

and were also yellower on the side of the head, with a yellow eye-ring; grayer on the back and rump; throat yellowish olive-green; the belly yellower. This is a fair-blended intermediate between Golden-winged and Blue-winged nestlings.

“These Blue-winged  $\times$  Golden-winged nestlings should have been Brewster's. But so should one of the types of Brewster's  $\times$  Golden-winged nestlings. That their plumage differed markedly from either indicates that nestling and final plumage are not clearly linked in heredity, and suggests that with nestling plumage, blending is less in later than in first generation hybrids.

“Incidentally, we find an entry in our notes concerning a young Lawrence's (male)  $\times$  Blue-winged (female) Warbler nestling on Long Island (Blue-winged territory), that it was olive in color, green above, yellow below, wing with two narrow, grayish white bars.

“Lawrence's (in final plumage) is the recessive hybrid, but it should be noticed that, mated with a Golden-winged which has yellow wing-bars, it gave a nestling with yellower wing-bars than the nestling Golden-wing, mated with a Blue-wing which has grayish wing-bars, a nestling with grayer wing-bars than the nestling Blue-wing.

“The Brewster's Warbler locality was Golden-winged territory, although a few Blue-wings nested there and there was Blue-wing territory not far distant. This is usually the case where Blue-wing  $\times$  Golden-wing crosses occur. It should be noticed that in all mixed nestlings observed, the female was a Golden-wing; the male, a Brewster's (five times), a Blue-wing (once), a Lawrence's (once). In the few mixed nestings that have come to our attention in true Blue-wing territory, the female has been a Blue-wing, the male usually a Lawrence's.”

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## THE LIFE-HISTORY OF THE PRONG-BILLED BARBET

BY ALEXANDER F. SKUTCH

THE Prong-billed Barbet (*Dicrorhynchus frantzii*) is an odd, attractive, little bird belonging to a family far better represented in the tropics of the Old World than in the New. In Central America, north of Panamá, only two species of barbets are known: the brilliantly colored Salvin's Barbet (*Eubucco bourcierii salvini*), which I have nowhere found common, and the more plainly attired Prong-bill,

abundant only in a wild, mountainous region which, however strongly it may attract the naturalist with its wealth of bright flowers and lovely birds, repels him by its dearth of sunshine and long-continued, frequently violent rainstorms. Neither of these birds of South American affinities reaches as far north as Guatemala.

Perhaps no bird I ever studied gave me more pleasant surprises than this one. The ornithologist, as he advances in his researches, tries to foretell the habits of a new bird by what he knows of its nearest of kin. The accuracy of such predictions is a measure of the thoroughness of his knowledge and depth of insight. They guide his subsequent studies and make them more complete, because he begins with definite questions in mind. But, although I was no longer a novice in the study of tropical American birds when I began to devote attention to the Prong-billed Barbet, most of my conjectures about its habits turned out to be wrong.

#### APPEARANCE AND HABITAT

My very first meeting with this bird made me aware of some of its baffling characteristics. In November, 1935, I had the opportunity to visit a dairy farm newly carved from the then nearly unbroken forest on the northern slope of the Volcán Irazú in central Costa Rica. The road from Cartago wound up the southern face of the huge, sprawling volcano almost to the rim of the outermost of its many ancient craters. Skirting the summit for a long distance at 11,200 feet, along a nearly level cart-road, we at length began to descend on the northern side, passing at first down long, empty slopes covered only with coarse grass and scattered, low bushes. From this sparse vegetation, we rode down into a zone dominated by bamboos, which in turn gradually merged into open woods of low, gnarled, moss-draped dicotyledonous trees of fantastic aspect. Gradually increasing in stature, the trees soon formed a closed forest in which oaks and the alder (*Alnus acuminata*) predominated. In places the alders grew in an almost pure stand, with magnificent specimens certainly not far from 150 feet in height, with their long, clean, gray trunks supporting open crowns of wide-spreading boughs. At slightly lower elevations, they stood scattered in a lofty forest of more varied composition, with many clustering, tall palms and tree ferns and a profusion of bright-flowered shrubs in the undergrowth. In the midst of this beautiful forest, at an altitude of about 7500 feet, the farm was situated.

The terrain was terribly broken, with towering precipices and bare, rocky cliffs, over which poured many a slender and graceful waterfall.

But between the escarpments were sloping or nearly level terraces of good soil which had been planted with pasture grass. The owner's little cottage looked over a chasm-like valley upon the bare summit of the neighboring volcano, Turrialba. Here I spent a day and a half, and when rain and mist permitted, began to form the acquaintance of the birds of the Costa Rican cloud-forests.

I had never been in a region where birds of all kinds were more uniformly easy to approach. A Hairy Woodpecker (*Dryobates villosus*) allowed me to watch him from only six feet away; and many other birds were almost equally confiding. It was easy to fancy that I had landed upon some mountainous, uninhabited island whose feathered denizens had, as yet, no unhappy experience of man. Along a trail through that lovely, mist-shrouded forest, I came upon three brownish birds, about the size of a Rose-breasted Grosbeak, eating the large berries of some melastomaceous tree, which they held beneath a foot while they tore them apart with their thick bills. Fearless as nearly all the birds in this wild district, they continued unconcernedly to eat their fruits, while I studied them from close at hand.

They were short-tailed birds, and with their big heads and dense plumage appeared unusually stout. Plainly attired, their upper plumage was olive, and their under parts chiefly grayish; but the crown, throat and breast were of a warm golden-brown. The feathers surrounding the base of the bill, on the forehead, lores, orbital region and chin, were black. On the hindneck of the male was a long, narrow, black streak which the female lacked. The short bill was excessively thick and bluish in color, and the eyes were brown. Although I believed that I could place most of the Central American birds in their proper families at sight, I could not imagine what these might be, unless some aberrant, grosbeak-like finch—although finches do not as a rule use their feet for holding food. Had I noticed then that two of the toes on each foot were directed backward, and that the lower mandible terminated in two sharp prongs, in the deep indentation between which fitted the pointed tip of the upper mandible, I would have known at once that my conjecture was far from correct. It was long before I discovered the proper name and classification of these peculiar birds.<sup>1</sup> Even familiarity with the sharp-billed, brightly colored Salvin's Barbet did not help me to place them—rather, it threw me off the track.

In July, 1937, I settled down for a year to study the birds and

<sup>1</sup> These Prong-billed Barbets, at 7500 feet, were at the highest point at which I have seen the species. Carriker (1910) gives their altitudinal range as "about 1,200 feet up to perhaps 6,000 feet." I personally have not seen them below 3500 feet.

plants at Vara Blanca, on the northern slope of the same volcanic Cordillera Central of Costa Rica; but this was farther to the west, between extinct Barba and Poás with its two magnificent crater lakes, the one a seething, sulphureous cauldron of Cyclopean proportions, the other blue and cold as any hemlock-rimmed lake of the northern forests. From my residence at 5500 feet, vast, uninhabited forests stretched to the north and east. The country was broken in the extreme; long, narrow, nearly even-topped ridges were separated by profound gorges, through which rushing streams tumbled with many a lofty cascade. The climate here is one of the wettest in Central America. Blowing in across the Caribbean and the great forested plains of northern Costa Rica and neighboring Nicaragua, violent storms of wind-blown cloud-mist and rain continue for days or even weeks on end, with scarcely a gleam of sunshine. One accustomed to a warmer and sunnier climate soon becomes chilled to the marrow and terribly depressed in the moisture-saturated air, and must, from time to time, glance at the thermometer to reassure himself that the temperature is still a good many degrees above freezing—actually, 5500 feet is still well below the frost-line at ten degrees North Latitude. But when at length the welcome sun rises up into the bluest of skies, lighting up the varied bright colors of the blossoms of a stupendous wealth of orchids and other epiphytic plants that burden all the trees and stumps, rain and mist are soon forgotten in the joy of existing in a land so unimaginably fair. It was in this region of alternate gloom and delight that I studied the nest-life of the Prong-billed Barbet.

