A NATURALISTS' TROPICAL LABORATORY

BY THEODORE ROOSEVELT

ILLUSTRATIONS FROM PHOTOGRAPHS

OUR zoological knowledge of the tropics, especially so far as concerns the higher vertebrates and the more prominent and interesting forms of invertebrate life, is now fairly complete in its larger outlines. The collector has still his part to play here and there—a necessary and important but by itself far from the highest part—and here and there desultory roaming or more systematic and extended exploration will still yield zoological results of prime consequence. But what is now especially needed is restricted intensive observation in carefully selected tropical stations, where the teeming animal life can be studied fully and at leisure. The student should be a scientist whose training is both broad and specialized. Unless he has breadth of outlook—such as Humboldt, as Cuvier, as Darwin possessed—he cannot reach the higher levels of his calling, where power of sound generalization, of controlled imagination, and of cautious work along lines of daring hypothesis are indispensable. Yet unless he also possesses the power of sustained, long-continued, highly specialized, and minutely accurate observation his generalizations and hypotheses will be either worthless or mischievous. He must be equally at home in the field and in the study. He must possess the unflagging, unwearying, patient industry of the scientific man who loves science with whole-hearted ardor. He must be able to see, and to understand what he sees; to interpret what he has seen in the light of wide knowledge; and finally to record it with comprehensive vividness and charm no less than with accurate fidelity to fact. A high ideal! and impossible of entire realization. But it can be measurably realized. Demerara is one of the tropical lands where there is a teeming life to be studied; and Mr. William Beebe is one of the scientific men who can study it as it ought to be studied.

The New York Zoological Society, thanks to the far-sightedness of some and the generosity of others of its members, has established a tropical-research station in Demerara, and has placed Beebe in charge of it. In late February, 1916, I was able to visit this station. While doing so I stayed at the house of Mr. Withers, as I shall describe in the next article.

Beebe's laboratory was half a mile distant from the Withers house. It likewise was on a hilltop, with a steep path leading down to the landing-place for the boats in a bay of the river. Across the river were the buildings of the penal settlement. The house had formerly belonged to a man who was a famous old fellow in his day—a white man who led a life more than half savage—a kind of life well known to all wild communities on the shifting frontier between untamed barbarism and the almost equally wild and untrammelled vigor of the first pioneers of the rude oncoming civilization. He had lived with the Indians as protector and tyrant; he was as hardy and as well versed in woodcraft as Carib or Arrawack; he dominated them, and was thereby enabled to render useful service to the colonial government. He had finally come to live definitely with his own people, and had built the house in question. When he died it came into the possession of Withers, who most generously gave it to Beebe for use as the laboratory—a gift for which science is much indebted. The house stood on high brick and stone piers, so that the lower story was a skeleton, with shelters in which goods were stored. A wooden staircase led to the floor above. On this floor the front was occupied by one big open compartment, which could be called either room or veranda. The naturalists used this as workshop, living-

From photograph by G. K. Withers.

Manager's bungalow from factory, Kalacoon.

room, and dining-room, and the other half of the floor was occupied by the bedrooms. The cabins of the coolies and negroes were not far off. There were Indian attendants also, most of them bearing the names of saints or prophets. They lived in open huts, and served as hunters; and they were kept on the watch for rare specimens. There was good bathing in the river; but there was need of some caution, for, although caymans were rare at this spot, there was an occasional electric eel, and Carib fish were sufficiently common to make watchfulness advisable.

In this big, roomy, airy house at Kalacoon, near where the Mazaruni River empties into the Essequibo, Beebe had found just the spot for his tropical-research station. He had with him as associates and assistants Inness Hartley and Paul Howes. Nor was this all. Hartley's sister, Miss Hartley, and her friend Miss Taylor, of South Carolina, were with them, and were just as eager and enthusiastic as the men; their work was to draw and paint animals and plants from life and immediately after death—for many creatures which when living have naked skins, or scales or feathers, with beautiful metallic lustres, lose these hues almost immediately after death. People who are fortunate enough to be devoted to their work for its own sake, and to find in it an absorbing pleasure, are to be congratulated; and this little party of naturalists—the old-fashioned word seems a little less pedantic than "biologists"—were enjoying the rare combination of working hard at a task in which their souls delighted, and of also taking part in a thrilling kind of picnic. All were in high spirits, bound to enjoy everything, and bound to make the experiment a success. Each had his or her particular branch of labor, and there was in addition the agreeable diversion of finding out, for example, what they would get for dinner, or whether they would have any dinner at all.

Opportunities for study lay not only at their very doors but within them! One day when I lunched with them two palm tanagers kept entering through the windows to catch spiders; and when one of the birds dropped a spider Beebe carefully preserved it as a sample of their diet. As we sat at lunch, through the unglazed window we saw in the top of a palm, only a few yards away, the nests of palm tanagers and moriche orioles. The birds were nesting, and were flitting in and out. In the same tree-top were perched gray-headed king-birds, and the noisy ques-que-dit, all on friendly terms. After nightfall bats flitted through the rooms, and my zealous friends were gravely discussing whether it would be possible for

one of them, by leaving one foot exposed as bait, to get a flash-light picture of a vampire sucking blood. This plan was

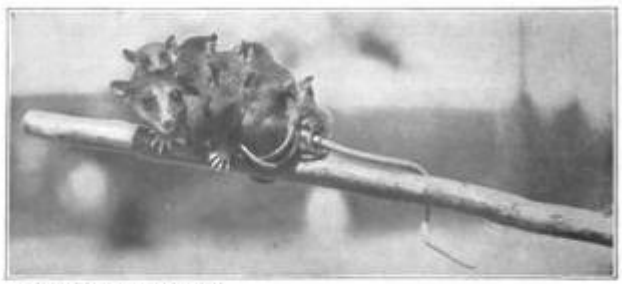
From photograph by P. G. Howes.

