

LIFE HISTORY OF THE SCALY-BREASTED HUMMINGBIRD

By ALEXANDER F. SKUTCH

The Scaly-breasted Hummingbird (*Phaeochroa cuvierii*) is a rather large and very plainly colored species about four and a half inches in length. The sexes are alike, and in both the upper plumage is metallic bronze-green. The tail is more bluish green, with the two or three outer feathers on each side tipped with dull white, the outermost most broadly. There is a small, whitish spot behind each eye. The feathers of the throat and breast are dull green with grayish buff margins, producing the effect of scales when the hummingbird is viewed at close range. In the field, however, the scales are hardly noticeable, and the anterior under parts appear gray tinged with green. The abdomen is pale brownish buff. The fairly long, straight bill is black on the upper mandible, while the lower mandible is reddish tipped with black. This description applies to the race *Phaeochroa cuvierii maculicauda* of southern Central America, the subject of the present paper. Northern representatives of the species have a more extensively dark lower mandible.

The Scaly-breasted Hummingbird ranges from Guatemala to northern Colombia. It is fairly common in the Pacific lowlands of Costa Rica, including the Terraba Valley, up which it extends to the basin of El General at the head of the valley, an elevation of 3000 feet above sea level. Here in El General, where alone I have studied it, this hummingbird avoids woodland with a closed canopy, both primary and secondary, and seeks areas with moderately tall but scattered trees, such as coffee plantations with light shade, shady pastures, roadsides, dooryards, and open second-growth woods. Like other hummingbirds without highly specialized bills, it sucks nectar from a variety of flowers, large and small, and it likewise catches minute insects in the air. I have noticed no remarkable peculiarities in its feeding habits.

In our dooryard at Quizarrá are two poró trees (*Erythrina Berteroana*) which toward the end of the wet season drop their trifoliolate leaves and display masses of scarlet flowers on their nearly naked branches. Each tree is usually claimed by a Long-billed Starthroat (*Helimaster longirostris*), whose bill is excellently fitted for extracting the nectar from the base of the long, tightly folded, sword-shaped standard, the only part of the corolla that is well developed and exposed to view. These big hummingbirds drive away smaller species, which can only surreptitiously visit the scarlet flowers. Most of them have bills too short to reach the nectar in the usual way, and they can obtain it only by piercing the thick, tubular calyx that forms a collar around the base of the standard. This is done by the Purple-crowned Fairy (*Heliathrix barroti*), whose short bill is very sharp, and likewise by the Scaly-breasted Hummingbird, whose far longer bill seems less adequate for this kind of work. The Scaly-breast pierces the calyx either while hovering or while clinging to the end of the standard.

In late November of 1962, the poró tree nearest the house was not defended by a Star-throat, and two Scaly-breasts contended for its possession. Sometimes they clutched each other and fell together to the ground, where after a few seconds they separated and rose into the tree again. Here they might perch only a few inches apart, resting, with tails partly spread, for as long as ten minutes. Then one hummingbird would dash at its adversary; and the two would dart around, uttering low squeaks, and clashing together at intervals. They pulled feathers from each other, and one had a tuft of down clinging to its bill for many minutes. This bird had dishevelled plumage, but the one that had lost the feather was even more bedraggled. The hummingbird whose plumage was less tattered was evidently a male, for while he perched with his bill pointed toward

his opponent his throat swelled out and vibrated; he was evidently singing in an undertone with closed bill, as male hummingbirds frequently do.

While watching from a blind set in tall second-growth woods not far from a clearing, I saw a Scaly-breasted Hummingbird bathe on a soft cushion of green moss attached to a slender stem. The hummingbird clung to the water-soaked cushion, pushed in its breast, rubbed its face against the moss, then perched nearby and shook its relaxed feathers. A little later a Rufous-tailed Hummingbird (*Amazilia tzacatl*) bathed here in much the same fashion. This seemed to be a recognized bathing place of the hummingbirds, for three weeks earlier I had seen a Rufous-tailed Hummingbird bathe on the cushion of moss. One frequently sees hummers, as well as other birds, perform their ablutions amid foliage laden with dew or rain drops, but the use of a sponge of moss seems to be less common.

VOICE AND COURTSHIP

December 25, 1935, dawned with a brisk, chilling breeze driving down the narrow valley of the Río Buena Vista from the high summits of the Cordillera de Talamanca at its head. The bushy pastures and thickets were bright with a profusion of flowering shrubs, among which yellow and white composites were prominent; birds were silent in the thick cover, as they usually are at the beginning of the dry season. I saw scarcely any until I came upon a singing assembly of an unusually plain hummingbird of a kind new to me. At least four of these birds participated in the assembly. They perched, from 20 to 40 feet above the ground, on exposed dead twigs of trees standing above the tangled, weedy growth which pressed close to the road on both sides. Three of the participants occupied the points of a roughly equilateral triangle with sides about a hundred feet long, while the fourth hummingbird was stationed about the same distance beyond one of the apices. Three were in trees beside the road, the fourth off in a bush-choked field.