#### HABITS AND VOICE

These were among the most abundant birds in the region. They were exceedingly numerous in the forest, where they usually foraged near the ground, and often ventured forth into the weedy pastures. Here they were almost as tame and fearless as on Irazú, permitting a close approach by man, and frequently scolding with their slight, rattling notes as they watched me intently from the edge of a thicket. In July, their habits of flocking were irregular, for sometimes I would see one alone, sometimes two or several together. Not infrequently one pursued a second, voicing low, harsh notes. Their utterances were, in general, low and unmusical, of a rattling or rasping character. Largely vegetarian, they consumed great quantities of fruits of all sorts. Often I would see them cling beside the heavy fruiting spikes of the epiphytic aroids, to pluck the red or orange berries from the thick, fleshy axis. They also ate the petals of large flowers, plucking

the blossom and holding it against a branch with one foot, while they tore it with their thick bills. Anthophagy is apparently not widespread among birds; the only other flower-eaters I can recall at the moment are the saltators, thick-billed finches of warmer regions.

Floating out of the surrounding forests, at widely scattered hours through the day, I would hear a deep, far-carrying, somewhat throaty call, not unmelodious in the distance, sounding somewhat like the syllables *cwa cwa cwa* rapidly repeated many times over. The call always began as a sudden outburst of sound, in the production of which, to judge from its character, a number of birds joined their voices. For many days I continued to hear this mysterious cry without succeeding in tracing it to its source; but it always conjured up a vision of some fowl certainly no smaller than a quail; and I inclined to the opinion that it was of the gallinaceous order. My surprise was unbounded when the true author of this utterance was revealed to me.

One morning, while I walked along the ever-miry Sarapiquí trail, some birds at the edge of the forest, unseen by me, began to shout in the manner described. Soon a barbet perching in a young *Cecropia* tree beside the trail, where I had my eyes upon it, joined in the chorus. Presently two of the birds from the forest flew into the same low *Cecropia* tree, where they faced each other on adjacent branches and called loudly as before. Their greatly out-swollen throats accounted for the production of so loud, far-carrying a sound by so small a bird. Later, in the breeding season, I sometimes watched a mated pair, male and female together, join their voices in this loud call. The voice of the male is distinctly fuller and deeper than that of his consort. These sonorous calls earn for the bird its local name, *cacaleón*—from the Spanish *cacarear*, to cackle—a not particularly pleasing nor appropriate epithet.

#### SLEEPING

At the end of August, I discovered my first dormitory of the Prong-billed Barbets. Seven individuals slept together in a cavity in a tall, slender, dead trunk at the edge of the forest. The round entrance, shaded by a growth of bromeliads and other epiphytes, was about seventy-five feet above the ground, and so closely resembled the doorway of a woodpecker's hole that at first I took this to be an old, abandoned, woodpecker nest, never dreaming that birds with such short, thick bills as these barbets could carve into wood. Many months passed before I discovered my error. The seven barbets came forth very early in the morning, about the same time as that habitually early riser, the Allied Woodhewer (*Lepidocolaptes affinis*), left its cranny

in a neighboring trunk, and considerably before their ease-loving neighbors, the Costa Rican Woodpecker (*Chloronerpes rubiginosus*) and the Hairy Woodpecker (*Dryobates villosus*) abandoned their snug bedchambers in the adjacent pasture. Emerging one by one, the barbets gathered in the open and sounded their loud, far-carrying call in the dim gray light of the dawn.

The seven barbets continued to sleep in the same hole until at least the middle of October. When next I devoted attention to them, during the second week of December, I found that, before retiring to rest in the evening, the birds flew back and forth between their usual quarters in the tall, slender trunk at the edge of the forest and a big, blasted, but still living tree standing in the pasture, about a hundred feet distant from the first. Some remained to sleep in their old dormitory, while others of the flock found shelter in the big tree in the pasture. The almost unremitting fogginess and rain at this period made it difficult to discover just where in the big tree they slept, or how many retired into each hole. Apparently the barbets were then in a state of indecision as to which of the two dormitories they should occupy.

By the middle of January, the slender, dead trunk where I first found the barbets sleeping had fallen; but continued unfavorable weather delayed my discovery of their new quarters. At last, early in February, I followed them to their latest dormitory, in the big, blasted tree in the pasture. The huge trunk of this tree divided near the ground into two massive forks, one living and the other dead. The dormitory was situated about twenty-five feet above the ground, in the dead fork; but the doorway was so well screened by some leafy boughs springing from the living fork that it was most difficult to see. Watching this hole at dawn on February 8, 1938, I counted five barbets as they came through the doorway, one by one, and flew to the neighboring woods. Then for some minutes no more appeared, and I began to fear that some mishap had befallen two of the seven that had slept in the now fallen trunk. But soon another came through the doorway, and another! and another! and still another! until sixteen had sallied from the cavity! While the first few went directly to the nearby woods, the last to emerge flew off across the pasture, in the opposite direction. Apparently they did not all form a single flock during the day.

That evening I was present to watch the barbets return to their shelter. At 5:40, a lone bird arrived, and continued to go in and out of the hole until, after a number of minutes, a second came up

to keep it company, when both remained in the chamber together. Until six o'clock, or over a period of twenty minutes, the barbets continued to fly singly from the woods across to the isolated tree in the pasture and to enter the hole until sixteen had gone in. Two, as they were about to enter the doorway, had a brief altercation, made evident by low, grating notes, but of no consequence. The hole was not capacious, and I could only conjecture how sixteen birds arranged themselves within it for the night. They must have slept in two or three layers. Sixteen was the largest number of barbets—or of birds of any kind—that I ever found sleeping in the same dormitory.

The little bickerings which, in February, sometimes arose between two barbets as they retired to sleep in the same hole, were an indication that the good comradeship that prevailed in the flocks during the winter months was being supplanted by other feelings. During March, the birds which had been in the habit of sleeping together gradually dispersed. Thus, by March 10, the sixteen in the big, blasted tree in the pasture had dwindled to eight or ten; since they now entered and left when the light was quite dim, it was difficult to count them with accuracy. By March 25, only three individuals slept in this once crowded hole, and after April 2 it was no longer occupied.

