

Undoubtedly there are innumerable ways in which the young of birds and mammals are instructed and educated in the art of survival, and the rôle which instruction plays in this process probably increases with the higher forms of life and the greater progressive development of intelligence, culminating in man. In the reverse direction, with more primitive forms, parental care is minimized, until it is non-existent, and inherited instinct alone can account for the protective actions of the offspring. Parental responsibility and the development of the brain and higher functions of intelligence appear to be closely related. It might be said in closing, that the greater the need for this responsibility and training, the greater the penalties for failure, as witnessed by the antisocial behavior of neglected children. Inherited instincts remain a powerful and compelling force in man, but without deliberate control and training, beginning in infancy, these instincts, instead of serving to protect against danger, to perpetuate the race, and to encourage strong individual efforts directed towards the attainment of well rounded character, become the dominant force which results in the destruction of the individual and immeasurable harm to all who are associated with him.

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LIFE HISTORY OF THE TURQUOISE-BROWED MOTMOT

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Plate 9

DURING my early years in Central America, few birds so attracted and delighted me as the motmots. The first species in this beautiful family whose nest-life I studied was the Turquoise-browed Motmot (*Eumomota superciliosa*) of which I found two occupied burrows (of the race *euroaustriis*) in the Lancetilla Valley near Tela, Honduras, in 1930, and two more (of the race *sylvestris*) near Los Amates in the Motagua Valley of Guatemala, in 1932. The following year, 1933, I was able to work out the life history of the Blue-throated Green Motmot (*Aspatha gularis*) in the high mountains of Guatemala, and in publishing I gave precedence to this more mature and thorough study (*Auk*, 62: 489-517, 1945). In the present paper I wish to make amends for the neglect of an earlier love, and to place on record what I was able to discover of the habits of a member of

the family that dwells in the lowlands, and is probably more typical than the green motmot of the high mountains.

The Turquoise-browed Motmot ranges through the lowlands from southern México to northwestern Costa Rica. On the whole, the species prefers more or less arid, open country such as prevails along the Pacific coast from the Gulf of Nicoya northward into México, but on the Caribbean side of Central America is met chiefly in mountain-rimmed valleys in northwestern Honduras and adjacent parts of Guatemala, and on the Yucatán Peninsula. I found Turquoise-browed Motmots exceedingly abundant in the arid portion of the Motagua Valley of Guatemala between Zacapa and Progreso. Here they live in a semi-desert, among cacti, prickly pears, and low, thorny, scattered trees, and along with the Chestnut-headed Motmots (*Momotus castaneiceps*) are among the most abundant and conspicuous of the feathered inhabitants of the region. The sandy walls of barrancas and the rises of the terraces on the barren hillsides are penetrated by innumerable nesting burrows, most of which appear to have been made by these two species of motmots. But farther down the Motagua Valley, where rainfall and humidity are high and the vegetation as lush and heavy as I have seen it anywhere in tropical America, Turquoise-browed Motmots are also abundant, although they appear to be somewhat less numerous than in the arid country. The same is true of the humid and naturally heavily forested Caribbean littoral of Honduras. In these regions of high rainfall our motmot dwells only in the cleared lands and the lighter and more recent second-growth, especially where the sandy banks of rivers furnish sites for its nesting burrows. I have never met the bird within the heavy rain forest. It seems likely that the Turquoise-browed Motmot has invaded the clearings in the rain forest from its headquarters in neighboring arid regions, but it has dwelt in the humid districts long enough for local races to have developed.

APPEARANCE

It is a paradox that one of the loveliest of birds is hatched and reared in a fowl hole in a bank, and emerges at length with its wonderful feathers all undefiled. It is still more strange that the Turquoise-browed Motmot should find its colors in the earth, for they are not brightly glittering like gems and other earth products, but as soft and delicately blended as the rainbow and the sky at sunset. Central America has numerous birds more brightly colored—many orioles, tanagers, trogons, jacamars and hummingbirds are far more brilliant—but the subdued beauty of the motmot is of a distinct and

perhaps a higher order. While these others might be painted in enamels, only pastels could do justice to the plumage of the motmot. Its brightest color is the broad band of turquoise above each eye, margined below by a black line extending from the base of the strong black bill to the ear. Behind each eye is a triangular patch of chestnut. The body plumage is olive-green and chestnut, delicately blended; and the bird's throat bears in its center a conspicuous, short, black streak, bordered on either side with blue. The wing-coverts are olive-green and the remiges blue, broadly tipped with black. But the feature of the motmots which most attracts our attention is the tail. The two central feathers extend far beyond the lateral ones and their shafts are without vanes for a considerable length. At the end of each naked stalk is a roundish disk of vane, blue tipped with black. The Turquoise-browed Motmot is at once distinguished from the Chestnut-headed Motmot and the Blue-dialedomed Motmot (*Momotus momota*) with which it associates, by the much greater length of the denuded portion of the shaft, which imparts to its tail an airy grace that the others lack. Male and female are indistinguishable in plumage, and both alike trim their tail feathers.