As these modestly attired hummingbirds perched on the exposed naked twigs, they repeated at irregular intervals a little phrase which was certainly not the least musical of the hummingbirds' songs that I had heard. There was some variation among the verses of the four individuals, and even between successive songs of the same bird, but this seemed to be the most typical: *Chee twe twe twe twe*—trill—*chup chup*. The trill, which first caught my ear, was so like the little trill of the Black-fronted Tody-Flycatcher (*Todyrostrum cinereum*) that I looked for this diminutive yellow-breasted bird and was surprised to find that a hummingbird was the author of the clear notes.

In addition to the foregoing verse and its numerous variations, these hummingbirds delivered a very different kind of song. It was a sort of medley, composed of the faintest possible notes, too slight even to be called squeaky. Indeed, much of this second song was too weak to be audible to me at a distance of 20 or 25 feet, if not too high in pitch to be perceived by the human ear at any distance. Yet after this tenuous medley ran off into silence, I could see by the hummingbird's outswollen, vibrating throat that he was still singing. Such whisper songs are not rare among hummingbirds. The performance of these Scaly-breasted Hummingbirds, especially the scarcely audible verses, reminded me of the more richly varied song of a much smaller species, the Wine-throated Hummingbird (*Atthis ellioti*) of the Guatemalan highlands.

As the drought increased in January, this singing assembly of Scaly-breasted Hummingbirds dispersed; but at the end of June, when the rainy season was in full sway, I noticed that it was active again. In May of the following year, 1937, I again found the hummingbirds singing in the same place; so that this assembly was in existence during at least three wet seasons.

In later years, I have found many more Scaly-breasts performing in the same manner, usually on an exposed twig of a small or middle-sized tree that stood above tangled lower growth, but often also on a shade tree of a coffee plantation, well above the tops of the coffee bushes, but rarely more than 40 feet above the ground. In and around a small coffee grove on this farm, Scaly-breasts have been singing each year for as long as I can remember, probably for the last ten years. At present this assembly consists of only two birds, whose stations are about 125 feet apart. Their songs are similar but differ from those that I first heard, for they lack a clear trill. A frequent version runs, as well as I can paraphrase it: *See seea chweee, see seea chweee, see seea chip-chip-chip-chip-chip*. The dry, rapidly delivered *chip*'s evidently represent the trill that other Scaly-breasts utter. The *chweee* is a low, full note, unusually strong and mellow for a hummingbird. It is clearly audible at a distance of 200 feet. The song of these birds is by no means stereotyped, and there are many variants, such as *See seea chweee chip-chip-chip-chip chweee*, and *See seea chweee see chweee see chweee*. Between songs these birds sometimes fan out their rectrices, revealing the prominent whitish tips of the outer ones, and wag their spread tails vigorously while they shake their relaxed wings.

Scaly-breasts perform in their assemblies throughout the day, from early morning until late in the afternoon. In this they agree with many other species (Skutch, 1951), but differ conspicuously from another hummingbird that often shares their habitat, the Rufous-tailed Hummingbird, which sings methodically at dawn but rarely after sunrise.

In El General, Scaly-breasts are silent during the early part of the year, when the weather becomes increasingly dry. Sometimes they resume singing in April, after showers have refreshed the plant life; and usually by early May, when rains have become frequent and the vegetation is again lush, they are in full song. Sometimes the Scaly-breasts continue to perform through the long wet season until the end of the year; but in 1948 I failed to hear them after September. The period of song by the males coincides closely with the nesting season of the females; and it seems clear that, as in numerous other hummingbirds (Skutch, 1958:10), they perform to advertise their presence to the other sex rather than to proclaim possession of a feeding territory. Indeed, there are often scarcely any flowers around the singing perch, and the songsters fly beyond sight to forage. But as in other hummingbirds with singing assemblies, I have not succeeded in following courtship to its consummation. In this species it is impossible to tell whether another individual who approaches a songster on his perch and is rapidly pursued is a female or an intruding male.

NEST AND EGGS

In 1945 I found a female starting her nest on May 3, and on May 24, 1947, I discovered a Scaly-breast incubating. In June nests with eggs are not rare; I have found more in this month than in any other. Nesting continues through the wet season, including the very rainy months of September and October, and an occasional nest is found as late as January, when as a rule the rains are reduced to light showers and there is an abundance of blossoms. From my latest nest the young flew on February 11. In 1948, when I heard no song after September, I likewise found no nest after this month.

Most of the 21 nests that I have seen in El General were built in small trees growing in pastures and shady dooryards. They were placed at heights ranging from 6 to about 25 feet. Thirteen of them were from 10 to 20 feet up, and the average height of the 21 nests was 14.4 feet. One of the nests was beside a stream, and two were above water. Of the latter, one was eight feet above the rocky channel of a mountain torrent, 25 feet from the shore. The nest is often placed on an upright or ascending branch,

between several diverging twigs which hold it firmly; but sometimes it rests on a thicker horizontal branch, with perhaps one or two upright shoots to provide lateral support. The branch that holds the nest may be covered with moss or liverworts with which the structure blends, so that it is not conspicuous even in the absence of concealing foliage. Sometimes the nest is partly screened by leaves, but often it is in a very exposed situation, even on a leafless dead branch. One nest was built on the horizontal part of a dangling loop of a slender woody vine, about 25 feet above the mouth of a creek that flowed into a wide mountain stream. Well covered with gray lichens and green moss, it appeared to be an excrescence of the vine.

