LIFE HISTORY OF THE BLUE-THROATED TOUCANET

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IN spite of the general interest toucans have attracted since the days of Humboldt and even earlier, their habits, especially their manner of breeding, are little known. This is not surprising to one familiar with the difficulty of finding toucans' nests in the lowland forests and the unbelievably high proportion of nests in this environment that are destroyed by predatory creatures. Beebe (1917:183–209) described the nests, and the eggs or nestlings, of several species that breed in British Guiana; and Wagner (1944) recently published an account of the general habits, nest, and young of the Emerald Toucanet (*Aulacorhynchus prasinus*); but the only comprehensive life history of any toucan that has come to my attention is Van Tyne's "Life History of the Toucan *Ramphastos brevicarinatus*" (1929), which follows the nesting stages of the Rainbow-billed Toucan from egg laying through care of nestlings (until these were 36 days old, when they were destroyed by a predator). In Costa Rica, from July, 1937, to August, 1938, I observed the Blue-throated Toucanet (*Aulacorhynchus caeruleogularis*), which is the subject of the present study.

RANGE

Most of the toucans, particularly the largest species, dwell in the warm forests at low altitudes. In Central America the big toucans of the genus *Ramphastos*, and the middle-sized aracari toucans of the genus *Pteroglossus*, are still fairly abundant in various localities at 3,000 feet above sea-level, and are found occasionally as high as 4,000 feet, but scarcely ever above this level. At the higher elevations, the toucan family is represented only by the little green toucanets, of which two species occur in the Central American region.

The white-throated Emerald Toucanet dwells in the mountain forests from southern San Luis Potosí to northern Nicaragua. In Guatemala, where the bird is called "cucharón," I found it ranging vertically from heavy, subtropical forests, 3,500 feet above sea-level, to the temperate-zone woods of oaks, pines, and cypress, and even up to 10,000 feet above the sea. Van Tyne (1935:25) encountered toucanets of this species, although of a distinct race (*virescens*), among the lowland forests of El Petén, less than a thousand feet above sea-level.

In southern Central America, the Emerald Toucanet is replaced by the Blue-throated Toucanet, which is similar in appearance but has a blue instead of a white throat. It ranges from northern Costa Rica to Veragua, Panama. In the former republic it is quite generally known by the name "curré." I have met it on rare occasions as low as 3,000 feet on both the Caribbean and Pacific slopes of Costa Rica. Carriker (1910:577) states that it ranges down "to about 2500 feet on the Carib-

bean slope and perhaps a little lower on the Pacific." I doubt the second part of this statement, at least in so far as it may refer to southern Costa Rica; for during five years in the Basin of El General, I have only very seldom met the toucanet (and then only in the non-breeding season) as low as 3,000 feet, and I have never seen it in the forests about my house, 500 feet lower. As to the upper limit of the bird's altitudinal range, I found it at 6,200 feet in the Tablazo Mountains, and at 7,600 feet on the forested northern slopes of the Volcán Irazú. Carriker states that it occurs up to "at least 6000 feet." The absence of records of the toucanet at higher altitudes is to be explained, I believe, by the meager amount of ornithological work that has been done there. I should not be surprised to find it even at 10,000 feet in the oak forests on the Cordillera de Talamanca.

Description

The Blue-throated Toucanet, smallest of the Costa Rican toucans, is a bird about the size of a pigeon. Its plumage is chiefly green, in moderately bright shades, but not glittering or metallic. The throat and lower cheeks are blue; the under tail-coverts and the tips of the rectrices, cinnamon. The bill, though far smaller than those of the big lowland toucans, is huge in proportion to the body and is adorned with four colors. The greater part of the upper mandible is yellow with a slight greenish tinge, but its base and cutting edge, as well as the entire lower mandible, are black. There is a small patch of dull red at the base of the culmen. The bill is outlined, where it joins the head, by a broad white line. In the Blue-throated Toucanet the sexes are too similar in appearance and voice to be distinguished in the field.

General Habits

The toucanets travel in small, straggling flocks, which rarely consist of more than six or eight individuals. Not infrequently a lone bird is met. Although the mossy mountain forest is their true home, they wander through adjoining clearings where there are scattered trees, and often nest in such situations. They are restless, excitable birds, and scold a human watcher in tones which at times resemble the chatter of an angry squirrel. Their language, although varied, is nearly always unmelodious—throaty croakings and harsh rattles are the utterances one most frequently hears from them. But during their nesting season, they at times give voice to softer, more appealing sounds. Their food is like that of other toucans, consisting of a number of fruits and insects, varied now and then with the nestling of some other bird.

Study Area

My study of the nest-life of the Blue-throated Toucanet was made between July, 1937, and August, 1938, near Vara Blanca, on the northern slopes of the volcanic Cordillera Central of Costa Rica, at altitudes

between 5,200 and 5,600 feet. The house which I occupied stood amid pastures on the back of a narrow spur; but the pastures were bordered on three sides by heavy forests which dropped off abruptly into profound ravines, the one to the east a gorge about 500 feet deep, with the rushing Río Sarapiquí at its bottom. In my life histories of two neighbors of the Blue-throated Toucanet, the Quetzal and the Prong-billed Barbet (Skutch, 1944 *a* and *b*), I have described the climate of this storm-beaten, mist-shrouded region of high humidity, and its lofty forest giants burdened with an incredible profusion of epiphytes ranging in size from mosses and liverworts, through ferns, orchids, and aroids, to shrubs and even fair-sized trees.