There must have been a good deal of restlessness and moving about among the barbets before they all finally settled down in pairs. While some dormitories showed a steady decrease in number of occupants, neighboring ones would at this season enjoy a temporary increase. At the edge of the forest, on the opposite side of the same pasture in which the blasted dormitory tree stood, was a tall dead tree with two holes, whether made by woodpeckers or barbets I am not sure. On March 3, as the light waned, three barbets came to sleep in this tree. One entered the upper hole, then with low, rasping notes repulsed the second who attempted to follow. The barbet that had been refused admittance then went to the entrance of the lower hole, evidently with the intention of entering, but while clinging in front of the doorway was attacked from the rear by the third. The light had now become so dim that it was difficult to follow the birds with the eye; but as well as I could distinguish, two slept in the upper hole while the third vanished into the forest, leaving the lower cavity untenanted. But two evenings later, three barbets, presumably the same, slept together in amity in this tree. On the evening of March 16, three barbets came together and entered the sleeping hole; then, after a considerable interval, three more came and joined the first three in the same cavity. I noticed no dispute save that, after the

first of the early arrivals had entered, one of the remaining two drove at the other with angry sounds and made it flee; but soon both peaceably entered the hole and remained in tranquility. On the evening of April 6, four birds entered this hole without friction. After this, the old dormitories remained deserted.

In March, the barbets began to grow more vocal. I often heard their deep, full-voiced calls, joined in by a number of birds that answered back and forth in the woods, or from bushes and trees scattered through the clearings. By the second half of the month, the mated pairs had begun to prepare their nests.

### THE NEST

The bird-watcher at length learns from his repeated false inferences that it is hazardous to predict the form of a bird's nest from the structure of the instrument that fashions it. Not every bill is as obviously adapted to its several functions as the woodpecker's chisel. Who would suppose that the long, slender bill of the jacamar is used as a pick for digging a burrow in the earth; or that the seed-eater's short, thick bill serves to construct, of thread-like rootlets and cobweb, a little cup of filagree delicacy? For many months I had tacitly assumed that the barbets, like the araçari toucans (*Pteroglossus* spp.), slept in old woodpecker holes; for I did not believe that their short, swollen bills would serve for carving into wood. But at the beginning of the nesting season I discovered my error.

The Prong-billed Barbets carved out their nest-cavities themselves, in wood softened by decay but still firm and solid, in dead trees or dead branches of living trees. I saw none of their nests in wood so far advanced in decay that it had begun to crumble. The six occupied nests which I found ranged in height from eleven to over sixty feet. In general, such sites were chosen as would have appealed to woodpeckers, with the difference that the barbets sometimes placed their nests in such a position that the entrance was screened by leafy shoots or epiphytic growths, while woodpeckers nearly always prefer an exposed situation in a clean, leafless trunk, where they enjoy a wide outlook from their doorway. With a single exception, all the nests I discovered were in the clearings and pastures, but never far distant from the forest which covered most of the region. Four were in pastures and one beside the trail, in a low post which upheld the single telegraph line that ran down to El Muelle de Sarapiquí. This was the lowest of all, only eleven feet up. Although I found only a single nest in the forest, it is probable that more careful search



would have revealed a great many more. Most of the forest birds whose nesting I particularly wanted to study—Quetzals, Blue-throated Toucanets, Allied Woodhewers and these barbets—took advantage of the dead trees standing in the pastures as sites for their nests; and I soon found so many in the clearings that I had little time or necessity to hunt in the woodland for more.

The barbets began to carve out their nest cavities in late March or early April. They worked principally very early in the morning and late in the afternoon—at least, at these times of day I was most successful in watching them. Male and female shared the labor, whether equally or not I could not determine, for the nests where I watched them carving into the wood chanced to be so high that I experienced difficulty in distinguishing the sexes. While one of the pair was at work, the mate perched close by, often stretching a brownish wing as though bored with waiting. I never saw one working alone, as woodpeckers so frequently do. In their reluctance to labor at nest-building in the absence of the mate, barbets agree with trogons, jacamars, kingfishers, puffbirds, motmots, and parrots, all of which nest in holes or burrows constructed by themselves.

The most difficult part of the task of nest-carving was apparently making a start, when the barbets were obliged to cling to the side of the trunk in a posture far less natural to them than to woodpeckers. The carving, so far as I could see, was accomplished chiefly by biting away the wood rather than by chiseling—a procedure for which their short, swollen bills are hardly adapted. Yet sometimes I distinctly heard a tapping sound emanate from the hole in which a bird was at work. It might be imagined that the delicate prongs at the ends of their mandibles would be broken by applying them to such uses, but this apparently is not true. The wood into which they carve, although still in those early stages of decay when it is neither discolored nor crumbling, is so soft that a man might dig into it with his fingernails. While woodpeckers often choose harder wood, they sometimes make their nests in trunks far more thoroughly decayed.

The barbets worked in short shifts. Eight minutes was the longest interval that one remained continuously in the unfinished nest, presumably working, while I watched them. More often they stayed in the nest only a few minutes at a time. At the beginning, they left the cavity tail-first; but after it grew wide enough to permit them to turn, they made their exit head-first. Emerging, the barbet brought out a billful of loosened particles, which it took to a perch close to its waiting mate, or often carried out of sight among the trees, before

letting them drop. Frequently a bird would go into the nest apparently for no other purpose than to carry away a billful of wood chips. Of the many hole-nesting birds I have watched dig out their nest-cavities, barbets are unique in carrying off the loosened debris; but Odum (1941) found that Black-capped Chickadees, when excavating their chamber, take the chips a short distance away, and Coward (1928) states that the British Willow-Titmouse does the same, although not consistently. The form of the barbet's bill allows it to carry away a larger load than a woodpecker could do.

One nest which I watched the barbets excavate required no less than eight days for its completion. As soon as the cavity was big enough to accommodate them, male and female slept together in it, deserting the crowded dormitories in which they had hitherto passed their nights. Now they emerged considerably later in the morning than they were in the habit of doing while they slept in larger companies. While one looked out through the doorway upon awaking, the other might linger in the bottom, putting the finishing touches on the woodwork of their new bedroom; for I sometimes heard tapping, as of a woodpecker, coming from the nest before the morning departure of its inmates.

Viewed from the ground, it is difficult or impossible to distinguish the doorway of a barbet's nest from that of a small woodpecker—a *Centurus*, *Chloronerpes* or *Tripsurus*, for example. But at the first glimpse of the interior, one familiar with woodpecker holes notices obvious differences. The doorway of a woodpecker's nest has little thickness, for the bird begins to carve downward as soon as it has penetrated the outer shell, while the barbet continues to dig more deeply into the wood before turning downward, making an entrance-way like a short, horizontal tube, two or three inches long. The difference between the woodpecker's and the barbet's entranceways corresponds to that between the doorway of a thin-walled, modern, human dwelling and that of some ancient stone building with walls several feet thick. Once through the doorway, which is about  $1\frac{7}{8}$  inches in diameter, and well into the heart of the trunk, the barbet turns abruptly downward, leaving very little space in the top of its nest behind the aperture; while the top of a woodpecker's nest has a far more capacious vestibule. The difference is quite obvious to one who is in the habit of examining such nests with a mirror and electric bulb pushed through the entranceway; barbets' nests are much less convenient to look into than woodpeckers'. For the rest, woodpeckers' and barbets' holes are similar in shape, both being deep and rela-

tively narrow, rounded on the sides and bottom. The rotundity of some of the barbets' nests was broken by ridges of wood projecting irregularly into the interior, doubtless too hard for the birds to remove with their less perfect carving tools; but others, in wood of more uniform consistency, were as neatly rounded as the best woodpeckers' work. The cavity in which the sixteen barbets had slept differed from all the others I examined in being much wider than deep, flat on the bottom, with very irregular, instead of rounded, sides. Its peculiar shape was apparently determined by the configuration of the softer portions of this still slightly decayed stub. While I had not seen the barbets carve out this cavity, it was obviously a 'made' hole; and it is far more likely that barbets were responsible for it than that it had been carved by woodpeckers.