The Scaly-breasted Hummingbird's nest is a beautiful structure. Before the growing nestlings cause it to flare out, it is sometimes almost hemispheric in form, with a strongly incurved rim; but other newly finished nests are broader and shallower. Composed largely of soft, downy materials, it is more or less completely covered on the outside with cryptogamic vegetation: green liverworts, green mosses, light gray or blue-green foliaceous lichens. Usually one of these types of covering predominates, but there is an admixture of the others. If mosses are used to cover the nest, they may hang in streamers beneath it. Often whitish foliaceous lichens line the inside of the nest as well as cover its exterior. Sometimes fine black fungal rhizomorphs—vegetable "horsehair"—are mixed with the down that composes the body of the nest. One nest measured 2 inches in over-all diameter by $2\frac{1}{4}$ inches in height. The inside diameter was $1\frac{1}{2}$ inches.

Nineteen broods consisted of two eggs or nestlings. In two nests I found single eggs which were probably not complete sets. The tiny white eggs are long and narrow, as in other hummingbirds. In two instances, an interval of two days separated the laying of the first and second eggs. In three nests, the second egg was laid between 5:45 and 6:30 a.m.—around sunrise. In one nest, however, the second egg appeared between 9:00 a.m. and noon.

In the valley of El General, between 2400 and 3000 feet above sea level, 22 sets of eggs were laid as follows: May, 1; June, 6; July, 4; August, 3; September, 4; October, 2; December, 1; January, 1.

INCUBATION

Only the female attends the nest. The stage at which she begins to pass the night on the nest varies even with different broods of the same individual. In the evening I found one female covering her first egg, which she had laid that same morning; she flew off as I passed by. The following night she slept on the single egg, and next morning she laid the second egg. When this female again nested two months later, she did not cover her first egg on the night after it was laid. Three years later, a female slept on the first egg of her second brood on the night after it was laid, but she was absent from her nest the following night.

I spent the whole forenoon of September 12, 1961, and all the afternoon of the following day, watching a nest in which the second egg had been laid on September 1. In the morning, there were brief showers before 8:00, then the sun broke through the clouds. The afternoon of the following day was at first sunny, but after 2:00 rain and drizzle fell most of the time until nightfall. This hummingbird's active day began at 5:47 a.m. on September 12 and ended at 5:42 p.m. the following day. In 12 hours, she took 35 sessions, ranging from less than 1 to 103 minutes and averaging 14.3 minutes. An equal number of recesses ranged from less than 1 to 23 minutes and averaged 6 minutes. She covered her eggs for 70.4 per cent of the day. Her method of incubating differed greatly in the forenoon and afternoon. Before midday she left her nest 31 times, but after midday she did so only 4 times (not counting two absences of two or

three minutes each, when she left as domestic animals passed beneath her). In the forenoon her longest continuous session lasted 30 minutes, whereas in the afternoon it lasted 103 minutes and two other sessions continued for 69 minutes. Her longest absence in the forenoon was 23 minutes and in the afternoon it was 20 minutes. Her period of greatest restlessness was the hour from 7:06 to 8:06 a.m., during which she left her nest and returned to it 17 times. Her longest session during this hour lasted 11 minutes, and many of her periods on and off the nest were less than one minute.

This hour of greatest restlessness was when the hummingbird most actively added material to her nest. On at least 13 of her returns she brought either lichen or cobweb; probably each time she came back from her brief excursion she brought something for her nest, but I did not always notice it in her bill. The lichens were always larger or smaller fragments of a whitish, foliaceous species. Sometimes the hummingbird tried to attach them to the outer surface of her mossy cup, but it was already so thickly encrusted with them that no more would stick there. Accordingly, in the end she always placed them inside the cup with her eggs, or else on the rim. When she brought cobweb, she settled in the nest and then bent down her head to run her long bill over the outer surface, spreading the silk over the lichens that covered it. After this operation, she usually bounced up and down in the nest, a movement which suggested that she was using her feet to knead the nest's lining. After the middle of the morning, she incubated more constantly and brought far less material to her nest. Her last contribution for the day, a tiny bit of lichen, was brought when she returned to resume sitting at 11:12 a.m.

The hummingbird's different behavior in the morning and afternoon can be attributed to the circumstance that at this season long, hard afternoon rains were frequent, whereas mornings were often sunny. But many hummingbirds take time from incubation to add to their nests in the morning, even at seasons when rain is infrequent.

To leave her eggs, this hummingbird often flew backward until clear of the nest, then reversed her direction and darted away. Rarely she uttered a few sharp notes while sitting. All day I neither saw nor heard a second Scaly-breasted Hummingbird that might have been her mate.

