New York. Miss K. Bausch, of Bloomfield, New Jersey, found one of the stranded dovekies on her lawn on the Saturday afternoon, and immediately set out in her car to take the bird to us. While waiting at the ferry in Jersey City, she discovered some small boys playing with another, which she promptly confiscated, and added to her collection.

The most detailed of the first hand experiences that have come to our notice was furnished by Mr. William F. Drescher, of New York City. Mr. Drescher has been good enough to write for us the following account:

"A strong wind blowing during the night of November 18-19, it occurred to me that there might be a possibility of some of the sea birds being driven close to shore and of probably being able to observe birds not generally found in this region. Accordingly I travelled down to Jones Beach on Long Island.

"Arriving at the Jones Beach Bathing Pavilion at 7:30 A.M., I not only found a strong wind but a gale blowing, with a very high sea

4 Florida Bird Life, by A. H. Howell, 1932, p. 275.



A Panamanian forest jungle. Strangler vines have enmeshed the great trees at the left of the picture. Varying in thickness from a slim cord to the diameter of a fire hose or a man's thigh, they encircle these tropical giants with a titanic grip. The tension which these vines exert is almost beyond comprehension. If severed with a machete, they part with the snap of a tightly stretched wire cable. Once a tree is wrapped its life is doomed. In the end only the vine exists.

running, and intermittent heavy rain squalls. Finding a lee in the shelter of the Pavilion, I adjusted my binoculars and began to scan the ocean and the beach in search of birds. Aside from a few herring gulls, there was nothing to be seen. On the chance that the gale might have driven the birds to the bay side of the beach, I travelled for several miles among the sand dunes in search of bird life. While thus wandering about, a small bird flew by overhead, and from the brief glimpse I had of it, noticing a black band under its neck, I judged it to be a semi-palmated plover.

"Continuing along the dunes, I reached the Jones Beach Bird Sanctuary, where I saw a dead dovekie lying on the doorstep of Mr. William Vogt's house. After a short visit I continued my walk among the dunes, when suddenly another bird flashed by close to the ground and seemingly disappeared in the bushes. Though I searched for some time, I could not find it. However, this time I was sure of the bird's identity, namely, a dovekie. From then on in my walk to the beach, an occasional dovekie flashed by, all flying close to the ground.

"At about 10:30 A.M., the first fairly large flocks of dovekies began to pass by. The largest of these flocks consisted of about fifty birds. Most of the flocks were not over ten or twenty in a flock. All of the birds seemed to be coming from a westerly direction and flying east. The majority of flocks flew close to the shore line and close to the ground. On many occasions I expected them to land on the beach, where of course they would have been helpless. But on every occasion they soared up again when they seemed to have been only a few inches above the beach. Those of the flocks flying over the ocean appeared to be skimming the wave crests.

"One small flock landed on the water and every moment I expected them to be smashed to pieces by the exceptionally heavy sea that was running. They bobbed about on the water like so many corks and at times appeared to be diving through the crests of the waves.

"Some flocks flew by fairly high above the water, probably one hundred to two hundred feet. The flocks came flying by intermittently for about two hours. In all, I judge that at least one thousand birds flew by during the two hours I was observing them. All were going in the same direction—west to east.

"After the last flight had gone by, only an occasional bird was seen. The last one I saw was on the Sunrise Highway, five miles from the ocean."

Of these hundreds, quite possibly thousands, of storm-blown birds, not all were so unfortunate as to fall helplessly on dry land. A few managed to drop into ponds or open waterways, from which they may have worked their way back to the sea. Three found themselves in a small salt water pool, only a few feet from the shore, on the estate of Captain Frank J. Walcott, at Great Kills, Staten Island. Captain Walcott believes one of the birds to have been taken by a hawk. The two others, apparently quite happy and seemingly able to find food, were observed at close range by many bird lovers, eager to make first acquaintance with a species so seldom seen. Captain Walcott reports that, about ten days later, the birds managed to rise from the pool and take wing towards the sea.

Of the living birds among the fifteen brought to the Zoological Park, only one survived for more than a few hours. This one had been found in the middle of Heathcote Road, at Scarsdale, New York, on the Saturday night, and taken to Dr. Ditmars, who kept it until Monday. It did not feed but seemed so bright and strong on its arrival here, that Dr. Ditmars agreed to take the bird to City Island, where he liberated it in Long Island Sound. When last seen by him it was swimming, rather uncertainly, toward open water.

