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LIFE HISTORY OF THE AMAZON KINGFISHER

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In contrast to the large and varied assemblage of kingfishers in the Old World, only six species representing two genera occur in the Western Hemisphere. The Amazon Kingfisher (*Chloroceryle amazona*) is the largest of the four species which comprise its genus, and in the New World it is exceeded in size only by the two species of *Ceryle*. It is a stout bird about 11 inches in length, with a big, crested head and a short tail. The upper plumage of the male is deep metallic bronze-green, with a broad white collar across the hindneck and some white spots on the tail. The under plumage is largely white, varied by a broad zone of rufous-chestnut across the lower foreneck and chest. The female is similar but lacks chestnut on the underparts; the white of her breast is invaded by intrusions of green from the sides, which sometimes approach or even meet in the center. The Amazon Kingfisher agrees with the other four members of the family which breed in tropical America in the exclusive possession of chestnut, or the possession of a more extensive area of this color, by the male. It differs strikingly from the migratory Belted Kingfisher (*Ceryle alcyon*), in which only the female wears chestnut. The long, stout bill of the Amazon Kingfisher is black, the eyes are brown, and the short legs and feet are black.

This attractive kingfisher is distributed across continental tropical and subtropical America from southern México to Argentina, but it is absent from the Antilles. It prefers the broad, quiet, open waterways, although it establishes itself along broken, rushing mountain torrents if they are rather wide and contain scattered deep pools. Hence it is largely an inhabitant of the lowlands, where the rivers flow broad and deep and there are many winding lagoons. There are few records of its occurrence above 3000 feet; but along the Río San Juan at Aguacatán, in the Department of Huehuetenango, Guatemala, I encountered a single individual at 5700 feet above sea level, on November 13, 1934. The smaller Green Kingfisher (*Chloroceryle americana*), which hunts along narrow, rocky brooks, often in the depth of the forest, where the Amazon Kingfisher is never found, extends higher into the mountains and ranges farther to the north. I have seen it at 7000 feet in Guatemala, and Carriker (1910:493) records its presence at the same altitude in Costa Rica.

Like the other tropical American kingfishers, the Amazon Kingfisher never flocks and it is usually seen singly except in the breeding season. It is not unlikely, however, that male and female stay together on their territory throughout the year.

FOOD

The Amazon Kingfisher appears to subsist exclusively on fish as long as it can procure them. Sometimes it plunges directly into a stream from its perch on an overhanging bough, but at other times it hovers on vibrating wings while it sights the prey in the water beneath. So rapidly do its wings beat while it poises in mid-air that, to one standing directly in front or behind, its body seems to be suspended between two misty spheres. Suddenly the wings close, the hazy circles vanish, the kingfisher plunges swiftly downward, head foremost and breaks the surface with a splash; often it wholly submerges itself in the water. If the plunge has been successful, it promptly emerges with

the fish in its strong bill, flies to some convenient perch by the shore, shakes the drops from its plumage, and proceeds to beat the prey against the branch until its struggles cease, when it is swallowed head first. Although skilled in the art of fishing, this kingfisher misses more fish than it catches, and it is only because the bird will not be discouraged by repeated failures that it finally procures a meal. Often it waits long and patiently for a minnow to appear in a suitable position only to have the prospective victim dart away as it plunges toward it; the bird then planes off before striking the water and with a loud *kleck kleck kleck* returns to a perch for another attempt. Often, too, this kingfisher disappears beneath the surface only to re-appear with an empty bill. Once I watched an adult male make four unsuccessful plunges in succession in a stream which abounded in minnows.

Frequently while sitting on the bank of some clear, swiftly flowing, tropical river, I have watched the little silvery-scaled minnows gleam and flash in the current. As each at intervals turned on its side there was a bright, momentary gleam of silver, which vanished as soon as the fish righted itself and became almost invisible against the sandy bottom with which it blended so well. Are these the telltale gleams for which the kingfisher waits as it perches motionless on a streamside bough or hangs between two hazy circles of beating wings? If so, it must indeed be alert, for the gleam of silver from the minnow's side vanishes quickly. Sometimes the male kingfisher fishes in the dusk, well after sunset, and then, especially, the reflection of light from the scales of the minnows as they turn on their sides must be an aid to him. This late supper puzzled me until I learned how the sexes arrange their periods on the nest while they incubate (see p. 222).

VOICE

In addition to the hard rattles and reiterated sharp *kleck's* typical of its tribe, the Amazon Kingfisher possesses a very different utterance, which is apparently what Hudson (1920:14) referred to as "*warbling* long clear notes, somewhat flutelike in quality." This is a pleasing performance, consisting of a clear "singing" note repeated at first in ascending pitch and with increasing tempo, until at last it falls rapidly in both pitch and speed. The kingfishers sometimes deliver this refrain as a greeting to their mates, and they may also utter it when alarmed by a threat to their young.