On July 5, 1948, another Scaly-breasted Hummingbird incubated more constantly. In 12 hours of observation she took 13 sessions that ranged from 4 to 99 minutes and averaged 38.5 minutes. Her recesses varied from 1 to 34 minutes and averaged 9.3 minutes. She covered her eggs for 80.5 per cent of the day. Hummingbirds in general incubate more constantly than many larger birds (Skutch, 1962:121).

At night I have always found incubating or brooding hummingbirds sleeping on the nest with the head exposed and the bill pointing forward, rather than with the head turned back and buried in the plumage, in the manner of most birds. The few roosting hummingbirds that I have discovered also slept with their bills pointing forward.

At one nest the incubation period, counting from the laying of the last egg to the hatching of the last nestling, was 17 days and 8.5 hours \pm 3 hours. At another nest this period was at least 17 days. At yet another nest, where only one of the two eggs hatched, the incubation period was 19 or 20 days. This is unusually long for a hummingbird; probably the development of the embryo was retarded by two days of almost continuous rain early in September, soon after the eggs were laid. In this rainy spell, the parent doubtless neglected her nest to find food.

At one nest, both eggs hatched within an interval of six hours, and at another they hatched within ten hours. The female hummingbird does not, like most passerine parents, promptly remove the empty shells. Usually they stay in the nest for hours. Sometimes they finally disappear, evidently having been thrown out by the hummingbird;

but at other times they remain until they are flattened out and broken up. Probably the white shells are frequently overlooked by the parent because they do not contrast with the whitish lichens that often line the nest.

THE NESTLINGS

As has often been remarked of other kinds of hummingbirds, the nestlings break out of the shell in such an undeveloped state that, unless closely examined, they resemble insect grubs. Newly hatched Scaly-breasts have very short bills, completely closed eyes, rudimentary wings, and black skin, and along the middle of the back are two parallel rows of pale gray down-feathers, about eight in each row.

In the rainy season of 1962, a Scaly-breasted Hummingbird nested in the top of a calabash tree in front of our house. Although the nest was in a most exposed situation, it blended so well with the moss and liverworts that thickly covered the supporting branch that I failed to notice it until several days after the eggs were laid. This nest was especially favorable for study, not only because of its location but also because its attendant had a conspicuous swelling on her lower mandible near its base, which served to identify her. As has long been known, male hummingbirds as a rule neglect their progeny; but when Moore (1947) and then Schäfer (1954) produced evidence that in South America the male Gould Violet-ear (*Colibri coruscans*) helps the female to attend the nest, it became desirable to investigate this matter in as many species as possible. In the numerous species of which the sexes are difficult to distinguish on the wing, an occasional visit to the nest by a male might be overlooked. Likewise a female helper, such as Wagner (1959) found in the White-eared Hummingbird (*Hylocharis leucotis*) in México, might escape detection if her visits did not coincide with those of the mother, who would chase this unwanted assistant away. But at this nest attended by a female with a wart on her bill, I could hardly fail to recognize a second attendant of either sex, if one arrived.

On August 14, when the two nestlings in the calabash tree were five and six days old, I spent the morning watching their nest from the porch. In the first six hours of the day, the parent with the wart fed the nestlings 14 times, and no other hummingbird came near them. Since their nest was well above me, I could see little of the nestlings, but it was evident that on each parental visit they were fed in a number of installments or separate acts of regurgitation, between which the mother's bill was removed from the nestling's mouth. The number of installments which the parent delivered on a single visit varied from about 3 to 11, and the total time devoted to delivering food ranged from about 20 seconds to slightly over one minute, as measured by a stop-watch.

In the course of the six hours, the parent brooded the nestlings 20 times, for intervals ranging from less than 1 to 26 minutes, totalling 189 minutes, and averaging 9.5 minutes. There were 21 absences from the nest, ranging from 1 to 18 minutes, totalling 167 minutes, and averaging 8 minutes. The nestlings were brooded for 53 per cent of the morning. The longest sessions of brooding were not in the cool early morning, but after ten o'clock, when the sunshine was falling brightly on the fully exposed nest and the naked nestlings needed protection from it. At this time the parent brooded more often than she fed. Often she opened her bill to pant in the hot sunshine, as the nestlings did when she left them exposed to it.

When these nestlings were only nine and ten days old, with sprouting pinfeathers that failed by far to cover their skin, their mother no longer brooded them by night. Such early cessation of nocturnal brooding is not unusual in Scaly-breasted Hummingbirds. At another nest, the two young slept alone when they were only eight and nine days old, and again on the following night. On the next night, however, their mother

brooded them, although no rain was falling at nightfall. This was the last time that I found her on the nest at night; nocturnal brooding definitely ceased when these nestlings were 11 and 12 days old. At another nest the parent stopped brooding when the nestlings were nine days old and at still another when they were 11 days old.