Vampire bat shot in Kalacoon house in evening

rejected as impracticable. But while I was in their neighborhood they passed one evening of agreeable diversity. Four of them were hard at work around the lamp in the large, open, dark room, sketching, making records of the day's observations and results, and giving the last touches to the specimens collected; while the fifth, who was a crack shot, lay in a reclining-chair, almost on his back, and from time to time shot at some overhead bat which he hoped was a vampire. This sporting proceeding in no way disturbed the students of either sex on the evening in question; by the way, only one of the sacrificed bats proved to be a vampire.

All kinds of beasts abounded in the neighborhood. One of the commonest was a small opossum. The female had from eight to a dozen young, which she carried on fier back even when they were so well grown that their aggregate weight was over double what she herself weighed. As for the birds, their name was legion.

Beebe is a field naturalist of wide experience, and, in addition to various other trips in tropical and subtropical lands, he spent a year and a half (thanks to the generosity of Mr. Anthony R. Kuser) in a first-hand study of the wild pheasants of Asia; a group which is probably more interesting than any other, taking into account the size of the birds, the beauty of many of them, including the peacocks and argus pheasants, the wide variety in appearance, habitat, and habits of the various species, and their economic and æsthetic importance combined. Recently, while at work in the Amazon valley, his experience convinced him that the state of our knowledge of tropic-life forms warranted a complete departure from the time-honored methods of the collector and museum worker, and the attempt to embark on a scientific enterprise along lines as interesting as they are ab-



From photograph by P. G. Howes.

Marian opossum and ten young

They weigh two and a half times the weight of the mother. Common in stumps and hollow trees.

solutely new. After some rather aimless roaming he tried restricted and intensive observation: first, by a week's study of a particular cinnamon-tree, bearing ripe fruit, during which week he observed no less than ninety-seven species of birds from the canvas chair in which he lay; and, second, by digging up two square yards of jungle soil, under the tree, and thoroughly examining all its minute life. As regards the birds, he unhesitatingly shot any which it was necessary to identify—he is not a sentimental dilettante, and knows that it is absolutely essential to have specimens in the hand if there is the least doubt as to the species; but he treated collecting not as an end, but as a means to the end of studying their life histories. As regards innumerable birds the life histories are enthrallingly interesting and yet practically unknown, whereas the skins are so well known that additional specimens are of value chiefly to those ornithologists whose enthusiasms and interests are fundamentally the same as those of stamp-collectors. The two square yards of jungle soil yielded an astounding number of small or minute invertebrate forms, including not only many new species, but some very remarkable new genera.

From photograph by P. G. Howes.

Three nestling dusky parrots.

Mr. Beebe thinks he has distinct evidence of teeth in these.

Partly as a result of this experience, among many others, and partly as a result of a growing conviction that an altogether undue importance is attached to the mere cataloguing of species and subspecies, and to the collection of large series of skins of forms already well known, or only differing in minute points from those already well known, Mr. Beebe and his backers and associates determined to try a new kind of first-hand field investigation. The prime object was to secure ample facilities for the study of the evolution and life histories of various vertebrates, especially birds, and of various invertebrates, taking up various problems of embryology, of development, and of habit which can only be studied successfully in the jungle or by the aid of living material fresh from the jungle. A secondary object was the gathering of live creatures for the New York Zoological Park and Aquarium. The place chosen was conditioned primarily by the need of being in the tropics on the mainland, or on a large continental island, with an abounding and varied animal life within a radius of two or three hundred miles; and secondarily by the desirability of securing healthy living conditions. Demerara met both needs. It is classic ground for naturalists because it was here, a century ago, that Waterton met with the experiences which he chronicled in his "Wanderings," the first book ever written which was devoted to the work of a field naturalist in the wilderness. The animal life, especially of birds, the lower vertebrates and insects, is wonderfully full and varied. The conditions of life and work at the zoological station, as established by Beebe, are pleasant, healthy, and safe. The danger from poisonous snakes is dis-

tinctly less than the danger from automobiles in a land of joy riders. Mosquitoes and other flying pests did not exist at Kalacoon when I was there; and, although there are many places where they can be found in Demerara, there are many such places equally bad within a radius of fifty miles of New York. Life under the conditions obtaining at the zoological station is wholly different from the life necessarily led by the first explorers, who face starvation and disease and the extremes of toil and hardship in the untrodden wilderness. The Mississippi valley was, in parts, very unhealthy when the first explorers and pioneer settlers penetrated to it; and so was the South American wilderness. Nowadays there are large parts of the latter which are almost or quite as healthy as most of the former.

Kalacoon has many advantages from the naturalist's standpoint. Beyond it, south, well-nigh to the Amazon, stretches what is still, throughout most of its extent, a virgin wilderness; and yet to the north civilization is at its doors. It lies in a big clearing, which holds the birds of the clearing, and at the farther side of the clearing rises the untouched forest, the edge of the mighty equatorial forest of America, with its abundant and peculiar fauna and flora. A great tropic river lies at its doors, so that the riverine life is added to the life of the clearing and of the towering woodland.

