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ROOSTING AND NESTING OF ARAÇARI TOUCANS

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The genus *Pteroglossus* contains a number of species of toucans of small or medium size to which the name araçari is usually given. The slenderness of body and bill in the Central American representatives of this group is very evident when one compares them with the bulky toucans of the genus *Ramphastos* which inhabit the same forests. Of the two species of *Pteroglossus* in the lowlands and foothills of Central America, *P. torquatus* is of wide distribution, while *P. frantzii*, far brighter in color, is restricted to the Pacific side of southern Costa Rica and adjoining parts of the republic of Panamá. Although these two birds were united in the same species by Peters (1948), their differences in coloration are evident at a glance and they do not seem to intergrade. Yet their similarities in voice, habits, size, and color pattern show that they are closely related. Since my studies of these rather elusive birds are incomplete and since there is little information available on their behavior, I shall discuss them in the same paper. Thus gaps in my observations on one species may be filled in a measure by my studies of the other species.

COLLARED ARAÇARI

Appearance.—The Collared Araçari (*Pteroglossus torquatus*), the duller and more widespread of these two toucans, is a slender bird, whose length of about 16 inches is largely accounted for by its heavy bill and long, graduated tail (fig. 1). The general tone of the head and most of the upper plumage, including the wings and tail, is black. A narrow collar of chestnut separates the glossy black of the hindneck from the greenish slate-black of the back, while the rump and upper tail coverts are bright red. The plumage below, posterior to the foreneck, is generally yellow, interrupted by a band of black and red which crosses the upper abdomen from side to side. Anterior to this the yellow is more or less stained with red on the breast, which often bears in its center a black patch of variable size. The thighs are chestnut or cinnamon-rufous. The bill is long, high, hooked at the end, and has coarse serrations along most of the cutting edge of the upper mandible. As in many toucans, this relatively enormous bill is particolored in a rather intricate pattern. Most of the upper mandible is pale grayish-yellow or dull white, becoming darker toward the base, with dusky blotches between the tooth-like projections, and a broad black stripe along the basal half of the ridge. The lower mandible is black, and the whole bill is outlined at the base, where it joins the feathered portion of the head, by a narrow, embossed ridge of ivory-white. To add to the array of color on this bird's head, its eyes are bright yellow or orange-yellow, surrounded by bright red bare skin. The legs and feet are greenish-olive. The sexes cannot be distinguished by their appearance.

Range and general habits.—The Collared Araçari ranges from southern México to Colombia and Venezuela. In Central America it is found along the length of both coasts, except in the restricted region where the Fiery-billed Araçari (*P. frantzii*) is established. In both Guatemala and Costa Rica, it ranges upward to about 3000 feet—far less than many of its associates in the warm lowlands. It inhabits rain forest, semi-arid woodland, and adjoining clearings with scattered trees or shady plantations. Its flight is swift and



Fig. 1. Collared Araçari (*Pteroglossus torquatus*), one-third natural size.
Drawing by Don R. Eckelberry.

direct. A gregarious bird, it roams through the tree-tops in restless parties containing up to six, or rarely more, individuals, which straggle after each other rather than travel in a compact flock as do many parrots and pigeons. In the rain forests where the larger Keel-billed Toucan (*Ramphastos sulphuratus*) occurs, the araçari sometimes associates with it.

This araçari subsists largely on small fruits, which it plucks with the tip of its great bill and transfers to its throat by means of an upward jerk of the head. It also gathers insects and other small invertebrates, especially when feeding nestlings. Although, like its close relative the Fiery-billed Araçari, it probably includes birds' eggs and nestlings in its diet, I have no incriminating evidence of this. A further discussion of the feeding habits of this bird is to be found in the section on nesting.

Voice.—The notes of the Collared Araçari are, for so large a bird, remarkably thin and high-pitched and add to the impression of high-strung excitability which this toucan gives. Its common call is a *pink* or *penk*. Some members of a flock which I saw in August in the coastal mountains of northern Honduras were singing after a fashion. Their high-pitched, rather barking *peetch* was rapidly repeated in ascending pitch, becoming weaker and shriller with each reiteration. As they uttered this note they swung their heads from side to side. When suspicious or alarmed, the araçari gives a thin, sharp *pitiit*, and when it is highly excited it repeats this note with great rapidity.

Roosting.—Although I had tried previously to trace to their sleeping places flocks of araçaris that I encountered in the evening, I was not successful until I went to Barro Colorado Island in 1935. For many years after a portion of the valley of the Río Chagres was flooded to form Gatún Lake, a part of the Panamá Canal, the drowned forest trees, which stood like bleached skeletons above the shallow water, provided convenient quarters for a variety of birds that nest and roost in holes. Aside from cavities caused by decay, most of the holes had been made by various species of woodpeckers. These holes were taken over by other species of birds after the woodpeckers either had abandoned them or had been forcibly evicted.

At 6:40 p.m. on February 14, as I paddled my cayuco into the cove in front of the main building on Barro Colorado, I had the good fortune to see four Collared Araçaris enter a large hole in the top of a naked dead trunk which stood in the water just beyond the end of the wooded point of land at the entrance to the inlet. The hole had apparently been made by a woodpecker but it was now enlarged by decay. On the following evenings, the four araçaris retired at times ranging from 6:38 to 6:43 p.m. They always approached from the forest at the top of the banana plantation which occupied the steeply sloping ground on the opposite shore of the cove. One by one, the birds would fly rapidly down over the bananas, cross the cove, and enter the forest on the other side. Then they made their way through the trees to the end of the point, where the woodland came nearest to their exposed sleeping tree. In the morning, they emerged and flew back into the forest at about 6:15 a.m., so that at this season they took slightly more than 11½ hours of rest. At various times I saw them enter or leave this trunk through three different openings, but possibly all of these openings communicated with a single large hollow.

At some time between February 19 and 25, the araçaris deserted this dormitory. On the evening of March 17, I again saw the toucans enter it, but their number was now reduced to two. At 6:00 a.m. on March 29, four araçaris left the hollow stub. My next record for this dormitory is for May 29, when two araçaris flew out at 5:40 a.m. The fluctuations in the tenancy of this hole appear, at least in part, to be due to the fact that araçaris, like other birds which sleep in dormitories, often have several such dormitories scattered over their territory, and if disturbed at one they take shelter in another. Moreover, these observations were made just before and in the course of the breeding season, and, as we shall see, the number of individuals sleeping in the nest varied with the progress of the brood. This doubtless contributed to the fluctuations in the number of lodgers in this dormitory. It is not unlikely that the same individuals occupied, at different times, both this hole and a higher one that was used for rearing a brood.

Nine years earlier, Van Tyne (1929:20) discovered in this same locality four Collared Araçaris roosting in an old woodpecker hole which was about six feet below the top of a dead trunk that was 20 feet high. This trunk stood at the edge of the clearing beside the main building rather than in the water in front of it. As the birds "entered the hole they could be seen to jerk their long tails . . . flat against their backs, thus saving much valuable space."