Population

When I arrived at Vara Blanca in July, I found the toucanets exceedingly abundant, roaming in small flocks through the forests and shady pastures about the cottage. But thereafter they became increasingly rare, and in September and October I saw very few. It is not impossible that they had dropped down to slightly lower elevations; my own experience in El General, where I have seen them between 3,000 and 3,500 feet during the non-breeding season, would lend weight to this supposition, and Wagner (1944:68) describes marked altitudinal migrations which the Emerald Toucanet makes to escape the extremes of the rainy season in Chiapas. But in a country where there are scarcely any observers of birds, and travel, in most directions, is slow and exhausting, variations in the local abundance of a species are difficult to interpret. Possibly the Blue-throated Toucanets, without going elsewhere, had merely become quieter and more retiring during the wet and gloomy closing months of the year. I was absent from Vara Blanca during most of November and December, 1937, and during the intervals I spent there the weather was most unfavorable for bird-watching. During the opening months of 1938, however, the toucanets gradually became more noticeable among the local birds, and by March, when their breeding season approached, they were once more abundant and conspicuous.

The Nest

All toucans, so far as we have accurate information, nest in unlined cavities in trees. The biggest toucans (*Ramphastos*) are forced to hunt out spacious natural hollows, since none of their hole-carving bird-neighbors are large enough to provide for them. The middle-sized aracaris sometimes take advantage for nesting—and frequently for sleeping—of the holes excavated in dead trees by the biggest of the woodpeckers, such as the Guatemalan Ivory-bill (*Scapaneus guatemalensis*) and the Pileated Woodpecker (*Ceophloeus lineatus*). The nest-cavity of one of these woodpeckers will accommodate five slumbering adult Frantzius' Aracaris (*Pteroglossus frantzii*). The little toucanets find ample room for rearing a family even in nest holes as small

as those of the Hairy Woodpecker (*Dryobates villosus*), though they must enlarge the doorway. Wagner (1944:71) reports that the Emerald Toucanet nests in holes of the Green Woodpecker (*Piculus rubiginosus*) in Chiapas.

I have been unable to make an exhaustive search through the literature; but so far as I know, the only previous record of the nesting of the Blue-throated Toucanet is found in the following brief paragraph by Carriker (1910:577): "They breed in holes in trees, usually abandoned nests of *Campephilus* [*Scapaneus*] *guatemalensis buxans* or even *Chloronerpes yucatanensis* [=*Piculus rubiginosus*]. I have not seen the eggs, but nests examined at Juan Viñas in May each contained two young."

The six occupied nests of the Blue-throated Toucanet that I found at Vara Blanca were placed at heights ranging from 7 to about 90 feet above the ground. Five were in dead or dying trees standing in clearings with woodland near by; the sixth was in the woods near the edge of a clearing. In this connection it should be noted that, since the nests in the clearings were so much more readily found and so much more satisfactory for watching, I made no thorough search for others in the forest, where many were undoubtedly located. Apparently all six nests were in holes made by woodpeckers. The entrances were oval in form, considerably wider than high. The doorways of the three low nests ranged from 2⅛ to 2½ inches in width and from 1¾ to 2 inches in height. The one nest for which I have a measurement of internal capacity extended to a depth of 18½ inches below the lower edge of the doorway. In none of the accessible nests was there any lining; the eggs rested upon a layer of fine wood particles in the bottom.

My first nest was found on April 17, 1938. It was situated about 30 feet above the ground, in what appeared to be an old woodpecker hole in a barkless trunk of a cecropia, just within the edge of the forest, close by a pasture. Since the tree was unsafe to climb, I made no attempt to examine the interior of the nest; but I repeatedly saw the male and female replace each other in it, and judged that incubation had already begun. By May 6, the parents were taking food into this cavity for the nestlings.

Another nest was found on May 5, when three of the four eggs had just hatched, and the fourth was on the point of hatching. Since the incubation period (as subsequently determined) is about 16 days, and the eggs are laid on successive days, egg-laying in this nest must have begun about April 16. These two nests, then, indicate that in 1938 the nesting season at Vara Blanca began about the middle of April.

I was able to watch a third nest from the beginning of egg laying. I passed the morning of April 23 in my brown wigwam blind, which was set in the pathway that went round the ridge, with the pasture above it and the forest below. The purpose of my vigil was to record the activities of a Collared Redstart (*Myioborus torquatus*) in a nest

set in a niche in the mossy bank beside the pathway. On the steep slope above the bank stood an old decaying stub, in the side of which, only seven feet above the ground, was an old hole, possibly the work of the Green Woodpecker. A pair of toucanets were interested in the cavity; and while the warbler sat quietly on her eggs, I could watch their activities at close range.

From time to time during the morning, one of the toucanets went to cling before the doorway of the hole and look in; it would sometimes remain in this position for several minutes, sometimes for less than a minute. While one of the pair was at the woodpecker hole, the other sometimes clung to a vine that dangled from a leaning trunk close by. On these occasions, the toucanets uttered very soft, low, murmurous sounds quite different from their usual frog-like croaks and dry rattles. The murmurs were produced in the throat, with the bill quite closed, and when I first heard them I was puzzled to account for them, since I had never heard a toucanet deliver such sounds. They voiced these soft, amorous notes not only while one was at the hole, but also while they rested in the low trees above me.

