LIFE HISTORY OF THE WHITE-TAILED TROGON *TROGON VIRIDIS*

ALEXANDER F. SKUTCH

Received on 23 August 1961

In earlier papers (1942, 1944, 1945, 1947, 1948, 1953, 1956, 1959 a, b) I have given accounts of the nesting and other habits of seven species of trogons. The present account deals with one of the loveliest members of this beautiful family, although in elegance it falls short of the superb Quetzal *Pharomachrus mocinno*.

The White-tailed Trogon *Trogon viridis* is a medium-sized representative of its family measuring about 11 inches in length. The male's head and neck are black, glossed with violet-blue on the pileum and hindneck. The remainder of his dorsal plumage is metallic green or bluish green, strongly suffused with blue and violet, especially on the lower rump and upper tail-coverts. His long central tail feathers are dark metallic bluish green or violet-blue, abruptly tipped with black. His lateral rectrices are white, with areas of black that are concealed when the tail is closed, so that when viewed from below it appears wholly white. His wings are largely black. His throat is black, his chest black glossed with violet-blue, and his more posterior under parts are vermilion or flame-scarlet. His short, thick, strongly serrated bill is nearly white and the ring of bare skin surrounding each dark eye is pale blue to almost white. His legs and feet are grey. The female is nearly everywhere dark slate-grey, with reddish orange on her abdomen and under tail-coverts. Her wings are black, with narrow, widely separated bars of white on the coverts and secondaries, and some white spots on the primaries. Her four middle tail feathers are blackish slate-colour with still blacker tips; the lateral rectrices are black with white tips and narrow, widely spaced bars of white. Her upper mandible is black and the lower is greyish horn-colour. Her yellowish brown eyes are surrounded by conspicuous bare rings of pale blue, and her legs and feet are blackish. The foregoing descriptions refer to the northwestern form of the White-tailed Trogon *T. viridis bairdii*, which was formerly classified as a distinct species, and with which this account chiefly deals. In more southerly and easterly races, the abdomen and surrounding areas of both sexes are more yellow.

This exceptionally handsome trogon ranges from southwestern Costa Rica to Perú, southern Brazil, and the Guianas. In the Térraba Valley of Costa Rica, where it is not uncommon, it occurs from sea level up to at least 3,500 feet. It lives chiefly in the forest, where it usually remains high, but it often makes excursions into neighbouring clearings with scattered trees and may on occasion nest there. A rather solitary bird, it apparently does not remain in pairs throughout the year, although I have seen a male and female together, as though mated, in late January. Like other trogons, it is dignified and sedate, perching upright with its tail pointing straight downward, or perhaps inclined slightly forward beneath its perch. In flight, it traces a strongly undulatory course.

When alarmed or excited, the White-tailed Trogon rhythmically spreads and folds his tail with a rapid movement, thereby sending brief flashes of white to an observer behind him. This tail movement, which is evidently related to the pure white lateral rectrices, is different from that of some other trogons with less white on their tails. I was impressed with this difference one day when I watched some trogons and hummingbirds who, along with a male Green Honeycreeper *Chlorophanes spiza*, had gathered around a Spectacled Owl *Pulsatrix perspicillata* that perched high in the forest. Protesting at the presence of the great, somnolent owl, a Violaceous Trogon *Trogon violaceus* uttered sharp, rattling notes while he slowly raised his tail well above his back, thereby displaying

the black and white bars on the outer feathers. The male White-tailed Trogon did not elevate his tail but fanned out the feathers laterally. Even if there had been no difference in the size, body plumage, and voices of these two species, they might have been readily distinguished by their tails alone. None of the three trogons approached nearly as close to the motionless owl as did the far smaller humming-birds.

The female White-tailed Trogon sometimes spreads and closes her tail in the same manner as the male, although she has little white on the lateral feathers to display.

FOOD

In its feeding habits, this trogon hardly differs from the other American species. It perches quietly, looking around, until it espies an insect amid the foliage, then darts suddenly upward or outward, seizes its prey in its serrated bill while hovering on wing, and alights on a branch to devour it. The trogon's diet is diversified by fruits, often of considerable size, which it plucks from the trees while on the wing and swallows whole. A female who foraged among the guava trees in the pasture in front of our house used procedures which one does not often see in the family. In addition to repeatedly fluttering against the foliage and sometimes against the bark, she thrice dropped to the ground and rested on the short grass for a minute or so. On one of her descents she caught a small, dark lizard, which she held in her bill for a good while.