The creatures of the open swamps and flat, marshy plains must be sought nearer the sea. When Beebe and I drove through the sugar-cane country, near the ocean, we saw many waterfowl and waders of various species. Herons were plentiful, and the coloration, and the habits as affected by coloration, of these common birds invite the attention of competent observers whose object is to get at the facts and not to bolster unsound theories. The three commonest herons were the two white egrets and the tricolor heron—which is akin to our so-called Louisiana heron. The two former possess a strikingly advertising plumage; at any and all times and seasons, and under all conditions, they are so conspicuous as to challenge attention. The tricolors were not only relatively far less conspicuous, but under certain of the circumstances of their daily lives it might fairly be said that their coloration tended to make them

From photograph by P. G. Howes.

Akawai Indian woman and child.

Her husband, Daniel Jeremiah, kept Beebe's party in fresh meat for two months. When he calls all his Indians by name it sounds like a saints' calendar. Every necessity and luxury of an Indian life, year after year, is in this picture.

From photograph by P. G. Howes.

In the Guiana forest.

One huge buttressed tree keeps all the surrounding ones small, waiting for the giant to fall to give them their full need of light and air.

escape notice. But, so far as our superficial observations went, there was no difference in habit—the coloration, whether revealing or concealing, was seemingly a negligible factor in their life, success, and survival. Yet certain other herons, the bitterns, do skulk and hide, are inconspicuously colored, and seemingly profit by their coloration. These facts are worth study on the ground. Seemingly some herons which are advertisingly, and others which are, on the whole, concealingly, colored, have the same habits, and never seek safety by eluding observation; others are concealingly colored and try to elude observation. Are these the real facts? If so, is there any explanation? The answers can only be returned by field study.

Some of the familiar birds of the clearing will repay further study. This is perhaps especially true of the big ani blackbirds. They look like big grackles,

with high, short beaks, and live in the meadows and in open bush, accompanying the cattle like cow-buntings. Their nesting-habits are extraordinary. Apparently the genus has become demoralized and is in a state of flux as regards nesting. Now and then a pair will make a nest for themselves in orthodox fashion.

From photograph by F. W. Urich.

Scene along the Northern range.

Often, after such a nest has been begun, another female will come along and deposit her eggs in it; and then perhaps another, continually enlarging the nest, until one such nest contained twenty-eight eggs, while over a dozen old birds took part in brooding the eggs and feeding the nestlings; and I have heard of much larger numbers. There is a wide margin of difference in the size both of the birds and of the eggs; altogether it is a queer bird, in an unstable condition. Certainly this is a case where close field observation will develop interesting features in the birds' life history.

Of course, as regards other, and delightful, birds, where the habits are more normal, I suppose there will be little to learn. This may be true of the ques-que-dit king-bird, but it is a bird of so much character and individuality that I wish it could be carefully studied anyhow. It is practically the same bird which the Brazilians call ben-te-ví and which extends far south into the Argentine. It is a big, truculent, noisy king-bird, olive above, yellow below, with black-and-white stripes alongside the head. It incessantly utters its loud, three-syllabled cry, from which—with a difference of interpretation—it gets its various vernacular titles throughout Latin America. It is bold and familiar, living in the gardens and round the houses. The tanagers and orioles, of many different species, suggest their kin folk of our own orchards and lawns, but with marked differences; many of the orioles, for instance, nest gregariously. Other birds are apparently identical in habits with their Northern representatives. This seemed to be true of the house wren and yellow warbler, two of the friendly and intimate little singers of Demerara.

As soon as we left the clearing we entered the vast woods. While in them we usually either followed the road which led from Mr. Withers's rubber-plantation to his lime orchards half a dozen miles distant, a road over which he drove his automobile; or else travelled the long trail of the gold-seekers, which crossed the automobile road almost at right angles. These two trails, by the way, rendered it easy to find one's way back, by means of the compass, even if for the moment puzzled as to the direction when in the pathless forest; and as one could walk along them easily and noiselessly they offered special advan-

tages to the observer. In thick woods even an Indian finds it hard to approach game unnoticed, and usually gets it by lying in wait for it or else by patrolling the river and sending his dogs into the woods to chase the hunted animal into the water. In the forest we came on a small, rude platform, which some time previously had been built by Indians for a game ambush. Doubtless at that time a game trail passed it. It consisted of a couple of poles lashed to a tree-trunk with tough creepers, at a height a little above a man's head. On this platform the Indian crouched and waited, with the motionless patience of the savage, until tapir or deer or peccary or paca came along; for if there is no movement by the watcher, and especially if he is raised above the ground, even although only a few feet, animals are apt not to observe him.

From photograph by J. B. Rorer.

Cross surrounded by flor réal, erected by country folk at wayside on road to guacharo cave.

In the heat and moisture of the tropics the struggle for life among the forest trees and plants is far more intense than in the North. The trees stand close together, tall and straight, and most of them without branches, until a great height has been reached; for they are striving toward the sun, and to reach it they must devote all their energies to producing a stem which will thrust its crown of leaves out of the gloom below into the riotous sunlight which bathes the billowy green upper plane of the forest. A huge buttressed giant keeps all the neighboring trees dwarfed, until it falls and yields its place in the sunlight to the most instantly vigorous of the trees it formerly suppressed. Near the streams the forests are almost impassable, so thick is the tangle below; but away from the streams the walking is easier, because only a few bushes and small trees grow in the perpetual shade. To the newcomer one unending wonder is the mass of vines, the lianas or bush-ropes; everywhere they hang from the summits of the trees, or twist round the trunks, or lace them together. A few kill the trees; most seem to do them no damage. Some are huge, twisted, knotted cables, dragging down the branches around which they are wrapped, and themselves serving as supports for lesser vines that twine around them. Others stretch up, up, as straight and slender as the shrouds of a ship, until they are lost overhead in the green ceiling of interlocked leaf and branch. Of most of the trees I did not know the names; but among the tallest were the mora, with huge flying buttresses, and the greenheart, with its white trunk. It was unending pleasure to walk through the towering forest. In the shade it was always cool even at midday. There was no wind. All sounds seemed faint and far away. Under the solemn archways of the trees it was dim and mysterious, like some great cathedral at dusk.