When a squirrel climbed over the base of a large trunk near by, one of the toucanets flew at it with angry sounds and drove it away. But when the rodent, after retreating a short distance, returned to the same place, the toucanets ignored it. One of the birds alighted upon the ground, apparently to pick up something edible—the first time that I ever saw a toucan of any kind actually upon the ground.

In the afternoon, my vigil over, I brought a ladder and examined the hole in which the toucanets were interested. It had never been completed by the woodpecker that began it, and seemed far too shallow to serve as a nesting cavity for the toucanets. Apparently they had been trying to enlarge it by tearing out the extremely soft, decaying wood from its bottom. I found a good many large flakes on the ground below; and their freshness was evidence that they had just been removed, but I did not actually notice the toucans pull out any wood.

During the following days, I sometimes found one of the toucanets in this cavity, with its head in the doorway. There followed a period of about two weeks, during which I failed to see either bird at the hole. Then they returned, and on May 13 the first of a set of three eggs was laid. This was the nest that I chiefly studied during the period of incubation.

Toucanets do not always content themselves with old abandoned woodpecker holes such as this; sometimes they wrest newly completed nests from the industrious carpenters. At the end of April, I watched a pair of Hairy Woodpeckers taking turns at carving a hole, only 14 feet above the ground, in an old, decaying trunk that stood in the pasture hard by the forest. An oven-bird (*Pseudocolaptes lawrencii*) was nesting in a higher cavity in the same trunk. The wood was soft, and the woodpeckers (which had already lost an earlier, higher nest)

worked hard, rapidly enlarging their chamber. On the afternoon of April 30, when I went to visit the nests of the oven-bird and of the woodpeckers, to my great surprise a toucanet flew out of the latter. The following afternoon, a toucanet again emerged from this hole upon my approach. The woodpeckers could hardly have completed it before the larger, stronger birds took possession. Upon finding the toucanet in the woodpeckers' cavity the second time, I constructed a rustic ladder and approached the nest. I found that one of the toucanets had meanwhile returned to occupy the interior, but when I climbed up to look in with light and mirror, I failed to see the expected eggs on the bottom. It seemed that the invaders were keeping their captured citadel almost constantly garrisoned even in advance of laying their eggs, lest it be retaken in a counter attack by the rightful owners.

Although I did not actually witness the work, I have little doubt that the toucanets enlarged the woodpeckers' doorway, for it now measured 2⅛ inches in width by 1¾ inches in height. The entrance of a neighboring Hairy Woodpecker nest, still occupied by its makers, was only 1⅜ inches in width and 1½ inches high. Possibly the toucanets also somewhat enlarged the interior of the cavity, as they had in the old, low woodpecker hole that I had watched earlier. Although their great bills are not well adapted for wood-carving, they can tear away wood that has been thoroughly softened by decay.

The toucanets also attempt at times to capture the nest-cavities of the Prong-billed Barbet (*Dicrorhynchus frantzii*), which resemble those of woodpeckers with one important difference: barbets carve horizontally into the wood for several inches before turning downward, leaving around the tubular entranceway a greater thickness of wood than is usually found around the doorways of woodpeckers. These thick walls, coupled with the soundness of the trunks that the barbets select for their nests, sometimes at least, prove too strong for the clumsy carving tool of the toucanet. Fernando Gómez, my assistant, told me that he saw a pair of Blue-throated Toucanets tearing at the entrance of a barbet's nest containing eggs, while the owners flitted about and protested; but the pirates made so little headway that they soon gave up, leaving the barbets in possession.

The Eggs

The three nests that I could reach contained respectively four, four, and three, pure white eggs, laid in two of the nests at least, at one-day intervals. Wagner (1944:71) found two young in his nest of the Emerald Toucanet. Very little is known about the number of eggs laid by toucans, but four appears to be the maximum so far recorded. I have seen the eggs of only one other species of toucan, Frantzius' Aracari: the completed set consisted of two white eggs; in another, inaccessible, nest two young were fledged. In an unapproachable nest of the Collared Aracari (*Pteroglossus torquatus*) three young were reared. Van Tyne (1935:25) reports a nest of the same species from El Petén, containing

three eggs; and in British Guiana, Beebe (1917:199) found a nest of *P. aracari* with two young. Van Tyne (1929:24) records three nests of *Ramphastos brevicarinatus* with one, three, and four eggs; and Beebe (1917:192) found a set of two eggs of the Red-billed Toucan (*R. monilis*).

Since it was impossible to reach the eggs without making an opening in the wall of the chamber, which would have decreased the birds' chances of bringing forth a successful brood—and mine of completing my study—I did not remove the eggs for measurement, but viewed them in a small mirror placed in the top of the cavity, while the interior of the nest was illuminated with a small electric bulb let down on the end of a flexible cord, attached to the socket of a small electric torch. I observed the nestlings in the same fashion, never handling them. Such indirect examination of the young does not permit the study of certain points—the exact form of the heel-pads, for example—but it greatly increases the probability that the student will be able to follow the nestlings' development until normal nest-leaving age.

Incubation

The newly completed hole of the Hairy Woodpeckers captured by the toucanets at the end of April was occupied by one or the other member of the pair much of the time during the following days. Yet it was not used for sleeping even as late as the night of May 5. On May 6 the first egg was laid, and on that night one of the toucanets slept in the nest. The next day the second egg was laid, and the two eggs were apparently incubated more or less during the day, although two more were to be laid on the ensuing days. At the low nest on the bank, in which the completed set consisted of only three eggs, one of the parents was also found in the hole on several visits during the day the second egg was laid. But since a continuous watch was not kept, I do not know whether the eggs were kept covered for a substantial portion of the time before the sets were complete.