VOICE

In late December or January, when the returning dry season brings sunny days to southern Central America and with increasing frequency the calls of the several kinds of trogons sound stirringly through the lofty forests, that of the White-tail is easily distinguished from all the others. The male's song begins with full, mellow notes much like those of a number of other trogons, but with repetition they rise in pitch and come faster, until they form a long-continued roll, which often ends with a few more widely spaced notes. The other trogons with which the White-tail is associated, including the Violaceous, Black-throated *Trogon rufus*, Collared *T. collaris*, Massena *T. massena*, and Black-tailed *T. melanurus*, have songs which are scarcely accelerated; usually they are shorter and less melodious. Perching high in the forest where he is difficult to see, the White-tail may repeat his pleasant verse over and over, sometimes for half an hour. Here in the valley of El General in southern Costa Rica, he sings much from February to June, less frequently in the second half of the year; yet occasionally one hears persistent singing as late as the end of September.

This accelerated song appears to be used chiefly to attract a mate and probably also to proclaim the possession of territory. After he has won a partner, the male, who often seems more eager than she to proceed with the preparation of the nest, coaxes her to the site with utterances of a different character. The full, low, mellow notes are now more evenly spaced and all on nearly the same key; they form a melodious twitter, or a liquid ripple of sound, soft and soothing, at times intensely pleading, and always most beautiful. While the members of a pair are alternately working at their nest, the one not engaged in carving into the wood perches nearby, keeping up a constant flow of these soft notes, as though to encourage its partner.

When approaching their nest with food, both parents sometimes repeated, too rapidly to count, a low, soft " cow ". In the same circumstances, the male of another pair uttered clear staccato notes, like sharply plucking the taut wire of a stringed instrument, and as he did so he flashed the white of his tail by rapidly opening and closing it. When driven from his nest by my approach, this male delivered a soft, throaty note, likewise accompanied by tail flashing. Arriving to replace her mate on the eggs, a female called with a low " tuck ", less melodious than the " cow " call, from which it differed also by the more distinct separation of the notes. It is evident that these trogons have a fairly large vocabulary, consisting of a variety of notes whose finer modulations I am unable to convey by means of the written word. The utterances of nestlings will be mentioned in the section devoted to them.

NEST BUILDING

In the valley of El General, the White-tailed Trogons, especially the males, begin to examine nest sites about 1 March, and they may then sometimes nibble at the wood, but I have not observed active excavation until some weeks later, and breeding occurs chiefly from April to July. Although in the Panamá Canal Zone this trogon has repeatedly been found nesting in termitaries (Eisenmann 1952 : 28–29), in El General, 2,500 feet above sea level, I have found it breeding only in decaying trunks—a difference which is probably related to the greater abundance of large arboreal termites' houses in the warm lowlands, and which is exhibited also by the Massena Trogon. White-tailed Trogons' nests are usually in the forest, but in four successive years a pair nested, always unsuccessfully, in a massive, rotting trunk of an introduced flame-of-the-forest tree *Spathodea campanulata* almost in front of our house. This stub stood at the edge of a pasture, beside a creek, beyond which was an extensive stand of tall but light second-growth woods. The nest site was separated from the primary forest, where this pair of trogons appeared to spend most of their free time, by about 100 yards of shady pasture.

Although I have watched White-tailed Trogons carving their nest cavities at heights up to about 50 feet in dead trunks, the five occupied nests that I have found were from $6\frac{1}{2}$ to 18 feet up. Four of these were in the flame-of-the-forest trunk, each lower than its predecessor of the year before: they were at heights of 18, $17\frac{5}{6}$, $9\frac{1}{2}$ and $6\frac{1}{2}$ feet. The fifth nest was 16 feet up in a massive stub in the midst of the forest. High nests of this trogon would be very likely to escape detection by the bird-watcher, because, after the completion of the chamber, the birds' visits are infrequent, and they often refuse to come forth when he hammers on the base of the trunk.

To excavate a nest chamber, thick-billed trogons bite rather than chisel away the wood, and they dig into trunks so soft that most kinds of woodpeckers, with their more efficient carving tool, would disdain to rear a brood in them. Like other members of their family, White-tailed Trogons often have great trouble finding a dead tree that is neither too hard for them to carve, nor so far advanced in decay that it crumbles and will not hold the shape they give their chamber. Sometimes they try again and again until at last they find wood of just the proper firmness. In a massive, buttressed stump, a pair of trogons started six separate holes, but did not complete any of them, because the wood was too rotten. Wood that a man can dig into with his finger nails, yet which does not fall into powder when pressed between his fingers, is of about the right consistency for the trogons.

