

## LIFE HISTORY OF THE BROAD-BILLED MOTMOT, WITH NOTES ON THE RUFOUS MOTMOT

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IN earlier papers (1945, 1947, 1964) I gave accounts of the habits of three species of motmots that inhabit more or less open country, or cool woodland on high mountains. The present paper deals with two species of the wet lowland forest. The nests of these two motmots that we chiefly studied were in sight of each other on the "La Selva" nature preserve, which lies along the left bank of the Río Puerto Viejo just above its confluence with the Río Sarapiquí, a tributary of the Río San Juan in the Caribbean lowlands of northern Costa Rica. They were watched during two visits to this locality, from April to June in 1967 and from March to early June in the following year. The heavy forest of this very rainy region, with its tall, epiphyte-burdened trees, its undergrowth dominated by low palms, and its exceptionally rich avifauna, has been well described by Slud (1960).

### BROAD-BILLED MOTMOT (*Electron platyrhynchum*)

One of the smaller members of its family, the Broad-billed Motmot is about 12 inches long. The foreparts of its short body, including the head, neck, and chest, are mainly cinnamon-rufous, with a large black patch on either side, covering the cheeks and auricular region, another black patch in the center of the foreneck, and greenish blue on the chin and upper throat. The posterior parts of the body, including the back and rump, breast and abdomen, are green, more olivaceous above, more bluish below. The wings are green, tinged with blue on the primaries. The two central feathers of the strongly graduated tail, much longer than the others, are racquet-shaped; each has a roundish terminal disc connected with the basal portion by a stalk-like length of naked shaft. The ends of the discs are dull black; the remainder of the tail is bluish green basally and greenish blue toward the end. The bill, black with a light tip, is broad and flat, with finely serrated cutting edges. The upper mandible has a low ridge or keel along the center. The eyes and feet are dark. The sexes are alike.

The color pattern of the Broad-billed Motmot is almost identical with that of the much larger Rufous Motmot (*Baryphthengus ruficapillus*), the chief differences being the absence of blue on the chin of the latter (which is cinnamon-rufous like the chest) and the smaller patch of black on the bigger bird's foreneck. The bill of the Rufous Motmot is much narrower than that of the Broad-billed Motmot, and it lacks a pronounced keel. Although these differences are quite evident at close range, at a distance, in

the absence of a standard of size, one sometimes hesitates to decide to which species the motmot belongs—until, perhaps, the great difference in voice reveals its identity. Over much of their range, these two species, representatives of quite distinct genera, live in the same forests, and their astonishing similarity in coloration raises an interesting evolutionary problem.

The Broad-billed Motmot ranges through humid forests from eastern Honduras to the upper Amazon Valley in Ecuador, Perú, and Brazil. In Central America it occurs chiefly on the Caribbean side, but it crosses to the Pacific side in northwestern Costa Rica. An inhabitant of warm lowlands, in Central America it is rarely found above 3,000 feet. Except when attending its nests, it generally perches alone well above the ground in forest trees. Often it swings its tail, pendulum-like, from side to side, in a typical motmot gesture.

#### FOOD

This small motmot subsists largely on insects and their larvae, with an admixture of spiders, centipedes, small frogs, and lizards. Among insects, cicadas supply a substantial part of the motmot's food in the season of their abundance. Large butterflies and dragonflies are occasionally captured. I have never seen this motmot eat fruit, and in many hours of watching at three nests, none was given to the nestlings. The Turquoise-browed (*Eumomota superciliosa*) and the Blue-throated Green (*Aspatha gularis*) Motmots likewise eat little or no fruit, but the larger Rufous and Blue-diademed Motmots (*Momotus momota*) include much fruit in their varied diet. The latter may be attracted to feeding shelves by bananas.

Like other motmots, Broad-bills forage in a manner that avoids wasted movement. They perch quietly, scrutinizing their surroundings, until they spy some suitable item, which they then snatch from a leaf, a twig, a trunk, or the air by means of a sudden swift dart. Without alighting at the moment of seizure, they carry the object to some convenient perch, against which, if it be large, they beat it noisily while holding it firmly in their broad, serrated bills. Sometimes, from a low lookout, they fly downward to capture some small creature in the ground cover. Occasionally they join the crowd of birds that gather to catch fugitives from the army ants, a habit which they share with Blue-diademed and Rufous Motmots.

#### VOICE

For a small family, the motmots produce a surprising variety of sounds. At one extreme we have the clear, musical piping of the Blue-throated Green Motmot, at the other, the deep, lusterless, bass notes of the present species. The call of the Broad-billed Motmot is a loud, harsh croak, quite

lacking in timbre, a wooden *cwaa cwaa* that carries far. In April and May, at La Selva, this was sometimes the very first call of a diurnal bird that we heard at daybreak, shattering the stillness of the dusky forest as early as a quarter to five. Soon the hoarse croaks sounded on all sides, proving that this motmot was more abundant than occasional meetings with it would suggest. Presently the softer, hollow-sounding notes of the Rufous Motmot would join the dawn chorus, which in tropical forest is rarely so full and stirring as in the cleared lands where more thrushes, finches, and other first-class songsters reside. Except on certain days in March and April when Broad-billed Motmots seemed to be courting, or perhaps disputing over territories, their full croak was rarely heard after sunrise.

In addition to the drawn-out *cwaa*, the motmots sometimes utter similar but shorter notes in rapid succession, *ca ca ca ca ca ca*. Rarely I have heard from them a low rattle or clicking, *k-e-e-e-e*. A parent motmot hesitating to take food into its burrow while I stood near continued to repeat a sharp *keck keck keck*. Low, throaty notes indicate excitement or distrust.