At my first nest, in the dead cecropia tree, I had seen that the male and female alternated in incubating the eggs. But I thought it would be of interest to make an actual schedule of the movements of a pair during incubation, and for this purpose I chose the low hole in the stub on the bank above the Collared Redstart's nest, which I had found on April 23. The toucanets were tardy in using this hole, and fully three weeks elapsed from the time I first watched them examining it and murmuring softly (April 23) until the first egg was laid there (May 13). By May 15 the set of three was complete, and on May 22—that is, about the middle of the incubation period—I devoted the morning to watching continuously from my wigwam, set in the pathway below the nest. The record follows:

5:25 A.M. Daybreak. I begin to watch the toucanets' nest.
5:37 A toucanet leaves the nest.

5:53 One enters, but leaves after a few seconds.
6:11 One enters.
6:41 It flies forth when a large dry leaf falls loudly to the ground in the woods near by.
6:53 One enters.
7:06 It leaves when it hears the voice of another toucanet (its mate?).
7:23 One enters.
8:29 It leaves.
8:33 One enters.
8:36 It leaves for no apparent cause.
8:50 One enters.
9:12 The mate flies up and clings before the doorway. The toucanet in the nest looks out. They utter low, rattling notes. The bird in the nest pushes past and flies away. The newcomer enters.
10:33 It looks out, leaves.
10:45 One enters.
11:35 It looks out, leaves.
11:36 One enters.
11:37 I depart.

Since I could not distinguish the sexes, it was not possible to determine the exact share of incubation taken by each sex; but the change-over observed at 9:12 proved that they took turns on the eggs, as the pair had done at the higher nest. The toucanets' sessions on the eggs varied from less than one minute to 81 minutes. As a rule, one member of the pair did not continue at its post until relieved by its mate, but the longest period that they left the nest unattended during the morning was 18 minutes. The average length of eight sessions on the eggs was 33.3 minutes; the average of eight periods of neglect was 11.9 minutes. During the first six hours of the day (5:37 to 11:37), counting from the early-morning departure of the bird which was apparently in charge of the nest during the night, the pair incubated a total of 266 minutes, and left the nest unattended a total of 94 minutes.

Thus the pair of toucanets kept their eggs covered only 73.9 per cent of the morning. When parents alternate on the nest, as for example, pigeons, trogons, woodpeckers, jacamars, and antbirds do, the eggs are as a rule kept almost or quite constantly covered, and the continuous sessions of each bird are usually very much longer than those recorded for the toucanets. But inconstant sitting seems typical of the toucan family. In two successive years, I made records of what I believed to be the same pair of Frantzius' Aracaris, and their schedules were very similar to those of the smaller toucanet, with (usually) short sessions and frequent periods of neglect, since one member of the pair did not continue on duty until its partner came to take over. The first year, the aracaris kept their eggs covered only 63.6 per cent of eight hours' observation; and the second year, 65.9 per cent of five hours. One of them took one long session of 102 minutes; but their other sessions were all shorter than the longest of the toucanets', the average for the first year being 25.6 minutes, for the second, 28.1 minutes.

Even the big Rainbow-billed Toucans show the same lack of pa-

tience in incubation. According to Van Tyne (1929:28), the sexes share this duty and relieve each other often. He found that "they were surprisingly restless and frequently stayed on the nest only twenty minutes to an hour before being relieved, or left without being relieved. They were clearly not alarmed about anything, but seemed merely to be bored with the unaccustomed monotony."

The way a bird incubates is determined to a large degree by its temperament, whether phlegmatic or mercurial. Watching a kingfisher perching quietly for hours above a waterway, digesting its latest catch, or a trogon resting upright with calm dignity among the forest boughs, one is soon convinced that these birds' long periods of immobility upon the eggs are entirely in keeping with their character. The restless toucans, however, rarely remain long in one spot, but are constantly flying from place to place and disporting with their fellows.

At the low nest in the stub on the bank where the three eggs were laid from May 13 to 15 inclusive, two hatched on May 30 and the third on May 31. The distribution of hatching lends weight to the conclusion, drawn from casual observations, that fairly constant incubation began with the laying of the second egg. The incubation period was 16 days (if we assume that the last egg laid was the last to hatch). I am not aware of any other determination of the incubation period of any species of toucan.

The Newly Hatched Young

The nestlings in this low nest died when about two weeks old, apparently as a result of the seepage of rain-water into the somewhat dilapidated chamber. The toucanets who stole the nest from the Hairy Woodpeckers also had bad luck; a few days after they began to incubate their four eggs, I found only broken shells in the bottom of the cavity. I believe that one of the weasels that lurked in the pasture grass was responsible for the destruction.

But the nest found on May 5 fared better. It was situated 15 feet above the ground, in a slender, rotting stump in the pasture, near the edge of the forest. To prevent the access of snakes and small mammals to the nest, I encircled the trunk, at a height of about six feet above the ground, with a metallic band 14 inches wide (a 5-gallon kerosene tin flattened out). This is the method commonly employed in tropical countries for the protection of the open-air hen-roosts, and I can recommend it to bird-watchers. Above this metal guard, which gave no purchase to the sharp claws of weasels, squirrels, or tayras, nor to the scales of serpents, the young toucanets remained safe in the low, exposed cavity through all the six weeks of their nest life.