THE BURROW

In Central America, the Amazon Kingfishers breed in the drier part of the year, when there is less danger of low burrows in river banks becoming inundated or washed out by a sudden rise of the current. At this time the earth around the brood chamber is drier and more readily absorbs the nestlings' excreta, and the clear water favors fishing, which seems to become most difficult in the swollen, turbid current of periods of heavy rain. On our farm in El General, Costa Rica, 2500 feet above sea level, these kingfishers incubate in February and feed nestlings in March, the two months when the swiftly flowing mountain streams are lowest. Late broods are still fed in the burrow in April, when light rains have returned and the streams are slowly increasing in volume. In the Caribbean lowlands of Honduras and Guatemala, where I discovered four burrows in 1930 and 1932, digging began in February if not earlier, and one pair had nestlings a few days old by March 23. A replacement brood, however, did not hatch until early June, after the streams had become swollen and turbid.

All the burrows that I have seen were in river banks, with water flowing beneath or close in front of their doorways. In rocky banks where digging is difficult, the kingfishers may use the same tunnel for more than one year. Thus along the Río Peña Blanca in front of our house, in a high bank composed of rounded water-worn boulders and

pebbles of all sizes, closely packed together with the interspaces filled with blackish sandy loam, a burrow dug into one of the few available pockets of soil was occupied for nesting in three consecutive years, 1943, 1944, and 1945. In 1946 this pair of kingfishers bred in a new burrow about ten feet downstream from their old one. These tunnels were too crooked to see what they contained by looking in at the mouth, and they were too deeply embedded in the rocks to be opened. It is surprising that the kingfishers suc-



Fig. 1. Tela River in the Caribbean lowlands of Honduras, habitat of the Amazon Kingfisher.

ceeded in digging such long tunnels in this ground which is so full of closely compacted boulders and small stones that we find difficulty in making a hole big enough for setting a post or planting a small fruit tree.

More favorable for study were the burrows I found in the low, sandy banks of lowland streams in northern Central America. Here, where digging was relatively easy, and where the tunnels in the friable soil probably did not often last through the wet season, kingfishers of several kinds appeared to excavate fresh burrows each year. Those of the Amazon Kingfisher which I saw were situated from 17 to 38 inches below the tops of the vertical banks which they selected. A burrow beside the Río Morjá, a tributary of the Río Motagua in Guatemala, was already 3 feet long when found on February 22, 1932. By February 29 it was 3 feet 8½ inches in length, and by March 9 it measured 4 feet 10 inches, after which it ceased to lengthen. The excavation was accordingly

extended 22 inches in 16 days, or at the rate of 1.4 inches per day. If the kingfishers worked at the same speed from the beginning, they must have started their burrow in late January and spread their leisurely task over five or six weeks. After the tunnel ceased to lengthen, I made a small opening at the inner end and closed it with a board so that I could look in daily and record the laying of the eggs. The kingfishers then continued for a few days to enlarge the chamber at the end of the tunnel, but finally they abandoned their work and dug another burrow upstream. The latter, as is usual with replacement nests, progressed far more rapidly than the first and eggs were laid in it about the beginning of April. The abandoned tunnel was promptly claimed by Rough-winged Swallows (*Stelgidopteryx ruficollis*).

Although I spent a good many hours in sight of the earlier of these burrows beside the Río Morjá, the kingfishers worked at it in such a desultory fashion that I did not witness any serious digging. Both male and female entered for periods of one to three minutes, suggesting that they shared the labor of excavating, as was plainly evident in the case of a neighboring pair of Ringed Kingfishers (*Ceryle torquata*), who dug far more actively in my presence. While they are preparing to nest, the male Amazon Kingfisher sometimes gives his partner a fish, as I have seen on two occasions, on April 4, 1932, in Guatemala and on February 18, 1946, in Costa Rica. When the female flies up and alights beside her perching mate, or if he settles beside her, he raises his wings above his back and holds them so for a few seconds as a sign of greeting.