The voices of fledglings, of which we shall have more to say later, are amazingly different from those of the adults. The former utter soft, mellow notes of a sort rather frequent among birds; sometimes they might be mistaken for those of the Black-throated Trogon (*Trogon rufus*), at other times for those of the Chestnut-backed Antbird (*Myrmeciza exsul*), both of which live in the same forests. Possibly the ancestors of present-day Broad-billed Motmots had soft voices that were confusingly similar to those of some of their avian neighbors, but through the ages natural selection favored those individuals whose notes were more distinctive, until today these motmots have far-carrying calls that can hardly be confused with any other sound in the forests where they dwell.

#### DENUDATION OF THE SHAFTS OF THE CENTRAL RECTRICES

It is well known that when the central tail feathers of racquet-tailed motmots first grow out, their vanes are continuous to their tips, although they are commonly constricted in the subterminal region where the shafts will finally be denuded. I have long wished to follow the process of racquet formation; but this is difficult to observe in free birds, while in captives one cannot be certain that it takes its normal course. The nearest I ever came to following the course of racquet formation was on Barro Colorado Island many years ago, when I was there with Frank M. Chapman. One evening in late December, 1930, just as we were finishing supper, a Broad-billed Motmot perched on the petiole of a papaya tree close beside the main building and startled us with his loud *cwaa cwaa*. For the next three weeks, this bird, whom we took to be a male, entered the clear-



FIG. 1. Broad-billed Motmot, photographed on Barro Colorado Island after sunset on 5 January 1931. The longer central tail feather has already been trimmed.

ing from the surrounding forest almost every evening after sunset, to continue to feed when it was growing too dark in the woodland. Sometimes he was accompanied by another motmot, easily distinguished by the condition of its tail, who was apparently his mate. They had certain favorite low perches on which they rested while they looked for insects, which they caught on aerial sallies, or flew down into the grass to secure. Their eyesight was truly amazing; in the gathering dusk, they could detect and capture a small insect amid the grass 20 feet away. Often they did not return into the forest until it became too dark for us to see them clearly.

These motmots were far from shy. By setting our heavy, ground-glass-plate cameras on tripods and focusing them on the birds' habitual perches, with a thread attached to the trigger so that we could trip it from a distance, we obtained a series of photographs showing the progress of denudation of the central tail feathers. The motmots rested so quietly in one spot that a three-second exposure in the fading light often revealed no movement.

At the beginning of January, the motmot who was our most regular visitor had central tail feathers of unequal length (Fig. 1). The left was the longer of the two and appeared to be fully grown, but the shaft behind the terminal racquet had been denuded for only a short distance. The right central rectrix was about an inch shorter and had not been trimmed at all. By 7 January the full-grown left central rectrix appeared to have the shaft denuded for the usual distance. But when I last saw this bird, on 20 January, the right central rectrix, now nearly as long as the left, showed no sign of denudation.

On another Broad-bill that I saw about this time, the condition of the central tail feathers was just the reverse; the right one was longer, with the subterminal portion of the shaft denuded, whereas the left feather reached only a little way beyond the base of the racquet of the other and had uninterrupted vanes. In mid-January other Broad-bills had their tails completely trimmed, while on yet others the two central rectrices were apparently fully grown with no trace of denudation. From these observations, we may conclude that in this species the process of racquet-formation does not begin until, or some time after, the central tail feathers have stopped growing. On the other hand, in the Turquoise-browed Motmot, which has a much greater length of naked shaft, this is denuded of vanes while the central rectrices are no longer than the lateral ones and far from attaining their full length. In neither species have I actually witnessed the removal of the vanes.

#### COURTSHIP

On Barro Colorado Island, one morning in mid-January, I followed the calls of Broad-bills until I came in view of two of them resting, about six feet apart, on a branch somewhat below mid-height of the forest, apparently engaged in courtship. At short intervals, each uttered a deep *cwa cwa*, sometimes simultaneously, sometimes one following or answering the other, but neither obviously acting as leader. As they continued this monotonous conversation, they sat serenely still, as is their fashion. From time to time, one darted out to pluck an insect from a neighboring branch or twig and carry it to a different perch, after which they resumed their courtship, if such it was, in altered positions. Once the motmot with unequal central tail feathers, whom I took to be the male, snatched a beetle from a large limb and was knocking it resoundingly against his perch, when the other flew straight toward him, as though to claim the insect. But the male, far from gallantly presenting the food to the female, as I have seen the Turquoise-browed Motmot do, churlishly withheld it. Appearing to become angry, he repeated several times a loud *ca-a-wak*, *ca-a-wak* and switched his



FIG. 2. Nest site of the Broad-billed Motmot in a high bluff above the Río Puerto Viejo in the Caribbean lowlands of northern Costa Rica. The mouths of two burrows, occupied in successive years, are visible. Finca La Selva, May, 1968.

tail vehemently upward, while the other motmot, rebuffed, flew to another perch. Presently the monotonous *cwaa*-ing was resumed; but after about an hour the responses of the supposed female became less and less ready, until she ceased to reply, and soon thereafter departed. Thereupon, the male's calls became weaker, until he tired of uttering them unanswered and continued to perch in silence, motionless except for an occasional plunge after a passing insect. A stolid courtship, surely, but in keeping with the motmot's impassive nature!