#### EGGS AND INCUBATION

Soon after the pair began to sleep in the newly completed hole, the female started laying the eggs. The earliest egg of which I have record appeared on April 9. Thereafter, one was laid daily in this nest until there were five. Two other accessible nests contained four eggs each. The eggs were pure white and glossy, resembling those of woodpeckers. Since to open a nest of this type with saw and chisel decreases its chances of success, no matter how much care is devoted to closing it off again, I did not remove the eggs for measurement. They lay upon a bed of chips at the bottom; no softer material had been taken in as a lining.

At the nest to which I devoted most attention during this period, incubation began with the laying of the fourth of the five eggs. Male and female continued to sleep together in the nest cavity during the laying period, the incubation period, while there were nestlings, and even after these departed. Such an arrangement, although rare among birds, is by no means unknown in other species of which both sexes incubate. Male and female Golden-naped Woodpeckers (*Tripsurus chrysauchen*) and piculets (*Picumnus olivaceus* and other species) sleep together in the breeding nest, as at all times of the year (Skutch, 1943). Male and female Blue-throated Motmots (*Aspatha gularis*) do likewise in their burrows at all seasons. Male and female Black-eared Bush-tits (*Psaltriparus melanotis*) sleep with their eggs in their downy pouch (Skutch, 1935); the male Long-tailed Titmouse (*Aegithalus caudatus*) of the British Isles takes shelter with his mate and the eggs in the beautiful oval nest (Coward, 1928); and sometimes the male Gray-crowned Wood Wren (*Henicorhina leucophrys*) and the

male Banded Cactus Wren (*Heleodytes zonatus*) sleep with their mates while they incubate (Skutch, 1940). The male Blue-and-White Swallow (*Pygochelidon cyanoleuca*) slumbers beside the nest where his mate incubates, in a burrow, or cavity in a tree, or in a cranny beneath the roof. The Barn Swallow, at least sometimes, has the same habit of sleeping beside the nest in which his mate incubates. Both sexes of the White-rumped Swift (*Micropus caffer streubelii*) of Tanganyika Territory spend the night in the closed, mud-walled nests they have inherited from the swallow, *Hirundo abyssinicus* (Moreau, 1942). Although this appears to be a longish list of male birds which sleep in the breeding nest with their mates, I have for years devoted attention to this phase of nest-life, and in only a very small proportion of the species studied have I found both birds in the nest during the night.

Upon awaking at dawn, the barbets would sometimes utter low, rattling notes within their chamber. Soon one would take possession of the doorway and linger a short while—at times as long as eight or nine minutes—looking forth upon the growing daylight. Then it would emerge and fly away. The other might follow at once, or delay for a few minutes more. The eggs were then left unattended for a brief period while the pair sought breakfast. Then, from seven to sixteen minutes after the departure of the last, one would return to resume incubation. On the single morning when I succeeded in identifying the bird returning at this time, it was the female. Although the long black stripe on the back of the male's head distinguished him clearly from the female, in practice it was not easy to recognize the sexes at nests well above the level of the eye.

During the early hours of morning, the barbets were impatient at their task of incubation. The call of their kind coming from the neighboring forest would draw the bird from its nest, even if it had been sitting only a few minutes. Sometimes, after a very brief period on the eggs, the barbet would come forth, perch on a convenient branch beside the doorway to look about, then go back into the nest again. Or it would call until it received an answer, and fly off in the direction of the sound. Thus the eggs would be left uncovered for brief periods, but rarely for long, for one or the other of the pair would soon return to take a spell on them. When one of the pair stayed on duty until its consort arrived to replace it, the newcomer would cling beside the doorway until the mate made way for it. As nest-relief was effected, the birds would utter low, rattling notes. As the morning grew older and the drowsy hours of the day approached,

the barbets became reconciled to longer hours at their lonely and doubtless slightly boring task, and would sit for an hour to nearly two hours at a stretch. Sometimes, while incubating, the male barbet relieved his ennui by tearing or hammering at the wall of the chamber, thereby continuing to enlarge it.

Perhaps better than generalities will be the actual schedule I made on the morning of April 17, at a nest in which incubation had been in progress during five days. I began my watch at 5:20 A. M., as day broke. At 5:25, I heard low, rattling notes from the nest. Two minutes later, one of the pair began to look through the doorway, where it lingered until it flew forth at 5:36. The mate delayed inside for six minutes more, departing at 5:42. Sixteen minutes later, one of the pair returned to incubate. Beginning with 5:42 A. M., their sessions and absences, during nearly seven hours (until 12:28 P. M.) are given in the following table. If the figures are read from left to right, as the text of a book, the actual sequence of events can be followed:

<i>Nest attended by</i>			<i>Nest unattended</i>
<i>Male</i>	<i>?</i>	<i>Female</i>	
			16 minutes
		15 minutes	2
		14	3
24			13
		32	
12			30
		26	
81			12
15			1
		110	
<i>Totals:</i>	132	29	168 = 329
			77

The male covered the eggs a total of at least 132 minutes; the female, 168 minutes; while 29 minutes were accounted for by members of the pair not recognized as they entered. The total time devoted to incubation by the two together was 329 minutes, as against 77 during which the nest was unattended. Thus the eggs were left uncovered slightly less than one-fifth of the time. While, as a rule, when both sexes incubate, as with woodpeckers, trogons, kingfishers, motmots, antbirds, etc., the eggs are kept more constantly covered, other kinds of birds, notably toucans, are less patient sitters, and male and female together fail by a great deal to keep the nest constantly attended.

At this period, the mated pair of barbets gave many tokens of mutual affection. Once I saw a male feed his mate. Perching close together, they would bill each other's feathers and frequently they joined their voices in their loud, throaty cries, when it was evident that the female's tones were weaker than her mate's, and somewhat hoarse in quality.

Although so gregarious during most of the year, now in the breeding season the barbets had become strongly 'territorial,' and repulsed every trespasser of their kind that ventured near their nest, flying at it with harsh rattles and rasping scolds. Rarely two birds would clinch and fall to the ground; but on the one occasion when I witnessed such an encounter, neither contestant seemed to come off the worse for the scuffle. Birds of other kinds were also driven from close proximity to the nest. A female Hairy Woodpecker, which had been sleeping in a hole in the same small tree in which a pair of barbets nested, abandoned her quarters at about the time these began to lay, possibly having been driven away by them.

On the morning that I watched the pair incubate, the female barbet chanced to alight close beside a fairly large gray lizard that clung head downward on a hanging branch. The reptile immediately, and apparently as a warning, extended its pale pink gular pouch, which, projecting toward the barbet, almost came into contact with her. She lightly touched it with her bill, but did not seem alarmed nor move away at once although the lizard was bigger than herself. This mutual confidence and toleration between two very dissimilar creatures was most pleasing to witness.