The elegance of the motmots' plumage is fully matched by the grace of the birds' bearing and movements. They are of a rather sluggish disposition and sit long and motionless in one spot, often in a willow tree overhanging a stream, where with a pair of good binoculars one can admire at his leisure their varied plumage. They are by no means conspicuous against a background of foliage, and on dull days it is often difficult to distinguish them until at length they move. As they perch quietly as though sunk in meditation, they at intervals turn their heads from side to side, or swing their racquet-shaped tail feathers slowly from one side to the other, like a pendulum which has almost lost its impulse. The motmots' movements, following a long period of inactivity, come with a suddenness and rapidity which take the watcher by surprise and make them difficult to follow. It is amusing to witness the bird's quick 'about face' when perching on a twig. Its long tail is whisked up and over the perch with a graceful twitch such as a flag-bearer would use in handling his banner to prevent its furling on its pole. The motmots' flight is rapid and undulatory, but rarely continued for long distances.

FOOD

Because of its sedentary habits, the Guatemalans sometimes call the motmot *pájaro bobo* or 'stupid bird'; but too often a placid dis-

position is mistaken for dullness. As they perch in seeming abstraction, the motmots keep their eyes open for suitable food, upon which they dart with astonishing swiftness. They subsist upon insects of many kinds, including beetles, caterpillars and butterflies, and upon spiders, lizards and worms. They make a swift sally, without alighting pluck their prey from the foliage upon which it is crawling, and return in a trice to their original perch, against which they beat out its life before they swallow it. The loud, regular clacking of the heavy bill striking against the limb may often be heard when the motmot is out of sight in the thicket. Motmots have very keen eyesight and can discern a green larva against a background of green foliage at a surprising distance. At times they sally forth to catch an insect passing on the wing, in the manner of a flycatcher. Along with jacamars, they are among the few birds that pay much attention to the larger and more showy butterflies.

VOICE

In northern Central America, motmots in general are sometimes known by the name *toro voz* (bull-voice), which fits this species even better than the others. Although usually silent birds, in the mating season, which begins in March, Turquoise-browed Motmots frequently call *cawak cawak*, almost invariably twice in succession, or sometimes a single long-drawn *cawaaalk*, in a deep, throaty voice, as though they talked with a full mouth. In the scrubby thickets male and female call with their thick, lusterless voices, perch motionless side by side on the same branch, and at intervals fly down to examine the bare banks where they will soon dig their burrows.

EXCAVATION OF THE BURROW

Where there are sufficient sites for the burrows, each pair of Turquoise-browed Motmots prefers to nest in solitude; but where banks are rare in the midst of territory otherwise favorable to them, a number may dig their burrows close together. I recall a railroad cut in the midst of a large area of scrubby second-growth, poor in nest-sites, where seven pairs of motmots excavated their tunnels within a few yards of each other, despite oft-repeated interruptions by the passage of numerous pedestrians and an occasional train.

The Tela River, emerging from the deep shadows of the magnificent primeval forest which covers the precipitous mountain slopes among which it is born, flows for four or five miles through a flat and narrow valley to the Caribbean Sea. The bottom lands of the valley were once covered by banana plantations, but were abandoned

because of the ravages of disease and grew up with tangled, impenetrable, low thickets. Here lived many Turquoise-browed Motmots, which never ventured into the dark forests on the mountain slopes surrounding their valley home. As we rode on an open motorcar along the light tramline that led up the valley, we would sometimes, on rounding a curve, surprise a motmot perching on the telephone wire that paralleled the track. With a swift downward dart it would vanish into the dense thicket. At the end of April, 1930, I found a motmots' burrow in a low, sandy bank, beside a delightful reach of the stream, where the clear waters flowed over a clean, sandy bottom between willows and riverwood trees (*Pithecolobium* sp.). The owners of the burrow sat motionless in the willows for seemingly interminable periods. Once the one I took to be the male flew up beside his mate and solemnly gave her a morsel, all without a sound or any display; and on another occasion one of the pair drove off a Kiskadee (*Pitangus sulphuratus*) which had dropped down to forage on the river bank below the burrow.