From photograph by F. W. Urick.

The bushmaster.

Among poisonous serpents it is only rivalled in size by the diamond-back rattlesnake and by the hamadryad.
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Outside, in the clearing, it was very hot as soon as the sun was well above the horizon. But in the early morning and late evening it was attractive, and of course the glory of sunrise and sunset and

the splendor of the great stars at night were only to be had in the open. Moreover, the flowers of the open were wholly distinct from those of the deep forest, and were, on the whole, more lovely. One of the most striking was a great crimson passion-flower that closed in the heat of the day. Indeed, in the blinding glare of the hours around noon, all the life of the open spaces sought cover and was silent and motionless; whereas in the forest, although there also the noontide is a time of rest and quiet, yet even then there is always some life stirring.

To an unobservant man, walking quickly and rather noisily through these great woods, they seem empty. But as a matter of fact they teem with life. This life is shy, however, and patience, caution, and quick eyes are needed by the observer. The furred things he will rarely see, save by chance. Once, before sunrise, we heard from our bedroom howling monkeys in the distance; near by the sound is a kind of savage roaring, really impressive, which suggests some huge and terrible beast of prey instead of a medium-sized monkey. I caught a glimpse of a big black-and-white tayra weasel crossing the path ahead of me; but this was the only mammal I saw. With birds it is a different matter. When Beebe and I were walking through the forests, always slowly and with little noise, we continually heard bird songs, even while we were moving, and when we stopped we were sure, after a short time, to catch faint twitters and chirps. Generally Beebe could tell me what the birds were. The more conspicuous ones, and those easily recognizable because of some quality in their cries, I often knew myself—toucans or parrots, for example, and the big, showy woodpeckers. One bird was an old friend. He is one of the cotingas, dull-colored and about the size of a thrush. He sits motionless in the forest, about half-way up a tree, and utters at not very long intervals a loud, ringing, explosive call, a hurried, rather musical and arresting sound of three notes. This bird I had seen in mid-Brazil, and, not knowing exactly what he was had christened him, inappropriately, the false bell-bird. The Brazilian rubber-gatherers knew him well—his voice insures the attention of every passer-by—and called him the "rubber bird," insisting that wherever he called rubber was to be found. Here in Guiana he was credited with similar insight in the matter of gold, and was dubbed gold-bird accordingly. And gold-bird I shall call him.

But my knowledge of the birds was limited to those that were showy and noisy; and even as to these I made mistakes, as when I confused the note of a big oriole with the loud cooing of one of the forest doves—of which there were several kinds, all utterly unlike the little ground-dove which was underfoot everywhere in the open. Beebe, on the contrary, also knew the inconspicuous birds—the ant-thrushes, wood-hewers, and the rest—which were often the most interesting. He carried his gun, and realized that collecting was important on occasions; but collecting with him was merely an aid to the real work of observing; and, thank Heaven, he is not only a first-rate observer, but a writer able to record his observations. What he writes is not only readable and interesting; it also possesses both charm and distinction. Moreover, he is a man of such broad interest and cultivation that he sees his own particular facts in relation to all their surroundings.

Beebe's walks with me were a mere diversion; indeed, he and his associates had only just moved in, and were barely settling down to their serious work, so that what they had already done and observed represented a mere hint of what was to follow. I was making too much demand on him for information about what we saw and heard to permit him to study anything new. Only twice did he have to resort to the gun. In one case the bird proved to be an ant-thrush. In the other case we heard a peculiar three-note call, like a jew's-harp, in the thick forest near by. It did not sound like a bird, and at first we thought it was a cicada, or tree-frog. But after some minutes' search Beebe saw the performer, an obscure little bird which perched motionless some twelve feet from the ground most of the time, only occasionally shifting its position. He could not make out what it was, and accordingly shot it. It was a small, yellow-crowned flycatcher. We afterward heard several. Beebe has now identified it. He will shoot no others; he will do all he can to find out its habits;

and even the scanty facts we had gleaned were more than were recorded in the only books to which he had access, for these contained merely the description of the skins brought in by some collector.

From photograph by C. G. Hewes.

The jungle of Guiana.

Supreme above all Eastern jungles, holding secrets of evolution beyond all our wildest guesses.