#### NEST AND EGGS

At La Selva on 14 May 1967, I discovered my first burrow of the Broad-billed Motmot. In a high, wooded bluff rising steeply above the Río Puerto Viejo was a small bay or recess, about 20 yards across, evidently formed by a landslip long before, but now overgrown with ferns, palms, saplings, and small trees. At the head of this natural amphitheatre was the vertical bank of earth in which the burrow had been dug. It was screened by trees and vines from the broad expanse of the river, and behind was a great tract of heavy forest (Fig. 2). The exposed entrance to the burrow was  $3\frac{1}{2}$  feet below the top of the bank. The tunnel curved to the right, so that I could

not see to the end when I threw in the beam of a flashlight; but the motmot in charge of the eggs moved outward far enough to reveal its head and shoulders and stayed there gazing into the light. Since I could not examine the eggs without an excavation so extensive that it would have jeopardized the nest, I did not attempt to do so. When we left La Selva on 11 June, the parents were feeding nestlings in this burrow.

When next I visited this embayment of the bluff on 12 March of the following year, there was a new burrow about four yards from the old one, on a level with it. Although still unoccupied, parallel furrows along its bottom, made by the motmots' short legs as they shuffled in and out, showed that it had been recently entered. There was no pile of freshly dug earth below its mouth to show that it was newly excavated; perhaps, like Blue-diademed Motmots, Broad-bills dig in September or October the burrows in which they will nest in the following March or April. This new burrow ran straight into the bank, but the enlargement at its inner end was offset slightly to the left. Looking in at the front, I needed a mirror to see all of the eggs that were later laid, but much of the sitting bird was visible with no other aid than a flashlight. This burrow was 33 inches long. Near its mouth, it was 3 inches wide by  $2\frac{7}{8}$  inches high.

The third burrow was, like the first two, in the nearly vertical wall of a recess or indentation in a high bank above a stream, in this instance a small tributary of the Río Puerto Viejo. The landslide that had left this nick in the bank had also occurred years before, and it was now overgrown with vegetation. Several large clumps of plume-like fern fronds grew on the bank above the mouth of the burrow, which was 39 inches long and quite straight, so that a light was all that I needed to see what it contained. The bore of this tunnel was also wider than high,  $3\frac{1}{4}$  inches in horizontal diameter by  $2\frac{1}{4}$  in height.

The first burrow held an unknown number of eggs which hatched on 31 May 1967. Allowing three weeks for incubation (the period carefully determined for the Blue-throated Green Motmot), they were laid about 10 May. During the week following my first visit to the second burrow on 12 March of the following year, a twig set in its mouth showed that it was seldom entered, and no bird slept in it. Then followed three very rainy weeks, during which the bank became too soft and slippery to be safely climbed. When, after two dry days, I revisited the burrow on 13 April, it contained three eggs, their pure white shells already slightly soiled from contact with the earthen floor of the unlined nest chamber. As in other motmots, no soft material had been carried in to form a bed for them. These eggs hatched on 29 April, and accordingly had been laid about 8 April. The third nest was more advanced; it contained two nestlings with

sprouting pinfeathers when discovered on 30 April 1968. The eggs from which they hatched had been laid at the beginning of the month.

According to the few available records, in the Sarapiquí lowlands of northern Costa Rica Broad-billed Motmots dig, in vertical earthen banks partly screened by vegetation, straight or sometimes crooked burrows from 33 to 39 inches long. They do not use the same burrow in successive years. They lay, in April or early May, two or three white, unmarked eggs.

#### INCUBATION

Of the parents who attended the first burrow in 1967, one had an intact but somewhat worn tail, but the other, who passed the nights in the nest, had lost both racquets. In the following year, the motmots at the new burrow close by, evidently the same pair, showed the same differences: one had two good racquets, but the other, who slept in the burrow, had none; indeed, by the time the nestlings flew, it had only a short stub of a tail. Apparently the long hours it spent in the burrow in earth soaked by daily rains were deleterious to the tail feathers. To distinguish these motmots in our records, we called one "Racquets" and the other "Discless." probably the latter, who regularly attended the eggs and nestlings by night, was the female; but this is not certain, for in a number of cuckoos, woodpeckers, puffbirds, and other birds, the male takes charge of the nest through the night.

At the third nest, also, one parent had two whole racquets while the other had none, although its tail was otherwise in good shape, by no means so worn as that of Discless. I found this burrow too late to learn which parent occupied it by night, but the more frequent calling of the one with both racquets suggested that this was the male.

In sharp contrast to Blue-diademed Motmots, which when nesting in cultivated districts are sometimes so wary that they can hardly be watched even from a blind, these forest-dwelling Broad-bills were all amazingly fearless in our presence. Often they would enter their burrows while we stood at the edge of the bank directly above the doorway, our feet not two yards from their heads. Once, while I was looking into a burrow, a parent arriving with food almost bumped into me, then alighted so near that I came within an inch of touching it. Although their tolerance of an observer varied somewhat with the individual motmot and with time, in some cases decreasing if they had not been watched for a week or so, they would soon become reconciled to our presence. Sitting unconcealed only three or four yards from their burrows, we could watch these motmots carry on all their usual activities.

Both sexes incubate, as in other motmots. To learn the pattern of in-

cubation, we watched directly at the critical times of the change-overs, and set a little stick upright in the mouth of the burrow to indicate whether any bird had passed in or out during the long hours when no movement was expected. The least touch by a passing motmot would push over this small sentinel. The ease with which the two partners could be distinguished by their tails greatly facilitated our study. In 1968, when the burrow was straight, we could look in and see who was present, without disturbing the birds.