The motmots no longer dug at the tunnel, which made it seem likely that egg-laying had begun; and since I was eager to follow all the details of the nesting, I promptly set about to uncover the nest-chamber. I dug into the soft, sandy loam with my hands, not daring to use a shovel for fear of breaking the eggs, and at length made an opening in the side of the treasure house, where four pure white eggs lay on the bare earth in the obscurity of the burrow. This was my very first motmots' burrow; and in my inexperience of nests of this kind I completely uncovered the chamber, then fitted it with a glass ceiling darkened and protected by a wooden lid, exactly as I arranged a burrow of the Amazon Kingfishers (*Chloroceryle amazona*) that I opened the following day. But the motmots' eggs were fresh, while the kingfishers had newly hatched young in their nest; hence the former promptly deserted, while the latter clung tenaciously to their offspring.

I was not altogether sorry that the motmots deserted their burrow, for three days after I had opened it they set about to dig a new one in the same bank, only a few feet away from the first. It is often more interesting to watch birds construct a replacement nest, which they are in a hurry to finish, than their first nest, which in the Tropics they may start long before it is needed and continue with exasperating slowness. One of the pair of motmots clung repeatedly to the bank at the point where the new tunnel was to begin; then they both set to work with such zeal that they drove their shaft hori-

zontally into the light soil for a distance of twenty inches in a little over a day. I constructed a blind of the leafy boughs of the river-wood tree, at a spot where I could command both their favorite perch—a dead branch of a willow tree—and the bank in which they dug. Here I spent many hours watching the pair at work.

Both male and female labored in the burrow, but it was soon apparent to me that they did not share equally in the task. There was no difference in plumage to betray the sex of either; but one occasionally brought an offering of a spider or an insect to the other, and since with most kinds of birds it is the male which feeds his mate, I called the food-giver the male. By a disarranged feather, or a dust spot on the plumage, I could distinguish the twain for short periods, despite changes in position. The supposed female did by far the greater part of the work, and was rewarded only rarely by her mate's offerings of food. Flying down to the entrance, she paused there a minute, then went in, throwing out a shower of sand, or to be more exact, two parallel, intermittent jets, as she kicked vigorously backward with her feet, alternately. This stream of sand shortened and eventually fell short of the entrance as the bird moved inward, but was probably continued until she reached the head of the excavation, with the result that each time she entered, some of the earth which had been loosened on previous visits was moved gradually toward the outside. She remained in the burrow for periods varying from one or two to eighteen minutes, and always backed out of the tunnel, tail first.

Upon emerging, the female motmot usually flew up to perch beside her mate in the willow tree. After lingering beside her a few minutes, he in turn flew to the tunnel. Sometimes he entered, throwing out earth as he went in, just as the female did, and came out tail foremost after from one to four minutes. It was impossible to see what he did while hidden in the bank, but I believe that we must give him credit for working. But on other occasions, after the supposed female had taken her place beside him, he dropped down to the entrance of the tunnel, alighted there, then returned almost at once to the willow-tree perch. Once he gave his mate a caterpillar, then flew to a point on the bank near the mouth of the burrow, where he clung a moment and then returned to his perch. As soon as he regained his post beside the female, she entered the tunnel and worked for five minutes. It certainly seemed that by his offerings and his visits to the tunnel he was trying to suggest that the female should return to her task.

At other times the motmot which I took to be the male paused in the entrance of the burrow, scratched a little with his feet, looked around at his mate, scratched out a little more earth, looked around again, and finally flew back to perch beside her, without having done any real work. Upon his return, the female usually went to the tunnel and continued with the excavation. Such behavior strengthened my impression that the male motmot was coaxing his mate to increase her exertions, and with a fair degree of success. On the second afternoon of my vigil, the female emerged after eighteen minutes in the tunnel and went to the willow tree to preen her feathers. Her mate now flew to the bank, to which he clung for a few minutes, then moved over to the entrance, where he alternately scratched and pecked with his bill at the sand, at intervals looking around at the female, who appeared to pay no attention to him. Rested at length from her former exertions, she flew to the burrow and the male made way for her, but instead of entering, she went at once to perch on a weed near by. Again the male returned to the entrance and repeated his former wiles, scratching and pecking as before. At last the female seemed to take heed of him, entered the burrow, and worked seven minutes more. While she toiled, the male sometimes stood in the mouth of the burrow, and sometimes pretended to dig with his bill at an adjacent portion of the river bank.