On the evening of February 22, after watching an Olivaceous Flatbill (*Rhynchocyclus olivaceus*) dart into its pensile nest, I wandered through the darkening forest on Barro Colorado to look for other roosting birds. A sharp *penk* drew my attention to some Collared Araçaris in the trees high above me, and by rare good fortune I managed to follow them to their lodging, which was situated about a hundred feet above the ground, far out in a thick, horizontal limb of an immense tree. The entrance, on the lower side of the bough and facing straight downward, was barely wide enough for

the toucans to squeeze through it. I watched their dark, colorless figures, silhouetted against the sky, flutter below their narrow doorway and frequently turn back, to try again and perhaps a third time before they at last succeeded in gaining a foothold at the entrance. Having accomplished this difficult feat, they wriggled painfully in, the long tail of each projecting stiffly outward after the body had disappeared, then slowly following it. I counted six araçaris as they emerged at the night's end.

Apparently I had found the dormitory of these araçaris soon after they began to use it, for the difficulty they had in entering came largely from lack of practice. Between 6:45 and 6:48 p.m. on February 28, all six went in without fluttering below the doorway or returning to a perch for a fresh start after a fruitless attempt. That the aperture had not been appreciably widened in the interval was obvious from the slowness with which the birds squeezed through it, their long, projecting tails vibrating from their muscular exertions. Difficult as it was to reach this downward-facing orifice, with practice the araçaris became adept at entering it.

Nesting.—This high, inaccessible dormitory was soon afterward used for breeding, a conversion which caused all but one of the six occupants to find other sleeping quarters. Unfortunately, I could not reach the hundred-foot-high hole to learn just when the eggs were laid; hence I cannot demonstrate an exact correspondence between laying and the withdrawal of the majority of the lodgers, but my observations showed that this was a gradual and irregular process. By March 15, the number of occupants had been reduced to five; these entered the hole between 6:44 and 6:48 p.m. As it grew light on March 25, I saw one araçari looking out of the high doorway and another resting on a neighboring branch. After the former emerged, somewhat later than usual, a second araçari stuck its head through the orifice and remained in this position for a time, although in the past all the sleepers had emerged within a few minutes after the departure of the earliest. Either the araçari that I first noticed perching outside had left the dormitory while the light was still so dim that I had failed to notice its departure or it had slept somewhere near by. On the evening of March 27, I arrived just in time to see a bird leave the hole. Then another bird looked out and emerged after a few minutes, which was unusual at this late hour. After this, one araçari went in and promptly came out. Finally, at 6:47 p.m., a single araçari entered and stayed for the night.

By March 28, incubation had definitely begun, and whenever I stood in sight of the nest and clapped my hands loudly, a big pied bill was thrust forth from the narrow aperture. Despite the great height of the nest, and the fact that I stood as far as 100 feet from the base of the tree, the araçari in charge of the eggs felt so insecure that on seeing me it promptly squeezed through the doorway and flew off through the forest. For some nights following this, only a single bird slept with the eggs, but whether this was the female, or the male as in woodpeckers and some other families, I could not learn.

I made no detailed observations on incubation, which took place at the end of March and in early April. By April 11, five araçaris were again sleeping in this hole, and on the same day that I discovered this I, for the first time, saw one of them enter the hole with food. This was an indication that one or more nestlings had hatched. I soon became convinced that four of these five adult birds were bringing food, and I repeatedly had evidence of this. However, it was a long time before I could prove that all five did so. The best time for counting the attendants was in the early morning, when, after leaving the dormitory together, a number would return with food at about the same time. On May 16, when the nestlings were at least 35 days old, the adult birds began to return soon after emerging at 5:45 a.m. Five entered the nest in such

rapid succession that the last had delivered its food before the first flew out of sight, and I was quite certain that I had not counted the same individual twice. It was more difficult to learn how many of these attendants brooded, for while the nestlings were still very young a new arrival would usually enter the hole before the emergence of the one already present, and this made it impossible to tell whether there had been a change-over. However, it seemed that at least two birds brooded. By April 24, thirteen days after I noticed that the nestlings had hatched, they were brooded little during the day.

The nature of the nestlings' food, and the method of carrying and delivering it, changed as the young grew older. At all times the attendants were most wary in approaching the hole, and they would usually perch on a high bough of a neighboring tree, turning their heads and great bills from side to side while they scrutinized the surroundings, before they proceeded to the doorway. This pause often permitted me to see what they carried. During the first few days I noticed only insects, which were grasped in the tip of the bill, the wings sometimes projecting from the sides. When the young were a month old, they still received many winged insects, but small fruits were becoming a more prominent component of their diet. Although I saw a large cicada taken into the nest in the tip of an attendant's bill, when the young were about ready to fly, toward the end of the nestling period most of the food was carried in the mouth or throat and I rarely had an opportunity to see it. Apparently this change in the manner of transporting the nestlings' food was an adjustment to the larger quantities that were now required. Until the young were over a month old, the attendants laboriously wriggled into the hole each time they brought food, but by May 16, at least 35 days after the nestlings had hatched, I noticed that the young ones took some of their food through the doorway while the attendant clung below it. Thenceforth an increasing proportion of their food was passed to them in this fashion.

Although this new method of feeding spared the attendants the trouble of squeezing through the narrow orifice, to the detriment of their plumage, it brought new difficulties to them. They now delivered the food while clinging back downward, and in this inverted position they could not regurgitate what they carried in the deeper portions of their alimentary tract. The last article which an attendant had found for the nestlings was often held prominently in the tip of its bill when it arrived, and to deliver this caused no special difficulty. This was true also of the morsels carried in the mouth or throat. But after passing to the nestlings the more available pieces, the attendant was often obliged to fly to a neighboring perch, where, standing upright, it could regurgitate certain objects that had been swallowed. This was a feat which was accomplished with considerable effort, to judge by the contortions of the bird's neck which were clearly visible through my binoculars at a distance of fifty yards. The newly recovered food was then carried to the nest for transfer to a nestling. The rate of feeding was very rapid, especially in the early morning. However, since I was ignorant of the number of mouths which were receiving these contributions, there seemed to be no point in counting the feedings when there were so many other interesting details to be observed.

Toward the end of the nestling period, one of the principal articles brought to the young was the "wild nutmeg," the seed of a tall forest tree of the genus *Virola*. The elongate, grayish-brown seed was brought to the nest still encased in the bright red, coral-like, branching aril, which resembles the mace of the true nutmeg and is the only digestible portion. The seeds themselves were later regurgitated entire. The brown seed with its red aril formed a most attractive object; it measured about three-quarters of an inch in length by slightly over half an inch in width. When ripe, the aril was pleasantly spicy to my taste, but when not quite mature it was so hot and peppery

that I could scarcely endure it. Even at this stage, however, it seemed to attract Massena Trogons (*Trogon massena*) as well as toucans, which flocked in the early morning to a fruiting nutmeg tree at the forest's edge, where they swallowed these large objects whole.