In length and diameter, the burrows of the Amazon Kingfisher are intermediate between those of the smaller Green Kingfisher and the larger Ringed Kingfisher, which are often dug in the same banks. Four burrows which I measured were, respectively, 47, 56, 58, and 63.5 inches in length. All curved gradually to the right or left, so that it was impossible to see into the nest chamber when looking in at the entrance with a flashlight. The burrows also slope slightly upward, so that the space where the eggs lie is higher than the entrance, a provision that helps to keep the chamber dry. The enlargement at the inner end of the burrow was in one instance 10 inches wide, about 18 inches long, and $6\frac{1}{2}$ inches high at the center. Although the mouth of this burrow was 17 inches below the top of the bank, the ceiling of the chamber was about 12 inches below the surface of the ground, hence it was easily reached by digging down from above. The tunnel which led to this chamber was $3\frac{3}{4}$ inches wide by $3\frac{1}{4}$ inches high. In an occupied nest, the tunnel has two well-marked parallel grooves made by the legs of the kingfishers as they shuffle in and out. Each side is also scored by a rather deep groove made by the bills of the birds while they excavate. When deserted burrows are occupied by Rough-winged Swallows, a multitude of fine, irregular scratches replace the parallel grooves made by the original owners. Neither Amazon, Green, nor Ringed kingfishers take any lining into their nest. They lay their eggs on the earthen floor, which soon becomes covered by a hard pavement composed of scales and bones of fish regurgitated by the incubating birds and pressed into the ground by their feet.

THE EGGS

Three burrows, which I opened in Guatemala and Honduras, each contained four eggs or naked nestlings. From one of these burrows the contents disappeared as the eggs were hatching, and about three weeks later the female completed a replacement set of three eggs. Two of these eggs had already been laid when I discovered that the burrow was again in use, hence I could not learn the interval which separated the laying of successive eggs. In Trinidad, Belcher and Smooker (1936:794) found a set of four eggs in a burrow only three feet long.

The eggs of the Amazon Kingfisher are short ovate and pure white, or sometimes

slightly tinged with buff. The dimensions of seven eggs, all laid by the same female in Guatemala, average 31.5 by 27.1 mm. Those showing the four extremes measured 32.1 by 27.8, 30.2 by 27.0, and 31.4 by 26.6 mm.

INCUBATION

I studied the mode of incubation of this kingfisher at a nest beside the Río Morjá which contained four eggs within a few days of hatching. At 5:10 p.m. on April 18, 1932, I set a twig upright in the mouth of the burrow in such a manner that no kingfisher could enter or leave without pushing it over. When I arrived at 6:20 next morning, this marker told me that a bird had passed; probably it was the female arriving to begin her long night session. At a little before seven o'clock the male arrived and called. At 7:00 a.m. the female emerged from the burrow and flew upstream, and immediately afterward her partner entered. At 10:23 a.m. she returned, perched near the burrow, and called *keck keck*. Two minutes later the male, who had been inside continuously for well over three hours, flew out and went downstream, calling in his "singing" voice, whereupon the female promptly entered the burrow. At 11:00 I went off, leaving a twig standing upright in the doorway, but when I returned at 1:08 p.m. it was lying flat and I knew that some movement had taken place. At 2:17 p.m. the female left the burrow. Since it was she who had entered the burrow at 10:25 a.m., there had apparently been two change-overs while I was away visiting other nests, and the male had taken a turn on the eggs in the interval. Evidently the female now left because she heard her mate's voice, for he flew up as soon as he saw her emerge and at 2:22 p.m. he entered. At 5:48 p.m. the female returned and alighted in a tree leaning over the river near the nest, but after 19 minutes she flew downstream. Seven minutes later she returned, perched on a banana leaf near the burrow, and called *ket ket* in a low voice at measured intervals. This seemed to be the signal that she was ready to take over the nest, for the male at once emerged and flew downstream, at 6:14. After flying back and forth several times before the entrance, she went in at 6:18. I watched until it was dark, but she remained in the burrow.

When I returned at 5:54 the next morning, the upright twig assured me that no kingfisher had entered or left the burrow since the female had taken over the nest on the preceding evening. At 6:15 the male arrived in the perching tree. After waiting there for 12 minutes he flew down the river, but at 6:40 he returned. After another delay of 12 minutes he dropped down, poised a moment in front of the burrow, called a single *ket*, and in about half a minute his mate darted out. After flying back and forth several times before the doorway, he entered at 6:55. Setting up the sentinel twig, I hurried off to visit some other nests, hoping to be back before the male kingfisher ended his session. But when I returned at 9:20 a.m. I was disappointed to find that the twig had been pushed over. A kingfisher whose sex I could not determine was perching near the burrow, and when I opened the chamber I found the eggs still warm. Evidently the male had just come off the nest and my arrival had prevented the female's entry. I promptly waded the stream to my observation post on the opposite low shore. Although the female approached several times as though to enter the burrow, she did not go in, and the eggs remained unattended until the male returned at 11:40. Then there was no movement at the burrow until 5:43 p.m., when as the sun was setting the female arrived from downstream and called *keck keck* from a hidden perch. Two minutes later the male emerged after an uninterrupted session on the eggs of six hours and five minutes. The female entered for the night at 5:51 p.m.