It is difficult to account for our inability to keep these birds alive, by any other explanation than that they had suffered too greatly from exhaustion and lack of food before they were received by us. It is true that the normal food of the dovekie, as far as known, would be difficult to supply in captivity. A. C. Bent,[5] quoting W. E. Ekblaw, says:

"The food of the young dovekies is largely made up of the so-called 'shrimps' (*Schizopoda-Myris?*) so numerous in Arctic waters, and the so-called 'black-berries,' the little black 'arthropods' that are so numerous in the water too . . . . The food of the adult bird is probably the same as that of the young while they are in their summer home. This food it obtains in the sea, usually

[5] Life Histories of North American Diving Birds. United States National Museum, Bulletin 107, 1919, p. 219.



Mountains of Panama. These mountains are the connecting links between the Rockies in the north and the mighty Andes of South America. From base to summit, their winding, undulating ridges are clothed with luxuriant verdure. Giant trees with pendulous masses of swaying moss tower above, and brawling torrents roar their way down the precipitous slopes to appear as silvery ribbons in the valleys far below. In the rainy season, the summits are wrapped in storm clouds, which as the burden of moisture is released in torrents of rain, rise and swirl like gracefully flowing draperies. This is the country of the bushmaster, which finds security and shelter in the outcropping limestone ledges of its mountain habitat.

most easily, apparently in certain currents, or about headlands, ice pans or ice bergs . . . ."

Among other authorities quoted by Beck, the consensus of opinion seems to be that the dovekie feeds chiefly on "minute crustacea." On the other hand, William Brewster, previously quoted, states that several dovekies killed on Fresh Pond, Cambridge, Massachusetts, during the invasion of 1871, were found to have been feeding on young alewives, a species of herring. From this it would appear that, specialized as the normal diet of the dovekie is, it nevertheless retains some ability to adapt itself to unavoidable conditions. While the birds here refused to touch fish provided for them, and could not be kept alive by forced feeding, it is quite possible that they were already too much weakened to be able to recover.

Consideration of the food habits of the dovekie leads us to speculation concerning the causes of this double catastrophe. At first glance it all seems simple enough: a long-sustained wind of high velocity, combined with a deluge of rain, was more than the birds could face and they were blown ashore. But rains fall and winds blow during every winter season, without bringing us showers of dovekies. Each year the birds are called upon to face conditions at least as severe as those of the 19th of November, and each year they triumphantly survive. On the other hand, the rate of metabolism in birds is much more rapid than that of mammals, as evidenced by the higher temperatures of the former. Periods of great exertion, without sufficient compensation in food, quickly exhaust them. Weakened by the three day blow off the New England coast, when feeding would no doubt have been difficult, the survivors were caught farther south by another storm of shorter duration but high intensity, before they had completely recovered. The second disaster resulted.

It is quite possible, of course, that some variation in food supply may also have been involved but as to this we have, as yet, no evidence. At any rate, there is no doubt that the birds received here were greatly emaciated. Fourteen of these were sent to the American Museum of Natural History on November 22. With four others, they were weighed on that day by Mr. Charles O'Brien of the Department of Ornithology of that institution, with the following results: average for eighteen birds, 3 ounces; minimum, 2½ ounces; maximum, 3¾ ounces. While, unfortunately, we have found no weights of normal birds with which to make comparison, it is obvious that after making allowance for bones and feathers, the remainder would be poor comfort for a hungry Eskimo.

In Quest of the Bushmaster

Raymond L. Ditmars
Curator of Mammals and Reptiles, Zoological Park

Illustrations from photographs taken by Elwin R. Sanborn during a trip to Barro Colorado, Panama under the direction of the New York Zoological Society.