After the young were a month old, the attendants carried large billfuls of waste material from the nest. Apparently they were keeping the chamber clean. Probably I had not noticed the removal of waste earlier because of the smaller amounts that were carried away.

One day while I watched the araçaris' nest, two Chestnut-mandibled Toucans (*Ramphastos swainsonii*) flew into the nest tree. One of them soon discovered the location of the hole, probably by hearing the nestlings within. This bird appeared to be interested and flew from branch to branch around the hole, but it was not as easy for this big toucan to reach the downward-facing doorway as it was for the smaller and more agile araçaris. Presently it hovered beneath the hole and stuck the tip of its great beak into the opening. After an interval, it repeated the performance and pushed its bill farther into the hole. I doubted that it could reach the nestlings, for the entrance was far too narrow, to admit its big body and the cavity which provided space for six or more araçaris was obviously deep. But I did not consider the visitor's intentions to be benevolent, and I did not want to lose this interesting nest, so I emerged from the blind and drove the bird away. The araçaris were not in sight while their larger relative was present. Since the Chestnut-mandibled Toucan is a persistent nest-robber, the araçaris had done well to choose a hole with a doorway too narrow to admit this larger bird.

The fledglings' departure and attempted return to the nest.—The attendance of a single nest by five araçaris raised some interesting questions. Did these birds nest communally like the anis (*Crotophaga*)? Or did they require two or more years to reach breeding maturity and did yearlings help older birds to attend their young, as do White-tipped Brown Jays (*Psilorhinus mexicanus*)? Or was there an excess of males which assisted mated pairs to rear their offspring, as in Black-eared Bush-tits (*Psaltriparus melanotis*)?

These questions were difficult to answer because the five attendants all appeared very much alike, with no differences indicative of age or sex. But had I known the number of young in the nest, this would have helped to solve the problem. Since toucans generally lay only two or three eggs in a set, if there were considerably more young than this, one might assume that several females had laid eggs in the same nest. Because the nest was inaccessible, the only possibility of learning the number of nestlings was to count them as they emerged or, better, as they returned to sleep in the cavity. I had found in a number of species that when the adults use the nest space as a dormitory they often lead the fledglings back to roost in it, and I expected that the araçaris would do this, too. Accordingly, I watched carefully for the youngsters' departure.

Thirty-five days after I first saw an adult bring food to this nest, the attendants were passing some of the food to the young through the doorway, indicating that the nestlings had moved up close to the opening. Two days later I saw, for the first time, a nestling push its head outside to take its food. The young bird's bill already looked almost as big as that of the adults. When the nestlings were at least 42 days old, one of them spent much time looking through the doorway, and I now first heard their voices. They called *pitiit* like the adults, but their call was weaker. The attendants had now become extremely excitable, calling frequently and appearing to be uneasy.

On May 24, the five attendants left the hole at dawn, as they had done since the nestlings had hatched, and soon they returned with food for the young ones in the nest.

Other birds occupied my attention through the day, but after supper I returned to watch the araçarís retire. One of the young had emerged since sunrise and the attendants were helping it to return to the hole for the night. While one of the adults hung, back downward, beneath the doorway, the fledgling came and clung momentarily to its back. Meanwhile the other adult birds clustered around, crying *pitit pitit* in their high-pitched voices and displaying considerable excitement.

The leaves were fast falling from the nest tree and the araçarís were exposed to the open sky. Suddenly a White Hawk (*Leucopternis albicollis*) swooped down and seized the fledgling in its talons. The victim cried piteously as its captor bore it across a deep ravine, followed by all the attendants. Later, when the light had become very dim, the five adult araçarís returned to the nest tree and darted into the hole as rapidly as the narrow orifice would allow. On the next morning, May 25, after a cautious departure from the nest, and in a highly nervous state, they continued to bring food to the remaining nestlings. They often dashed off with shrill cries at times when I saw no cause for alarm, although they might have seen the hawk soaring over the forest or resting in a tree-top beyond my view. That evening, when the bird of prey appeared again, only two adults entered the hole in the waning light. On the following morning, May 26, a friend who helped me guard the nest saw another fledgling emerge from it. The young one, almost as large as the mature birds but with a noticeably shorter tail, was soon led off through the tree-tops. At nightfall only two adults went to rest in the hole, where at least one nestling remained. On May 27, I was unavoidably absent, but at dawn on May 28 I saw a single adult leave the cavity, where it had slept alone, for the last of the brood had apparently departed on the preceding day. But for the unfortunate intrusion of the White Hawk, whose relations with the araçarís are reported in some detail in an earlier paper (Skutch, 1950), I have little doubt, from the observed behavior of the young bird which had emerged first, that the whole family, adults and young, would have continued to roost in the high hole.

Apparently there had been three nestlings. I first saw an attendant take food into this nest on April 11. At least one young araçari left on May 24, and the last young bird left on May 27. From this we may deduce that the fledgling which departed first was no less than 43 days old. If the young hatched on successive days, the last one to emerge must have been about the same age as the others at this stage. Since the attendants might have been bringing food for a day or two before I saw them do so, the nestling period of the Collared Araçari may be placed conservatively at 44 days. I found the nestling period of the Blue-throated Toucanet (*Aulacorhynchus caeruleogularis*) of the Costa Rican highlands to be at least 43 days (Skutch, 1944:145), while from incomplete data Van Tyne (1929:34) calculated the nestling period of the Keel-billed Toucan at 45 days. This last is probably too short an estimate for the nestling period of this much larger bird.

On the evening of June 1, four adult araçarís retired to rest in the high hole where the family had been reared. The following day I left Barro Colorado, and I never learned where the young lodged.

Van Tyne (1935:25) records a nest of the smaller race *P. t. erythrozonus*, which was discovered at Uaxactun, El Petén, Guatemala. This nest was about 45 feet above the ground in a thick, upright limb of a tree at the edge of a clearing, and on May 20 it contained three plain white eggs on the point of hatching.

FIERY-BILLED ARAÇARI

Appearance.—In size and plumage, the Fiery-billed Araçari (*Pteroglossus frantzii*) resembles the Collared Araçari, but there are certain conspicuous differences. The trans-

verse band across the middle of the ventral surface is much broader and is completely red with the exception of a narrow black margin on the anterior side, or a line of black spots in this position. There is the same dark chestnut collar across the hindneck, the same chestnut or deep cinnamon-rufous on the thighs, and the same black patch in the center of the yellow, red-tinged breast. But the bill, which in all toucans is so conspicuous a feature, is strikingly different in the two forms. That of the Fiery-billed Araçari is orange-red over the greater portion of the upper mandible. Toward the base, this color fades to yellow or greenish-yellow, and there is a black band along the basal half or more of the culmen. The lower mandible is largely black, and both parts of the bill are outlined at the base by a narrow whitish line which contrasts with the black head. The eye is bright yellow, with a triangular area of bare, red skin behind it. The feet and legs are olive-green.