The male appears to choose the nest site, sometimes even before it is evident that he has won a mate. At the beginning of March, 1939, I watched a male who rested on a lower limb of a tall forest tree, incessantly repeating his far-carrying song. He interrupted his singing to fly to the top of a neighbouring, barkless, fifty-foot stub, where, clinging upright, he bit into the rotting wood, letting a few fragments fall to the ground. Then he returned to his former perch and continued to sing until past the middle of the morning. Protracted watching failed to reveal that he had a partner.

A fortnight later, in the same locality, I found a male, probably the same individual, who had proceeded farther toward the establishment of a family. After singing for a while, he flew to a neighbouring, tall, barkless trunk, where he clung to the side at a point near the top and dug into the wood with his bill. After a few seconds, he dropped down to a perch; and then the female, whom I had not previously noticed, darted up and took a few nibbles at the same spot. Soon both flew away; they did not return while I waited, and they did not carve a nest here.

When beginning to excavate a cavity, the White-tailed Trogons carve obliquely upward into the soft wood, forming the entrance-tube of their deeply placed chamber. The male and female take turns at the work, and while one carves the other usually perches nearby, uttering the beautiful, soft notes already described. Between 11.10 and 12.07 on 23 April 1942, a pair carving a high nest in the forest worked as follows: male, 5 minutes; female, 9 minutes; male, 2 minutes, after which he was frightened away by a falling branch; intermission, 2 minutes; male, 10 minutes; female, 10 minutes; intermission, 2 minutes; male, 10 minutes; female, 7 minutes. Nearly always, as soon as one partner dropped tail-first out of the obliquely ascending shaft, the other went to work with scarcely any delay. These trogons made no special effort to remove the particles of wood loosened by their bills; the debris slipped down in front of them, to fall out beneath their tails. When, at the end of a spell, the worker dropped out of the hole, a shower of fine wood particles was released; and many remained clinging to the bird's plumage. The excavation of this chamber proceeded rapidly: at the beginning of the hour the birds carved with the head and back inside but the rump, the ends of the wings, and the tail exposed; at the end of the hour, only the tail remained outside.

Sometimes the male seems eager to advance the carving of a nest chamber, although his mate desists from the work. Late in the morning of 20 May 1939, I found a pair of trogons beginning a nest in an exceedingly rotten stub. I watched for a short while, during which the male worked for five minutes and his mate for three minutes. In the afternoon of the same day, the male carved for five and then for two minutes, while his mate stood by and did nothing; then they flew away. On the following morning, the male again took two turns at carving, while the female rested inertly in front of the hole. Apparently she did not like the stub, which seemed too rotten to hold a nest chamber; and since her approval was indispensable for a successful nesting, the work was abandoned. Likewise, on 7 June 1944, I was attracted by trogons' calls to a pair carving into a very rotten stub in the forest. Soon after my arrival, the female flew away; but her mate lingered near the stub, continually repeating his soft, appealing notes, until at length she returned, whereupon he went to the newly begun cavity and tore away the soft wood with his bill for 14 minutes. Then he went to perch beside his mate, who in turn flew to the hole. But after a few seconds there she rose into the treetops and vanished. The male remained, vainly trying to coax her back with his murmurous, pleading notes. Finally he, too, drifted away.

At the late nest carved in July 1957 in the flame-of-the-forest stub in front of our house, the male often called persistently, from a neighbouring perch, while his mate was out of sight. This excavation proceeded slowly, and it was not ready to receive eggs until two weeks or more after I first noticed a shallow depression in the side of the trunk.

The completed chamber is roughly ellipsoidal in shape, with neatly rounded walls. Placed deep in the wood, it is entered through an obliquely ascending tunnel or shaft, about 7 inches in length by $3\frac{1}{4}$ inches in diameter. This shaft, which in some nests was wide enough to admit my hand but in one was too narrow, enters the chamber near the top; a ridge of wood separates it from the chamber's bottom and prevents the eggs from rolling out. In one instance, this ridge rose about two inches above the lowest part of the floor. This floor is covered only by coarse particles of wood loosened while the trogons carved, as no soft lining of any kind is carried in. From a nest in a massive trunk, there emanated such a strong odour of iodoform that, when I stuck my nose in the doorway, it was easy to imagine that I was entering a surgery. The chambers in the flame-of-the-forest trunk lacked this peculiar scent, which is evidently a product of the decomposition of the wood of only certain kinds of trees.