When first examined on May 5, this nest contained three newly hatched toucanets, and one egg that did not hatch until the following day. The day-old toucanets bore so close a resemblance to the newly hatched nestlings of the Prong-billed Barbet which I was studying at

the same time, that had the two broods been mixed together, it would have required close scrutiny to separate them. They also resembled day-old woodpeckers and kingfishers, but not quite so closely. The young toucanets were pink-skinned, with no slightest trace of feathers. Their eyes were tightly closed, their bills short and somewhat flattened, with the lower mandible both longer and broader than the upper (as in the hole-nesters mentioned above and the nestlings of jacamars). The heel-pads, studded with high, prominent papillae, were grotesquely large in comparison with the tiny feet, which seemed mere appendages to the pads. During many days these pads were to bear a far larger portion of the young birds' weight than the toes themselves, and they would prevent abrasion of the heel-joint as the young toucanets shuffled about over the rough nest-floor. Wagner (1944:72) describes and figures the similar nestling of the Emerald Toucanet.

Whenever I looked in at them with electric light and mirror, I found the infant toucanets huddling close together on the floor, their long, scrawny necks usually interlocked. One of the four vanished before it was five days old; the remaining three often arranged themselves in a symmetrical pattern, each with the head of a nest-mate resting on its neck, and its own head supported on the neck of the other nest-mate. They were noisy, uttering a variety of little squeaks and squeals, especially if I lightly shook the nest trunk as though one of the parents had alighted upon it, returning with food. During their first days, they were brooded much by both parents. When one parent arrived with food, it clung beside the doorway until the other came out. I did not see both adults together in the hole at any time, and only one stayed with the nestlings during the night—not both parents, as with Frantzius' Aracaris, or a flock of five grown birds, as was the custom at a nest of Collared Aracaris I watched in Panama. I was never able to determine whether the toucanet which attended eggs and nestlings during the night was the female, as with most birds, or the male, as with woodpeckers and anis—or indeed, whether it was always the same parent.

At this low nest the parents were amazingly fearless, in striking contrast to toucans of other kinds that I have watched attend far higher nests. While studying a nest of the Collared Aracaris, situated a hundred feet above the ground in a huge tree amid the forests of Panama, I found it desirable to conceal myself; but the toucanets would enter their low hole with food while I stood close beside the rotting stub. When I wished to watch their activities for extended periods, I had only to seat myself on a stump at a convenient distance, with no attempt at concealment. In fact, most of the birds of this wild region would go about the business of their nests while I looked on from no great distance, and in plain view.

Food

From the age of a few days onwards, the nestling toucanets were nourished principally with fruits, small at first, gradually increasing in

size as the birds grew larger. The fruits were carried in the tips of the parents' great bills. After the young were full-grown, they received many of the big, hard, green fruits of a tall tree of the laurel family that grew near the nest. These measured about 1½ inches in length by ¾ inch in diameter, and had a thin, olive-colored flesh between the green skin and the single large seed. It must not have required many such fruits to fill up a nestling, but each could have yielded only a relatively small amount of nourishment, since the hard seed was indigestible. Rarely the parents came with articles so small that they were nearly or quite enclosed in the bill and hence difficult to distinguish. Some at least of these small morsels were insects. Several times I watched the adults try to catch insects on the wing, within the edge of the neighboring forest. At times their clumsy efforts seemed to be successful. Once a parent entered the hole with a naked passerine nestling, apparently a Cabanis' Thrush (see below).

The nestling toucanets received rather infrequent meals. During the first four hours of their forty-second day, food was brought to the two surviving nestlings only 16 times, making an average of one feeding for each nestling every half-hour. Although the young toucanets now spent considerable time looking out through their doorway, usually their parents pushed inside to feed them. But on several occasions the parents delivered the food while clinging in front of the entrance. Then I could see that, when smaller fruits were brought, in addition to the one held visibly in the tip of the bill, the parent brought to light others—usually two—that it had carried out of sight in its bill or mouth.

Early one morning, one of the parents arrived with one of the big lauraceous fruits described above. It entered the nest, and after a minute or so started to come out, but when halfway through the doorway it stuck and could go no farther. With its head and breast outside, and its big bill wide open in a ludicrous attitude, it struggled to squirm through, but in vain. Finally it regurgitated the big fruit, which it had apparently swallowed inside the nest when it found that the nestlings could not. Holding the fruit in its bill, as it had done upon entering, it now came through the doorway without difficulty, since it was considerably thinner. For about 25 minutes the toucanet continued to hold the big fruit, resting most of this time on the end of a low stub near the nest. At intervals it went to the nest to offer the fruit once more to a nestling; and finally, on the third offering, one of the young managed to swallow it—or so I infer, for the parent entered the nest with the fruit in its bill and came out without embarrassment, with no fruit visible. Later in the morning, a parent again took in a big fruit, which the nestlings were too full to swallow just then, got stuck in the doorway as it tried to come out, and was obliged to regurgitate the fruit in order to reduce its girth. This time, it carried away the fruit for its own consumption. These laughable incidents demonstrated that the doorway of the nest was barely large enough to allow the adult toucanets to pass

through. One could also see this plainly by watching from directly in front while the bird emerged. The form of the aperture, an oval wider than high, matched the shape of the bird's body and left no room to spare.