The first afternoon on which I watched, the pair worked until five o'clock, and drove their tunnel fifteen inches farther into the bank. The following day they again worked until five o'clock and added another fifteen inches to the length of their burrow. I did not watch them on the next day; but by the following morning they regularly emerged from the burrow head first, indicating that they had begun to widen the nest-chamber at the far end and could already turn around in it. The tunnel was now five feet two inches in length, and had been dug in somewhat less than five days. The diggers' plumage was still remarkably fresh, and appeared to have suffered little from their strenuous labors underground. Some people have a knack of keeping themselves neat and clean, no matter at what task they are engaged, and birds possess this innate tidiness to a high degree.

I decided, the following day, to make another excavation of my own, and with an assistant dug a vertical shaft from the surface of the ground behind the bank. This was situated so that it just touched the side of the enlargement at the end of the motmots' tunnel, into which we made an opening barely large enough to permit us to feel

inside with a hand. This aperture we carefully closed with a board, and felt confident that the birds would not resent so slight an interference with their work, while now it would be possible to learn when the eggs were laid. The nest-chamber had not yet reached its final dimensions, and in continuing their excavations the birds were evidently annoyed by the board, for they promptly abandoned their work. The *pájaro bobos* were not so obtuse as their name implies! Three days later I found that this pair had started a third burrow, midway between the two which they had deserted as a result of my interference, and lower in the bank. Before they finished this, I had successfully uncovered the eggs of another pair much nearer my residence, and I decided to allow these much persecuted motmots to complete their nesting without further molestation from me.

Sometimes the Turquoise-browed Motmots display considerable adaptability in digging their burrows; at other times they are quite lacking in foresight. Along the Río Morjá—a tributary of the Motagua—I found a burrow which had been excavated in a low bank beneath a cane brake. The bank was composed almost entirely of coarse gravel, into which the birds could not possibly have dug, overlaid by a shallow stratum of sandy soil only four inches deep where it was exposed. The motmots began their tunnel at the bottom of this sandy layer, of necessity nearer the top of the bank than any other burrow I ever found. Fortunately for them, the workable layer became deeper as they followed it inward from the bank; and they inclined their tunnel downward, with the result that the nest-chamber at its end was a foot below the surface, about the usual depth for burrows in low river banks. It is not probable that the birds could have foreseen the dip of the layer of sandy soil, yet they were sufficiently adaptable to take advantage of it when they discovered how it went, whereas most motmots extend their tunnels in a more nearly horizontal direction.

Another pair, less clever, began their excavation only ten inches below the top of the river bank, from the edge of which the ground sloped downward on the landward side. When they had nearly completed their tunneling they suddenly found themselves digging into the light and air—two surprised and disappointed motmots! They lost no time in beginning a second burrow near by; but it was now nearly the end of May and late for their nesting. Evidently the female motmot's need to lay her eggs became so pressing that there was not time to finish the work in the regular manner, for the pair widened the nest-chamber when the burrow was still only forty inches

long, and still so straight that with an electric torch I could see to its end.

The burrows of the Turquoise-browed Motmots closely resemble those of their neighbors, the Amazon Kingfishers, but are distinguishable by their slightly inferior diameter. Six that I measured were, respectively, 40, 51, 55, 55.5, 60 and 61.5 inches (102, 130, 140, 141, 152 and 156 centimeters) in length; but in Baja Verapaz, Guatemala, Owen (*in* Salvin and Godman, *Biologia Centrali Americana*, Aves, 2: 465) found burrows up to eight feet (244 centimeters) long. Most burrows curve gently to the right or the left, and it is impossible from the entrance to look into the nest-chamber at the far end. This enlargement at the end of the tunnel is 8 or 9 inches (20 to 23 centimeters) wide and about 4 inches (10 centimeters) from floor to ceiling at the center. Here the eggs are laid on the bare ground, and here the nestlings remain until able to fly. At the entrance the tunnel is about 3.5 inches (9 centimeters) in width by 3 to 4 inches (7.5 to 10 centimeters) in height. It is easy to distinguish occupied from deserted burrows. In the former the bottom is marked by two deep, parallel, longitudinal ruts or furrows, made by the feet of the motmots as they shuffle in and out. When the burrow is no longer in use the ruts become indistinct, and cobwebs are usually stretched across the tunnel. When the motmots have finished using their burrows, Rough-winged Swallows (*Stelgidopteryx ruficollis*) often build their nests in them. Now the bottom of the tunnel is marked by innumerable fine scratches instead of the two parallel furrows.