In 1958, the trogons who nested in the flame-of-the-forest stub began a new excavation with its upper edge only two inches below the lower edge of the doorway of their nest of the preceding year. As the shaft deepened, it broke into the old chamber at a lower level,

and the birds then proceeded to deepen this chamber. When they finished their work, they had an unusually high nest cavity with two entrance tubes, one above the other, of which the lower was the newer.

The well-enclosed chambers carved by the White-tailed Trogon, the Massena Trogon, and the Citreoline Trogon *Trogon citreolus* contrast sharply with the shallow, superficially situated niches made by the Black-throated Trogon, the Collared Trogon, and the Mexican Trogon *Trogon mexicanus* (Fig. 1). In the latter, much of the incubating parent, especially its head and its long tail held upright against the rear wall, is visible from the front; in the former, the parent is well concealed in the wood, and can hardly be glimpsed without throwing a beam of light up the entrance tube while one stands below it. White-tailed and Massena trogons carve chambers of the same form in wood and in termitaries, but, as far as I know, Citreoline Trogons nest only in termites' houses. Those trogons which make the shallow niches, however, seem to carve them only in decaying wood; nests of this form would hardly be practicable in termitaries. Possibly chambers of the form carved by the White-tailed Trogon are an adaptation to nesting in termites' houses, but because of the better concealment they afford, they seem to be advantageous even when made in trunks.

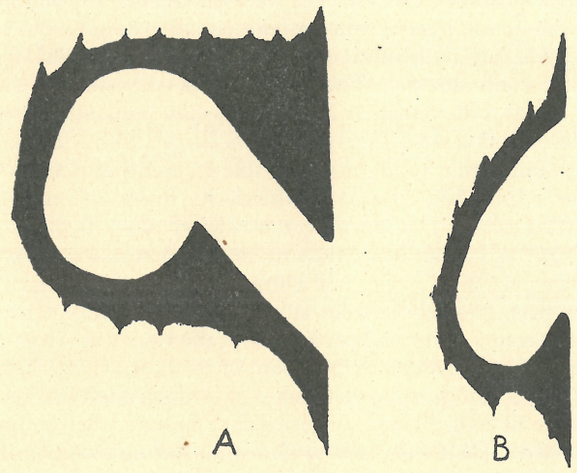

FIGURE 1. Schematic longitudinal sections through nest cavities of trogons. Enclosed chambers of type A are carved in wood and termitaries by White-tailed and Massena Trogons and in termitaries by Citreoline Trogons. Shallow niches of type B are carved by Black-throated, Collared, and Mexican Trogons and have been found only in decaying wood.

THE EGGS

In a nest which was begun about 17 July and seemed to be finished early in August, the first egg was found on 16 August. Probably this interval of about two weeks between the completion of the nest and the start of laying is unusually long. Two years later, another chamber in this same stub was finished about 27 April, and the following day I found part of an eggshell in it, the remainder on the ground below. No more eggs were laid here.

In a set of two eggs, two or three days elapsed between the laying of the first and the second; and in a set of three, the eggs were laid at intervals of two days. In this region, I have found three sets of two eggs and one set of three eggs. In Trinidad and neighbouring parts of Venezuela, where this trogon breeds from April to July, two sets of two eggs were found (Belcher & Smooker 1936 : 792). The eggs are white, with a slight

gloss, and they may be either blunt or rather sharp at the narrower end. The measurements of seven eggs average 33·1 × 25·0 mm. Those showing the four extremes measured 34·9 × 24·6, 33·3 × 25·4, 31·0 × 24·6, and 33·7 × 24·2 mm.

The approximate dates of the beginning of laying of five sets of eggs in the valley of El General, around 2,500 feet above sea level, are as follows: 17 April, 27 April, 28 April, 22 May, 16 August.