Range and general habits.—This brilliant toucan is confined to the Pacific side of Costa Rica, from the Gulf of Nicoya southward, and to the adjoining regions of western Panamá. In Costa Rica, it breeds from sea level up to no less than 3000 feet and it ranges at least a few hundred feet higher. In the Volcán Chiriquí region of Panamá, it has likewise been recorded at 3000 feet above sea level (Ridgway, 1914:347). It lives chiefly in the upper levels of the tall rain forest of this wetter part of the Pacific littoral of Middle America, but it often forages and nests in neighboring clearings where there are scattered living or dead trees. Its flight is swift and direct, and it travels in loose, straggling bands which at times contain as many as ten individuals but are usually smaller.

Sometimes a number of these toucans fly back and forth among the boughs in what appears to be a playful mood, and then they occasionally strike their heavy bills resoundingly against a trunk or branch, apparently merely to hear the report. One morning in April, I watched what seemed to be a more elaborate form of play, which took place on a lofty horizontal branch of a tall tree a short distance within the edge of the forest. Two araçaris, facing each other, struck their long red bills together, somewhat as fencers do with their swords when on guard. Then they grasped each other's mandibles and pushed, until at length one of the contestants was forced backward and hung below the limb, after which it admitted its defeat by flight. The victor held its ground, and soon a third member of the flock approached to challenge it. Again the opponents struck their bills together, then grasped and pushed. This time the winner in the first bout was itself forced from the bough and flew away, leaving the newcomer there as undisputed champion. These contests appeared to be carried on without anger, and the loser was never pursued.

While travelling through the great forest which twenty years ago covered most of the middle reach of the Térraba Valley, I watched a flock of araçaris bathe, one after another, in a pool of rain water which filled a small cavity in the upper side of a thick, horizontal branch above the trail. Similarly, I once watched a pair of Chestnut-mandibled Toucans bathe in the rain water that filled a crotch high up in a tree, but I have never seen toucans of any kind wet their plumage in a stream or pool at ground level.

Food.—Fiery-billed Araçaris eat the fruits of forest trees and sometimes descend into the low, rank growth of new clearings where, in company with a variety of tanagers, honeycreepers, manakins, and other birds far smaller than themselves, they feast upon the juicy purple-black berries of the jaboncillo or pokeweed (*Phytolacca rivinoides*) that grows so profusely on burnt ground. Seizing a little berry in the hooked tip of its great bill, the araçari tosses it into its throat by means of an upward jerk of its head. The eggs and nestlings of other birds vary the largely frugivorous diet of this toucan. I once

surprised one removing a white egg from the hole of a pair of Golden-naped Woodpeckers (*Tripsurus chrysauchen*) while the parents vainly protested, and at another time I saw a parent araçari bring a newly hatched nestling of some passerine bird to its own young. In the breeding season, the araçaris periodically visit our dooryard, which adjoins the forest, to search through the shade trees and shrubbery. Although I cannot recall having actually seen them pillage a nest, the distress of the birds breeding in the area, and the fact that nests are often prematurely empty after the toucans have left, are strong circumstantial evidence that they come to plunder. Hence, before they have an opportunity to carry out their designs, they are usually sent on their way.

Whatever other uses the toucans' huge bills may have, one need only watch these birds on a pillaging excursion to become convinced that the size and color of the bills serve to intimidate the smaller birds which the toucans persecute. As far as I have seen, the boldest of them will not dare to touch a perching araçari or other toucan and risk a nip from the terrifying beak. But some of the larger and more spirited flycatchers will buffet flying toucans when the latter seem unable to turn their heads and defend their backs.

Early in March I watched two araçaris eating the fruiting spikes of the guarumo tree (*Cecropia* sp.). Sometimes one would break off a small piece and, after a little pressing between the tips of the mandibles, throw it back into its throat with an upward toss of the head and swallow it. Sometimes, detaching a longer piece of the cylindrical green spike, the bird would hold it against the perch with one foot and tear off small pieces to swallow. Finally, one of the pair, probably the male, approached the other and gave it a piece of the food. Then both flew off to the forest.

I was reminded of this incident when, years later, also in early March, I saw a Fiery-billed Araçari with a strangely deformed bill. The brilliant upper mandible of this bird was strongly bent both upward and sideways, so that there was a prominent gap between the two mandibles in the terminal half of the bill; moreover, the tip of the upper mandible was not above that of the lower but well to the side of it. I believe that such a deformity could have arisen only in the embryonic, or at least in the nestling stage of this bird's development, and I doubt very much whether it could have fed itself well enough to stay alive. Certainly it would have been greatly handicapped in eating; yet it was full grown, in fine plumage, and apparently otherwise in good condition. I surmised that its companions, or possibly only its mate, supplied it with much of its nourishment; unfortunately the flock did not remain in view long enough for me to witness this.

Voice.—The call of the Fiery-billed Araçari is a high, sharp *pink*, *pitit*, or *pity*, in tone very much like the note of the Collared Araçari. I am not certain that I could distinguish the two species by their voices.

Roosting.—Most of my observations on the sleeping habits of the Fiery-billed Araçari were made in my early years in the valley of El General in southern Costa Rica, from 1936 to 1943. In this period, new settlers were pouring into this originally forested region and making great inroads on the woodland. Usually, when clearing an area of forest, they would spare a few scattered trees to avoid the labor of felling them or to serve as future sources of firewood. These isolated trees were invariably killed by the fire set to clear the land for planting, and often the flames would attack additional trees at the margin of the intact forest. Soon decaying, these dead or dying trees were drilled by woodpeckers, especially the Golden-naped Woodpecker, the Red-crowned Woodpecker (*Centurus rubricapillus*), the Lineated Woodpecker (*Dryocopus lineatus*), and the Pale-billed Woodpecker (*Phloeocastes guatemalensis*), to make holes for roost-

ing and nesting. When the woodpeckers had finished with these cavities, or sometimes before, they were claimed for nesting and sleeping by the araçaris, Streaked-headed Woodhewers (*Lepidocolaptes souleyetii*), Masked Tityras (*Tityra semifasciata*), Black-crowned Tityras (*T. inquisitor*), Gray-breasted Martins (*Progne chalybea*), and sometimes Southern House Wrens (*Troglodytes musculus*). When, in 1941, I bought my farm in El General, there was a large new clearing that still smoked, with its usual quota of standing charred trees. Since then, no more forest has been felled on this farm. After the fire-killed forest trees toppled over, observations on the roosting and nesting of the araçaris came to an end, for I have not found them sleeping or breeding in the midst of intact forest, as doubtless they originally did and still often do.

Only the largest of the woodpeckers which nest in these clearings, the Pale-billed and the Lineated, carve holes large enough to accommodate the araçaris. The Lineated Woodpecker is more abundant and accordingly it is the chief provider of lodgings and nest chambers for the toucans. As they wander through the log-cluttered recent clearings with scattered standing trees, the araçaris, ever on the lookout for good dormitories, examine the available cavities, often poking their heads into the holes before the makers have abandoned them. This causes much distress among the smaller of the hole-nesters. The progress of a band of araçaris through such a clearing at the height of the nesting season is attended by the angry, darting flights and complaining cries of the numerous birds which breed there.