THE EGGS

My earliest date for the eggs of the Turquoise-browed Motmot is April 22, 1932. These eggs were in a burrow in the bank of the Río Morjá, a tributary of the Río Motagua, near Los Amates, Guatemala, and appeared to have been newly laid when the burrow was opened on this date. Another set of eggs, also apparently freshly laid, was uncovered in the same locality on May 1, 1932. Near Tela, Honduras, I found a set of eggs on May 5, 1930, and a second set, far advanced in incubation, on May 19. The earliest of these four sets consisted of three eggs, the other three sets of four eggs each. Owen states that in Baja Verapaz the set of the Turquoise-browed Motmot consists usually of four eggs. The eggs are pure white when newly laid, short-ovate, and resemble those of kingfishers. The fifteen eggs in the four sets mentioned above averaged 26.5 by 22.5 millimeters. Those showing the four extremes were 27.8 by 23.0, 24.6 by 22.2, and 26.2 by 21.8 millimeters.

INCUBATION

Male and female alternate in incubation, sitting an hour or more at a stretch. When one of the pair wishes to relieve its mate, it perches above the entrance of the burrow and calls in a low voice for the other to come out. In my experience, the motmots are more easily driven from their burrows than the kingfishers (*Chloroceryle amazona*, *C. americana* and *Ceryle torquata*) that inhabit the same region, and desert their eggs with less provocation. As they sit in the burrow they regurgitate the shards of beetles and the other indigestible portions of their food, until at length a considerable mass of this material accumulates on the floor of the nest-chamber and forms a bed beneath the eggs.

The curvature of the longer tunnels made it impossible to see the motmots as they sat upon their eggs, but the unusually short burrow already mentioned was sufficiently straight to permit a view of the lovely birds as they incubated. I went by night to visit this nest in the bank of the Río Morjá, passing through a silent grove of tall banana plants, whose polished stems glinted in the beam of my electric torch. Emerging at length on the river bank, I frightened up a Boat-billed Heron, which rose into the air and flew downstream uttering a weird *quok, quok, quok, quok, co-wa-ee*. On the sandbar on the farther shore, a raccoon feeding at the water's edge looked into the flashlight's beam with two brilliant orbs, then turned and walked deliberately away. Approaching cautiously along the sandy shore at the foot of the low bank, I threw the beam into the motmots' burrow, and beheld a creature which was strange to me. Some gray furry animal, bearing a large chestnut mark in the middle of its back, had stolen into the burrow, devoured the motmot and her eggs, and now slumbered curled up in her place. But no! There was turquoise on the animal's head and blue on its sides; it must surely be the motmot safe and sleeping peacefully on her eggs, but so transformed in the yellow light of the electric torch that I did not at once recognize her. Her back and all the regions which by day are a soft green appeared yellowish-gray, for they were compounded of colors inadequately represented in the rays from the incandescent filament. The bird's soft, loose plumage was fluffed out and looked very much like fur. But the blue on the wings, and especially the turquoise band on the brow, shone with such a bright and radiant luster (as though it were some hard and glittering porcelain, rather than the softness of feathers, which bore them) that I switched off the light, more than half expecting to find them self-luminous—but all remained dark in the burrow.

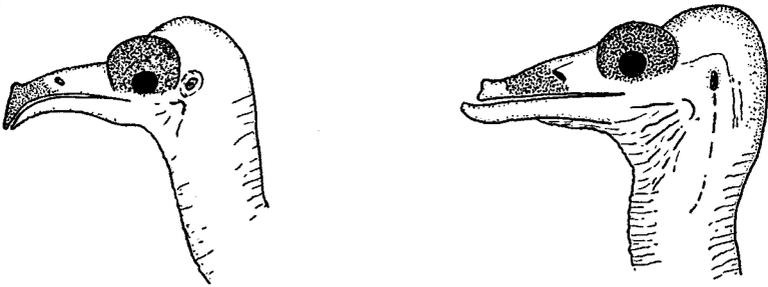
The motmot's tail ran forward into the tunnel, and the blue-and-black racquets rested so far behind the remainder of the bird that they appeared not to be connected with her, but rather to be isolated discs of feather caught up in the ceiling. I returned several times, and always found the motmots incubating with head inward and the tail running outward into the tunnel, where alone it found ample space without becoming bent. This was the secret of how the birds preserved their long racquet-feathers clean and unbroken during the course of incubation.