INCUBATION

At the exceptionally late nest in the flame-of-the-forest stub in front of our house in August of 1957, the trogons were very dilatory in their proceedings. The first egg was laid about a month after they started to excavate the nest chamber, and during the first four days after their set of two eggs was complete, they incubated most inconstantly. On most of my visits in this interval, I found the nest unattended and the eggs cold. On the fifth day, however, the parents were more constantly present. The female of this pair was moulting, as I judged by the irregular lengths of her tail feathers, and perhaps this retarded the nesting operations. At the nest in this same stub in April of the following year, I repeatedly found the eggs of the incomplete set quite cold immediately after a parent left the chamber. These eggs were unattended during the night following the completion of the set of three, but thereafter incubation appeared to proceed regularly. After they have settled into their routine of incubation, White-tailed Trogons keep their eggs covered almost continuously. Their schedule is very simple: the male takes one long session each day and the female is in charge for the remainder of the 24 hours.

At an occupied nest situated 16 feet up in a massive stub in the midst of the forest, the parents were so indifferent to my presence that I could watch them without concealment. At 5.15 on 2 June 1942, I entered the dusky forest and sat beside a log about 40 feet in front of the nest. The morning wore slowly on, with never a glimpse of the trogons. Finally, at 9.03, I at last heard the soft, rapidly repeated notes of the male floating down from the treetops. With wings and white tail spread, he fluttered down to a lower branch, nearer the nest, and repeated his subdued summons to his mate. He dropped yet lower and called again. Now she darted out of the round doorway in the stub's side and rose to the limb of a tree, above and in front of the nest, where she called softly with rapidly repeated notes, like those of her mate. He descended to the doorway, before which he clung while he took a single lingering look around, then promptly climbed up the shaft and vanished. He seemed not to notice me sitting so near, unscreened by the foliage.

For the next five hours, nothing noteworthy occurred in the silent forest around me. Soon after two o'clock, rain began to fall and continued intermittently until the middle of the afternoon. At 14.59, the female re-appeared and perched about 30 feet up in the tree that grew in front of the nest. She called " tuck tuck tuck " over and over, slightly twitching her tail to beat time to her notes, which were less melodious than those which the male had used in the morning. Since he was slow in responding to her summons, she advanced to a bough nearer the nest and continued to call. Then she flew to the doorway and bumped into her mate as he was coming out. She retired to her last perch until he emerged and rose into the treetops. Then she flew to the opening and entered in one continuous movement, not pausing before the doorway to look around, as trogons usually do. It was then 15.03, exactly six hours after her partner had replaced her in the morning. On a number of other days I always found the female with the eggs after the middle of the afternoon. Once I found the male incubating as early as 8.15 in the morning.

These trogons, who lived in forest which had long been abandoned by the Indians and had only recently been invaded by Spanish-speaking settlers, were amazingly fearless of me. Usually no amount of hammering or scratching on the lower part of their

trunk would make them leave their nest. Noises like clapping my hands and shouting, or chopping in the neighbouring undergrowth, failed to make them look through their doorway. A disturbance nearer their own level, as when the top of the long ladder grated against the trunk, usually brought them forth. If this failed to move them, they left when I climbed up and shook a leafy branch in front of their doorway. But on the day the eggs hatched, I ascended and saw the male's white-rimmed eyes looking down the entrance tube at me, his head little over a foot above mine. When next I moved, he darted forth.

When finally it flew from the chamber, the parent would rise a short distance to a low bough of a neighbouring tree, where it perched upright, its long tail feathers strongly bent and crumpled by long hours of confinement in the narrow space. On the morning when I found the nest, the male stayed here, a few yards from me, for nearly half an hour, while I took measurements and made notes. For a long time he complained loudly, the while flashing his white outer tail feathers, but before I finished he became silent, staying in the same spot. Never had I known any other trogon so steadfast in remaining in its nest, so loud and untiring in its complaints after it was driven forth, nor so fearless in remaining near the intruder. While I stood on the ladder to look into the nest, the female sometimes perched as close to me as her mate did, but in contrast to him she was always silent and immobile save for an occasional slow turning of her head. In the first days after I found the nest, she was less strongly attached to it than her partner; but before the eggs hatched, she had become as steadfast and fearless as he was from the beginning.

After I finished my inspection of the nest, descended to the ground, removed the ladder, and retired a few paces, the parent who had been in charge of the eggs would soon return to them while I watched, without the long-drawn, cautious survey at the doorway which many trogons habitually make before they enter. Doubtless I would not have discovered this nest, as I passed through the forest tapping on the trunks and stubs with holes in them, if I had not happened to encounter it at the critical time of the morning change-over. The female promptly came forth when I knocked, and her mate, who was nearby, entered while I stood directly below the doorway.