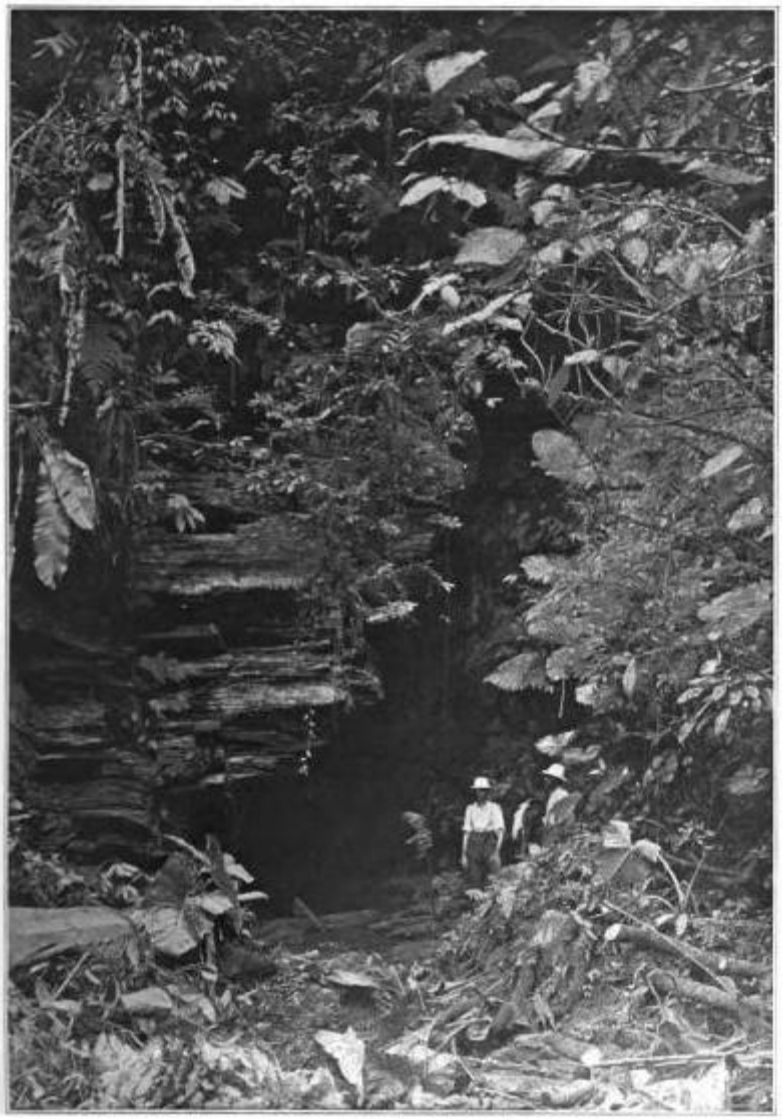
Already the experiences of the naturalists had raised all kinds of interesting questions. For example, many of the observations indicated differences of habits in closely allied forms which are at present inexplicable, and many more observations are needed to show whether these differences are real or are merely the accidents of individual observation. Some of them related to peculiarities of life history that are extremely strange. For example, they had found half a dozen nests of one little bird, the streaked toady flycatcher, every one of which was built near a nest of the formidable polybia wasp, an irascible fighter near whose home few foes of nestlings and eggs care to venture. But the nests of the closely related ashy toady flycatcher, which they found, were never in such positions. Further observation must determine whether this difference in nesting-site is invariable—whether one little bird always, and its close kinsman never, takes advantage of the neighborhood of so dangerous a protector. The mutual understanding or tolerance between the little bird and the big wasp is sufficiently remarkable; and observation must try to determine whether only one of the two closely related little birds really has the habit, and whether anything can be gleaned as to the effect of this habit on the bird's other habits and on its success in life relatively to the other. What has

been already observed in this case is a mere foreshadowing of what Beebe and his comrades hope to find out by observation, carried out at length, of these birds, beasts, and insects, in their native haunts under their natural surroundings; and surely such observations are far more valuable and important than *mere* collecting—as distinguished from that limited and purposeful collecting which is a necessary part of such observation.

Mr. Roosevelt and his two companions at the guacharo cave

As regards vultures, collecting is at present an indispensable prerequisite to the work of observation. They are not attractive birds to collect, and so have been let rather severely alone, with, as a result, much confusion as to not only the habits of the different species but even as to their identity, and as to such points as the colors of their naked head-skins, which fade after death. Again, there are many birds—the hoatzin and ani, for instance—where careful embryological study is necessary in order to get some hint of the ancestral development which has resulted in the existing physical peculiarities.

Of many species which are well known in collections and in the woods, we as yet know nothing as regards some of the most important features of their life history. The toucans, for instance, are among the most conspicuous and wide-spread of South American birds; every traveller has seen them in the forest, every museum possesses the skins of dozens of species and subspecies. But no one had ever studied their nesting-habits. Beebe intended to supply the lacking knowledge; and, after I left, his party discovered the nest and eggs of one species of toucan. The nest, a hole in a tree, contained two white eggs, and in them were curious long-tailed embryos. In some nestling parrots Beebe discovered traces of teeth, a reminder of the days when the Age of Reptiles was at its height and all the birds had teeth. All kinds of queer things are to be found out in connection with the nesting of tropical birds. Once Howes had found the nest of a grallaria, a passerine ground-bird, with short tail, long legs, and a loud, whistling voice. It was by a stream. The eggs—previously unknown—were three in number, white with fine reddish-brown spots. The nest was on a big boulder, by water. It was lined with the scales of the tree-fern, and the walls and bottom were composed of very fine green fern tendrils, still alive, which were interwoven with the ferns growing on the boulder, so that the nest itself was actually growing. Another time he found a colony of humming-birds nesting under a bridge; the nests, some fifteen in number, were placed close together and were fastened to the rafters by moss, not mud.



Entrance to the guacharo cave, Trinidad.

Howes's real concern, however, was with insects. He was already busily at work. The fascinating leaf-carrying ants had of course attracted him. He had found a colony which seemed to be carrying on its work by relays—sufficient time has not elapsed to make his observations more than provisional. Some of the ants had ascended a tree, and cut off many leaves which dropped to the ground. Here other ants took them and carried them to a spot in the road where they made a pile of them; and from this heap they were removed by yet a third set of workers. He had just run across a wasp which was closely related to one of our paper-making wasps, polistes, but which built a mud nest containing one or more cells and fed its young almost as a bird would. It brought to the larval grubs live geometric caterpillars. It did not chew them up and feed them to its young piecemeal, as some of our wasps do, nor, as is the habit of others, paralyze them and store them up in a sealed cell with the larva, but fed them to the larva one at a time and alive.