These motmots followed the same simple schedule as the Blue-diademed Motmots (Skutch, 1964). There were only two change-overs in each 24-hour period, at dawn and in the middle of the day. Discless incubated from around noon until the following dawn; Racquets, throughout the morning. Discless usually flew silently from the burrow before 05:00, when the loud calls of Broad-bills were sounding through the forest but the light of the approaching day was still so dim that I could hardly see her go. Sometimes I was apprised of her departure only by the swaying of the dusky foliage in front of the tunnel. The earliest hour at which I recorded her exit was before 04:40; the latest, 05:14. The eggs then remained unattended until Racquets arrived 16 to 45 minutes later, before sunrise, at times varying from 05:15 to 05:46.

After sitting for from five and three quarters to eight and three quarters hours, Racquets left the burrow at hours ranging from before 11:00 to 14:03; but on most days he emerged between 11:45 and 13:30. Sometimes he deserted the eggs before his relief arrived, and once they remained unattended for more than 130 minutes; but often he stayed at his post until his partner came. Sometimes, hearing her low croaking notes as she alighted on a slender leaning palm stem in front of the burrow, he would fly out before she entered, but on other days she entered first and he emerged a minute later.

The stick set in the mouth of the burrow after Discless went on duty nearly always remained upright until nightfall, and this was true even on the day when she entered before 11:15. But on 16 April, when Discless was found on the eggs at 12:10, she was absent at 17:10. A minute later she reentered while I stood above the burrow. This was the only time when the sentinel indicated a departure from the usual routine of one entry and one exit by each partner every 24 hours.

The foregoing paragraphs summarize observations made on 26 days at the nests of this pair in 1967 and 1968. Only minor differences were noticed in the two years. In 1967, when these birds incubated in May, the morning departure of Discless and the arrival of Racquets tended to be

earlier than in the following year, when they incubated in April and day dawned somewhat later.

When I looked into the straight burrow in 1968, I nearly always found the motmots sitting on their eggs with head inward and tail projecting straight outward into the entrance tunnel. Only in this orientation could they incubate without bending the tail against the wall of the chamber—at least in the case of Racquets, whose central rectrices were whole. Years earlier, I had found Turquoise-browed Motmots sitting on their eggs with their tails outward.

#### THE NESTLINGS

*Development.*—In the straight burrow where I could see the three eggs and nestlings, they hatched on 29 April 1968, and the empty shells promptly vanished. The newborn motmots were blind, pink, and devoid of down. The nestlings could already stand and move around, keeping their abdomen above the ground and supporting their weight on their heels which, as in other motmots, were doubtless protected by smooth callous pads, although I did not notice this detail in these nestlings beyond my reach. When they were a week old, their pinfeathers were pushing through the skin, which had become a darker pink. At nine days, some of the contour feathers were escaping from the ends of their long sheaths; and when 11 days old the motmots were partly feathered.

I still had not seen them with open eyes, but perhaps they closed them in the beam of the flashlight with which I viewed them. While I was looking into the burrow two days later, however, a parent arrived with food and called, whereupon one of the 13-day-old nestlings, after pushing another aside, ran down the tunnel toward the entrance, with open eyes. I stood aside, so that it could not see me, and the nestling came about two thirds of the way to the burrow's mouth. When I looked in again, necessarily with the light, it ran backward to join its nest-mates at the inner end. At 15 days, the young were taking their meals at the burrow's mouth, making it unnecessary for their parents to enter. When 16 days old, the nestlings were nearly covered with plumage. Nevertheless, they remained safely in their burrow for another eight or nine days.

When the 13-day-old nestlings heard the voice of an approaching parent, they trilled softly, and the parent answered with a throaty rattle. Thereafter, the young motmots became increasingly noisy; their trills, which grew louder and clearer, were often given even when no parent was near. On their last day in the nest, the choruses of trills were punctuated by loud, full, almost soprano notes such as I had never before heard from a Broad-billed Motmot.

*Brooding.*—On 1 June 1967, when the nestlings in the first burrow were a day or two old, Racquets entered the nest with food at 05:20 (about the time he did so while he incubated) and remained brooding for 138 minutes. After an interval of 22 minutes, Discless entered to feed and brood, and was still inside when I left 80 minutes later. On 5 June we watched from 05:25 until noon. Racquets fed the nestlings, but Discless was not seen. Unless she remained in the burrow all this time—which is unlikely—the five-day-old nestlings were not brooded on this wet morning. On the following afternoon, from 13:30 until 18:00, the naked nestlings were certainly not brooded, for both parents were bringing food and neither remained in the nest longer than was necessary to deliver it.

A pair of Blue-diademed Motmots did not brood their week-old nestlings in the course of a morning. Even nocturnal brooding was discontinued when the nestlings were about five days old. Evidently nestling motmots remain sufficiently warm in their deep burrows without a parental coverlet, and the early cessation of brooding reduces the risk that some predatory animal, blocking the only avenue of escape, will capture a parent along with its young.

*Feeding.*—The newly hatched nestlings were given small insects so thoroughly mashed that it was hardly possible to recognize their kind. But when only five or six days old the young motmots received objects as large as cicadas, that had doubtless been prepared by some beating against a branch but were only slightly mutilated. Thereafter, cicadas, which were abundant in the forest at this season, became a prominent item in the nestlings' diet. In a total of 19 hours of watching from 5 to 10 June 1967, when the nestlings in burrow 1, of unknown number, were five to ten days of age, they were fed 43 times, one object on each parental visit. These 43 meals included 20 cicadas, two green mantises, 15 other insects, one spider, one tiny frog, one small lizard, and three unrecognized objects.