Apparently it is chiefly as a safeguard against these great-billed intruders that the larger woodpeckers spend so much time with nestlings that are already feathered and no longer require brooding. At a nest of the Lineated Woodpecker that I watched for nine hours on April 3, 1940, the male spent four and a half hours guarding two young which were almost as large as he and nearly ready to fly. Twice during my vigil, parties of araçaris came to the nest and were repelled by the parent woodpeckers, once by the male from the inside and once by the female from the outside. Whenever a large bird flew up to the charred trunk, the male drew down into the cavity where he could not be seen from the front. Apparently not noticing that the hole was guarded, an araçari thrust its head inside and received on its beak an audible tap from the sharp bill of the woodpecker. This happened twice, on different days.

Since the Lineated Woodpecker does not, like some other members of the family, use its nest cavity as a dormitory after the departure of the young, these holes become available to the araçaris as soon as the brood has flown. The nesting hole just mentioned remained untenanted at most two nights after the fledglings had left, for on the third night I discovered araçaris sleeping in it. In 1936, a nest of the Lineated Woodpecker that I had been watching was also taken over by araçaris a few days after the brood had flown. In each of these holes, five araçaris sometimes lodged. In 1942, in another locality, I again found five araçaris roosting in a woodpecker hole which had been made apparently by this species. The capacity of the Lineated Woodpecker's nest cavity seems to be limited to five full-grown araçaris, for one evening when five araçaris entered a woodpecker hole that I watched in 1940, three more went to rest in an older cavity not far away.

I have never found more than five Fiery-billed Araçaris sleeping together, but I have often seen from one to four enter a hole. Their sleeping arrangements change within short periods of time. Apparently they usually know a number of available lodgings, discovered on their periodical tours of investigation, and if alarmed or ill at ease at one, they readily fly off to another as the day ends. Often there is much cautious inspection of the holes while clinging in front, much going in and out of the cavities, and much flying back and forth in the waning light, before all the members of a flock are com-

fortably installed for the night. Compared with woodpeckers, araçarís retire late in the evening and arise early in the morning.

The abandoned woodpecker holes are also in demand by other birds, especially by Gray-breasted Martins and Masked Tityras, for nesting, and this brings these birds into competition with the araçarís. In my life history of the Masked Tityra (1946:352-360), I related some of the difficulties which this timid bird has with her huge-billed, greatly feared neighbors. Even when they do not contend for the same hole, the araçarís often sleep or breed in another cavity in the same tree that holds a nest of the tityra. But sometimes the araçarís are the aggrieved party. In 1939, in a narrow clearing between two strips of forest, I watched a hole in the top of a tall dead tree into which a female tityra was carrying inflorescence stalks and dead leaves for her nest. When in the evening three araçarís arrived to sleep in this hole, where they may well have been lodging long before the tityra claimed it, she and her mate pursued them in flight and darted at them while they clung at the doorway, inspecting the interior before they entered. The toucans, however, paid slight attention to the tityras, which remained watching the hole until after the larger birds had retired; then they flew off in the dusk to sleep in the forest. This went on for a number of evenings, and, although I doubt that the tityras ever found courage to strike the toucans, some of their pursuits showed great spirit. By day, when the araçarís were absent, the female tityra continued to fill the cavity with coarse material, and one evening the lodgers arrived to find the space so reduced that they had difficulty in accommodating themselves. The first araçari went in without trouble but the second tried several times to enter and then flew to the edge of the forest. The first araçari came out, whereupon the second returned to the hole, stuck in its head, pulled out a bunch of material consisting largely of dry leaves, carried it to a neighboring tree, and dropped it. Finally, two birds entered the cavity to sleep and the third went elsewhere.

The following evening two araçarís entered the hole without difficulty. Then the tityras stood side by side on the top of the stub, peering over the edge to see what was happening below them. Presently, as it was growing dark, the male flew off leaving the female alone on the stub. While she stood there the third araçari arrived very late, and finding it troublesome to enter the reduced space head first, it turned around and inserted itself forcibly tail foremost, as woodpeckers sometimes enter their dormitories. As the araçari went in, I clearly saw it turn its long tail forward over its back; on subsequent evenings I repeatedly witnessed this procedure. In these circumstances, the value of this arrangement in saving space was obvious.

On the morning of April 26, the female tityra, after much hesitation, entered the hole and stayed for about 20 minutes, probably laying an egg. This was doubtless broken when three araçarís squeezed in above it that evening. The last araçari folded its tail over its back as it struggled rump first into the crowded quarters. A few days later, this hole was abandoned by both araçarís and tityras. If, as I suspect, one or more eggs were broken in it, ants might have arrived and made it untenable by the birds. By the middle of May, however, the tityras were nesting in this disputed cavity. Mild mannered as they are, tityras often gain their objective through their great persistence. Higher in this same tree a pair of Golden-naped Woodpeckers nested while the dispute was in progress, and one evening, before the araçarís arrived, eight small bats dropped one by one from a neighboring hole, where they had slept through the day.

Roosting arrangements of a mated pair throughout the year.—The parties of four to eight araçarís, which, even at the height of the nesting season in April and May, wander through the clearings and lodge either together or in neighboring holes, appear to be composed largely, if not wholly, of nonbreeding individuals. The presence of

these groups suggests that Fiery-billed Araçaris do not begin to nest until at least the second spring following that in which they were hatched. These observations on a related form make it appear probable that three of the five attendants at the Collared Araçaris' nest previously described were young, unmated helpers, probably yearlings, as has been noted in the Brown Jay (Skutch, 1935).

At the end of my first February in El General, a flock of between five and eight Fiery-billed Araçaris would come in the evening to an abandoned cornfield at the edge of the forest, on a slope high above the Río Buena Vista and 3000 feet above sea level. Here were a number of tall, fire-killed trees, standing above the bushes and vines that were fast growing up into an impenetrable tangle over the steep mountainside. In the trees were many woodpecker holes, some still unfinished, some with eggs or nestlings, some newly deserted by their makers, and others in various stages of decay. The araçaris examined many of these cavities, but they were chiefly interested in one that had been abandoned only a day or two earlier by a brood of Lineated Woodpeckers. On the evening of February 26, four araçaris entered this lofty hole, while one clung beside the doorway; then all swarmed out and flew off to the forest, and finally one returned to sleep alone in the cavity. The following evening, two slept in this hole, while a third retired into an older cavity close by in the same trunk. On the third night, the new hole was occupied by four araçaris, while the old one where a single bird had slept remained empty. On the fourth evening, no araçari came to lodge in this clearing. On the fifth evening, five packed themselves into the Lineated Woodpeckers' hole and stayed, to the great annoyance of a Masked Tityra which was beginning to nest in a neighboring cavity in the same trunk. On the sixth night, four araçaris slept in the woodpecker hole; on the seventh night, there were again five. This will serve as an example of the inconstant behavior of a flock of Fiery-billed Araçaris as their nesting season approaches.