But the barbets were fearless of most creatures, great or small. At their nests, as well as while foraging through the woods and bushy fields, they showed the utmost confidence in the good intentions of man. Even at low nests, it required a great deal of hammering and shaking of the trunk to make the bird in charge come forth when I wished to examine the contents. A few slight taps would cause it to look out to see what was happening below; but it was rarely in a hurry to depart. Often it would watch while, with an assistant, I set the heavy 23-foot ladder against the trunk, and reluctantly depart only when I had climbed to within a yard or two of the doorway. And often one would return to the eggs before we had time to remove the ladder. Even at the eleven-foot-high nest in the telegraph pole, the barbets would enter while several people stood about it. One even tried to go in before I had removed the electric bulb that illuminated the interior, but desisted upon striking against the cord

that passed through the doorway. With this, as with the great majority of birds whose nest-life I studied at Vara Blanca, I was not obliged to conceal myself in a blind—a most fortunate circumstance since the climate was so wet and sitting for long periods in a confined space enclosed by wet cloth is neither comfortable nor healthful.

#### THE YOUNG AND THEIR CARE

On the afternoon of April 26, as I climbed up toward the barbets' nest that at this period chiefly engaged my attention, I heard weak, subdued cries, as of nestlings, emerging from it. But when I inserted the electric bulb and mirror and looked in, I beheld only the unbroken white surfaces of the five eggs. The little barbets were crying within their shells as they strove to escape them. The parent in charge of the nest when I arrived became more excited than I had ever before seen either of the pair. He flew back and forth between the ends of the two stubs of branches which were all that remained on the dead tree, a yard or two above me, and uttered loud, cackling cries such as I had not hitherto heard. These soon drew his mate, who shared his distress.

The following afternoon, when I again visited the nest, I heard, while climbing the ladder, cries of the same character as had issued from the hole on the preceding day, but now far louder and of a somewhat strident, squeaky nature. Hastening to illuminate the interior of the cavity and to push in the little mirror, I beheld my first barbet nestlings—perhaps the first nestlings of the Prong-billed Barbet that any naturalist had ever seen. There were five of them, pink-skinned and utterly devoid of down, huddled in a compact mass in the center of the floor. Their eyes were tightly closed; and the lower mandibles of their short bills were both longer and broader than the upper mandibles, as in newly hatched woodpeckers, toucans, and kingfishers. Their egg-teeth were less prominent than those of woodpeckers. Their heel-pads were large and conspicuous, and covered with long, sharp papillae. The fleshy caudal protuberance was longer and more prominent than in most nestlings, and was used as a third point of support by the little barbets as they stood upon the wood particles that carpeted their wooden nursery floor. The shells, save a single remaining fragment, had already been removed from the nest by the parents, which flew back and forth close above me and voiced the same loud, sharp cries of distress that I had first heard on the preceding day. I had hardly descended to the ground before one returned into the nest.

The eggs had hatched in the surprisingly short period of thirteen days, counting from the date on which the last was laid, and all within the space of twenty-four hours, despite the fact that both parents had slept in the enclosed nest with them during the period of laying. Moreau and Moreau (1940) give fourteen to fifteen days as the incubation period of the African barbet, *Tricholaema leucomelan*. I am not aware of any other determinations of incubation periods in this family.

One of the nestlings vanished within three days of hatching, and another on the following day, leaving only three survivors. Apparently, as so frequently happens with woodpeckers, the weakest of the newly hatched nestlings lost out in the competition with the strongest for food and died of starvation; but possibly the prevailing bad weather may have had much to do with their death. The survivors always stood in the center of the floor with their naked bodies pressed together and their slender necks intertwined, and from time to time gave voice to sharp little cries of hunger.

During the first days, the parents brought them tiny insects, some with wings, and other objects too small for recognition while held in their thick bills. If they arrived with food while I was at the nest, they hopped about close above me and entered as soon as I had descended the ladder a few feet. Fruit became an increasingly important constituent in the nestlings' diet; and when over a week old they were nourished almost entirely upon fruit while insects were very rarely brought. Whole small berries were sometimes given the nestlings, but the red pulp of some larger, unidentified fruit was brought in great quantities. Once the male entered the nest with the green drupe of the *ira rosa* (*Ocotea pentagona*), a lauraceous tree whose hard fruits are a favorite food of the Quetzal. But this was obviously more of a mouthful than the little barbets could swallow, and after a minute or two their father reappeared in the doorway and, with some difficulty, gulped it down himself. The two parents took virtually equal shares in feeding and brooding the nestlings.

The interior of the nest-chamber was kept scrupulously clean. The parents removed the droppings mixed with the wood fragments that covered the bottom of the nest, and on departing would, as a rule, carry away a large billful of this mixture, always letting it fall at a distance from the hole. By the time the nestlings were four or five days old, all of the original litter of fragments had been removed from the bottom of the chamber; yet the parents continued to bring out large billfuls of such material. I could account for this only by the



assumption that they continued to dig into the sides or bottom of the cavity and loosen fresh chips; yet it was impossible to obtain direct confirmation of this view.

Both parents continued to sleep in the nest, as before the eggs hatched. Yet by day the two were never seen in the nest together. Upon arriving with food for the nestlings, the parent flew direct to the doorway, whether or not the mate happened to be brooding within, as it usually was during the nestlings' first days. If the nest was occupied, the new arrival, advised by sounds that the other was within or else prevented from entering by its prompt appearance in the top of the chamber, flew back to the nearest convenient perch to allow its mate to come forth, then promptly entered to feed the nestlings. Golden-naped Woodpeckers, piculets, and White-rumped Swifts (see Moreau, 1942) all of which, like barbets, sleep together in the nest, are often within together for brief intervals by day, while incubating or attending the young; but woodpeckers, which sleep singly, are scarcely ever found in the nest together.

On the afternoon of May 6, a torrential rain, blown by a hard south wind, was driven into the southward-facing doorway of this hole in such quantities that the water-tight bottom was flooded and the nestlings drowned. At the age of nine days, the pin-feathers of the little barbets were just beginning to be visible beneath the transparent skin, and the eyes were still tightly closed. Their development had been very slow, and doubtless they would have remained in the nest at very least a month. Moreau and Moreau give the fledging period of *Tricholaema leucomelan* as five weeks, and add that *Bucanodon o. olivaceum*, another African barbet, is in the nest for more than thirty days.

With the loss of this and all the other accessible nests I had found, I was unable to study in detail the later stages in the development of the nestlings, or to determine the length of their sojourn in the nursery. But on June 12, I found a nest only twenty feet above the ground, in a massive, epiphyte-burdened stump in a pasture, excellently situated for watching. There was no need to bring the ladder to see what it contained, for the well-feathered nestlings showed their heads in the doorway, and to approach them too closely might have caused their premature departure.

Although these young barbets spent most of the day looking, by turns, through the doorway, the parents, upon arriving with food, almost invariably pushed inside to feed them. Only once did I see a parent pass food to a nestling while clinging outside, as so many

hole-nesting birds do under these circumstances. Small, soft fruits and fruit pulp formed the great bulk of these nestlings' nourishment. Hard fruits, such as were preferred by the Blue-throated Toucanets and Quetzals nesting in the neighborhood, were rarely brought by the barbets. They would arrive at the nest with their thick bills full to capacity with soft fruit pulp, and apparently still more in their throats. The nestlings were fed very frequently, and the amount of fruit they now consumed was prodigious. Rarely they received an insect.