It is noteworthy that these trogons, although exceptionally bold in my presence, never darted toward me or threatened me, nor made any distraction display. The male showed his concern for the nest only by calling, and the female never did even this while she watched me examine her eggs. Even after the nestlings hatched, the parents were equally undemonstrative, in this agreeing with all the other trogons, of whatever species, that I have studied.

At the nests 18 feet up in the flame-of-the-forest trunk in 1957 and 1958, the female was almost as indifferent to my presence as the female of the first nest. Early in the incubation period, she would fly out if I tapped on the lower part of the stub. Later, however, she refused to leave when I did this, and to make her come forth when I wished to examine her eggs, it was necessary to scratch the stub near the nest with the end of a long stick. Then she would fly out and perch nearby. Once while she rested in front of the nest she permitted me to touch her tail with the point of my pole. In contrast to the male of the first nest, her mate was less confiding. At first he would leave the nest in response to a whistle or a hand-clap. As the days passed, he became more wary and flew forth whenever I walked in front of the nest, where he could see me by looking down the entrance tube. Unlike the male of the first nest, he would not enter if he saw me looking, even from a considerable distance.

Accordingly, to watch this more exposed nest, it was necessary to set up a hide, in which, on 30 August 1957, we made an all-day vigil. At 5.37, long before sunrise, the male arrived and called softly from a tree near the nest. After 10 minutes, he alighted on a branch in front of the doorway, the female emerged, and he entered. Throughout

the sunny morning, no trogon was seen. At 13.04 the male darted out of the nest, where he had remained continuously for seven hours and 17 minutes, rested in front, and called once, softly. After six minutes, he re-entered, as rain began with thunder. He stayed inside only a minute, then again perched in front and called. After another three minutes, he went to the doorway but did not enter, then he flew to the forest. At 13.23 the female arrived and perched silently in front of the nest, to enter at 13.27. Through the remainder of the rainy afternoon, she stayed with her eggs without revealing herself, while her mate remained beyond sight in the forest until I ended my vigil in the dusk. At this nest, the male's session was an hour and a quarter longer than that of the first male, and it came much earlier in the day.

On 2 September, the male entered the nest in the flame-of-the-forest stub at 5.50. Two hours later, I heard him calling in a tree in front of the house, and while I watched he flew to the forest. Why was he not warming the eggs, as on all previous days at this hour? Suspecting that something had gone wrong, I went to the nest to investigate. It was unattended. At 8.42, the female arrived and went to the doorway. Evidently she had met her mate in the forest, and this encounter had sent her back to her neglected eggs, four or five hours before her usual time to resume incubation. After some hesitancy, she entered. But a moment later she shot out and alighted on a branch, where she shook herself vigorously all over, half lifting her wings, and pecking at her plumage. After a minute or so of this, she again went into the nest, only to come out just as promptly as last time and shake herself as before. Then she flew silently back to the forest.

Bringing a ladder, I climbed up to the nest and stuck in a mirror and electric bulb. The chamber swarmed with fire ants, which at this season were a terrible plague. I did not know how to get rid of them except by putting poison in and around the nest, and I hesitated to take this course for fear that it would harm the trogons. At half-past ten the male returned and called much in front of the nest, but I did not see him enter. On the following night the eggs were unattended; no female flew out when the male came to relieve her before sunrise next morning. Through much of the forenoon he lingered in the vicinity of the nest, repeating his melodious calls.

During this day the fire ants withdrew, leaving the two eggs intact. On the succeeding night, I saw the female in the nest when I looked up into it by torchlight. The eggs had been left unwarmed for only a single night and parts of two days. I hoped that they had suffered no harm; but to my great disappointment, they failed to hatch at the expected time. Through the remainder of September and the first eight days of October, the parents continued faithfully to attend these eggs, which then vanished. From the laying of the second egg, incubation had continued for 51 days, or about three times the normal incubation period of this trogon.

I did not again watch this nest through a whole day, but during the seven weeks that incubation continued I made many observations on its occupancy. As already recorded, this pair was slow to settle down to incubation. On 23 August, five days after the last egg was laid, I found the male in the nest at 7.00. At 12.30 he was perching in front and calling from time to time, and after 10 minutes he flew to the forest, leaving the eggs unattended. At 13.30 the female flew from the nest when I tapped on the trunk. While she perched in front, her mate arrived, whereupon she flew away. At 14.10 I found him incubating. Accordingly, on this day the male took two sessions on the eggs, separated by one of the female.