THE American tropics form the home of the world's largest viper, the Bushmaster, Surucucu or Mapepire Z'Ananna, *Lachesis muta*. The Spanish-speaking natives sometimes call it La Cascabela Muda (the mute rattler) as it vigorously shakes its tail, when angry, the tip fading into blur of motion as rapid as that of the specific caudal appendage of the rattlesnake. The bushmaster grows to a length of twelve feet. Its pattern is particularly vivid owing to its body hue of pale or pinkish brown, sometimes the shade of salmon. Along this body, rather widely spaced, are broad black bands. The body scales are rough, and protrude as knobby points like the surface of a wood rasp or in reduced replica of the skin of a pineapple. Hence one of the names, Mapepire Z'Ananna, signifying the resemblance of the bushmaster's scales to the skin of the rough fruit.

The bushmaster's head is heavy and blunt. Its canaliculated, venom-conducting fangs are enormously developed—two inches in length with a big specimen. The species is a particularly insolent snake, not actually gliding into attack, but without inclination to retreat from the human intruder. Its attitude, in fact, is to edge in closer, while more widely forming its lateral striking loops to lurch its fangs at an offending object. It has always been very rare in collections. But three specimens have been on exhi-



Howler Monkeys. This is the largest monkey of the American tropics, the big males being the equal in bulk of a medium sized Old World baboon. This species is largely nocturnal, and the mournful howls and roars of a band of these monkeys in the silence of a tropic night is surely an awsome sound. It is truly beyond the comprehension of the layman to understand the kind of animal that can produce a noise so formidable. A band of the howlers may be seen in the lofty tops of the trees, perched at perilous heights on structures so frail as to seem of insufficient strength to bear their weight. Yet they leap across great spaces, trusting to hands, feet and the long prehensile tail for a firm clutch and none seem to fall.

bition in the Park in over thirty years. The snake has had the reputation of being rare throughout its habitat.

A year past, the writer was surprised to hear that seven bushmasters had been killed in and around the area then being cleared for the Madden Dam, an engineering project to provide additional water for the Panama Canal. This area is about fifteen miles from the Canal Zone, and situated in the valley of the Chagres River.

The United States negotiated with the Panamanian Government to secure a strip of land leading to the site of the Dam, and built an excellent cement road to the area of construction. This road winds inland from the location of the Pedro Miguel locks. The building of this road has been of great interest to tropical research workers. It leads through virgin forest-jungle, can be quickly negotiated by automobile, and a stop anywhere along the greater portion of its length offers alluring opportunities for observation.

With this prospect in mind, and being in receipt of several invitations to visit the area, the writer left New York in August, on the United Fruit Company's vessel, the "Calamares." The trip was not of formal arrangement, nor was there opportunity to remain away longer than three weeks. It was, in fact, a vacation trip, in the nature of a preliminary reconnoiter to more extensive investigation during 1933.

Through the courtesy of General Harry Burgess, Governor of the Canal Zone, and also the cordial assistance of James Zetek, Supervisor of the tropical wild life sanctuary known as Barro Colorado Island, I was able to start at once for the site of Madden Dam. Before leaving for the back country, however, I visited Dr. Herbert C. Clark, Director of the Gorgas Memorial Laboratory, at Ancon. Doctor Clark has been compiling statistics relating to the occurrence of poisonous snakes in the Madden Dam area. The writer was astonished to learn that eleven additional bushmasters had been killed there during a period of eighty-five days. Some of them had been big brutes, about nine feet long, and their fang length was most impressive. The heads ranged from about three inches in length to those of growing examples with head not much larger than a walnut. These observations clearly demonstrated that the bushmaster is of more frequent occurrence in Panama than any other known portion of its range, which appears to extend from southerly Costa Rica to the Matto Grasso in Brazil, and easterly Bolivia.

In company with John O'Reilly of New York, and Arthur Greenhall, a student in the University of Michigan, I motored from Ancon and up the cement road to Madden Dam on the evening of September 2nd. It was the height of the rainy season, and a steady shower fell all the way, accompanied by almost incessant lightning. As we left the Canal Zone and entered the road through jungle country, we ran slowly to watch the surface ahead of the car. Boas are often seen crossing this road at night, and several bushmasters have been likewise killed. The rain was apparently too heavy for serpents to be abroad. We saw nothing except frogs and toads, legions of which were squawking, trilling, croaking and chattering in ditches alongside, their songs loudly apparent over the sound of the motor and slosh of tires on the wet surface.