Of the length of the incubation period, I can only state that it is seventeen days or somewhat more. Once I opened a burrow which contained three eggs so fresh that the yolk shone through the thin, white shell, and no blood vessels were visible when they were held up to the light. After seventeen days they hatched. The incubation period of the Blue-throated Green Motmot is 21 days.

THE NESTLINGS

The first burrow of the Turquoise-browed Motmots which I succeeded in opening without causing desertion was situated in a low bank beside the narrow-gauge tramline which ran along the Lantilla Valley in Honduras. As I dug down behind the nest-chamber, the owners perched in a tree across the tracks and uttered low, guttural notes of complaint, but otherwise showed no excitement nor made any demonstration. Making a small opening at the back of the nest-chamber, I found four partially incubated eggs lying among the beetle shards on the bottom. Then I closed with a board the aperture I had made, and filled in the pit with earth. Happily the motmots accepted my alterations and continued to incubate.

Eight days later, on May 27, I first noticed that the eggs were pipped. For more than twenty-four hours the little motmots tapped at their white prison walls, at times peeping weakly, before at last they broke through and effected their release. The parents now become bolder, and instead of deserting their burrow when I removed the board at the rear, merely retreated into the entrance tunnel where they voiced low, frightened grunts. The four pink-skinned, blind nestlings were without a trace of down or feathers, and bore considerable resemblance to the equally ugly new-born kingfishers. The most conspicuous difference between the two was in their bills. The upper mandible of the newly hatched motmot is somewhat longer than the lower and strongly hooked at the tip (Text-fig. 1), whereas the young kingfisher's upper mandible is straight and shorter than the lower. The nestlings peeped in a weak, hoarse voice, could



TEXT-FIGURE 1. Profile of Turquoise-browed Motmot (left) and Ringed Kingfisher (right); each one day old.

already stand and, sensitive to light although they were sightless, retreated into the tunnel when their nursery was opened at the rear.

To study the care of the nestlings, I constructed a little wigwam of coconut fronds on the side of the tramline opposite the burrow. Seated within this green retreat, I could watch the motmots without being seen by them. Both parents fed the nestlings, bringing food of the most varied sorts, including moths, large, brilliantly colored butterflies, small green mantises, green caterpillars, many insects too small to be identified as the birds held them in their bills, and small lizards up to six inches in length. The prey was, in most instances, dead by the time the parents arrived with it in the tree where they rested in front of their burrow, but if it still struggled, they knocked it vigorously against the perch until it became motionless before taking it to their offspring. Before a lizard was fed to the young, the reptile's head was apparently pecked or bitten off by the parents inside the burrow, and the viscera and soft parts pressed out through the neck. On several occasions I later found the empty skin lying almost entire on the floor of the nest-chamber. Rates of feeding varied greatly from day to day. When a week old, the four nestlings were given food ten times during 105 minutes. On the preceding morning they were fed only five times in two hours.

Although, while watching them, I was well hidden in my little wigwam of palm leaves, the parent motmots displayed the utmost caution in visiting the burrow. They never made a direct approach, but upon flying out of the thicket where they hunted, came first to perch in a small tree on the opposite side of the tramline, where they rested while surveying the surroundings with great deliberation. Advancing from this point, they sometimes delayed again on a banana leaf close above the entrance of the burrow; and many minutes were

lost between the first appearance of the parent with food and its final delivery to the nestlings. Often the two flew up together with food and perched in the low tree across the tramline. Here one lingered, sometimes uttering a low *wha wha*, while its mate entered the tunnel. When at length the latter came out tail first, as was almost invariably the way when they fed the nestlings, it flew up beside the waiting partner, which now in turn carried its offering to the hungry young. Sometimes one member of the pair, holding food in its bill, procrastinated in front of the burrow while the other came and went, feeding the nestlings several times in the interval. Thus one morning a motmot brought a lizard and delayed before delivering it to the young, holding the reptile for twenty-five minutes during which the mate fed the nestlings three times. Sometimes the parent delayed so long, holding food evidently brought for its progeny, that at last it grew hungry and swallowed the morsel itself, then flew away to hunt more.

At the age of a week the nestlings' eyes began to open, and the sheaths of the body feathers to push through the skin. When the burrow was opened at the rear, the youngsters retreated down the tunnel more quickly than at first, but could be driven back into the nest-chamber by throwing the beam of an electric torch into the entrance of the burrow. At the age of twelve days, the young motmots bristled with the long pin feathers, from the ends of which the true plumage was just beginning to burst. When they were twenty days old, we removed the youngsters from the burrow for another photograph, not without some difficulty in extracting one from its retreat in the tunnel, beyond reach from either end. The nestlings, now well feathered, screamed and attempted to bite when handled. The nest was becoming disgustingly foul and swarmed with maggots, for motmots devote as little attention to the sanitation of their burrow as the related kingfishers; and it was necessary to wash the bills and feet of the little birds to make them presentable for their portraits. Their docility, as they perched in a row on a stick, was in marked contrast to the restlessness of Amazon Kingfishers at the same age. Already they seemed to be acquiring a taste for a life devoted largely to motionless contemplation.