In other hummingbirds that nest in mild climates, brooding stops at a similarly early age. Anna Hummingbirds (*Calypte anna*) in California were not brooded either by day or by night after they were 13 days old, at which age they maintained their temperature well above that of the environment at all times (Howell and Dawson, 1954). But at high altitudes, where frost is frequent at the season when many hummingbirds nest, brooding may continue considerably longer. White-eared Hummingbirds breeding in November and December at 8500 feet in the Guatemalan highlands covered their young by night until they were 17 or 18 days old and well feathered.

Strangely enough, Scaly-breasts cover their nestlings during a daytime shower long after they cease to brood them through the night, even after they are covered with plumage. Yet nocturnal rain is by no means absent at the season when these hummingbirds breed, although the hardest downpours generally come in the afternoon. Probably if rain were falling hard in the evening the parent would remain on the nest through the night; but while the nestlings are still practically naked they are liable to be exposed to a rain that starts after it is dark. And in one instance, the mother of two thirteen-day-old nestlings left them exposed to a shower that was falling as the day ended. However, nestling hummingbirds are unbelievably hardy, as I learned long ago (Skutch, 1931).

On August 24, when the two nestlings in the calabash tree were 15 and 16 days old and clothed in plumage, I again watched through the morning. In the first six hours of the day, they were fed 19 times, only a slight increase over the number of meals they had received ten days earlier. On each feeding visit the parent, perching on the nest's rim, delivered food in from 4 to 8 separate acts of regurgitation; but when as many as eight were made, each was short. Sometimes I clearly saw that the parent regurgitated to the two nestlings alternately, but because of the height of the nest I could not always see plainly. On a single visit, food was delivered over an interval ranging from about 25 seconds to 1 minute. Once the parent brought a small object, evidently an insect, in her bill and gave it to a nestling along with the regurgitated food. Such bringing of visible food is rare in hummingbirds.

Although the mother had long since ceased to brood in rainless weather and by night, for two minutes early in the morning she rested on the nest's eastern rim and shaded the nestlings from the rising sun. But otherwise she made no effort to protect them from its bright rays, which fell full on them until late in the morning, when the nest was in the narrow shadow of a higher mossy branch of the calabash tree. When the bright sunbeams fell on the nestlings, they stretched up their heads and panted with open bills. The ability of these diminutive creatures to resist strong insolation was amazing. Many years ago, a feathered nestling of a Spotted-breasted Wren (*Thryothorus maculipectus*), that I had placed in the sunshine for photography, succumbed to a far shorter exposure than these hummingbirds resisted morning after morning.

I also watched the nest in the calabash tree through the afternoon of August 28, when the nestlings were 19 and 20 days old. In the first hour, they were fed three times. Then a moderate shower began and lasted ten minutes, during which the nestlings rested with their bills pointing almost straight up. After an intermission another shower began. While it was falling, the parent fed the nestlings and then tried to brood them, but they persisted in keeping their heads exposed in front of her breast, and one flapped

its wings. During the 19 minutes when rain fell rather hard, all three, mother and nestlings, held their heads tilted sharply upward, and the latter sometimes kept their mouths open, as though catching the rain drops. When the rain abated to a drizzle, the parent left to collect food; and after receiving a meal one of the young rose up in the nest and flapped its wings vigorously. From 3:00 to 4:53 p.m. the parent was mostly out of sight, and the nestlings received no food. Then she returned, and in the last 80 minutes of the day she delivered six meals, sometimes feeding the nestlings alternately, sometimes in the order ABBA. Occasionally one youngster received three installments and the other only one. The last meal was delivered at 6:13, in the dusk when the bats were flying.

On other evenings, too, these nestlings were fed generously well after six o'clock, when the light had grown dim. At other nests I have watched Scaly-breasted Hummingbirds feed their young when the evening twilight was so far advanced that I could scarcely distinguish the parent, even through field glasses. Practically all the diurnal birds of other kinds had by this hour gone to rest and fallen silent. This accelerated feeding in the last hour of the day, continuing until it is nearly dark, fortifies the nestlings against the long night when no food is brought.

In the $6\frac{1}{4}$ hours of the afternoon, the nestlings in the calabash tree were fed 12 times, and half of these meals were delivered in the final 80 minutes of this period. If we combine this record with that made in the forenoon of August 24, we find that two feathered nestlings of the Scaly-breasted Hummingbird, 15 to 20 days old, received 31 meals in the course of a day of $12\frac{1}{2}$ hours. The parent brought food at the rate of 1.2 times per capita per hour. Nestlings of the White-crested Coquette (*Paphosia adorabilis*) were fed at about the same rate (Skutch, 1961). I have rarely known hummingbirds of any kind to feed more often than 2.5 times per capita per hour.

Nestling Scaly-breasts develop slowly. At the end of a week they look much as they did when newly hatched, except that they are much larger. At the age of nine days their pinfeathers begin to sprout from the skin. When the nestlings are 15 days old they can open their eyes, but they keep them closed much of the time. At 16 days they are fairly well clothed by their expanding plumage, but they stay in the nest a week or ten days longer. As the time for their departure approaches, they often exercise their wings by beating them rapidly, while they cling to the nest with their feet to avoid being lifted from it.