On 23 May 1968, when the three nestlings in burrow 2 were about 24 days old, we watched throughout the day. The first feeding came at 05:10 and the last at 17:55. In this interval of 12¾ hours, 54 meals were taken to the burrow. These included 16 cicadas, four beetles, three caterpillars, two grasshoppers, one butterfly, one walking-stick insect, and two centipedes. Most of the remaining meals consisted of insects of undetermined kinds. The cicadas were brought chiefly during the middle of the day, when they were most active and noisy. Between 09:00 and 14:00, they accounted for half of the nestlings' meals. On this day, one young motmot left the burrow at 14:03, and thenceforth we could not see how often it was fed. During the nine hours when all three nestlings were within, they were fed 42 times, or at the rate of 1.6 meals per nestling per hour.

While watching these motmots carry cicadas to their nests, I was struck by the similarity of their broad, heavy bills to those of the Boat-billed Flycatchers (*Megarhynchus pitangua*), which also feed largely on cicadas in their season. Such bills appear well fitted to deal with these large, hard-bodied insects. However, White-fronted Nunbirds (*Monasa morphoeus*), whose bills have a quite different shape, also take many cicadas. And although in both years the motmots we called Racquets and Discless gave many cicadas to their young, the same was not true of other pairs of Broad-bills. On 30 April and 1 May 1968, I spent nine hours watching nest 3, which then contained two blind nestlings with sprouting pinfeathers. They were fed 39 times, or at the rate of 2.2 times per nestling per hour. Their meals included at least 31 insects, of which 1 was a dragonfly, 1 a damselfly, 1 a butterfly, 1 a beetle, and 3 were larvae. There were 2 spiders and 6 unrecognized items, but no cicada. Nine meals were brought between 07:00 and 08:00; eight between 10:00 and 11:00.

At this nest, the parent with a complete tail brought food 25 times and the other, whose discs were lacking, 14 times. At nest 1 in 1967, we saw Racquets bring food 25 times and Discless 18 times; but if we exclude the morning of 5 June, when Racquets brought food seven times and Discless was not seen, each parent fed the nestlings 18 times while we watched. During the first nine hours of 23 May 1968, Racquets brought food 19 times, Discless 23 times, to the three nestlings who were about to leave. The two sexes take nearly equal shares in feeding the young.

Arriving with food for their nestlings, the parent motmots usually alighted on a branch in front of the burrow and uttered low, throaty notes while twitching their tails sideways, as is their habit. Sometimes they beat against their perch the insect they held conspicuously in their bill, nearly always with wings still attached; but as a rule such preparation as the food received was done before they came into view. After more or less delay, with perhaps an advance to an intermediate perch, the parent darted into the burrow. Soon it shot out headfirst and flew away. When the nestlings were eight or nine days old, however, the parents began to emerge tail-first, after a visit lasting only a few seconds. Evidently the nestlings were now advancing part of the way up the tunnel to take their food, making it superfluous for the parents to go inward as far as the chamber, where alone they could comfortably turn around. During the second half of the nestling period, the young motmots trilled and purred when the parents came to feed them. On their last day or so in the burrow, they stood visibly in its mouth to take their meals, which they did the moment a parent alighted in front of them, to leave an instant later. Now the adults did not enter the burrow at all.

*Sanitation.*—The parents were not seen to carry any waste from the burrow. After they ceased to go in far enough to turn around when delivering meals, they probably never entered the brood chamber for the purpose of cleaning it. Soon the filthy floor swarmed with white maggots, which doubtless helped to break down the waste matter. Even before they were feathered, the nestlings, standing on their heels, could hold their bodies out of contact with the ground, so that at last they emerged with clean, fresh plumage.

*Departure.*—The first arrival of the stubby-tailed parent Discless with food for the feathered nestlings in burrow 2, in the dim light at 05:10 on 23 May, set off a chorus of loud, clear trills and duller churrs, mixed with which were full but soft, mellow notes such as I had never before heard from a Broad-billed Motmot. For the next hour the trilling and churring in the burrow continued with little interruption, finally to die away as the nestlings' hunger was satisfied. Throughout the day, the approach of a parent with food usually released a fresh outburst of churring, purring, or trilling, which varied in intensity and duration with the young motmots' appetite. As we could see when one stood in the burrow's mouth, their throats swelled out strongly as they produced these sounds.

The full mellow notes, heard increasingly as the day advanced, were most surprising. Usually they were delivered in pairs, sometimes three together. Even those of the same pair might differ in pitch and tone, so that sometimes they reminded me of the Chestnut-backed Antbird's rather plaintive whistles, sometimes of the Black-throated Trogon's subdued *cow cow cow*. We were to hear much of these soft notes from young who had left the burrow.

As the hours passed, the nestlings delayed more and more in the entrance, looking out, after taking food from their parents. After receiving a cicada at 14:03, the young motmot who had been resting in the doorway with its foreparts exposed suddenly took wing. It covered about 60 feet on a slightly descending course, to alight in the thick crotch of a riverside tree. The parent who had just fed it escorted it closely on its first flight. Resting in the fork, the fledgling preened its fresh plumage, which resembled that of the adults, except that its tail was very short, and it lacked the black patches on face and foreneck. Another nestling promptly stationed itself in the burrow's mouth.

After three more meals had been delivered to the young in the burrow, another took wing, at 15:45, two minutes after it was fed. It appeared to leave spontaneously rather than in obedience to parental urging. Flying obliquely upward for about 20 feet, it tried to alight on the tip of a palm frond, but finding itself unable to cling there, it reversed its course and

came to rest on the ground at the edge of the bank, just above its burrow. After remaining here for a quarter of an hour, it flew back into the forest beyond view.