By March 10, one member of the flock had begun to sleep in another hole which had a doorway so narrow that the bird could hardly squeeze through. It was about a hundred feet above the ground in a great dead tree which stood a short way down the slope from the one in which the others roosted. This woodpecker hole with a narrow orifice was selected as a nesting site. Now the flock rapidly dwindled away, until the old cornfield on the mountainside was left in the possession of two birds which soon showed clearly that they were a mated pair. The two slept apart, one in the hole in the tree lower on the slope, where incubation began at about the end of March; the other slept 50 feet away in the Lineated Woodpeckers' hole, which not long before had provided shelter for the five araçaris. Since among toucans the male and female are similar in appearance, I could not learn which was in charge of the eggs through the night and which slept in the neighboring lodge. By day, the two took turns on the eggs (see section on eggs and incubation). By the middle of April, the parents were carrying small insects into this high nest, but before the young were fledged the tree was cut down.

After the loss of their nest, the pair slept together in the Lineated Woodpeckers' hole. They now came out so unusually late in the morning that I concluded that they were feeling broody and would attempt a second nesting, but apparently they laid no more eggs that year. With the araçaris' usual wavering attachment to their dormitory, they slept in the woodpecker hole intermittently until the owner of the land cut the tree for firewood in August. Then for two months I lost track of them. But in October I found a pair, without much doubt the same, lodging in a hole recently carved by a woodpecker in the trunk of a *Cecropia* in the same clearing. This hole was only 20 feet above the ground, and it had a doorway so wide that in the morning, when they lingered in their dormitory, both birds could look out together, with the end of the great red bill of one beside or above the projecting head of the mate. Although they did not sleep

in this hole consistently, it was one of their principal lodgings until the following February. These two araçaris, once mated, seemed never to rejoin the flock from which they had separated in the preceding March. They kept apart, at least by night, and preserved their domain through all the months when they did not breed. Yet they were not strictly intolerant of others of their kind on their territory, and for a while they permitted a third araçari to sleep not far from them in a hole which they had formerly occupied.

In February, these birds, which I had now watched for a year, took possession of a hole which had been abandoned by a pair of Pale-billed Woodpeckers after they had lost their newly hatched nestlings to a predator. In this low hole the pair of araçaris slept together, with occasional inexplicable absences in true araçari style, until the female laid in it at the end of March. Now, as in the preceding year, a single parent slept in the nest, while the other took up quarters once more in the trunk of the *Cecropia* where formerly both had found shelter. This time the nest was pillaged even before the eggs hatched (see section on eggs and incubation). Still, the araçaris did not abandon the clearing where, in two successive years, they had been unable to rear a brood. As after the loss of their nest in the previous year, both now slept in the dormitory of the member of the pair which had not incubated by night, in this case the low hole in the *Cecropia* trunk that had so long been their shelter. Again I could detect no attempt to replace their lost eggs. In mid-June I left the locality, and my observations of this pair, which had lasted more than 15 months, came to an end.

Eggs and incubation.—I made no attempt to reach the hundred-foot-high hole in which this pair nested in 1936. However, the following year, when they used a hole only 20 feet high, I constructed a ladder and climbed to the nest on April 1. When the interior was illuminated with an electric bulb, my mirror, thrust through the doorway, revealed two pure white eggs resting on a layer of regurgitated seeds which covered the whole floor and looked much like a bed of assorted beans. Since I could barely touch these eggs with my finger tips, I did not jeopardize future studies by trying to remove them for closer examination and measurement. These are the only eggs of the Fiery-billed Araçari that I have seen or of which I can find a record.

I gave some attention to the mode of incubation in both years. Because I am not certain whether, in araçaris, the nest is occupied through the night by the female, as in most birds, or by the male, as in a number of cuckoos, woodpeckers, and puff-birds, I shall designate as A the member of the pair which slept on the eggs and as B the mate that lodged in a neighboring hole. In 1936 I noticed that the early morning behavior of these araçaris varied considerably from day to day. On April 4, bird A left the nest and flew into the woods at 5:28 a.m., returning to the eggs ten minutes later. Bird B did not emerge from its dormitory until 5:42 a.m., at which time it flew directly into the forest. The following day, however, B flew from the dormitory to the forest at 5:20 a.m.; A remained in the nest until B returned and entered it at 5:44. On April 12, B left the dormitory at 5:32 a.m.; A emerged from the nest at 5:45 but perched in front of it until B came to take charge of the eggs a minute later. Often, as B flew from the old woodpecker hole in the morning, it was pursued as far as the forest by one or both of the tityras whose nest was in the same trunk. Sometimes the tityras also chased B as it came to its lodging in the evening.

In addition to these early morning vigils, I watched this nest while incubation was in progress from 5:18 to 10:38 a.m. on April 5, and from 2:12 to 6:06 p.m. on April 7. Araçari A left the nest at 5:44 a.m. on April 5; on April 7 it entered for the night at 5:25 p.m. In the slightly more than 8 hours during which changes in the occupancy of the nest took place while I watched, I timed 12 sessions by both parents. These ranged

from 2 to 102 minutes in length and averaged 25.6 minutes. Only one session, in the afternoon, was over an hour in length. Since I could not distinguish the parents, it was impossible to tell how nearly equally they shared in the task of incubation. The change-overs were witnessed most frequently in the early morning, and when they occurred the newcomer often entered the nest before the other emerged. Sometimes the incubating bird left the hole, perched in front of it for two or three minutes, and then went in again. Once one member of the pair did this three times in the course of 81 minutes, breaking what might have been one long session into four shorter ones of 24, 21, 21, and 7 minutes. These sessions were counted separately in computing the average attendance period. The result of all this restlessness was that the nest was left unattended for 11 periods ranging from 2 to 53 minutes in length and averaging 15.9 minutes. The eggs were incubated for only 63.6 per cent of the 8 hours.

On April 9 of the following year, I watched the lower nest of the same pair of araçaris from 5:20 to 11:12 a.m., but since A did not leave the nest until 6:13, this vigil covered only 5 hours of the active period. The araçaris were so restless that neither stayed at its post until the mate arrived, and I did not witness a single change-over. Once, however, one partner came to the doorway while the other was within, but it flew off again as the latter tried to push out past it. Doubtless both sexes participated in incubation as they had in the previous year. Seven sessions ranged from 12 to 33 minutes and averaged 28.1 minutes. An equal number of periods when the eggs were unattended ranged from 2 to 31 minutes and averaged 14.6 minutes. The eggs were covered 65.9 per cent of the 5 hours. The two records, made in different years, are surprisingly similar, especially when one considers only the earlier part of the record made in 1936. In that year, between 5:44 and 10:38 a.m., the eggs were covered a total of 199 minutes and were unattended for 95 minutes, whereas in 1937, from 6:13 to 11:12 a.m., the corresponding figures were 197 and 102 minutes.