The parents continued to devote much attention to cleaning the nest, carrying away great billfuls of wood particles with which the droppings were mixed. Much of this debris still looked bright and fresh, as though newly separated from the solid wood. Its appearance, and the amount that was daily removed, left little room for doubt that this was so, and strengthened my earlier assumption that the parent barbets dug into the sides or bottom of the nest to make fresh particles, possibly at the very time they cleaned the nest. The parents were most active in removing waste material between six o'clock and a quarter past six in the evening, when they carried away many billfuls in rapid succession. After this quarter-hour devoted to preparing the nest for the night, both parents disappeared for an equal period, during which they doubtless got their own supper. Then, at half-past six, both entered to sleep with their well-fed nestlings.

#### THE FLEDGLINGS; RETURN TO THE NEST

This low nest was the latest of all I found. The two young birds flew from it before nine o'clock on the morning of June 16. At this hour, I found them in a clump of epiphyte-laden trees fifty feet in front of the nest, where the parents were feeding them. The fledglings bore a fairly close resemblance to the adults, but there were certain evident differences. The foreheads and fore-necks of the young birds were not quite so bright a golden-brown. Their bills, instead of being bluish like those of the adults, were horn-color, with a suffusion of black that was most dense in the middle of the upper mandible. Their eyes were framed by conspicuous rings of bare, pale yellowish skin, giving them a facial expression quite distinct from that of the old birds which lacked such orbital rings. Neither of these two fledglings bore on its hind-neck the tuft of black feathers that distinguishes the male, but had a little, round, gray spot on the occiput, that both parents lacked. They were evidently both females; for about this time I saw another young barbet, still fed by

his parents, that wore a black stripe on its hind-neck, very much like that of the adult male. Thus the young in juvenal plumage resemble the parents of the same sex; the sexual differences are, as with wood-peckers, evident at an early age.

From what I knew of other birds with similar sleeping habits, I felt confident that the young Prong-billed Barbets would be led back to sleep in the nest with their parents. Accordingly, I was present late in the afternoon of the day of their departure to witness the event. Although rain began to fall at four o'clock—there had been a very hard shower at noon—the family did not appear in the vicinity of the nest until 4:55. Then one of the parents went into the nest, but promptly came out and flew to the clump of trees fifty feet in front. The two young barbets then came and clung to the top of the trunk in which they had been hatched, but not finding the doorway of the nest, they likewise went to the clump. They could already fly considerable distances, fifty feet or more, without a rest; but their flight was slow and poorly controlled.

For the next hour, the parents continued to go in and out of the nest, just as Costa Rican House Wrens and Banded Cactus Wrens do when they guide their newly emerged fledglings back to shelter for the night. Sometimes upon leaving the hole they flew only as far as a young *Cecropia* tree that stood close by, upon whose yard-long petioles they perched; but more often they winged back to the clump of trees where the youngsters rested. During this period, the fledglings made little effort to reach the nest. Once, indeed, one went to the dead trunk, but without finding the doorway. Then it started back to rejoin the family in the clump, but on the way grew tired and dropped to the close-cropped grass beside me. It was wholly devoid of fear. After a short rest on the ground, it rose to perch on a low branch of a lovely *Cavendishia* bush growing on the trunk of one of the trees in the clump. Here she allowed me to touch her, even her bill, without attempting to move away, merely regarding me with curiosity like a new-born calf. The youngsters were fed scarcely any after their arrival in the vicinity of the nest; they did not appear to be hungry.

At first, but a single parent went into the nest at a time, and came out before the other entered; but as night drew near both stayed in together. At about six o'clock, one of the fledglings—both had hitherto been quite silent—called *cwa cwa cwa*, much as the parents call, but in a weaker voice. Upon hearing this, both parents left the nest and returned to their fledglings, now perching close together in the

top of a tree. Then the adults flew back to the hole; and the young birds followed, one close behind them and the other after a few seconds, as for the last hour the parents had been trying by example to persuade them to do. The parents entered the nest while the youngsters came to rest upon petioles of the great-leaved *Cecropia* tree. After a brief pause here, one of the young barbets reached the doorway of the nest and entered without much difficulty. The parent, which was looking forth at the moment, thoughtfully drew back into the interior at its approach to leave the passage free. Then the second parent, which meanwhile had emerged again, returned into the nest for the night.

But the second fledgling, although it flew to the trunk, did not so easily reach the doorway of the nest. Clinging to the trunk, it gradually slipped to the ground. It wandered beneath the dead trunk, which was held up on charred prop-roots, and upon coming forth seemed completely bewildered, for it flew farther off into the pasture and came down upon the grass. Again taking wing, it wandered still farther from the nest. Following, I caught it, then stood in front of the nest with the little bird upon my open hand. Here it rested quietly for a quarter of an hour, in the rain. When at last it took flight, it was not toward the nest, but away from it. Alighting in a tree down the slope, it flitted from bough to bough until I lost sight of it amidst the foliage and the gloom, for the daylight was waning fast. Here the little barbet passed that wet night. As soon as they had one fledgling in the nest with them, the parents remained quietly within, to all appearances forgetful of the other in the open. Yet they had retired twenty-five minutes earlier than on the preceding evening, before the departure of the nestlings.

The following morning at dawn, I resumed my watch of this nest. The first parent came forth at 5:37, the second a minute later. For over two hours they remained out of sight, quite neglecting the youngster that had slept with them, but no doubt stuffing the other that had passed the night amongst the foliage. Thus it received its recompense. As the morning wore on, the little barbet in the hole looked forth more and more, until at length, seeing that its parents had returned to the trees in front, it flew out to them and at last began to receive some breakfast. Among other things, it was given pieces of the green fruiting spikes of the *Cecropia*.

That evening, both fledglings succeeded in entering the nest; the more backward of the two was not obliged to pass more than a single night in the open. I had not been there to watch them enter—the

toucanets had claimed my attention that evening—but the following morning I was present to witness their departure. They now came out much earlier. The parents, after one of them had delayed many minutes gazing through the doorway upon the wet landscape, emerged at 5:46. Since now they had both youngsters inside, they started to bring food to the nest. At 6:10, one returned with a morsel and alighted in the Cecropia tree. Immediately upon its arrival, the fledgling that had been looking through the entrance came out to receive the food. The other followed three minutes later; and the whole family moved off through the tree-tops where I could not follow.

At the end of the fledglings' third day in the open, the family returned to the vicinity of the nest at a quarter to six. The male at once went to the hole to remove an overflowing billful of wood particles that appeared quite bright and fresh. Then all four rested quietly in the top of a tree for the next quarter of an hour. They did not eat, but appeared full and contented. After a while, another heaping billful of wood particles was carried from the nest by one of the parents. Thus attention to the cleanliness of the hole did not cease with the departure of the nestlings. Then one of the youngsters flew to the Cecropia tree beside the nest. It took the torn edge of a leaf in its bill, but found that it was not good to eat—its instinct to feed itself had developed ahead of its discrimination of what was edible. Soon after six o'clock, both young barbets followed the parents into the dormitory without difficulty.