At the age of twenty-five days, when we removed the young motmots from their burrow for a final photograph, they resembled their parents in coloration and were very beautiful. We marvelled that such loveliness could have come into being amid such foul surroundings. Their contour feathers had long, pliant, free barbs, making

the plumage remarkably soft and downy. We noticed that both mandibles of the broad, heavy, black bill were finely serrated along the terminal third of their length, enabling the birds to hold their food the more securely; and that, like flycatchers, goatsuckers, and other birds which catch insects on the wing, they were provided with long, stiff bristles at the base of the bill. Their two outer toes were joined together for the greater part of their length, and only a single toe was turned backward, as with their relatives the kingfishers.

One of the twenty-five-day-old motmots, when removed from the burrow, slipped from our hands and flew into the dense thicket behind the nest, where it could not be recovered. The remaining three were posed for a photograph, but two escaped and covered about thirty feet with strong, direct flight. They came to rest on a perch at the edge of a thicket, slowly swayed their short tails from side to side in the manner of their elders, and made indescribable throaty noises which bore a recognizable resemblance to the calls of their parents. With difficulty we caught them and returned one to the burrow, which it left, apparently spontaneously, three days later, when twenty-eight or twenty-nine days old. Later, along the Río Morjá, I studied another burrow containing three nestlings. One of these slipped through my hands and flew too well to be retrieved when twenty-five days old; the other two departed from the nest when between twenty-five and twenty-seven days of age. Unfortunately, all of these young motmots had been handled; if quite undisturbed they would probably have lingered in the burrow a few days longer.

We kept two of the fledglings from the former nest in order to follow their subsequent development, and especially to watch the process of denuding the shafts of the central tail feathers. But when I beheld through the meshes of a cage a bird I had hitherto known only wild and free, I was overcome with remorse for what I had done. If I reared these birds as dull and spiritless captives, motmots could never be the same to me as they had been. I decided to return the twain to their parents, if it was not too late, and to take my chances as a field naturalist of seeing motmots trim their tail feathers in their natural environment. I carried the fledglings back to the vicinity of their burrow, where they heard the loud *cawak cawak* of their parents, and answered with weaker voices, higher in pitch. They flew from my opened hands into the thicket, whither their two nestmates had preceded them; and the parents led the united family farther into the impenetrable tangle. What I might have lost in knowledge I gained in inward satisfaction; for the motmots' nesting

had ended as I like every nesting over which I watch to end, with the parents leading their brood off to the feeding ground.

The years have sped by, and still I have failed to surprise a motmot trimming its tail feathers. In the dry limestone country of Yucatán, Turquoise-browed Motmots are said by Gaumer (Trans. Kansas Acad. Sci., 8: 63-66. 1881-1882) to nest and pass much of their time in caverns and crevices of the porous rocks and in the chambered walls of wells, in the seclusion of which alone they operate upon their tails. The districts in which I have known the species are devoid of such subterranean retreats, yet the motmots seem equally careful not to alter their tail feathers in public. I have never seen a Turquoise-browed Motmot with a fully grown central tail feather which did not have its shaft denuded. In early July, I found a young motmot, which was still attended by its parents, and whose central tail feathers projected only an inch beyond the others; yet the shafts were already naked for a short distance above the terminal racquets. On another occasion, at the beginning of the breeding season, I saw an adult motmot, evidently just through the molt, whose central tail feathers did not project at all beyond the lateral ones, yet the shafts were already denuded. The bare shafts were not evident against the solid background of the other feathers, and it was only when the wind blew the tail sideways, or by examining the bird through binoculars at close range, that I could distinguish them.