DEPARTURE OF NESTLINGS

Soon after six o'clock on the morning of September 2, one young hummingbird (A) left its nest in the calabash tree. A little later I found the fledgling resting on a dead twig at the very top of the tree, where it was exposed to the sky. This perch, about two yards from the nest, was a favorite resting place of its mother, and here she fed it. Both this youngster and the other still in the nest (B) preened much. The latter was restless, turning its head from side to side, twitching its wings, and sometimes whirring them rapidly. Then, at 8:05 a.m., it flew from the nest to an exposed perch two or three yards away. At the moment of its departure, the parent was resting about a yard from the nest, but, as far as I could tell, she did not urge it to leave. While one young was in the nest and the other outside, she had fed both of them.

When, at 8:22, fledgling B flew down into a madera negra tree, its mother followed closely in "shielding flight." But she did not try to move her offspring to less exposed situations. Presently fledgling A flew to another exposed perch at the very top of the tree in which it had hatched. For nearly three hours it rested here, fed periodically by its mother. Soon after noon I lost sight of both fledglings, but at 1:00 p.m. I noticed

one of them perching in an annatto tree in view of my study window. All afternoon, for more than 4½ hours, it rested here in the same spot, receiving meals from its parent. Since these fledglings rarely uttered a note to guide their attendant to them, their immobility doubtless made it easier for her to find them for successive feedings. When young birds are noisier, their voices guide their parents to them, and it is not so important that they remain stationary.

That evening I noticed a fledgling resting on a nearly leafless branch at the top of the calabash tree, two or three yards from the nest that it had left earlier in the day. Here it remained until morning, without a leaf to shelter it from the rain that began soon after nightfall. But I did not again find a young hummingbird roosting in such an exposed situation.

I saw only the parent with the wart on her bill take an interest in these young hummingbirds while they were in the nest and after they left it. One morning, before the young fledged, a male Scaly-breast perched on a twig of the nest tree and sang for a minute or two, but he did not approach the nest.

Eighteen years earlier I had watched another brood of two leave their nest in a tree beside a stream. Both flew from the nest quite spontaneously, while their mother was out of sight, one at 6:56 a.m. and the other at 7:32. In the interval when one was in the nest and the other beyond it, both were fed. The first flights of both fledglings were short, only a yard or two; but one left the nest by flying almost straight upward, an admirable feat for a bird with untried wings. Soon both took longer flights, up to about 20 feet. They alighted without difficulty, even after their very first flight. Both of these young hummingbirds refused food soon after departing the nest. Neither they nor any other Scaly-breasted Hummingbirds that I have watched returned to rest or sleep in the nest after their first departure. Before the young are fledged, they quite fill the nest, which they sometimes burst asunder and flatten out. Occasionally, however, they leave the nest in sufficiently good condition to be used for a second brood, after some refurbishing by the parent.

I know the approximate hour of departure of 11 fledglings from seven nests. Seven fledglings left in the early morning, before 8:15 a.m. One left between 8:45 and 12:40 p.m. Two departed between 10:30 and 1:15. Only one is definitely known to have gone in the afternoon.

The nestling period of 12 young in seven nests varied from 22 to 29 days and averaged 24.6 days. The shortest period was that of a nestling which grew up alone at the very end of the breeding season, in January and early February, when there was little rain and an abundance of flowers. Doubtless liberal nourishment hastened the development of this lone nestling. For four broods of two, the nestling period ranged from 23 to 25 days. Two nestlings reared together in very wet weather in October stayed in the nest for 26 and 27 days. A lone nestling that grew up in another wet October left at the exceptionally advanced age of 29 days. This nestling attempted in a very rainy spell was in every way retarded: the second egg was laid late rather than early in the morning; only one egg hatched, after an incubation period two or three days beyond the normal; and the nestling period was prolonged about four days beyond its average length. A similar retardation of the nestlings' development by unfavorable weather is not unusual in other species. Violet-eared Hummingbirds (*Colibri thalassinus*) usually leave the nest between their twenty-third and twenty-fifth days, but their nestling period may be prolonged to 27 or 28 days by a few cold, rainy days while the young are in the nest (Wagner, 1945:183). Yellow-bellied Elaenias (*Elaenia flavogaster*) usually leave the nest when 17 or 18 days old, but two young of a late brood

reared in wet weather stayed for 20 or 21 days. The nestling period of swifts (*Apus apus*) varies greatly with the abundance of nourishment their parents are able to provide for them, and this in turn depends on the weather (Lack, 1956:90).

ATTAINMENT OF INDEPENDENCE

For more than a month after the fledglings left the nest in the calabash tree, I saw little of them. Occasionally I heard the sharp, rapidly repeated, staccato note which their mother used to call them when she was ready to feed them. One afternoon she rested on a dead twig at the top of a large orange tree in front of the house, repeating this call for several minutes, yet the young failed to appear. Finally, on October 7, I saw her feed a juvenile in a low tree near the nest. I identified her by the wart on her lower mandible, which had been shrinking since August but was still discernible through field glasses. The young bird was almost as large as his mother, but his bill was slightly shorter. I use the masculine pronoun advisedly, for reasons which will presently appear.