Nest Sanitation

Unlike the Frantzius' Aracaris that I had watched the preceding year and the Rainbow-billed Toucans studied by Van Tyne, the parent toucanets did not allow regurgitated indigestible seeds of the fruits they ate to accumulate in the nest. Whether or not they regurgitated such seeds while incubating it was impossible to see, but if so, they did not allow the mouth-castings to remain in the cavity. The parents also removed the empty shells within a day or two after the young hatched. The parents were always careful of sanitation, carrying away a large billful of waste on leaving the hole at daybreak, and again at intervals through the day. In this process all the loose chips on the floor of the nest were eventually removed. Only during the nestlings' last few days in the hole did the parents relax their attention to cleanliness and allow waste material to accumulate.

Growth of Nestlings

The young toucanets developed with extreme slowness—more slowly even than woodpeckers, kingfishers, and motmots, which for small birds have a notoriously long nest-life. They were two weeks old—an age at which many passerine birds are feathered and can fly—when with the mirror I detected the first traces of the feather sheaths. The difference in length between the two mandibles, which a few days earlier had still been conspicuous, now began to disappear. When the nestlings were 20 days old, the sheaths of their contour feathers were just beginning to break through, while those of the remiges had grown distinctly longer. The bill was now becoming somewhat like that of the adult toucanet in shape. It was not until May 30, when they were 25 days old, that I saw the nestlings with open eyelids, but the eyes still appeared cloudy, as though covered by a delicate membrane. By June 1, however, the eyes were both open and clear. The remiges and the contour feathers (except those of the head) were then beginning to break forth from the ends of their sheaths, though these had not yet become so long and conspicuous as those of kingfishers, motmots, jacamars, or lowland trogons. From their very first appearance, the feathers were green like those of the adults. At this age the nestlings were very noisy, uttering a variety of little grunts and squeals, so that their nursery reminded me of a piggery in miniature.

Even after the feathers began to expand at the ends of their sheaths, the young toucanets were long in acquiring a complete covering. On June 5, when they were a full month old, much of their skin was still exposed. By June 9, when they were 35 days of age, they were fully clad

(at least on their upper parts, which alone I could see), but their tails were still very stubby. Even now, they were not ready to venture forth into the world. They were 39 days old before I saw one with its head in the top of the chamber, looking out through the doorway. And still they lingered a few days longer.

Before they took flight, the young toucanets began to resemble their parents closely in plumage, even to their blue throats. But their eyes were still surrounded by rings of light-colored bare skin, and their bills, though gradually approaching adult dimensions, were still much smaller, and somewhat different in coloration. The upper mandible was much like that of the adults—black at the base and along the lower edge, elsewhere light yellow—but it lacked the red area at the base of the culmen. The lower mandible was black only along the cutting edge; elsewhere it was yellow clouded with black. The white line around the base of the bill, so conspicuous on the grown birds, was lacking in the young.

Departure of the Young

The two young toucanets left the nest on June 17 (at 43 days of age) before nine o'clock in the morning. Upon my arrival at that hour, I found one of them perching in a low tree at the edge of the woods, where the parents brought it food. It was nearly as big as they. It took a leaf in its bill, as though to test its edibility, but decided that it was not good to eat. I failed to find the other fledgling, which had apparently wandered farther into the woods.

A nestling period of 43 days is amazingly long for so small a bird, but other toucans remain in the nest as long, or longer. Wagner (1944: 73) estimates a nestling period of at least six weeks for the Emerald Toucanet. On Barro Colorado Island, in 1935, I watched a nest of the Collared Aracari situated high in a forest tree in a perfectly inaccessible position. The first of the young birds did not emerge until 44 days after I first saw food taken into the hole, and it is probable that I overlooked the first tiny morsels, and that the nestlings were already a few days old when I found evidence that they had hatched. Van Tyne (1929: 34) lost his brood of Rainbow-billed Toucans to some predacious animal when they were 36 days old, and was unable to determine the nestling period by direct observation. But from the known rate of growth of the young toucans, and the measurements of fledglings collected immediately after they left the nest, he estimated that if undisturbed they would have flown at the age of about 45 days. This is certainly a conservative estimate. In other families, as, for example, woodpeckers, kingfishers, and the Icteridae, the nestlings of big species depart later than those of small ones, and I think it likely, therefore, that these big toucans would remain in the nest at least five or six days longer than the toucanets or the aracaris.

Sleeping Habits

A single parent continued to sleep nightly with the nestling toucanets until they were at least 41 days old. I have no observations on this point for their next-to-last and final nights in the nest; unfortunately, I did not know exactly when they would depart. At the close of their first day among the trees, I watched for their return to the nest, but none of the family came near it, and thereafter the hole was abandoned. The same was true of a second, high, nest that I watched later. A slight litter of droppings in the bottom of the cavity at the time of the fledglings' departure was not subsequently removed by the parents.

The toucans' ways of sleeping are of considerable interest. Wagner (1944:69) apparently found the Emerald Toucanet roosting in holes in trees. Collared Aracaris and Frantzius' Aracaris regularly lodge in such holes, either natural cavities or abandoned nests of the larger woodpeckers. I have known as many as seven of the former, and five of the latter, to pass the night in the same hole. Male and female may sleep in the nest cavity before the eggs are laid; during the period of incubation, a single parent attends the eggs by night; but after the nestlings hatch, both parents sleep with them. Among Collared Aracaris, I have known as many as three other grown birds to take shelter with the parents and the nestlings. The newly departed fledglings return to sleep in the cavity where they were reared.