Thus the Amazon Kingfisher's pattern of incubation differs greatly from that of the Ringed Kingfisher. In the latter, each sex is responsible for the nest for alternate periods

of 24 hours, so that the male sits through one night and the female through the next. The single daily change-over takes place in the morning between seven and ten o'clock, and thenceforth the oncoming partner is solely responsible for the eggs until the next morning. The Ringed Kingfisher breaks its long period of duty by a single outing in the afternoon, when for from half an hour to an hour the nest is unattended. But the female Amazon Kingfisher sat through consecutive nights, and it is fair to assume that she did so every night, for with this pair the cycle repeated itself every 24 hours, not every 48 hours as in the Ringed Kingfisher. On April 19 the male Amazon Kingfisher incubated for at least 7 hours and 17 minutes, including a morning session of 3 hours and 25 minutes and an afternoon session of 3 hours and 52 minutes. On April 20 the male incubated a total of about 8.5 hours, including his long afternoon session of 6 hours and 5 minutes. The female's desire to incubate by day was weak and when disturbed as she was about to return, she stayed away a long while and omitted her session entirely.

While the Ringed Kingfishers that I watched entered the burrow before the sitting partner came out, the Amazon Kingfisher announced, by calling *ket ket* or *keck keck* in a low voice at measured intervals, that it had arrived to take charge of the eggs. Although this sound was not loud, it seemed to reach the mate at the end of the burrow, who emerged almost at once. In its pattern of incubation, the Amazon Kingfisher resembles the congeneric Green Kingfisher. At a nest of this smaller kingfisher, the longest diurnal session that I timed lasted 3 hours and 33 minutes and was taken by the female. Sessions from 1½ to 3 hours in length were commonly taken by both sexes. In the Half-collared Kingfisher (*Alcedo semitorquata*) male and female also alternated on the eggs, sitting from one to two hours at a stretch and keeping them almost constantly covered. Because of the similarity of the sexes, it was not possible to learn which took charge of the nest through the night in this species (Moreau, 1944).

After studying the Amazon Kingfishers' mode of incubation, I understood why the male sometimes fishes in the dusk, after other diurnal birds have retired to roost. His mate relieves him from incubation late in the evening, and after fasting all afternoon he doubtless requires several fish to satisfy his hunger.

Like other members of their family, Amazon Kingfishers are strongly attached to their nests and remain at their posts in spite of danger. This was very evident at the burrows which I had prepared for study by making a small opening at the rear of the chamber, which after each visit was closed by a stone and covered with earth tightly packed. At first, when the stone was removed and light suddenly appeared at the wrong end of the burrow, the parent would fly out the front entrance, *klecking* wildly. After a few days it only retreated into the tunnel, where it stayed until the chamber was again closed. Toward the end of the period of incubation, however, it sometimes remained with the eggs and permitted me to touch it gently. But the kingfishers never, at any stage of the nesting, simulated injury nor made hostile demonstrations when I visited the burrow. Such displays could be of little value to a bird that nests in a burrow, for they are not likely to attract the attention of a predator with its head in the mouth of the tunnel or when digging a hole above the nest chamber. Moreover, the water which flows in front of most of the burrows is not a favorable stage for the act of "feigning injury."

The single burrow which I prepared for observation before the eggs were laid was deserted, and it was only through a fortunate accident that I was able to learn the length of the incubation period. At a neighboring burrow, apparently made by the pair of kingfishers which had abandoned the first burrow, I made a small opening at the back of the chamber a few days before the four eggs were pipped. The eggs or nestlings disappeared at about the time of hatching; I never saw the latter, nor can I guess what befell them. But I continued to look into this burrow from time to time, expecting it to be

occupied by the Rough-winged Swallows, which had been waiting for the kingfishers and motmots along this stream to leave their burrows so that they might begin their own belated nesting. Great was my surprise when, 19 days after the eggs of the ill-fated first brood had begun hatching, I looked into this burrow to find that the kingfishers had slightly lengthened and deepened their old nest chamber and that the female had already laid two eggs in it. On the following day, May 14, the third and last egg of this replacement set was laid. All three of these eggs were pipped at 9:00 a.m. on June 3. One had hatched by 10:30 a.m. on June 4, and at 9:30 a.m. on June 5 there were three nestlings. Thus the incubation period was 22 days. This may be compared with the period of 23 or 24 days of the Belted Kingfisher (Bent, 1940:115) and that of 19 to 21 days of the far smaller European Kingfisher, *Alcedo alcedo* (Kendeigh, 1952:224). It is also close to the incubation periods of the related motmots, which in the case of the Blue-throated Green Motmot (*Aspatha gularis*) is 21 days.