Arriving at the clearing where the engineers' houses are grouped, the area walled in by jungle on all sides, we found everything dark, with everybody in bed — for it seems the working crowd at Madden Dam rises early, or anywhere between three and four o'clock in the morning. A great deal of work is thus accomplished before the steamy heat of midday. We finally located and aroused Mr. Randolph, chief of construction, and were comfortably quartered in a mosquito-screened house on high, stilt-like posts, as all of the engineers' and workers' houses were built.

The nocturnal chorus of amphibian and insect songs was so amazing that we unpacked our flash lamps and turned to investigation and collecting for several hours. The yield that night, as on the several evenings we were there, was highly productive of particularly interesting specimens. We collected a large species of *Leptodactylus*, an extremely decorative frog as large as the bullfrog of the States. Its hues were bronze, red and yellow, but most unique about it was a spur on the inner portion of each forelimb, very effectively used by the creature in grasping one's fingers and inflicting painful wounds. A half dozen species of *Hyla* (large tree frogs) were found. One of these had a vivid green body and a head as blue as if it had been dipped in cobalt. Another species was almost white. Our lights revealed it sitting on broad leaves



The Toucan. The toucan is a rather friendly and fearless dweller of the tropics, and makes his presence known as though aware of the interest that his bizarre form and colors will present to the eyes of the explorer. One of these birds, the Aracari toucan, is perched on the topmost horizontal bough of the tree and the photograph was made at a distance of not more than twenty feet. As he displayed himself, he fed on the fruit clusters of the tree, plucking the seeds from the tips, tossing each one into the air and catching it in his enormous beak.

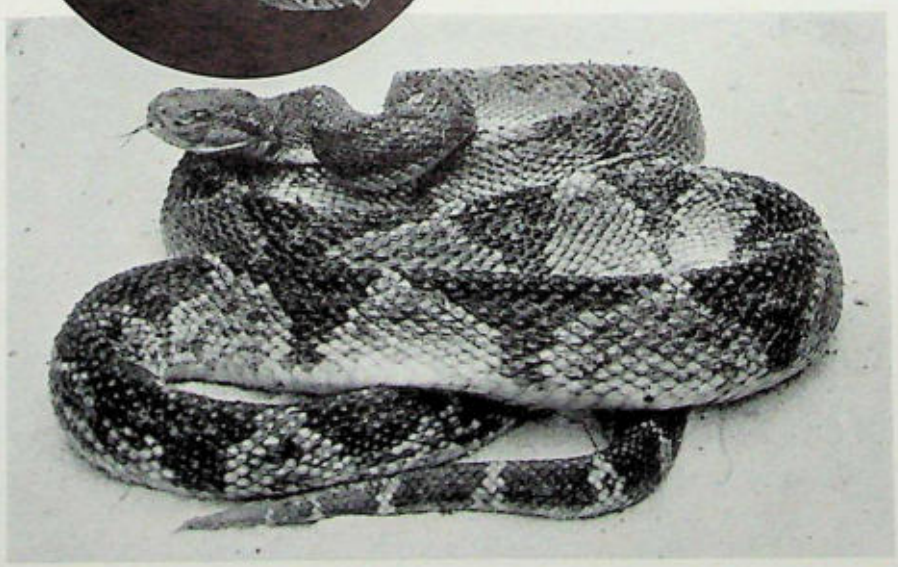


A tropic jungle. To the layman a tropic jungle is a dream of the garden of Eden. Open glades, beautiful flowers, gorgeous birds and an endless array of delicious fruits. True enough, but unless the bed of a stream can be followed or a trail exists, a tropic jungle is a formidable barrier of close-growing vegetation and a labyrinth of vines, so tightly interwoven as almost to defy penetration. Beneath a canopy of luscious greenery the air is like a super-charged steam kettle and under foot are myriads of rapacious insects that relentlessly defy any invasion of their domain.





Photographs of the Bushmaster made in the Zoological Park. (*Center*) Head of the Fer-de-lance. The upper picture shows how the pattern of the bushmaster may blend with fallen leaves and patches of light. The lower picture gives a good idea of the rough carination of the scales. The head of the Fer-de-lance illustrates the formidable fang development of this deadly tropical reptile.



overhead. Incongruously, for a frog, its *fore-feet* were extensively webbed. All of the toads and frogs had characteristically different songs and we traced them by these sounds, then located their exact situation with our lamps. Greenhall had a jacklamp attached to his head, with battery suspended from his belt. We found this immensely useful. In later experiments, it was found that with such lamps, with diffuse reflectors, one can walk through the jungle trails at night with as much facility as during daylight.