The nestling still in the burrow continued from time to time to give the mellow call, and often it was answered by the one who emerged first. During the last hour of the day it received six meals, all from Racquets. Discless, who alone had been present when the first young departed, was evidently giving all her attention to the fledglings in the open, and we saw little of her.

After the departure of the second fledgling, the parents apparently divided the brood between them, as do numerous other birds. Next morning Racquets started to feed the nestling in the burrow at 05:20. By 06:30 this young motmot had received five winged insects and one larva. When the seventh meal was offered, the nestling, satiated, refused it. For ten minutes Racquets continued to hold this insect, instead of taking it to one of the fledglings whose trogon-like calls sounded plainly among the neighboring trees. Finally, Racquets swallowed what he had been holding and flew away. By 07:00, when I left, Discless had not been seen. Evidently she was wholly occupied with the two fledglings who had flown on the preceding afternoon.

By noon of that day the last young motmot had flown, leaving a dying cicada in the tunnel. The young had remained in the burrow for 24 or 25 days, an exceptionally short nestling period for a motmot. Turquoise-browed Motmots remain in the nest for 28 or more days; Blue-throated Green Motmots for 29 to 31 days; Blue-diademed Motmots for 29 to 32 days, and exceptionally as much as 38 days. During the day after the young Broad-bills first flew, their mellow calls sounded at intervals from the forest behind the burrow; but they perched so inconspicuously amid the foliage that I succeeded in glimpsing only one, who swung its short tail from side to side, just as the adults do with their long tails. It was alert, and flew off as I approached. After two or three days in the open, the young motmots became much quieter, and I rarely heard the soft calls which revealed that they were still nearby.

The stick that I set upright in the burrow's mouth after the last young Broad-bill flew bore testimony that it was not entered during the following week. As far as I know, none of the lowland motmots uses its burrow as a dormitory. But in the cool highlands, Blue-throated Green Motmots, who sleep in pairs in burrows throughout the year, may return at nightfall to that from which their brood has just flown, leaving their fledglings to roost outside on cold, rainy nights.

RUFIOUS MOTMOT (*Baryphthengus ruficapillus*)

The Central American race of this largest of the motmots attains a length of 17 to 20 inches and is sometimes known as the Great Rufous Motmot. Well over half its length, however, is accounted for by its long, racquet-tipped tail. Its head, neck all around, and most of the under parts are bright cinnamon-rufous or tawny-ochraceous, with a black band extending across the face from the lores to the ears and a small black patch in the center of the chest. The remaining upper plumage, the lower abdomen and under tail coverts, and the wings are green of varying shades, which on the primaries merges into greenish blue and violet-blue. The bluish green at the base of the tail gives way to greenish blue toward the end, and the central feathers are tipped with black. The rather narrow, coarsely serrated bill is black, and the eyes and feet are dark. Although northern forms with racquet-shaped central rectrices are now held to be conspecific with southern forms that have continuous webs on these feathers (and other important differences), they were formerly classified in distinct genera (*Urospatha* for the northern races, *Baryphthengus* for the southern)!<sup>1</sup> The surprising similarity in coloration of the Rufous and Broad-billed Motmots was discussed in our account of the latter.

The Rufous Motmot ranges from Nicaragua and Costa Rica (where it is confined to the Caribbean side) to southern Brazil, but it is absent from Venezuela and the Guianas in northeastern South America. Although in southern Brazil the species has been found nesting as high as 3,800 feet (Mitchell, 1957:116), in Central America it rarely occurs higher than 2,500 feet. Here, at the northern end of its range, its home is in the tall, wet, lowland forests, from which it may come forth into adjoining shady plantations, such as those of cacao and bananas, to hunt for food. In the forest it seems generally to remain high, where when silent it escapes detection, but it sometimes forages in the undergrowth, and may even pick food from the ground, especially when accompanying army ants. Mostly it is found alone or in pairs; but at La Selva, where this motmot was abundant, 13 gathered, before sunrise on a morning in late April, in a fringe of forest between the house and the river. They were highly excited, moved around and called much, but were not seen to fight. One held in its bill something green that was apparently a fragment of leaf, reminding me of the similar puzzling habit of the Blue-diademed Motmot in its courtship gatherings (Skutch, 1964:323-324). One of these 13 Rufous Motmots

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<sup>1</sup> Since this account was written, Wetmore (1968:448) has supported the specific distinctness of northern and southern forms. If considered distinct, the northern species should be called *Baryphthengus martii*.

lacked racquets on its tail. To see so many of these handsome birds together was a rare and memorable experience.

In the southern part of its range in Brazil, where it lacks racquets, the Rufous Motmot is not so closely restricted to the heavy forest as in the north, but it appears to be adapting itself to man and the changes he makes in the environment, as the Blue-diademed Motmot has done in Costa Rica and elsewhere. Mitchell (1957:115-117) found it nesting in a wooded part of the Parque da Cidade, Rio de Janeiro; and at a hotel on Mt. Itatiaia she "came upon a pair dust-bathing like a couple of old hens under a carport" which was "certainly not in deep woods."