The fifth morning after the young barbets' graduation from the nest was wet and blustery; and they lingered in the shelter of the dormitory about three quarters of an hour after the departure of their parents. They were neglected until after the first of the youngsters had come into the open, by which time the parents returned and began to give them a breakfast of Cecropia fruits. But by July 5, three weeks after the young barbets had begun to fly, the whole family departed from the dormitory at about the same time; while in the evening young and old went to rest in no set order. By the end of the month, the hole in which the family had been raised remained quite deserted. I could not discover what had become of the four barbets.

Early in August, I discovered a single barbet sleeping in a hole, sixty feet above the ground, in which a pair of Boquete Woodpeckers (*Dryobates villosus extimus*) had raised a brood earlier in the year. This was my first unequivocal evidence that the barbets may, at times, make use of woodpecker holes for sleeping. This woodpecker hole

was not far distant from the cavity in which the four barbets had slept; and it seemed not improbable that the lone barbet that now occupied it was the single survivor of some nocturnal tragedy that had befallen its family. Thus, from the six nests I had found, five of which certainly had held eggs, only two young were fledged, and possibly only one, or none at all, grew to maturity. This is an exceptionally high mortality for a hole-nesting bird; and I feel confident that a statistically significant number of nests would show a higher degree of success. I found no evidence of a second brood.

#### ENEMIES

One day, I saw a White-throated Falcon (*Falco albigularis*) carry off a full-grown Prong-billed Barbet. This fierce little hawk is—aside from man—the one living enemy of the adult barbet that I discovered during a year's residence in its range. Another formidable enemy is the long-continued rainstorm so frequent in the region, which at times saturates the plumage of the birds until they can no longer fly. During a spell of bad weather in December, some children found one in this pitiful condition; but after a few days in a dry place, with an abundance of berries as food, it recovered and flew away.

In the highlands where the Prong-billed Barbet dwells, one of the most relentless enemies of nesting birds is the Blue-throated Toucanet (*Aulacorhynchus caruleigularis*), which preys insatiably upon eggs and nestlings, even as its far larger relative, Swainson's Toucan, in the forested regions of the lowlands. Both of these species are, in my experience, far more addicted to nest-robbery than the araçari toucans (*Pteroglossus* spp.), which are intermediate between them in size. At Vara Blanca, a pair of the toucanets took possession of a nest-hole newly made by a pair of Hairy Woodpeckers and, slightly enlarging the doorway, laid their own eggs therein. The boy who helped me in my work and was thoroughly familiar with the birds concerned, told me one day that he had seen a pair of *currés*, as the toucanets are called, tearing at the entrance of a barbets' nest in which eggs had recently been laid, while the owners flitted about and protested. But in this instance the toucanets were less successful in their attempt to force an entry than they had been in the case of the woodpeckers' nest. For the barbets' nest, as already mentioned, is carved more deeply into the trunk than woodpecker nests; the wood surrounding the portal, two or three inches thick and quite firm, completely baffled the efforts of the toucanets to enlarge the orifice with their clumsy carving tools. None of the six barbets' nests that I kept under ob-

servation was occupied by toucanets; and I do not believe that these thieves were responsible for the losses which most of the pairs suffered.

May it not be that the barbets' habit of placing their holes so deeply in the wood was developed as a defense against the toucanets? These barbets apparently originated in the same region as the toucanets, and hence it is likely that their habits have been modified by the presence of so formidable a predator. But the breeding woodpeckers of the region (*Dryobates villosus extimus*, *Balanosphyra formicivora striatipectus* and *Chloronerpes rubiginosus uropygialis*) belong to far-reaching species that in all probability originated in other regions, and hence would be less likely to have developed a special defense against an enemy whose habitat they subsequently invaded as they extended their range.

Of the nests that were lost, one at a great height had been torn open, apparently by a tayra (*Tayra barbara*) or some other powerful arboreal mammal; one appeared to have been entered by a rat or a weasel; one was destroyed by human agency; and in one, as already mentioned, the nestlings were drowned.

#### COMPARISON WITH OTHER SPECIES

The only other Costa Rican barbet, and the only other member of the family Capitonidae I know at first hand, is Salvin's Barbet (*Eubucco bourcierii salvini*). This bird is so different in every respect from the Prong-billed Barbet that, without the presence of intermediate forms, it is difficult to believe that they can be, in fact, members of the same family. The plumage of Salvin's Barbet—brilliant red head set off by a white nuchal stripe, green upper plumage, red throat and chest fading to orange and yellow on the lower breast and sides—contrasts as sharply with the Prong-bill's subdued colors as its sharp yellow beak does with the latter's blunt, swollen bill. In habits, the two species differ no less than in appearance. While the Prong-bill is highly sociable, I have found the other solitary, both in Costa Rica, where it is widespread but apparently nowhere common, and in Ecuador, where it is more abundant. Except in the breeding season, it is always quite alone and repulses all others of its kind. The Prong-bill is largely vegetarian; but Salvin's Barbet is insectivorous, spending its time well up among the forest trees, where it investigates curled or rolled dead leaves, either probing the interior with its sharply pointed bill, or else biting them on the outside, to force from its retreat any small creature that might be lurking within. In contrast to the somewhat garrulous Prong-bill, Salvin's

Barbet is habitually silent; and I have never succeeded in identifying its call, if it has one. So far as I am aware, its breeding habits are quite unknown.

The habits of the numerous kinds of barbets of British India are fairly well known. The species treated by Hume (1890), nine in number, all nest in cavities in trees, apparently excavated by themselves. In the case of the Blue-faced Barbet (*Cyanops asiatica*), a pad of softer material was found in the bottom of two nests; but it was not certain that this had been taken in by the barbets themselves. The Ceylon Green Barbet (*C. zeylonica*) is said to collect a few grass stalks for the eggs to lie on; but this accumulation is "scarcely worthy of the name of nest." Otherwise, the nests described by Hume contain no lining beyond the accumulation of wood particles in the bottom. The Small Green Barbets (*C. viridis*) do not always make a fresh nest cavity each year, but sometimes reoccupy the hole used the preceding year. The Crimson-breasted Barbet (*Xantholaema haemacephala*) uses the same hole year after year but generally lengthens it each season, so that finally the cavity may reach four or five feet in length. When it becomes very long, the birds open another entrance nearer the end where the eggs are laid. These barbets may carve their nests in horizontal branches or beams, with the doorway on the lower side. In some species, at least, the holes are used also as dormitories. Thus the Small Green Barbets "usually occupy these holes to roost in the whole year round."

The beginnings of colonial nesting may be seen in some of these Indian barbets. Five nests of the Small Green Barbet were found in one stump twenty feet high; but it is not clear how many were actually in use at the time. Three holes of the Crimson-breasted Barbet were found in the same branch of an old dead tree, one above the other, and about one foot apart. The lower contained chicks; the middle was used by another pair of birds "which doubtless would have laid in a day or two" if they had not been disturbed; while the uppermost was not in use. Of a West African genus of barbets, *Gymnobucco*, Friedmann (1935) states that a dozen or even two dozen pairs may have their nest-holes in the same tree, while neighboring trees are wholly devoid of holes. The Prong-billed Barbet, while decidedly gregarious during most of the year, becomes strongly intolerant of the presence of other pairs while it is nesting. It has not progressed so far in the development of social life as some of the Old World barbets, yet it is well in advance of its solitary neighbor, Salvin's Barbet.