Guacharo eggs and nest.

Young guacharo in nest.

Taken as a whole, this zoological research station offers a chance for original and productive work such as has not hitherto been even attempted. It represents the effort to strike out on a new line, and the results may be, and I think will be, of the utmost value. It always needs both boldness of conception and very hard work to carry through anything which is entirely original; people naturally like to do both their thinking and their acting along the grooves with which they are familiar. It is earnestly to be hoped that public-spirited laymen who are interested in science will continue to back the undertaking, which has been rendered possible only by the generosity of five of their number. It is also to be hoped that in addition to the present director of the station and his associates, other naturalists, trained in both the study and the field, will go down to the station to carry on investigations into special subjects. No man should go unless he is thoroughly trained in both types of work—enthusiasm is not a substitute for training, nor training for wide intelligence. But Messrs.

Osborn, Hornaday, and Grant, who are responsible for starting this research station on the edge of the great tropical wilderness, have announced that they will welcome to it all biological investigators of the right type, and the chance is too good to be lost. The government of British Guiana, with characteristic broadmindedness, is granting every facility to the station; and the generosity of Mr. G. B. Withers has given it excellent quarters without cost.

From photograph by F. W. Urich.

Two guacharo birds sitting on a nest in the cave.

In Trinidad, whither I went after leaving Demerara, I met several out-of-doors naturalists. One of them was Mr. Eugene André, the botanist, who in his exploration of the Cana River, in Venezuela, so nearly lost his life; for the genuine explorers of his stamp, who penetrate into the untrodden tropical wilderness of South America, risk the extremes of hazard and hardship. He took me to see Mr. R. R. Mole, who has made a special study of the snakes of Trinidad. He possessed living specimens of a dozen different species, and also of the huge bird-killing spider, and of centipeds a foot long; these sinister invertebrates were fed chiefly on large cockroaches, but they attack small vertebrates without hesitation, and in several instances, of which the details were given me, my friends had seen both the giant spider and the giant centiped kill mice and lizards.

Among the snakes were fair-sized boa-constrictors and anacondas; the latter were said to be much more irritable than the former. Anacondas, moreover, grow to a much larger size. Some species of snakes feed only on certain kinds of animals—mammals, or birds, or reptiles, or insects—and even only on more limited groups, as, for example, on other snakes or on frogs. Other species eat indiscriminately all living things of suitable size. Others when young feed on entirely different animals from those they kill when full grown. Yet others vary individually for inscrutable reasons. Thus some of Mr. Mole's boas would eat only rats, and others would eat only rabbits. The big anacondas, when hungry, mastered formidable things. A nine-foot anaconda in his possession swallowed a three-foot alligator; and in the stomach of a fifteen-foot anaconda he found the teeth of an alligator which must have been over seven feet long. Some young boas would eat only lizards.

I was much interested at seeing a representative of my old Brazilian friend, the mussurama, the devourer of other snakes, poisonous or non-poisonous. I asked Mr. Mole if it paralleled the friendliness of the Brazilian form to men; he in answer opened the cage containing it and handed it to me to hold. This is by no means the only snake-eating snake in Trinidad; there is also the cribo, which is said likewise to be immune to poison, but which is a less finished killer than the mussurama.

I was especially interested in the two most deadly of the poisonous snakes: the great bushmaster, which among poisonous serpents is only rivalled in size by the diamond-back rattlesnake and by the hamadryad; and its smaller but fiercer and more nervous brother, also belonging to the genus Lachesis, the jararaca, known in Martinique as the fer-de-lance. These ordinarily bring forth their young alive, but a big female bushmaster in Mr. Mole's possession had produced a number of eggs, and brooded them in ordinary snake fashion. The bushmaster is a

snake of rather sluggish temper, which dislikes to run, and it is formidable because of the immense quantities of poison which it spirts into its victim through the hollow fangs, which may be an inch and a half long. A Trinidad gentleman whom I met, a devoted hunter and lover of wilderness life, Mr. Arthur B. Carr, had dealt much with the species, and had once nearly lost his life from the bite of an individual. He said that this snake was active at night, and that in the daytime it slept, or at least lay still in such sluggish fashion that it was difficult to rouse. If in the daytime a man stepped on one, it would bite him unless he showed extraordinary agility. But if he brushed by it, it would only partially rouse itself; if his companion brushed by, it would become more alert but would probably not strike; but if several men were thus travelling in single file it would almost infallibly strike the third or fourth man. It would also strike repeatedly, not being one of those snakes whose poison is speedily exhausted; in one instance a single individual struck four hunters' dogs in quick succession, killing them. One which was put in a cage with a rattlesnake struck it, and the rattler died of the poison.

It feeds on possums, agoutis, and the like. It goes into burrows, or holes, and it was owing to this fact that Mr. Carr nearly lost his life. He had chased a paca into a hole, and digging after it for some feet he found the paca and killed it, and to his surprise found that the hole continued. He did not then know that when a paca is thus chased into a hole, and finds the end occupied either by a snake, a peccary, or another paca, it will stay halfway down and permit itself to be killed rather than go to the end. He thrust his cutlass into the hole as far as his arm would reach, and touched something which yielded slightly. Again he tried, and moving the cutlass up and down found that the thing had scales—an old and big bushmaster has rough scales—and concluded that it was an armadillo. Again he thrust in, and this time the head of the aroused and angered bushmaster flicked out and struck his hand. He had received from Venezuelan Indians with whom he had hunted a decoction of plant-juice which they asserted to be sovereign against such snake-bites, and he always carried some with him; he now drank it and also slashed the wound, and although he was very sick he recovered. Recovery from the bite of the bushmaster is rare. He tried the remedy subsequently on snake-bitten animals, and saved several. It would certainly be interesting to make scientific experiments with this supposed remedy.