After this, I noticed no departure from the White-tailed Trogon's usual routine of only two change-overs in the course of a day. From 25 August to 10 September, the male came early every morning; on 12 days in this interval, he arrived between 5.37 and 6.15 to call out his partner and begin his long session on the eggs. For the next fortnight, I neglected to watch in the early morning. When I resumed observations, I learned that the male arrived much later; between 25 September and 8 October, I often found the female in the nest between 7.00 and 8.00. If I put her out, even at this late hour, she returned rather promptly to await her mate's arrival. One morning at 7.35 I found a spider's web spread out in the doorway, suggesting that the female had stayed constantly within since the preceding evening. On 28 September, the male did not arrive until 8.57. Now that he came later in the morning, he stayed later in the afternoon and was sometimes on the eggs between 15.00 and 16.00. On the day he came at 8.57, he was still present at 16.10. Sometimes he did not wait for the arrival of his mate, who now often came after 15.30, instead of between 13.00 and 14.00, as she frequently did before the invasion by the ants.

In the following year, when the trogons were again breeding in this same chamber, which they had provided with a second doorway and deepened, the male often began to incubate early in the morning, as he had done during much of the preceding nesting. Once his partner came to relieve him at the unusually early hour of 12.24. Of the four years in which the trogons attempted to rear a family in this flame-of-the-forest trunk, this was the only one in which they suceeded in hatching their eggs. The three eggs were laid on 17, 19 and 21 April, 1958, and the first and second hatched on 7 May. Unfortunately, the third egg's failure to hatch makes it impossible to state the incubation period with due precision; but since the parents incubated little before the completion of their set (indeed, the female failed to sleep in the nest not only during the period of laying but even on the night after the last egg was deposited) the incubation period cannot be much in excess of 16 days.

THE NESTLINGS

Feeding and brooding.

The newly hatched trogons have pink skin wholly devoid of down and their eyes are tightly closed. They already utter hoarse little grunts. Nestlings of all ages are fed infrequently but with very substantial portions. On 12 May 1958, when the two nestlings in the flame-of-the-forest stub were five days old, still naked and sightless, I watched their nest from a hide from 5.30 to 11.30. I saw nothing of the parents until 7.00, when, suspecting that something was amiss, I left my concealment to investigate and the female flew from the hole, where she had been since the night. At 7.26 the male brought the nestlings' first meal, a green insect of medium size. Perching near the nest, he repeated a low, soft note many times, then proceeded to the doorway and spent three minutes clinging there while he delivered the food, after which he flew away. At 8.33 he returned with a very large, green, winged insect, which had been greatly torn, and called as before. Soon he flew up into the trees with it, probably because he had seen my field glasses at the window in the hide. Presently his mate arrived, also with a big green insect, perched in front of the nest and called as he had done, whereupon he descended to rest near her, still holding the same insect. He went first to the nest and clung in the doorway for five minutes to deliver the meal. Then the female spent about ten minutes at the entrance, apparently feeding the nestlings, after which she brooded them. I do not know how long she stayed, for she flew out unnoticed by me. At 11.30, just as I ended my watch, she returned with another big insect. Thus the parents brought food only four times in six hours, and only the female brooded.

On 17 May, when these same two nestlings were ten days old, with long pinfeathers and open eyes, I again watched for the first six hours of the morning. The female ended her night session in the nest at 5.49, and thereafter the young were not brooded on this slightly cloudy morning. At 6.40, the male arrived with a thick brown phasmid or stick insect that seemed longer than his own body, exclusive of his tail. He had grasped it in the middle and half hung down on each side of his thick white bill. After perching for a few minutes in front of the nest with it, he suddenly flew away. In about a quarter of

an hour he returned with the same unmistakable object, and for the next 70 minutes he rested inactive in the same spot, while yellow and black-banded wasps *Polybia fasciata* hovered around and even alighted on the stick insect, which now hung more limply than before. Finally, when a horse sneezed in the neighbouring pasture, he darted away with the same long insect. It was then 8.12, and he had not re-appeared when I ended my watch at 11.30. The female gave the nestlings, or one of them, their first meal at 8.49, three hours after leaving the nest before sunrise. By 10.45 the nestlings were very hungry and called in low, soft voices, which soon became loud enough to be plainly audible above the babble of the neighbouring stream. Finally, at 11.28, the female came with another green insect, promptly delivered it, and flew away, while the nestlings continued to call. Only one meal had been taken to the nest for each nestling in the course of the morning.