THE NESTLINGS

The method of emergence from the shell of kingfishers and motmots is different from that of other small birds I have observed. It is the rule, I think, for the chick of most species to hammer at a small area of the shell until a break is made. The chick then rotates slowly in the egg in such a manner that the head, bent under a wing, moves backward, and the rhythmic upward thrusts of the bill continually bring the hard egg-tooth in contact with the edge of the lengthening hole. The result is that the large end of the shell is cut off along a line transverse to the long axis. When this line of separation has lengthened sufficiently, the struggles of the imprisoned bird break off a symmetrical cap, and the nestling wriggles forth. But in kingfishers and motmots the chick moves its head in such a fashion as to crack the shell in a number of points scattered irregularly over an entire quadrant between the greatest circumference and the thicker end of the egg. The cap which is finally pushed off is markedly assymetrical and is separated from the body of the shell by an oblique rather than a transverse line. Young kingfishers take between one and two days to emerge from the shell.

To follow the development of the young, let us return to my first nest, which early in May, 1930, I found in a low, sandy bank of the Tela River in northern Honduras. To explore the interior of the burrow I dug down to the nest chamber from the level ground. After I had removed a little earth, the female kingfisher, disturbed by the noise above her, darted out from the front of the tunnel and uttered a little rattle by way of protest as she flew down the river. Her voice was not raised above the tone she ordinarily used when cruising above the stream. The Chipsacheery Flycatchers (*Myiozetetes similis*), who were feeding three newly hatched nestlings in their domed nest among the branches of a dead tree that had fallen into the river in front of the burrow, were far more troubled by my activities than the kingfisher herself.

After removing a few more shovelfuls of earth, I broke through into the burrow. The widening aperture revealed four, naked, squirming nestlings, who barely escaped the rain of loosened sand that I vainly tried to stem. They had apparently just hatched, and two of the empty shells lay on the floor of the chamber beside them. Not the slightest trace of down shaded their pink, peculiarly transparent skin. They could not by any standard be called pretty, least of all when viewed in profile. Two black knobs, extending above the forehead, indicated the points where their sightless eyes were buried beneath the skin. They were decidedly prognathous, the lower mandible projecting about two millimeters beyond the upper. They could already stand upright and even walk unsteadily, supporting themselves on the abdomen and the entire tarsus. Their heels were covered with a thick pad of skin roughened by numerous small tubercles, which served

to protect them from abrasion through the long days when the young groped around on the sandy floor of their dark nursery. They uttered a little, high-pitched, buzzing or sizzling sound when I touched them.

After carefully uncovering the nest chamber, I roofed it with a pane of glass, above which I fitted a wooden lid to exclude the light. The excavation was further concealed with boards laid across at ground level and covered with leaves and litter. Only because it is almost impossible to make kingfishers abandon their young did this pair continue to brood and feed them in their elaborately modified nest. The far simpler procedure of making a small opening at the rear of the chamber and closing it with a stone is the only one which the birds are likely to tolerate before their eggs have hatched. Also, this method exposes the nest to less risk of discovery by predatory animals and prying men.



Fig. 2. Nestling Amazon Kingfisher nine days old; near Tela, Honduras, May 15, 1930.

However, this mode of opening the burrow has the disadvantage that, when the stone at the back is removed and light suddenly enters the aperture, the young kingfishers, even when newly hatched and with tightly closed eyes, retreat forward into the tunnel, where it is difficult if not impossible to reach them. When the entire chamber is uncovered, it is far easier to catch the nestlings before they can escape into the tunnel. Sometimes, when I lifted the lid over the kingfishers' nest, I found one of the parents brooding the nestlings, and it flew up against the glass before retreating toward the mouth of the burrow. Never until I had this close view from above did I appreciate how intensely green their upper plumage is.

The two parents shared nearly equally in the care of their progeny. As far as I could determine, they brought them nothing but fish, which were delivered and apparently swallowed whole. They showed a nice discrimination in adjusting the size of the minnows to the capacity of their nestlings. When the latter were only a few days old, the parents brought minnows so small and slender that, when carried lengthwise, they were almost concealed by the bill. Such small fish were also carried athwart the bill. The parents gradually increased the average size of the minnows until, when the nestlings were feathered, they brought many which were longer than their bills and quite thick. These large fish were always carried lengthwise of the bill, with the head pointing inward. If I happened to be in sight when a parent arrived with food, it delayed on some branch overhanging the stream, repeatedly elevating its head and tail simultaneously with a jerky motion, as though the two were attached together by a hinge as in some mechanical toy and could not move independently. Each time its head and tail went up the kingfisher uttered a sort of nasal click.