On October 11, 12, and 13, this young hummingbird spent much time in view of my study window. On these days I saw the parent feed him nine times, always on the same thin, exposed twig, which I shall call the "feeding perch." Even when the young bird was resting in full view a few yards away, she did not alight beside him, as she might well have done, but went to the feeding perch and called with the usual staccato notes, whereupon he flew up beside her. After he opened his mouth, she pushed her bill into his throat and regurgitated, with much violent shaking of the heads of both. The meal was delivered in from one to four installments. Then she would fly away. Sometimes he also left, but at other times he stayed in the annatto tree. He spent long intervals resting on the feeding perch itself, where his mother fed him on her return. Once, when he was out of sight when she arrived, she waited on the feeding perch, uttering a single low note. After five minutes, the young bird returned and received a generous meal. Having a definite spot for the delivery of meals doubtless helped the adult to maintain contact with the youngster, whose calls were weak.

At 11:20 a.m. on October 11, I found the young hummingbird in the annatto tree and decided to watch until he was fed. Nearly two hours passed before his mother arrived, and during this interval he was out of my sight for less than five minutes. Occasionally he made a short dart into the air, apparently to catch an insect too small for me to see, but he could have taken little food during this long wait. When finally, at 1:13 p.m., his mother alighted on the feeding perch and called, he briefly vibrated his half-spread wings like a hungry passerine fledgling, repeating this several times with momentary pauses between them, and accompanying each flutter of his wings with a little weak *peep*. Then he went to his parent and was fed in one installment. Evidently he was still hungry after this meal, for he followed his mother to another perch and alighted beside her with open bill. But he received no more food on this occasion. On the following morning he was fed more frequently, four times in the three hours from 8:05 to 11:05, which is about the rate of feeding a brood of two older nestlings.

Although on this morning the juvenile rested for long periods on the feeding perch—once for 55 minutes and again for 33 minutes continuously—he was also out of sight for intervals of 10 to 28 minutes. Possibly he then foraged for himself. Rarely I saw him probe a flower, sometimes while clinging beside it.

While resting on or near the feeding perch, this young Scaly-breast sang so much that I was convinced that he was a male. His performance sounded like a very subdued version of an adult male Scaly-breasted Hummingbird's song. Weak, high notes followed each other without much order, forming a sort of medley. Often the notes were so slight that I could not hear them above the roar of the distant river, although the

songster was only 25 feet from me. Even when his song was inaudible and he kept his bill closed, I had no doubt that he was singing, for his strongly distended throat vibrated, its partly erected feathers separated from each other and moving up and down. At such times, I could hear very faint notes when I approached to within two or three yards of the hummingbird. While he sang in this fashion, his back was humped and his neck depressed, but his head and bill were inclined strongly upward. This whisper song was often continued for many minutes together. In their singing assemblies, adult hummingbirds of a number of species sing whisper songs while holding their bodies in much the same posture, but these *sotto voce* interludes occur between louder utterances.

At intervals the young Scaly-breast stretched both wings together above his back, with the longer remiges closed and pointing rearward. As he did so, his neck and head were lowered. Often this upward stretch was followed by a lateral stretch, when one wing was spread sideward and at the same time the fanned-out tail was inclined to the same side. Frequently the hummingbird scratched his head or bill, always by raising his foot over the base of the slightly drooped wing of the same side, between the wing and the body. As far as I have seen, this "over-the-wing" head-scratching is customary in hummingbirds. When a small black bee hovered around the young hummingbird's head, he retreated to a neighboring twig, but soon returned to his preferred perch.

I last saw this juvenile receive food from the adult with the wart on her bill on October 13, when he was 65 or 66 days old and had been flying around for 41 days. Information on how long after young hummingbirds leave the nest parental care continues is hard to find. Most of the statements on this subject that I have seen give the impression that the female feeds her offspring for only a few days after they take flight. Thus Wagner (1945:181) states of the Violet-eared Hummingbird: "After five to seven days, the young are completely independent." The same author believed that young White-ears are attended for only two to four days after they leave the nest (Wagner, 1959:286). However, in the Guatemalan highlands I saw a female White-ear repeatedly feed a young male who was 40 days old and had been out of the nest just two weeks. She was incubating her second brood, and she fed this survivor of her first brood during her absences from the eggs. He was well able to hover before the flowers and feed himself, and while resting near his parent's second nest he often gave a subdued version of the song that adult male White-ears deliver in their singing assemblies (Skutch, *in* Bent, 1940:461-462). It is evident that at least some hummingbirds attend their fledged young about as long as passerines and woodpeckers do.

While attending her young both in and out of the nest, the female with a wart on her bill drove away other birds much larger than herself. She chased a Buff-throated Saltator (*Saltator maximus*) for about 50 feet. One day after her young left the nest, a Blue-diademed Motmot (*Momotus momota*) alighted in a small tree near it. The parent darted back and forth, passing close to the motmot but apparently not touching it. She did this at least a dozen times before the intruder flew away, with the hummingbird pursuing it closely until both were out of sight.