With these facts in mind at the time I studied the Blue-throated Toucanets, I made every effort to learn whether they used holes in trees as dormitories. Although I spent many an evening watching promising holes, I did not once see a toucanet enter one before the breeding season began. The birds would vanish through the foliage as darkness deepened, and I never succeeded in learning exactly where they roosted. The fact that the second parent did not sleep in the chosen nest before the eggs were laid, or spend the night with the nestlings, in the fashion of the aracaris, also weighs against the supposition that these toucanets use holes as dormitories. Even the parents' neglect, after the departure of the nestlings, to remove the last vestiges of excrement from the hole, suggests that the former nest is not employed as a dormitory—woodpeckers and barbets that continue to use the nest as a family dwelling after the young are a-wing, are careful to clean it thoroughly upon their exit. Of course, the young toucanets might have been led to take shelter in other cavities; but weighing all the evidence, my conclusion is that Blue-throated Toucanets do not lodge in holes, but rather roost among the foliage. The toucanets were no less abundant, and far more conspicuous, than the Prong-billed Barbets, the Hairy and the Green Woodpeckers, and the Allied Brownies (*Lepidocolaptes affinis*) among which they dwelt. During my year at Vara Blanca, I found several dormitories of each of these species, but not one of the toucanets.

Similarly, I have never been able to discover dormitories of the big toucans of the lowlands, the Rainbow-billed and Swainson's Toucans (*Ramphastos swainsonii*). I have often watched in the evening while these great, yellow-breasted birds sang their vespers among the tree-tops, hoping that I might at last follow their flight to their sleeping quarters. But usually they continue their monotonous singing until the light grows dim and practically all other diurnal birds have sunk into drowsy silence. Then they fly off through the dusk, baffling any attempt to keep them in view until they reach their destination. I am familiar with no definite record of their lodging in hollow trees, although Van Tyne (1929:20) surmises, largely from analogy with the aracaris, that they do so.

The Second Brood

Of the three accessible nests, two, as already recorded, were prematurely destroyed. If the parents in the third nest, whose nestlings departed on June 17, attempted a subsequent brood, I was unable to discover their second nest. Each of two pairs that nested in holes high out of reach reared, or tried to rear, two broods in the same cavity. One of these pairs incubated in April and fed nestlings during May; in late June they appeared to be incubating once more, and through much of July they were again taking food into the hole. At the other nest, 90 feet above ground, to which I gave only casual attention, the parents were bringing food on May 15 and again on July 6. The spread of these dates makes it practically certain that they were not feeding the same nestlings on both occasions.

It was unexpected to find these highland toucans raising two broods in a season. The pair of Frantzius' Aracaris that I watched for two years, at lower altitudes, lost young nestlings the first year, while in the second their eggs were destroyed. On neither occasion could I find evidence of a second attempt to nest (which, of course, would not have been a true second brood). Van Tyne (1929:34) concluded that the Rainbow-billed Toucan raised only a single brood in a season. In this connection, it is of interest that the Quetzals, neighbors of the Blue-throated Toucanets in the highland forests, quite generally reared second broods at Vara Blanca in 1938; but I have yet to find unequivocal evidence for a true second brood among the lowland trogons.

Relations with Other Birds; the Significance of the Bill

The boy who helped me to find nests saw a Blue-throated Toucanet fall prey to a White-throated Falcon (*Falco albigularis*), a hawk scarcely larger than its victim, but fierce out of all proportion to its size. Aside from this, I discovered no dangerous enemies of the adult toucanet. But if it has few enemies, it has likewise few friends. Its nest-robbing habits cause it to be intensely disliked by the small birds

among which it dwells. The Costa Rican Wood Pewees (*Myiochanes lugubris*) have a particular antipathy to the toucanets, and become greatly excited whenever one appears anywhere in the vicinity of their mossy nest.

I actually witnessed nest robbery by the toucanets on only one occasion. One afternoon in May, my attention was drawn by a Cabanis' Thrush (*Turdus plebejus*) which was very much upset. She perched on the ends of the branches of a wide-spreading, dense, shrub-like epiphyte attached high above the ground to the trunk of a lofty tree, where she nervously twitched her wings and uttered sharp, Robin-like calls of distress. She flew back and forth around the shrub in which she doubtless had her nest, darting at something that was screened from my view by the compact foliage and by the mist that shrouded the trees. Presently a toucanet flew out of the shrub, with the thrush in hot pursuit. I then went to the toucanets' nest where I had been observing the nestlings, and which was situated at no great distance from the scene of this episode. Presently one of the parent toucanets arrived there with the legs of a passerine nestling dangling from its bill—the body of the victim was largely concealed, but I assumed that it was a nestling taken from the thrush.

There has been a good deal of conjecture as to the significance of the huge, usually brightly colored, bills of the toucans. Some of the conflicting opinions are summarized by Van Tyne (1929:38). Belt (1888: 197) believed that the great size of the toucan's bill made it more effective as a weapon with which to defend itself, its eggs, and its young. He thought that the big bird, surrounded by the solid wooden walls of its nest-chamber, could ward off the attacks of monkeys, raccoons, opossums, and other small animals that might seek to force an entrance through the narrow doorway. My own experience with toucans of several kinds is essentially that of Van Tyne (1929:28), that they forsake their nest-holes upon the approach of real or fancied danger, making slight effort to defend them, either from within or without. Once at dawn, I surprised a kinkajou at the nest of the biggest toucan of Central America (*Ramphastos swainsonii*), high up in a great trunk at the edge of the forest. The toucan was not within, presenting its supposedly formidable beak to the foe, but was darting at the kinkajou from the outside. The quadruped scrambled down the trunk; but if it had not already devoured the eggs, it probably came back for them later; for soon after this the nest was abandoned.