When the nestlings were about five days old, their eyes began to open, and the black rudiments of the feather sheaths were visible through their transparent skin. Two days later their eyes were fully open. They were at least 11 days old before the upper mandible approached the lower in length. At the age of 12 or 13 days their body feathers began to escape from the horny sheaths, which had grown very long. Now for the first time they tried to bite when I picked them up. When about 19 days old they were well clothed with plumage and even had rather prominent crests. They had wholly outgrown their ugliness, and they had already acquired the parental habit of jerking up the head and tail simultaneously as they stood on the ground. I believed that I could distinguish

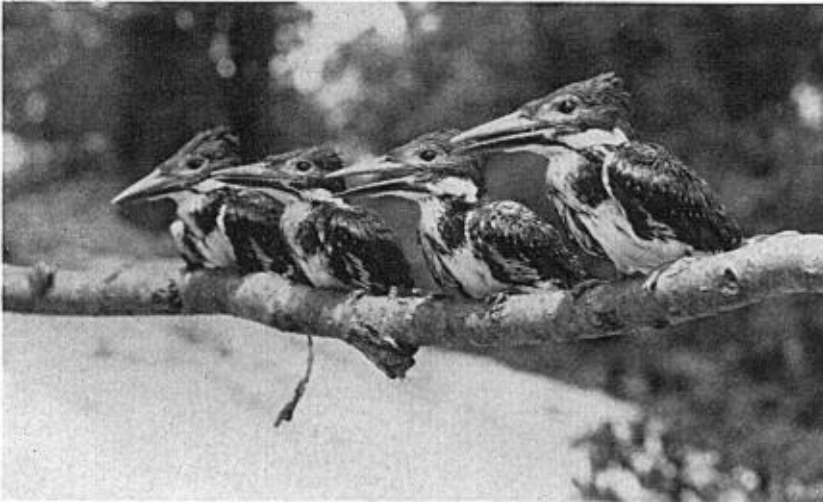


Fig. 3. Nestling Amazon Kingfishers, 18 days old; near Tela, Honduras, May 24, 1930.

their sexes. All four of the young bore a close resemblance to the female. They had broad peninsulas of dark green projecting from the sides into the white of the breast; but the white pectoral feathers of two of them were perceptibly tinged with chestnut in the position of the band across the male's breast, and these were probably males. Their upper mandibles were now longer than the lower ones. They did not attempt to fly until they were about 24 days old, and even then they could do no more than flutter. They now defended themselves with spirit, biting my fingers whenever I gave them an opportunity.

Kingfishers, like motmots and jacamars, take no measures for the sanitation of their burrows. The decomposition of the nestlings' nitrogenous wastes sometimes generates enough ammonia to make one's eyes smart when placed close to an opening at the rear of the nest chamber. The indigestible bones and scales of fish are regurgitated by the nestlings and add to the accumulation of such material already begun by the parents while they incubated the eggs. Maggots crawl in this debris on the floor of the nursery and green flies buzz out when the burrow is opened. However, the light, sandy soil which kingfishers prefer for their burrows absorbs much of the offensive matter and prevents the chamber from becoming unbearably foul. I noted in one instance that the chamber was somehow enlarged while it contained nestlings, and the earth dug or worn from the walls covered some of the filth on the floor. In dry, porous soil the burrow remains surprisingly clean throughout the long period of occupancy by the four nestlings. The young kingfishers themselves, except for their feet and bills, are usually as neat and clean as though they had just been washed and brushed. They rise superior to their environment.

Twenty-eight days after I found the newly hatched nestlings, I paid them a visit and placed a female on the ground beside me while I held one of the males. The female parent was flying over the river close by and the young female answered her loud calls in a much weaker voice. Finally I noticed that I had placed her in a spot where fire-ants swarmed and I tried to pick her up, but she would no longer submit to handling. Her wings beat, and she rose from the ground and traversed the river without difficulty. She alighted in a small willow tree on the opposite shore. I started to cross the channel on a fallen log to retrieve and return her to the burrow; but now that she had tasted freedom