In the Costa Rican highlands, I found the Blue-throated Toucanet only slightly more constant in incubation (Skutch, 1944:140). One wonders why araçaris, taking turns on the nest, should sit so inconstantly that the two parents together keep their eggs covered less constantly than many small female passerines that incubate alone. Compared with other non-passerines of about the same size, including pigeons, trogons, motmots, kingfishers, puff-birds, and others, whose sessions on the eggs usually last for hours, araçaris, like other toucans, make a poor showing. The contrast between the araçaris and the Pale-billed Woodpeckers, which earlier had occupied the same hole used by the araçaris in 1937, was especially striking; the woodpeckers kept their eggs almost constantly covered, with only two change-overs in a whole day's watching. The only explanation which I can offer for the araçaris' inconstant incubation is temperament. They are restless birds, and their behavior contrasts strongly with that of trogons, puff-birds, and kingfishers, which are more phlegmatic. Perhaps for this reason they find it difficult to remain sitting quietly in the narrow chamber. However, jays and jacamars, also vivacious birds, stay on their eggs for long periods, so that additional factors appear to be involved in determining the constancy of incubation.

When approaching their nest, the araçaris frequently carried some small object in the end of their great bill. Sometimes they dropped this before going to their eggs and at other times they took it inside. When they thrust their heads through the doorway or flew from the nest, they likewise often held something in the bill, only to let it fall after a short time. These objects were probably the regurgitated seeds of forest fruits which were very prominent on the floor of the low nest. During my afternoon vigil in 1936, a family of four Red-crowned Woodpeckers, including two young ones which had recently left a nest in a neighboring dead trunk, climbed and pecked over the ara-

çaris' nest tree. The young male cautiously peered into the hole where one of the toucans was incubating. Later, when the nest was unattended, he went again to the orifice and after much hesitation entered but emerged a moment later. Apparently he was prospecting for a dormitory since he was inside hardly long enough to harm the eggs.

At dawn on April 10, I found that the araçaris' eggs had vanished from the low nest. Apparently they were taken during the night by the same predator that had enlarged the entrance to the hole of a pair of Golden-naped Woodpeckers a little higher in the same trunk and carried off their nestlings. Although the parents survived and continued to roost in the clearing, no attempt at renesting was noted, just as none had been made after the loss of the nestlings in the preceding year. Araçaris are not only single-brooded, but unlike many other single-brooded birds they seem to make no second attempt to reproduce if their first effort is unsuccessful. Van Tyne (1929:34) concluded that the Keel-billed Toucan is single-brooded, but the Blue-throated Toucanet rears two broods in a season.

The young and their return to the nest.—By April 16, 1936, the araçaris were bringing food to the high, inaccessible nest. The small insects which they now carried in the tip of the bill contrasted with the large, regurgitated seeds, which at an earlier stage they had often held, and they were far more difficult to see. Early in the morning of April 22, a flock of five araçaris flew into the clearing and were joined by the nesting pair, making seven in all. Some of the newcomers came near the nest, but they did not actually visit it. Although I saw no quarreling between the residents and the visitors (I have never seen araçaris fight), I sensed tension, and after the whole party went to perch at the forest edge, I heard sounds suggestive of a dispute. But before I could get a clear view of the araçaris, the momentary flare-up had subsided, and soon the visitors vanished. A week later I found that the nest tree had been felled, apparently to take the nestlings, if they survived the fall of well over a hundred feet as the tree crashed down the steep slope. At no time did I see more than two adults in attendance at this nest.

The third and last nest was situated about 45 feet above the ground in an old hole in a tall, branching, fire-killed tree standing in a newly made pasture. This cavity had probably been carved by a Lineated Woodpecker. When I found it on April 24, 1943, the parents were feeding nestlings. This nest was in plain view of the main road from San Isidro to Quizarrá, and perhaps for this reason the araçaris were far more shy than were those in the more secluded clearing where I had found the first two nests. I could watch the parents approach the nest only if I stationed myself a long way off, behind screening bushes. They brought insects, fruits, and once a newly hatched nestling of a passerine bird. I saw no indication that other individuals were assisting them in the care of the young. By May 7 the young had begun to look through the doorway; at times two birds looked out at the same time. Their bills were already of considerable size. Both parents now slept in the nest, but if they saw me watching them, even a long way off, they would, unlike most other araçaris that I have observed, go elsewhere to spend the night.

Early on May 10, I saw only one nestling in the doorway, and continued watching convinced me that the other had flown. By the evening of the following day, the second young bird had not yet emerged. While it looked through the doorway, both parents flew down from the neighboring forest to alight in a small dead tree standing near the nest. They were excited and called *pitit pitit* in high, sharp voices, at the same time twitching their great bills up and down. Presently the fledgling which had emerged on the preceding day came down from the forest to join them. It flew fairly well but made a c'umsy landing and hung for a moment below the branch before it succeeded in right-

ing itself. One of the parents entered the nest but promptly returned to the lower tree where the young bird rested. Soon an adult went into the hole to stay, while the other flew to a more distant tree. Left alone, the fledgling started toward the nest, only to veer to one side of the trunk and continue its flight unbroken to the forest edge. There it remained for its second night in the open. Later the other parent retired into the nest. Thus, on this night the two adults slept in the hole with the remaining nestling, while the more advanced young bird was exposed to the elements.

Continuous rain interfered with observations on the evening of May 12, but at dawn on the following day there were two adults and two young in the nest. Thus it was evident that one of the latter had succeeded in entering the hole after two nights outside. This young bird left the nest 42 minutes after its parents and with little difficulty flew to the nearest part of the forest. Until six o'clock the second young araçari stayed inside and called *pit pit* in a high, slight voice, in answer to the reiterated *piiii* of its parents from the margin of the forest. I then went to breakfast, but when I returned at seven o'clock I found that the second fledgling had flown forth and was resting on a fallen charred log between the nest and the woodland. The parents' excited behavior had revealed its position, and I approached quite close before it tried to escape. It flew with directness and force but gained altitude with difficulty, and since the slope ahead was inclined more steeply than the young bird could rise, its course ended abruptly in the deep calingüero grass, among the charred logs and stumps 50 feet from its starting point. Advancing cautiously, I captured it by throwing my hat over it, while the parents looked down from the dead trees with obvious concern. Taken in hand, it struggled forcefully to escape and once bit hard enough to hurt. After I had written a description of it, I released the young araçari, and it resumed its journey to the forest. It had left the hole three days later than its nest-mate, and after its departure the nest cavity was empty.

During a lull in the afternoon rain at 5:06 p.m. on the same day, I found that one young bird, doubtless the older, had already returned to the nest and was looking through the doorway. Half an hour later both parents flew down from the forest, and soon they were followed by the other young araçari, whose skill on the wing had improved noticeably during its first day in the open. Presently one parent entered the hole, and then the young one tried to follow. But it aimed too high and clung to the trunk above the doorway. While it rested there, the other parent slipped into the hole below it without giving the least encouragement. After another unsuccessful attempt to join the others in the hole, the young araçari started off toward the forest but came down among the charred logs and stumps in the pasture, where I lost sight of it in the drizzle and gathering gloom. A few moments later both parents emerged from the dormitory and flew toward the young bird but passed above it to the forest, where they remained until it was dark. Thus the more advanced fledgling slept alone in the nest cavity, while the younger of the two, repeating the experience of the other, was obliged by its inadequate power of flight to sleep in the open on its first night out of the nest. The following evening, May 14, none of the family came in sight of the nest tree between 4:30 p.m. and nightfall. The hole remained deserted. Probably the parents had taken little trouble to guide the fledglings into the nest because they were themselves ill at ease in this exposed situation.