The jararaca is in places fairly plentiful in Trinidad, as it is in Demerara, and in both cases causes some not very important loss of life. In the Antilles proper it is found only in Martinique and St. Lucia, where it was formerly a veritable scourge. In both islands the mongoose was introduced to check it, and the experiment was completely successful, the snakes having now become so scarce that they are no longer a serious menace. In Martinique I visited a hospital, and happened to ask if they had many cases of snake-bite. One of the directors, a white-haired man, answered that they had very few indeed, because

From photograph by F. W. Urich.

Ledge of rock in cave showing guacharo nests.

the mongoose had almost exterminated the fer-de-lance; whereas in his district, when he was young, before the mongoose was introduced, no less than forty per cent of the total deaths were from snake-bite.

On all the other islands where the mongoose has been introduced, I was informed that it has become a veritable scourge, killing chickens, exterminating ground-birds, etc. In Trinidad it had not had much effect, although on the whole obnoxious; in Demerara I was told that it had had no perceptible effect at all.

The guacharo bird.

These facts, as regards both the poisonous snake and the carnivorous, snake-eating mammal, indicate how much disturbing effect in an island with a limited fauna, and how little disturbing effect on a larger land mass with a large and varied fauna, the introduction of the same new species may have. In Demerara and even in Trinidad, the jararaca had numerous rivals and enemies and never attained more than a limited importance; in the two islands it had neither rivals nor enemies and was a very abundant and most formidable pest. The mongoose on these two islands did its work well and almost exterminated the snake, a feat of capital importance; on the other Antillian islands it found no poisonous snakes and, being without rivals or enemies, became itself an intolerable pest; in Demerara and Trinidad it found itself in a large and varied fauna, it found both rivals and enemies, and it neither seriously diminished the poisonous snakes nor itself became a serious pest.

Carr related his experiences with the coral-snakes, whose poison is, in equal quantities, more deadly than that of the jararaca, but which have much less of it and relatively small fangs. In the daytime he found this snake very sluggish and reluctant to bite. After nightfall it is active, searching for the small snakes on which it feeds. If a man then treads on it, or too close to it, it will bite at once, and if it strikes bare skin the wound is dangerous and often fatal. It does not, when about to strike, coil, like the bushmaster, jararaca, and rattlesnake, but lies in a loose figure eight or S-shape.

Carr had seen many interesting things in the woods. His chief success was when motionless and unseen he studied the ways of beasts and birds —as field naturalists worthy of the name should do. Once he heard some red howler monkeys and crept up to watch them unperceived. An old male sat high in a tree; half a dozen females were near him, and several young males were farther off, not venturing near. One of the females went toward the old male, mincing and showing off, pressing close to him; he uttered grunting sounds, not the loud roars of his dawn chant; but all the advances and caresses came from the female. She retired; two others took her place, showing off and stroking his cheeks; again he grunted, and received but did not return the caresses. For some minutes this went on; then the whole party came down to the ground to pick up some nuts.

I made an interesting trip with three friends—F. W. Urich, the entomologist, G. B. Rorer, the mycologist, and the solicitor-general, Archer Warner—into

Interior of the cave.

the northern mountains of Trinidad to see a guacharo cave. The guacharo is an extraordinary bird, akin to our night-hawk or whippoorwill but the size of a barn-owl, which is nocturnal, lives gregariously in caves, and feeds exclusively on hard fruits, that is, on the nuts and seeds of palms. Humboldt visited the great guacharo cave in Venezuela over a century ago, and in Trinidad there are guacharo caves in the sea-cliffs which can be entered only when the water is calm. Hornaday once visited these sea-caves; and both Chapman and Cherrie have since visited caves such as those which I visited.

We motored out some thirty miles, to a point where the governor had most kindly arranged to have horses meet us. Then we rode four hours back among the mountains to a plantation belonging to Mr. Francis Leotand, who had courteously arranged that we should sleep in a room of the overseer's house. It was a lovely ride. We saw blue tanagers and heard the songs of thrushes and orioles. There were repeated showers, and we were drenched before we reached our destination, but between times the sun almost dried us, and the rain made the brilliant green woods fairly glisten. Most of the time we rode under the primeval tropic forest, with its incredible wealth of strange and noble forms of plant life. Cecropias grew on the newly cleared soil. Moras sent out buttresses. Here and there a giant vine

had strangled some mighty tree. There was a wealth of ferns on the wet slopes. Orchids were numerous. Large blue butterflies and smaller red and black ones floated in the glades. In one part of the trail, although the sun was high, a bat flitted. Occasionally we passed clearings planted with banana-trees or cocoa-bushes, the excessively primitive house of the colored owner standing to one side. There were many different kinds of palms. One of the interesting trees or arborescent plants was akin to a wild pineapple. It holds water at the bases of the big, thick leaves, where they jut from the stem, and it is inhabited by a little fauna of its own, including a little frog and a lizard, and also, unhappily, a species of mosquito which breeds in swarms. In places the road zigzagged up steep mountainsides. Elsewhere it crossed brooks. From one point we had a wonderful view out over a magnificent forest-filled valley, a sea of billowy green, sprayed here and there by the orange foam of the immortelle-trees. Twice we came on high hillsides where there were bell-birds. These are not the true bell-bird of the mainland forests, which is snow-white with a voice like the tolling of a bell. They are dull-colored, with curious wattles on the throat, and their voices, although loud, are not musical. They perched in the tops of the tall trees, and sat almost motionless. Twice I saw one in the bare top of a dead tree, and watched it through my single-barrelled pocket-glass. The birds were very noisy, continually uttering their harsh, explosive call; in giving this call the neck was stretched straight out and the head thrown upward.