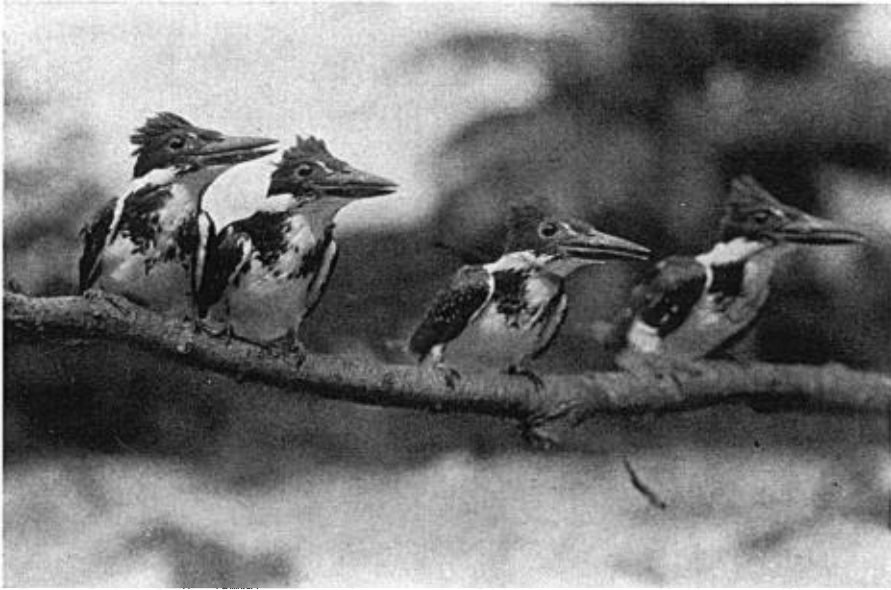


Fig. 4. Nestling Amazon Kingfishers, 24 days old and fully feathered; near Tela, Honduras, May 30, 1930.

in the sunlight, she would not permit herself to be caught and replaced in the dark subterranean nursery. Before I was halfway over, she took wing for a much longer flight and rose into a tall willow tree, followed by the female parent. This juvenile had been long in discovering the use of her wings, delaying a week after her feathers had seemed sufficiently expanded to support her in the air, but finally flight had come to her all at once. The importance of the long nestling period, and the sudden development of the power of flight after the youngster is well grown, is apparent in a bird whose burrow frequently opens on a wide expanse of river or lake. A weakly fluttering departure from the nest, such as many fledglings make, would, in this situation, bring the bird to a premature and watery grave.

When I approached the river next morning, the alarmed cries of the parents told me that the rest of the brood was on the wing. When I uncovered the burrow it was empty. Only a single, silvery-scaled minnow, probably taken in after the last fledgling had flown, lay upon the sandy floor. The young had remained in the burrow 29 or 30 days, several days less than those of the larger Ringed Kingfisher, whose nestling period is 35 days or more. But the African Half-collared Kingfisher leaves the burrow when about 27 days old (Moreau, 1944). I watched one of the young Amazon Kingfishers diving for fish, twelve days after it left the nest, but it caught nothing.

The brood whose incubation period I determined was exceptionally late. Because the parents had deserted their first burrow after I opened it, their replacement brood did not hatch until early June, when most young kingfishers were already on the wing. The rainy season now set in and the muddy flood waters of the Río Morjá rose to within a foot of the mouth of their tunnel. Fishing must have been difficult in the swift, beclouded stream; but the parents somehow managed to catch enough minnows, and in July they were feeding at least two of their young in the trees along the bank.

BATHING

Although the burrows of the kingfishers in the high, stony bank of the Río Peña Blanca are far less favorably situated for study than those I had found earlier in the almost stoneless banks of lowland streams in northern Central America, I witnessed here one phase of behavior which I had not previously observed. After entering the burrow with large minnows for older nestlings, the parents regularly bathed in the river. Sometimes on emerging from the tunnel the female would plunge directly into the water. Then she would fly to a rock projecting above the shallow, dry-season current in the middle of the channel and take additional baths. More often the parents would go first to a boulder, from whose top they dipped into the stream. As far as I saw, they never omitted these ablutions after they came out of the burrow. The number of dips they took after a visit to the nest varied from two to five. The kingfishers did not completely immerse themselves in the shallow water. After the last plunge in the series they sometimes preened their plumage as well as they could with their great bills and shook their wings and tail. Then they flew up- or down-stream searching for more fish. Since the water where they most often bathed flowed shallowly over a rocky bottom, it is not likely that these plunges were for the purpose of catching fish, for I never saw them capture any on these occasions.

Lockley (1953:69) observed that Puffins (*Fratercula arctica*) regularly bathe in the sea after a spell in the burrow with the egg. Moreau (1944) wrote of the Half-collared Kingfisher in Tanganyika Territory: "About the middle of the fledging period the tunnel must have got into extremely foul condition, because liquid faeces were constantly oozing from its entrance. The old birds evidently disliked this; it became their invariable custom when they emerged to plunge repeatedly into the water to clean themselves. Usually they did this four or five times, but once eighteen plunges were recorded. A similar observation on the European Kingfisher . . . has been recorded by Ris."