THE SEQUENCE OF BROODS

In a small cashew tree (*Anacardium occidentale*) in our dooryard, a Scaly-breasted Hummingbird nested three times in each of the years 1944, 1945, and 1948. I believe that all these nests belonged to the same individual, and I am fairly certain that those built in 1944 and 1945 were by the same bird. In 1946 and again in 1947 I was absent from the farm for three months of the wet season and might have missed a nesting. This tree with a very open crown is not attractive to hummingbirds, and no nest has

been found in it during the last 15 years. The important dates in the history of this Scaly-breast's successive nestings in the cashew tree are as follows:

1944. June 22, nest 1 found with two eggs; July 8, both eggs hatched; July 31, both young left nest.

Aug. 9, nest 2 begun on side of tree opposite nest 1; Aug. 17, one egg present; Aug. 24, the single egg was apparently not incubated and was broken.

Sept. 4, nest 2 with 2 eggs and incubation begun; Sept. 21, both eggs hatched; Oct. 17, one young left nest; Oct. 18, other young left nest.

1945. May 3, nest 3 begun; May 9, nest torn apart, probably by larger birds gathering material for their nests; May 11, building continues; May 17, nest again torn apart.

June 8, nest 4 found, well begun; June 11, appears finished; June 12, first egg laid; June 14, second egg laid; July 1, both eggs hatched; July 9, nest destroyed and nestlings gone.

Aug. 5, nest 5 under construction in site of nest 3; Aug. 11, first egg laid; Aug. 13, second egg laid; Aug. 23, eggs gone.

1948. Jan. 16, nest 6 found with two eggs; Jan. 21, one nestling, apparently hatched on the preceding day; Feb. 11, the single nestling left nest.

July 2, nest 7 found with two eggs; July 9, one egg hatched; July 10, other egg hatched; Aug. 2, one nestling left nest; Aug. 3, other nestling left nest.

Aug. 15, nest again contains one egg, probably laid on 14th; Aug. 16, second egg laid; Aug. 22, eggs gone.

From the foregoing synopsis, it is evident that in 1944 this hummingbird made three nesting attempts and reared two broods. In 1945 she made three nesting attempts and all failed. In 1948 (not counting the January nest, which belonged to the breeding season that began in 1947) she made two nesting attempts and reared one brood. On two occasions, an old nest was used a second time, once after an egg had been lost from it, and once after a brood had been successfully reared in it. The interval between the departure of one brood and the resumption of laying was in one instance 17 days and in another instance 11 days. The interval between the loss of week-old nestlings and the resumption of laying was in one instance apparently 33 days, but possibly in this interval another nest had been built and lost elsewhere.

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SUMMARY

The Scaly-breasted Hummingbird occurs from sea level up to at least 3000 feet in Costa Rica. It inhabits areas with open stands of trees, such as shady pastures and dooryards, coffee plantations, and open second-growth woods.

Males form singing assemblies, in which each is stationed about 20 to 40 feet up on an exposed twig and 100 feet or more from his nearest neighbors. The pleasantly varied song, which sometimes includes a little trill, is repeated throughout the day. These assemblies are active through the wetter part of the year, from April or May until, in some years, December.

The nesting season extends through the rainy season from May to December or January and is at its height from June to October. Most nests were found in small trees in pastures and shady dooryards, at heights ranging from 6 to 25 feet, usually between 10 and 20 feet. The downy cup is well covered with mosses, liverworts, or lichens. It is often lined with whitish foliaceous lichens.

The two eggs are laid on alternate days, usually around sunrise. The female may or may not pass the night on the first egg before the second is laid. She incubates with

a constancy of 70 to 80 per cent. From 7:00 to 8:00 a.m. one female sat most restlessly, leaving her eggs often to seek lichens and cobweb, which she added to the nest. The incubation period is about 17 days but may be prolonged to 19 or 20 days in very wet weather.

At the nest of a female with an identifying mark, only she attended the nestlings. With two feathered nestlings, she brought food at the rate of 1.2 times per capita per hour. On each visit the regurgitated food was divided between the nestlings, each receiving one or more portions. The rate of feeding was accelerated as night approached, and the last meal was delivered in the dusk.

At several nests, nocturnal brooding ceased when the young were from 8 to 11 days old and still nearly naked. Sometimes they were exposed to nocturnal rain. Yet nestlings were covered during a daytime shower, and occasionally shaded from the sun, long after nocturnal brooding ceased.

The nestling period of 12 young ranged from 22 to 29 days and averaged 24.6 days. It was shortest for a nestling reared alone at a season of little rain and abundant flowers. It was longest for a nestling reared alone in a very wet spell. Nestlings usually departed early in the morning, and those that were watched left the nest quite spontaneously.

The rather silent fledglings perch for long intervals in the same spot, making it easy for the parent to find them. Sometimes there is a special perch where meals are delivered to them. One juvenile was still being fed at the age of 65 days, or 41 days after leaving the nest. This young male sang much in an undertone while waiting for his meals.

At least two broods may be raised in a season, sometimes in the same nest.

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