#### FOOD

The Rufous Motmots' diet is varied, including large quantities of both vegetable and animal foods. On Barro Colorado Island, Chapman (1929: 47-48) watched them eating the yellow, plum-sized fruits of the nutmeg tree (*Virola panamensis*), which they plucked while fluttering on wing—although, as he remarked, there seemed to be no reason why these birds with fairly strong feet and bill should not gather the fruit while perching near it. At La Selva, I watched a Rufous Motmot devour, while perching, a number of the little orange fruits of a small palm. To their nestlings they carried fruits of various kinds, and also white objects that appeared to be seeds of *Inga* or *Protium*, enclosed in soft, sweetish, white coats. They eat many insects which they catch in the usual way of motmots, perching motionless until they sight their victim, then seizing it at the end of a sudden, swift sally. When foraging with army ants, as they frequently do, these motmots commonly perch somewhat more than head-high and pluck fugitive insects and other small creatures chiefly from foliage and trunks, but occasionally they descend briefly to the ground to capture them. Once, in a cacao plantation, I saw a motmot pick a large, pale red, cylindrical milliped from among fallen leaves. Still standing on the ground, the bird beat its prey until it broke, and swallowed it piecemeal. According to Wetmore (1968:446) this motmot eats caterpillars, wasps, spiders, lizards, small fish, small crabs, and large scorpions, as well as fruits.

#### VOICE

In the wet Caribbean forests of southern Central America, the hollow hooting of the Rufous Motmots is one of the characteristic dawn sounds. Until they have been traced to their source—which may take long—the deep, soft, scarcely birdlike notes create an atmosphere of unfathomable mystery. It is easy to imagine that the ghosts of the vanished aborigines are calling to each other through the dripping woodland. The notes come

in pairs or triplets—*hoo hoo*, or *hoo hoo hoo*—or sometimes four or more together. There are strong contrasts in pitch. One morning I heard three low *hoo*'s followed by three higher ones, then three distinctly lower. This series of nine notes was repeated several times; but in the feeble dawn light I could not learn whether a single motmot was hooting or a male and female were calling antiphonally, with voices contrasting in pitch. On another morning, while standing near a nest in the earliest dawn, I listened to two motmots, on opposite sides of me, calling alternately with phrases of two notes. I took this to be a mated pair answering each other: *hoo hoo*—*hoo hoo*—*hoo hoo*. . . If so, there was little difference in the voices of the two sexes. But soon a third motmot, farther to my left, joined in with similar notes and complicated the situation, so that I could reach no definite conclusion.

#### NESTING

While I watched the nest of the Broad-billed Motmots on the wooded bluff above the Río Puerto Viejo at La Selva, a pair of Rufous Motmots carrying food betrayed the location of a nest which otherwise I never should have found. About 50 feet from the Broad-bills' burrow was a small opening in the canopy made by the fall of a tree. Amid the clutter of trunks and branches below this opening was a cave-like den or burrow, that seemed to have been made by some middle-sized mammal. This cavity in the steeply sloping ground was roughly semicircular, about a yard wide and high; but the entrance was too narrow to admit my shoulders, and access to it was impeded by a large log lying in front. Illumination of the den by a flashlight beam failed to disclose just where the nest was. Probably the nestlings rested at the end of a long tunnel which the motmots had dug, beginning in the side of the little cave. Blue-diademed Motmots often choose a similar situation for their burrows, making them exceedingly difficult to find.

Early in the morning of 16 May, these Rufous Motmots were carrying fruits and white arillate seeds into the cave, but later in the day they brought chiefly well-mangled insects and other small invertebrates, always one at a time, held in the tip of their serrated bills. To enter the den, they alighted on the mound of excavated earth in front and hopped down the declivity until they had vanished underground. Soon they came hopping up the mound, from the top of which they took wing. These motmots and the Broad-bills nesting nearby never seemed to pay any attention to each other.

On the morning of 20 May, a Rufous Motmot carried a white seed into the den, only to emerge after a short interval still holding it. Then the bird swallowed the seed and flew away. Perhaps the young had just flown,

but I could not find them in the vicinity. Could they have succumbed—possibly drowned—during the heavy rains two days earlier?

My suspicion that some mishap had befallen the nestlings was strengthened when, on 6 June, the parents were discovered preparing to nest again in the same den, for motmots are not known to rear two broods in a season. The two sexes alternated in the task of digging a new tunnel from the side of the den or lengthening the old one—I could not learn which. Arriving with clean bills, they perched side by side on a low horizontal branch in front of the cave, into which presently one vanished. While it was underground, the mate on the branch tirelessly repeated a low *coot* at measured intervals. After a quarter of an hour, the digger reappeared, its black bill caked with brown earth. While they rested close together between spells of work, both kept up this sound, as I could assure myself by watching their throats swell slightly as each note was uttered, with closed bill. The muddy-billed bird returned for a shorter spell of work. After it emerged, the partner with a clean bill went underground, to reappear seven minutes later with its bill muddy, too. Then the first motmot went in for another turn at digging. While waiting in front of the den, the motmots preened their lovely plumage with their clay-encrusted bills, which to me seemed a stupid thing to do. After about 40 minutes, one of the pair flew away, and its mate soon followed. Neither would work unless the other were nearby.

These motmots worked at various times from the late morning to the early afternoon. As they descended into the cave from the mound of excavated earth in front, they kicked the loose earth backward with alternate strokes of their feet, just as motmots do when they enter a burrow that they are digging. Doubtless they continued this activity after they passed from view, thus gradually shifting outward the earth that they removed from their tunnel, and preventing the cave from filling up. Sometimes, too, a motmot emerged from a spell of work with a lump of clay in its bill, to drop it after perching. Probably only a minor portion of the excavated earth was removed in this second manner.