British Guiana, showing location of the naturalists' tropical laboratory at Kalacoon.

Early in the afternoon we reached the house of the overseer, a colored man. It stood on a hill in the midst of cocoa gardens and cocoanut groves. It was raised on stilts, with a piazza. One room, furnished with a table and benches, was given to us; in the other rooms dwelt the overseer and his family. A rough stable was near by, up a wet path; a couple of store-houses and two or three palm-thatched cabins, where the barefooted workmen dwelt, were close at hand; the cooking was done with a pot and an earthen fireplace in a big shed, which was open at the sides. The boundaries here, as elsewhere generally in Trinidad, are marked by dracænas, which sometimes grow twice as high as a man's head. Their topmost leaves are red, and they are boldly decorative; the Spaniards named them the "flor réal," the royal flower. On our route that morning, at a turn in the trail through the forested mountain, we had passed a shrine on the ground, where around the crucifix was planted a half-square of dracænas.

After lunch we went to see the guacharos. We followed a stream through cocoa plantations for half a mile, until we came to where it flowed out of a limestone cliff from a cave which was the guacharo home. Thick forest grew along and over the crumbling front of the cliff; and vines and creepers and wet rock-plants overhung the edges of the cave, partially obscuring it, while water-loving plants grew in front, some with enormous leaves. At the entrance, near which there lay large boulders, the irregular opening was perhaps fifteen feet across and rather higher. Out of it rushed the stream, here knee-deep, and covering the whole bottom.

With torches we entered the cave. It was hard walking, for the clear stream slid over sand, pebbles, and ragged-edged boulders, and might at one moment be ankle-deep and the next reach almost to our waists. The cave twisted, and we speedily passed out of the pleasant half-light of the entrance into obscurity. Immediately we began to hear the birds, and dimly to make them out flapping and fluttering above us. They uttered loud, growling cries, and also a continuous metallic clacking, and the naked young birds in the nests piped and wailed. It was all very weird, and I did not wonder that the superstitious black peasantry, who believe the woods and waters to be thronged with jumbies, should have christened these birds "diablotins" (the name once given in Martinique to nocturnal petrels which burrowed in the mountains). They will not enter the cave on Good Friday and, although they plunder the nests of the incredibly fat and oily young birds, which are used to eat and also to make oil out of, they regard the place as uncanny. But the birds are merely comic devilkins, poor creatures, are as harmless as they are curious, and should be carefully protected.

The cave must have been occupied for untold centuries, and the ledges and recesses in the sides, and the slabs of rock which were raised above the level of the water—in fact, every portion which was neither too steep nor water-swept—was covered inches deep, in some places a foot or two deep, with guano. The nests themselves, of which we soon began to see many, were on the ledges and in the crannies and holes; and when we were quiet the birds soon began to settle on them. They were made of the guano, being cup-shaped, with thick, raised walls. Some contained two to four short, pear-shaped eggs, white, but stained with the guano; others contained very fat, naked young. We saw the old birds brooding, sometimes one, sometimes both parents sitting side by side. They crouch like a whippoorwill or night-hawk; they do not perch erect, in the posture in which some museum specimens are mounted. We did not desire specimens and molested nothing.

A singular thing was that in the guano of the nests grew many fungi, slender things like reed-stalks, sometimes only an inch or two long, sometimes a foot or eighteen inches. They also grew elsewhere in the guano, and in places had matted it into a kind of peaty consistency. It seemed extraordinary that they could grow without any sunlight. There was a good deal of life in the place aside from the birds. There were many bats. Beside the water at one spot we found a toad the size of a bullfrog. Insects swarmed, including crickets, earwigs, and moths. Everywhere through the guano were the seeds and nuts of various species of palms; among the commonest were nuts nearly the size of betel-nuts. Some of these nuts were from kinds of palm which did not grow within ten or fifteen miles. The birds emerge from the cavern after nightfall, occasionally uttering their growling cries, and fly for long distances to their feeding-places, sometimes hovering in the air as they pluck the nuts, seeds, or fruits. Whether they also sometimes alight while they pluck them I do not know. They feed their young by regurgitation and live in the caves all the year round.

We went on and on, wading, clambering over the rocks, slipping and plunging in the darkness. At last, where the roof was still high, but getting lower, we put out the torches. There did not seem to be a ray of light, but this portion of the cave was still filled with the birds, which were flapping overhead and uttering their extraordinary noises; and when we relighted the torches we saw many of them on their nests. Farther in, however, where the roof became lower, only bats dwelt.

Then we halted, waded and clambered back to the entrance, and left the excited devilkins growling, croaking, and clacking behind us. It was late in the afternoon and we returned to the house. We dried our clothes as well as we could, but it was moist and rainy and they were still wet when we put them on next morning. We dined well on what we had brought with us. My companions had hammocks; I slept soundly on the table. Next morning the sunrise was glorious; the day was clear and bright and the ride homeward was pure pleasure.