The newly emerged fledgling which I had in my hand rather closely resembled the adults in plumage, although its colors were slightly duller. Its bill was far less colorful, the upper mandible being yellow clouded with dusky, with the culmen blackish at the base and greenish toward the center of its long axis. The lower mandible was dusky, but both parts of the bill were brighter yellow at the tip. The inside of the bill was yellow.

The iris was straw-color instead of bright yellow as in the adults. The bare skin surrounding the eye was bright yellow behind the orbit (this area is red in the adults), greenish-yellow above it, and greenish in front, on the lores. The legs and feet were yellowish-green, with black toenails. The heel pad, characteristic of nestlings which grow up in unlined holes in trees or banks, was still quite evident in the form of five prominent protuberances in a ring surrounding each heel.

Araçaris as neighbors.—Although the araçaris are undoubtedly fond of eggs and nestlings, they do not systematically prey upon the other birds that breed in holes in the vicinity of their own nests. The inspection of a large share of the cavities in a clearing with dead trees appears to be carried out chiefly by the parties of nonbreeding birds which wander about at all seasons, and by mated pairs looking for a nest site and a lodging. After the pair of araçaris which I watched in 1936 and 1937 had become comfortably established, I did not see them give attention to any holes other than the two in which they nested and slept.

I have on numerous occasions known other hole-nesters, including Masked Tityras, Gray-breasted Martins, Golden-naped Woodpeckers, Red-crowned Woodpeckers, and Lineated Woodpeckers, to rear their families within sight of an araçari nest and often in the same tree with it. The immunity of the smaller woodpeckers might be attributed to the depth of their nest holes combined with the narrowness of the doorway, which places the eggs beyond reach of the araçaris' bills, whereas the safety of the brood of the Lineated Woodpecker may be due to the rather constant guard kept by the parents. Neither of these explanations, however, would account for the immunity of the tityra and the martin, which often nest in old holes, the doorway of which is wide enough to admit an araçari. The only instance of predation on a hole-nesting bird that I have witnessed was the removal of a single egg from a nest of a Golden-naped Woodpecker. The cavity of this nest was perhaps shallower than usual, for the toucan managed to seize the egg while clinging to the front of the doorway. Yet in this same hole, only a yard above an occupied nest of the araçari, the woodpeckers succeeded in hatching one or more remaining eggs. Although all of these hole-nesters are fearful of the araçaris and are greatly perturbed whenever they approach, the latter are not such dangerous neighbors as their predatory habits might lead one to suppose.

SUMMARY

The Collared Araçari inhabits the lowland forests of Central America from sea level up to about 3000 feet, where it roams through the tree-tops in straggling bands containing up to six or rarely more individuals. It subsists largely on fruits. Its notes are thin, high-pitched, and of limited variety.

These araçaris roost in old woodpecker holes or in cavities resulting from decay. The greatest number of araçaris found sleeping together was six. These birds retire late in the evening and arise early. Each band appears to know a number of available dormitories, and with slight provocation they shift from one to another.

At the end of February, six araçaris were found lodging in a hole about 100 feet up in a great tree on Barro Colorado Island, Panamá Canal Zone. In March this cavity was taken over for breeding, and for most or all of the period of incubation a single bird slept in it. But at about the time the eggs hatched, most of the original flock returned to roost each night with the nestlings.

All five of the full grown birds which slept with the nestlings helped to feed them. These attendants probably consisted of the parents and three helpers that were too young to breed. At first the attendants brought small insects but, as the nestlings grew, they brought an increasing proportion of fruits, including many seeds of *Virola*. The attendants were also seen to remove large amounts of waste from the nest.

The nestlings, of which there were at least three, first appeared in the opening of the nest holes when they were about 37 days old. They left on different days, 43 to 46 days after the attendants were first seen bringing food to the nest.

The Fiery-billed Araçari differs from the Collared Araçari chiefly in the more vivid color of its bill. It occurs in a restricted region on the Pacific side of southern Costa Rica and western Panamá, breeding from sea level up to at least 3000 feet. This araçari subsists on a variety of fruits, with the occasional addition of the eggs and nestlings of other birds. Its high, weak notes are very similar to those of the Collared Araçari.

In the valley of El General, Costa Rica, these araçaris were frequently found lodging in old woodpecker holes or other cavities in fire-killed trees left standing in new clearings in the forest. Favorite lodging places are the holes made by Lineated Woodpeckers; on two occasions, holes of this species were occupied by araçaris a few days after the nestling woodpeckers left. Five araçaris appears to be the maximum capacity of a Lineated Woodpecker's hole, and larger parties divide up between neighboring cavities. Each flock seems to have several dormitories, and they often shift from one to another, so that the occupancy of a single cavity fluctuates.

The sleeping arrangements of a single pair were followed over a period of 15 months which included two breeding seasons. While incubation was in progress, one member of the pair slept on the eggs and the other lodged alone in a neighboring cavity. Between breeding seasons the two slept together, often in their nesting territory, although from time to time they went elsewhere as is usual with araçaris.

In the breeding season, parties of nonbreeding araçaris wander about. Apparently these birds do not nest until they are nearly two years of age, or older. These unmated birds were not seen to help mated pairs attend nestlings, as has been noted in the Collared Araçari.

Each year the female of the mated pair laid eggs at about the end of March. Once the eggs were deposited in a hole about 100 feet high and once they were laid in a hole only 20 feet high that had been made by a Pale-billed Woodpecker. The lower hole contained two immaculate white eggs which were found resting on a bed of regurgitated seeds. Both sexes incubated, but they sat so restlessly that, except in the early morning, change-overs on the eggs were rarely witnessed. The periods of incubation of both sexes averaged 25.6 minutes the first year and 28.1 minutes the second year. A period of 102 minutes was the only session longer than one hour that was observed. In the first year, the eggs were covered only 64 per cent of eight hours and in the second year 66 per cent of five hours. The first nest was destroyed by men who felled the nest tree, and the second was destroyed by a predator.

At a third nest, both parents slept with the feathered nestlings. The newly emerged fledglings tried to return in the evening to roost with their parents. This nest contained at least two young, the first of which left three days before the second.

In El General, a single brood is reared yearly. In two instances when eggs or young nestlings were lost, no attempt at renesting was noticed.

Although these araçaris take the eggs and nestlings of other species, smaller hole-nesting birds often successfully rear their young in the same clearing and even in the same dead tree in which araçaris nest. The immunity of some smaller birds from predation by the araçaris can be accounted for neither by the inaccessibility of their eggs nor by the effectiveness of their defense. It is to be attributed rather to the araçaris' lack of interest in these nests.

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