Doubtless toucans do well to escape from the cavity when an arboreal mammal approaches. I do not believe that even Swainson's Toucan could face on equal terms such animals as the white-faced monkey, the coatimundi, the tayra, or even the kinkajou, all of which enjoy an occasional bird's egg or nestling. Even the little toucanet can put a squirrel to flight—as do many birds with far smaller bills—but for all its formidable appearance, the great bill of the toucan is of slight, hollow

construction, likely to be broken if put to too strenuous use. A Swainson's Toucan, with the terminal inch or two broken from its maxilla, has frequented this vicinity for the past two years. It appears to keep well nourished, but leads a solitary existence, apart from its fellows.

Van Tyne (1935:24) wrote: "It appears that length, as such, is the significant feature of its [the toucan's] bill." That the long bill brings within the toucan's reach edible objects that would otherwise be inaccessible to a bird so heavy and so clumsy upon the wing, such as fruits at the tips of weak and slender twigs, and eggs in nests attached to the drooping extremities of twigs, must be clear to anyone who has devoted much attention to the habits of these birds in their native forests. But it is obvious that a slender bill of the same length, soberly colored, would serve equally well for this purpose. As I watched the Blue-throated Toucanet despoiling the nest of the Cabanis' Thrush, while the owner flitted about in helpless indignation, it occurred to me that the great beak served yet another function; and during subsequent years, after watching Swainson's Toucans on their marauding expeditions, I have become convinced that this function is important to the toucans: I believe that the huge, boldly colored beak intimidates other birds and prevents their attacks. To any bird of the toucan's size, or smaller, this bill must seem indeed a formidable object. Bright coloration heightens the psychological effect that any object tends naturally to produce; it makes agreeable things more pleasing, but augments the fearsome aspect of objects that inspire dread. The bright colors of the toucan's bill doubtless make it appear more terrible to other birds than it would if more soberly tinted.

When a toucan alights near the nest of a small bird, the distressed owners merely dart back and forth above it, fearing to come within range of the terrifying bill, while the marauder snaps at them as they swoop past, sometimes voicing harsh, angry notes at the same time. Even the bigger and more aggressive flycatchers are afraid to attack a perching toucan. The Boat-billed Flycatcher (*Megarhynchus pitangua*), a giant in its family, has a strong antipathy to the Swainson's Toucan; a nesting flycatcher will leave eggs or young and fly a thousand feet to meet and worry a toucan that comes within sight of the nest; yet it dares not actually attack until the toucan begins to fly. On the wing, the toucan cannot defend its back, and the flycatcher pounces upon it to relieve its feelings by tearing out feathers. The Costa Rican Wood Pewee behaves similarly when the Blue-throated Toucanet comes near its nest.

Briefly, the length of the toucan's bill brings within reach food that might otherwise be inaccessible; its bulk and brightness make it appear more formidable than it actually is and serve to intimidate the birds whose nests the toucan loots. In these ways the immense beak is undoubtedly of use at the present day. But I do not, of course, claim that these uses are sufficient to explain its evolutionary development.

SUMMARY

A study was made of the Blue-throated Toucanet (*Aulacorhynchus caeruleogularis*) near Vara Blanca, Costa Rica, from July, 1937, to August, 1938.

This toucanet dwells in the mountain forests of Costa Rica and western Panama. Its recorded altitudinal range is from 2,500 to 7,600 feet above sea-level.

These birds nest in woodpecker holes and similar cavities, which they sometimes slightly enlarge. The doorway of the nest is barely large enough to permit the passage of the adults through it.

Six occupied nests were found; these were placed at heights ranging from 7 to 90 feet above the ground.

Even before the first egg was laid, one or the other member of a pair of toucanets spent much time by day in a newly carved hole they had stolen from Hairy Woodpeckers.

Of three accessible nests, two contained four eggs and the other, three eggs. The eggs were white, laid on successive days, and rested upon wood fragments in the bottom of the unlined cavity.

Incubation was carried on by both sexes. The toucanets were restless on the nest, often going off without awaiting relief, leaving the eggs uncovered.

At one nest the incubation period was 16 days.

The young are hatched blind, perfectly naked, and with the lower mandible both longer and broader than the upper. They are equipped with large heel-pads upon which they rest during the long nestling period.

Both parents brooded and fed the nestlings. Their food consisted chiefly of fruit, varied with small insects, and now and then the nestling of some other species.

The parents kept the nest perfectly clean until just before the young were ready to depart.

The nestlings developed with extreme slowness. Their eyes did not open until they were about 25 days old, and they were not completely clad with feathers until 35 days old.

One or the other of the parents stayed with the nestlings each night, at least until two days before nest-leaving.

The young toucanets left the nest when 43 days old, before 9 A.M. They now resembled their parents in plumage and color of bill, with certain minor differences, but their bills had not yet reached full adult size.

Two pairs reared two broods in a season.

Blue-throated Toucanets were not found sleeping in holes.

The Blue-throated Toucanet sometimes falls prey to the White-throated Falcon (*Falco albigularis*). Aside from this, the adult appears to have few harmful enemies.

The length of the toucan's bill is important in bringing within reach food that would otherwise be inaccessible. The bulk and bright coloration of the bill intimidate the small birds whose nests they despoil, thereby preventing attacks on the toucans by angry parents.

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