With other kinds of motmots, the central tail feathers are nearly or quite full grown before the vanes are removed from the sub-terminal portion of the shaft. This is true of the Lesser Broad-billed Motmot (*Electron platyrhynchum minor*). On Barro Colorado Island, in Gatún Lake in the Panamá Canal Zone, this motmot is abundant; and here in January, 1930, I encountered an individual with both of its central tail feathers of the same length and apparently full-grown, yet with the shafts everywhere bordered by the vanes. The vanes are originally narrower about an inch from the end than elsewhere, so that the feathers are somewhat racquet-shaped even before the birds begin to trim them. Several other Broad-billed Motmots which I saw at this time had the two central tail feathers of unequal lengths, and then the shaft of the longer, alone, had a denuded portion. Sometimes it was the right feather, sometimes the left, which was longer and had the naked shaft. One motmot appeared almost every evening, just about sunset, at the edge of the clearing in which the laboratory stood, and announced its arrival with a full, deep-toned *cwaa, cwaa*. One of its central tail feathers was apparently

full-grown, but the shaft had been cleared for a very short distance behind the terminal knob, while the other feather was about an inch shorter and still entire. The bird had two or three favorite perches to which he returned at each visit; and by focusing our cameras on these, Dr. Frank M. Chapman and I were able to obtain its portrait on a number of occasions. These showed that the naked portion of the shaft of the longer tail feather was gradually extended to the customary length, although the bird never worked at it in our presence. But when I left the island, more than three weeks after I first saw this motmot with a short length of naked shaft on one tail feather, it had not yet begun to trim the second, now nearly equal to the first in length.

SUMMARY

1. The nest-life of the Turquoise-browed Motmot (*Eumomota superciliosa*) was studied in northern Honduras in 1930 and in the humid lower Motagua Valley of Guatemala in 1932.

2. The motmots' food is almost entirely animal and includes beetles, caterpillars, butterflies, spiders, small lizards and worms. The prey is snatched from the vegetation at the end of a sudden swift dart, or else caught in the air.

3. Late in March the mated pairs begin to dig burrows in the vertical banks of rivers, sides of railroad cuts, and similar situations. Male and female share the task of excavation, but with one pair the bird supposed to be the female did most of the work. The mate fed her from time to time, and seemed to coax her to increase her efforts whenever she rested too long. A replacement burrow was dug in about five days.

4. Completed burrows go into the bank horizontally for about three to eight feet. Usually they curve slightly to one side or the other. At the inner end they widen into a low chamber where the eggs are laid upon the bare ground, for motmots' nests are never lined.

5. The full set consists of four, or less often three, pure white eggs laid in April or May.

6. Incubation is performed by both parents and continues for seventeen days or more. The motmot sits on the eggs facing inward, its long tail extending outward along the entrance tunnel, where alone it can find room without being bent.

7. The newly hatched motmots are completely naked and have tightly closed eyes. At the age of twelve days the nestlings bristle with long pin feathers, from which the true feathers are just beginning to escape. When twenty days old they are well feathered, and



TURQUOISE-BROWED MOTMOT, TWENTY-SIX DAYS OLD.

closely resemble the adults in coloration. They remain in the burrow for twenty-eight days or more, not leaving until they can fly well.

8. Both parents feed the nestlings, bringing them a variety of insects and an occasional lizard. No effort is made to clean the nest, which soon becomes filthy and malodorous. Yet the young emerge with their beautiful plumage unsoiled.

9. The subterminal portion of the central tail feathers of both juvenile and adult birds is denuded of the vanes while these feathers are still no longer than the lateral ones.

10. Observations are given on the process of denudation of the shafts of the central tail feathers of the Lesser Broad-billed Motmot (*Electron platyrhynchum minor*). In this species, denudation does not begin until the feathers are nearly or quite full-grown.

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LOWERY ON TRANS-GULF MIGRATIONS

BY GEORGE G. WILLIAMS

A COUPLE of years ago I wrote a brief article (1945) saying that all available evidence pointed to the existence of major spring migration routes around the sides of the Gulf of Mexico, and that no good evidence for trans-Gulf migration in spring existed. Mr. George H. Lowery, Jr. (1946) has replied with a long article defending the traditional belief in trans-Gulf migration. His article is important enough to deserve the most careful analysis. The present paper, therefore, making no pretense to originality, devotes itself entirely to an examination of Lowery's contribution.

His article contains a wealth of new and valuable material which will be mentioned in due course. It contains also a wealth of errors. These belong to six principal types: lengthy straw-man arguments about admitted matter, misinterpretation of other observers' data, misinterpretation of original data, misinterpretation of my first article, cardinal omissions, and a tendency to formulate large general laws on the basis of a minute amount of fact. This last type of error pervades the whole article; the other five will be considered here in the order named.

I. ARGUMENT ON ADMITTED MATTER

1. Lowery continually implies that anyone's doubts about trans-Gulf migrations must rise from doubts as to the migrants' ability to