Our search for a bushmaster started the next morning, with Abe Halliday, engineer of sounding projects, as our guide. Mr. Halliday had killed several bushmasters. He took us to the very spots where the serpents had been encountered. Our route followed a narrow trail kept open to inspect borings made by the engineers to determine the stability of the ground at depths of several hundred feet. These borings are in areas extending on each side of the "wings" of the dam. If the Chagres later shows an inclination to seep underground and around the dam, hollow areas, between hidden limestone ledges, will be pumped solid with clay or cement. The impressive variety of flora, the great ceiba trees and pendant lianas, and the narrow trail through an atmosphere like a hot-house, freshly watered, indicated nothing of disturbance to the area, no sign of an engineering project. The only indication of the soundings was an occasional heavy pipe protruding from the ground. All scars of work or excavation had been smothered by rapid jungle growth, which comes with the rainy season.

A unique condition of this jungle was the presence of extensive limestone ledges. They cropped up unexpectedly as we rounded turns in the trail. Between them were stretches of jungle floor, soft and matted disintegrated vegetation and forming the richest type of root-feeding medium. Mr. Halliday explained, however, that underground was a labyrinth of limestone shelves and caves. We found many evidences of this in natural holes, which looked like wells. Some of the surface ledges, running to contours of three hundred feet, or a bit over, looked like the rattlesnake "dens" in New England. They were seamed with fissures and big flat fragments for reptile shelter. Their only difference was in situation. A rattlesnake den would be open to the sun, facing to the south. These ledges were heavily shaded by the tropic forest. Little or no sun ever reached them. An aeroplane reconnoiter over these forests would not have given one the remotest idea of this peculiar, ledgy condition, with its many sheltering crevices—appearing to account for the unusual abundance of the bushmaster.

The bushmaster is thought to represent the ancestral stock whence the rattlesnakes were derived. In form and relationship, it is close to the rattlers. Throughout the rattlesnake genus, there is invariably the tendency, where ledges are present, for these snakes to make such places their home. Thus the bushmaster appears to indicate both parallelism in habits and relationship to the rattlesnakes.

At one spot in particular, where Mr. Halliday had shot a big bushmaster, the association with the presence of the snake and limestone shelter, was clearly evident. The spot was at the base of a giant ceiba, the buttressed roots of which appeared to spread at least twenty feet. This giant base was flattened, in crescentic form. One could stand within the curve and seek shelter under a hollow like a half of an Indian tepee. The bushmaster was seen in the natural clearing near the tree. It immediately showed fight, edged up toward the party, and after sweeping strokes, extended its striking loop for more telling effect. Not ten feet away—in fact, extending nearly to the tree—was the base of an extensive limestone ledge. We investigated this ledge, finding it seamed with great crevices, and finally found a cave which we entered to a depth of fifty feet. Such a ledge in the southerly Berkshires, the Kittatinny Mountains of New Jersey, or along the Delaware in Pennsylvania, would have stopped us short, to look for rattlers. We saw no sign of bushmasters on this ledge, but then again, I have been in spots where I knew there were plenty of rattlers, and day after day have failed to find them. There are days when they are out, and periods when they are not to be found. What the combination is, whether temperature or some other condition of weather, remains a puzzle to the writer. I located no bushmasters in the few days possible to remain among these ledges, but the studies will be resumed the coming summer, with the hope of adding an interesting exhibit to the Park.



The Ceiba tree. The ceiba or silk-cotton tree of tropical America grows to lofty heights and may be commonly seen towering over the surrounding foliage of the jungle, its white trunk appearing like a bar of silver against the green background. These mammoth trees set solidly in the ground and to make their support the more secure their buttressed bases spread out over a diameter of twenty feet or more. In a situation precisely like this, prospecting engineers engaged in the hydraulic improvements of the Panama Canal system, killed a large bushmaster. The thick undergrowth offers a safe and scarcely invaded retreat for these deadly vipers.