#### SUMMARY

1. The Prong-billed Barbet (*Dicrorhynchus frantzii*) is widespread on the outer (northern and eastern) slopes of the Cordillera Central of Costa Rica, ranging from at least 1200 to 7500 feet above sea-level; between 5000 and 6000 feet it is one of the abundant birds. It inhabits the cloud forest and small clearings with scattered trees and bushes in an excessively humid region subject to much fogginess and long-continued rainstorms.

2. It is largely vegetarian, consuming fruits and berries of many kinds and the petals of flowers. It holds food beneath a foot to tear it apart.

3. During the non-breeding season, the barbets are found in small, irregular flocks, or sometimes singly.

4. The most commonly uttered notes are low and unmusical, of a rattling or rasping character; but several individuals may join in uttering loud, far-carrying, somewhat throaty calls of a volume surprising for so small a bird. The voice of the female is similar to that of the male, but not so full and powerful.

5. At night the birds sleep in dormitories resembling woodpecker holes. Sixteen was the largest number found in one hole. They retire late and arise early.

6. In March, as the breeding season approached, there was much shifting about of the birds among the available dormitories. While at some holes the number of inmates decreased, at others there was a temporary increase. At this period, there was growing antagonism among the several individuals that slept, or wished to sleep, in the same dormitory. By early April, when the paired barbets began to sleep in their new nesting holes, the old dormitories remained deserted.

7. The nest-chamber is carved in the dead, but fairly sound, wood of trunks and branches. Both externally and internally it resembles the hole of a small woodpecker. The chief difference is the thicker wall around the doorway of the barbets' nest.

8. The hole is excavated by both sexes, working alternately. Each labors only in the presence of the other. The birds work for short spells—usually less than eight minutes. The loosened wood particles are always carried out in the bill and dropped at a distance from the nest. At least eight days were required for the completion of one nest. The cavity is not lined, but the eggs rest upon the wood particles on the bottom.

9. As soon as the hole is large enough, male and female sleep in it,

continuing to do so through the whole period of egg-laying, incubation, raising the nestlings, and even after these have departed.

10. The barbets are now 'territorial,' repulsing trespassers of their own kind. Only one fight was witnessed.

11. The earliest egg recorded was laid on April 9. An egg appears daily until the set of four or five is complete. The eggs are pure white and glossy, resembling those of woodpeckers.

12. Male and female share almost equally the task of diurnal incubation. During the early morning they are very restless, shifting about frequently. Later in the day, they may sit continuously for an hour to nearly two hours.

13. The eggs in one nest hatched thirteen days after the last was laid, and all within twenty-four hours.

14. The newly hatched nestlings are pink-skinned, utterly naked, blind, with prognathous lower mandible and prominently papillate heel pads.

15. The parents share the work of brooding and feeding the nestlings.

16. The newly hatched nestlings are nourished chiefly with small insects; but as they grow older, fruit rapidly gains in importance in their diet. Older nestlings are given enormous quantities of fruit, both whole berries and the pulp of larger fruits. Soft fruits are preferred.

17. The nest is kept scrupulously clean; the parents assiduously remove the droppings mixed with the wood particles that cover the floor of the nest. Apparently fresh particles are loosened for this purpose from time to time until the nestlings depart, thereby enlarging the chamber.

18. The development of the nestlings is slow. At the age of nine days they are still naked and blind. Because of misfortunes, it was not possible to determine the period the young remain in the nest, but this appears to be at least a month.

19. The young flew from one nest before nine o'clock in the morning. They still fly weakly despite the advanced age at which they normally depart. In the juvenal plumage they bear fairly close resemblance to their parents, with certain evident differences here described.

20. The newly emerged fledglings are led in the evening to sleep in the nest they have just left. The parents show them the doorway by going in and out many times over, until the youngsters succeed in following.

21. The parents at one nest were indefatigable in urging their two

fledglings to enter, continuing to show them how until the first gained the interior. Then they seemed to forget about the other, which flew weakly and was obliged to pass the night in the open, but with no ill effects.

22. Upon leaving the nest, the fledglings can utter the loud call of the adults, but in a weaker voice.

23. The young birds at first leave the dormitory considerably later in the morning than their parents. But after a few weeks, all depart at the same time.

24. Apparently only a single brood is raised each year.

25. After the close of the nesting season, a single barbet was found sleeping in a hole of the Hairy Woodpecker (*Dryobates villosus*) recently abandoned by its original occupants. Thus either woodpecker holes or holes made by the barbets themselves may serve as dormitories.

26. Among the enemies of adult barbets are the White-throated Falcon (*Falco albicularis*) and long-continued rainstorms which soak their plumage until they can not fly. The very thick doorway of the nest is a defense against the Blue-throated Toucanet (*Aulacorhynchus caeruleigularis*), an inveterate nest-robber of the same region. Yet, from five nests with eggs only two young were fledged.

27. The habits of the only other Costa Rican barbet, *Eubucco bourcierii salvini*, are briefly described. It contrasts strongly with the Prong-billed Barbet, being brightly colored, solitary, largely or wholly insectivorous, and habitually silent.

28. The habits of the Prong-billed Barbet are briefly compared with those of Old World species.

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*Finca "Los Cusingos"*

*Quizarrá de Pérez Zeledón*

*Costa Rica*

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## SEASONAL TERRITORY STUDIES OF RUBY-THROATS

BY A. L. PICKENS

"Do you sleep on your dining table?" Answering question with question, like an ancient Greek, this query is a fitting answer to those who enquire if Ruby-throated Hummingbird (*Archilochus colubris*) nesting areas are not in tangles of gorgeous flowers. Personal records of bird-flowers supplemented by those of a helpful group of correspondents from New England to California; Neltje Blanchan's 'Nature's Garden,' of which many specialists apparently remain ignorant; Otto Porsch's 'Grellrot als Vogelblumenfarbe' in *Biologia Generalis*, Band VII; Aretas A. Saunders's 'Ecology of Birds of Quaker Run Valley'; and F. W. Pennell's monumental work on the Scrophulariaceae—all these note the attraction of red flowers for hummers and other birds. But a nesting bird is not seeking display but is courting concealment. Remembering this will enable one to see that this article is not in conflict with the findings of our bird-flower-census takers.

The farm on which Old Richmond, church of Revolutionary veterans, began its historic career, of all areas has furnished the largest share of Ruby-throat nests for the personal notes used in this article. For this vicinity a total of ten was recorded, and all but one were visited personally. They fall naturally into four areas, A, B, C, and D, with a fifth very strongly indicated, which is provisionally noted as E (see Text-figure 1). Of ten nests, all were in the licheniferous post-oak (*Quercus minor*) except No. 3 in a sugar plum, and Nos. 7 and 8 in one yellow pine (*Pinus echinata*) at different times. No one was immediately near or above any brilliantly flowering tree, vine, or plot. Flowers immediately near were not ornithophilic. In fact, the spring-blooming fire-pink (*Silene virginica*), columbine (*Aquilegia canadensis*), pink-root (*Spigelia marylandica*), and coral honeysuckle (*Phenianthus sempervirens*) were found on this farm, if at all, merely as ornamentals, artificially transplanted. Cross-vine (*Anisostichus*