We did not remain at La Selva to learn the outcome of this second nesting of the Rufous Motmots in 1967; but in May of the following year, they were again incubating somewhere in the side of the same den in the bluff above the Río Puerto Viejo. Again they were close neighbors of the Broad-billed Motmots; but whereas in the former year their eggs hatched more than two weeks earlier than those of the Broad-bills, this year they hatched a whole month later. A few observations indicated that the incubation pattern of the Rufous Motmots was the same as that of the Blue-diademed and Broad-billed Motmots. One partner left the burrow at daybreak and

the other entered soon after, to remain until the middle of the day. There was a change-over in the early afternoon. Apparently the parent then entering remained uninterruptedly until the following dawn; but since the gaping mouth of the cave gave doubtful value to the use of little sticks to indicate whether a bird had passed in or out, we did not prove this. By 1 June these motmots were feeding nestlings in this cave.

In southeastern Brazil, Mitchell (1957:116) found Rufous Motmots nesting in burrows in bare perpendicular banks, where they were more easily detected than was our nest in the side of a den that obviously had not been dug by the motmots themselves. This may or may not be another racial difference between Rufous Motmots at opposite extremes of their vast range, for in Costa Rica Blue-diademed Motmots dig their burrows either in exposed banks or from the side of a pit or animal burrow, although they seem to prefer these more secluded sites. Two occupied nests of the Brazilian Rufous Motmots were only 75 feet apart.

#### SUMMARY

An inhabitant of warm, humid forests, the Broad-billed Motmot rarely ascends to more than 3,000 feet above sea level. It is usually seen alone, perching well up in the trees.

Its diet consists of insects and their larvae, including many cicadas and a few butterflies and dragonflies, supplemented by spiders, centipedes, small frogs, and lizards. It was never seen to take fruit.

The motmot's call is a loud, wooden note, devoid of timbre. At daybreak, the hoarse croaks are among the earliest bird notes. Except in March and April, when the motmots appear to be courting, they are rarely heard after sunrise. Courtship appears to consist of interminable calling by the male and answering by the female.

In a free bird in the Panamá Canal Zone, the denudation of the shafts of the central tail feathers was followed and photographed.

In the lowlands of northern Costa Rica, these motmots nest in April, May, and June. Three burrows, in high, vertical banks partly screened by vegetation, were 33 to 39 inches long, and either quite straight or slightly curved. No lining was brought. One nest contained three plain white eggs and another two nestlings.

These motmots incubate according to the same simple schedule that the Blue-diademed Motmot follows. One parent, evidently the female, enters the burrow around midday and sits continuously until the following dawn. After an interval of 16 to 45 minutes, the other parent enters before sunrise and remains until midday, sitting for 5¾ to 8¾ hours continuously. Often, but not invariably, he waits to be relieved by his mate. The motmots incubate with head inward and long tail projecting back into the entrance tube, where alone there is room for it without bending. Nevertheless, the partner who sat through the night had, in two consecutive years, a badly damaged tail.

The nestlings, which hatch blind and perfectly naked, were fairly well feathered at 16 days. The two parents took about equal shares in feeding them, bringing a single item in the bill on each visit. Three feathered nestlings were fed 42 times in 9 hours.

No waste was removed from the burrow, which soon swarmed with maggots.

The young left spontaneously at the age of 24 or 25 days, an exceptionally short nestling period for a motmot. However, they could fly well. Shortly before they emerged from the earth, they began to utter soft, mellow notes, much like the calls of certain trogons and antbirds, but wholly different from anything heard from younger nestlings or from adults. These surprising utterances continued for some days after their departure.

Neither the parents nor the fledglings returned to sleep in the burrow after the latter left.

At the northern end of its range in Central America, the Rufous Motmot is restricted to humid lowland forests and adjacent shady plantations, chiefly below 2,500 feet. It generally remains high in the trees and is usually seen alone, but one gathering of 13 excited motmots was watched before sunrise in April.

Its diet includes both fruits and small invertebrates, with an admixture of small vertebrates, all of which are usually seized on a sudden swift sally. It often forages with army ants, when it catches fugitive insects and other small creatures from low elevations or even from the ground.

The call, a hollow, ghostly *hoo hoo hoo*, uttered in contrasting pitches, is one of the characteristic dawn sounds of the lowland forests.

In May, a pair of these motmots were discovered carrying food into a cave-like den or burrow, apparently dug by some middle-sized mammal, in a steep, wooded bank above a river. The nestlings, which could not be seen, were evidently at the end of a tunnel that the motmots had dug from the side of the semicircular cavern. These nestlings were given both fruits and insects, in contrast to the diet of a neighboring brood of Broad-billed Motmots, which consisted of only animal food.

The outcome of this nesting is unknown, but in early June the Rufous Motmots were again entering the cave to dig. The male and female took turns at the work and emerged from the earth with muddy bills. Most of the earth appeared to be removed by kicking backward as the birds entered the ground, but sometimes they emerged holding a lump of clay in their bills.

In May of the following year, Rufous Motmots were again nesting in a burrow dug from the side of this den, and by 1 June they were feeding nestlings here.

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EL QUIZARRÁ, SAN ISIDRO DEL GENERAL, COSTA RICA, 15 MARCH 1970.

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#### NEW LIFE MEMBER

A recent addition to the list of Life Members of the Wilson Ornithological Society is Dr. George A. Clark, Jr. Dr. Clark is a graduate of Amherst College and Yale University and is currently Associate Professor of Biology at the University of Connecticut. He has published a number of scientific papers on birds, including one on pages 66-73 of this issue of *The Bulletin*, and his interests spread over a wide area of anatomical and behavioral subjects. He is a member of the A.O.U., Cooper Society, American Society of Naturalists, Society for the Study of Evolution, A.A.A.S., Ecological Society of America, and numerous other scientific organizations.