I never examined a burrow of kingfishers, motmots, jacamars or puff-birds in such a foul condition as Moreau described. As already noted, the burrows of the Amazon Kingfishers that I studied in northern Central America were, despite their ammoniated atmosphere, surprisingly clean, considering the parents' inattention to sanitation. Perhaps for this reason the old birds were never seen to bathe after emerging from them, although it is not impossible that they did so out of sight around a bend in the river. Although I could not open the burrows beside the Peña Blanca for examination, it is probable that in this rocky ground the waste matter did not drain off as well as in the sandy loam along the northern rivers. Considering the number and size of the rocks in this bank, it would not be surprising if one of them formed the floor of the nest chamber, and such a bottom would be impervious to liquids, hence the greater need for bathing. It is probable that only their feet, and to some extent their under plumage, were soiled as they shuffled in and out of the burrow; and these were the parts which the kingfishers seemed to wash by their partial immersions in the stream.

I found no indication of second broods in the Amazon, Green, and Ringed kingfishers, and Bent (1940:114) stated that the Belted Kingfisher rears only one brood in a

season. Although the American kingfishers are, as far as we know, single-brooded, the African Half-collared Kingfisher rears two broods between September and March, in the "short rains" and subsequent hot, dry season (Moreau, 1944).

SUMMARY

In Central America the Amazon Kingfisher lives chiefly along the broader and deeper waterways. It is most abundant in the lowlands below 3000 feet, but it is occasionally found as high as 5700 feet. Except in the breeding season, it is solitary.

As far as observed, this kingfisher subsists exclusively on fish, for which it plunges directly from a perch or from a hovering station above the water. Often it misses its prey, and most of its dives seem to yield nothing.

In addition to rattles and loud *kleck's*, it has a more songlike performance consisting of a single soft, clear monosyllable uttered with increasing pitch and tempo until it reaches a climax, then falling rapidly in both pitch and speed.

These kingfishers breed chiefly in the drier months early in the year, when burrows in river banks are not likely to be washed out or inundated and clear water facilitates fishing. Burrows were found only in the banks of streams. In very rocky banks, where digging is difficult, the same tunnel may be used for at least three successive years, but in sandy banks new burrows seem to be dug each year. Excavation may begin in January and proceed very slowly. Over a period of several weeks, one burrow was lengthened at the rate of only 1.4 inches per day. Apparently both sexes dig the burrow.

Burrows measured in Central America ranged from 47 to 64 inches in length. They are usually more or less curved, so that it is impossible to look into the nest chamber from the front. This enlargement at the inner end of the tunnel is not lined, and the eggs are laid directly on the earthen floor.

Three nests each contained four eggs or nestlings. A replacement set consisted of three eggs. The eggs are pure white or, exceptionally, faintly buff.

The female incubates through the night, and by day the two sexes alternate on the eggs. At one nest the male did most of the diurnal incubation, taking a fairly long session in the early morning and in the afternoon a longer one, which in one instance lasted six hours and five minutes. The female relieved him late in the evening, and he fished for his supper in the dusk.

At one nest the incubation period was 22 days.

The nestlings are hatched without any trace of down or feathers on their pink, transparent skin. Their heels are equipped with tuberculate pads. Their protruding eyes are tightly closed and the lower mandible projects beyond the upper. The latter grows faster and equals the lower mandible in length about 11 days after hatching. The pinfeathers grow long and the contour feathers begin to escape from them when the nestlings are about 12 days old. At the age of about 19 days the young are covered with feathers, but they can scarcely fly even when 24 days old.

Both parents feed the young with minnows whose size is adjusted to that of the nestlings, so that the fish brought are increasingly larger as the young kingfishers grow. Although the kingfishers are devoted parents, sometimes staying with their eggs or nestlings and permitting themselves to be touched when their burrow is opened, they never make hostile demonstrations nor give distraction displays.

No provision is made for the sanitation of the nest, which is fouled not only by the droppings of the nestlings but by an accumulation of regurgitated fish scales and bones begun by the incubating parents and augmented by the young. Despite the ammoniated atmosphere produced by the decomposition of these nitrogenous wastes, the burrow remains fairly clean if it is in rather dry, porous soil. Parents feeding older nestlings in

a tunnel in a very rocky bank plunged repeatedly into the stream to bathe each time they came out of the burrow, but kingfishers with burrows in light, sandy soil were not seen to bathe.

From one nest the young left when 29 or 30 days old; at this time they flew well. Apparently only a single brood is reared each year in Central America.

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