Although the male failed to brood them on the two mornings I watched from the hide, I found him with them occasionally during the first four days after they hatched. After they were six days old, I did not find even the female brooding them by day. She continued to cover them by night until they were 11 days old. On her last night in the nest, they were so large that she sat very high, and I could see much of her vermilion abdomen when I looked up the entrance tube with an electric torch. Thereafter, the young trogons, whose plumage had not yet begun to expand, slept alone.

Two weeks after these nestlings hatched, a hole was torn through the very rotten wood above their chamber in the flame-of-the-forest stub and they vanished, probably eaten by some small mammal. The only successful nest of the White-tailed Trogon over which I have watched was that in the massive trunk in the forest, 16 years earlier. The female of this pair disappeared soon after the nestlings hatched. On 16 June, when they were seven days old, I began to watch at daybreak, but failed to see her leave the hole, and by 9.05 only the male had brought food—a big green caterpillar at 5.37 and a large winged insect at 6.38. He did not brood during the four hours of my vigil. Three days later, I found one of the nestlings dead and already putrefying in the chamber, whence now emanated an odour far less agreeable than that of iodoform, which had been so prominent there. The other nestling, standing beside its nest-mate's decaying corpse, was strong and vigorous. I removed the dead nestling, which may have succumbed to exposure when the female failed to brood through the night (I saw nothing to suggest that the male took over this office), or may have died because he was not bringing enough food for two young.

In 11 hours of watching between the seventh and twenty-first days after the eggs hatched, the male parent came with food only nine times. Sometimes a spider spun a web across the entrance to the nest between the male's widely spaced visits; but when he came, he nearly always brought something substantial. As at the nest in the flame-of-the-forest stub, large, green, winged insects formed the bulk of the nestling's food, the kind most often recognizable having a huge, swollen abdomen and relatively small wings that were partly or wholly pink. Sometimes the abdomen of such an insect was brought without the remainder of the body. Some of these insects were either too large for the nestling to swallow or else they were refused because it was already satiated. One day, when the young trogon was becoming feathered, I removed from beside it a dead orthopterous insect that was green and $3\frac{1}{2}$ inches long. Its flattened, expanded thorax, which resembled a green leaf, was $1\frac{1}{2}$ inches wide. The massive abdomen was $1\frac{1}{4}$ inches long and $\frac{5}{8}$ inch thick. In addition to this recently dead insect, I found in the bottom of the nest another of the same kind that had been there longer and was already full of maggots, and still another big insect too far decayed for recognition. The most frequent feeding that I recorded was four times in two hours, when the nestling was 21 days old. Although some were of fair size, the four items brought in this interval were much smaller than most that I saw, and they included two green larvae.

The parent trogon seemed to do most of his hunting in the high tree-tops, for his approach to the nest was always a descent. Usually I first became aware of his arrival when he flew down to perch at mid-height of the forest, where he repeated clear, staccato notes while he rapidly spread and closed his tail feathers, fanwise, to send forth flashes of white. After delaying here briefly, he would drop to a lower perch nearer the nest, then to one still closer and slightly below its level. As he drew nearer, the monotonous calls of the nestling became louder and higher in pitch. Then the parent would dart to the doorway and cling there with only his rump and tail outside while he delivered the meal. After the nestling was older, this was accomplished in a second or two, after which the trogon always flew up into the tree-tops and vanished.

Lack of sanitation.

At this nest, as at the other that I watched, the parent never removed any waste matter. This began to accumulate as soon as incubation started, for the sitting parent sometimes regurgitated the seeds of fruits that it had swallowed whole and left them in the chamber. In this nest were seeds of three kinds, the largest of which were half as big as the eggs beside which they lay. After the eggs hatched, the collection of seeds in the nest did not increase appreciably, thereby corroborating the conclusion I drew from direct observation, that the food delivered to the nestling included few, if any, fruits, in this differing greatly from that of the Quetzal, which brings many large fruits to the nestlings.

The empty shells from which the nestlings emerged were not removed, but, broken into fragments, increased the accumulation of debris on the nest's floor. Soon all this litter was buried by the young bird's excrements, in which maggots squirmed. Food which the young rejected swelled the putrefying mass, and even the dead nestling was left until I removed it. The antiseptic odour of iodoform which had pervaded the chamber before the eggs hatched was now replaced by the pungent fumes of ammonia, generated by the decomposing nitrogenous compounds.

Development of the young.

When newly hatched, the nestlings have pink skin wholly devoid of down. The upper mandible of the short, thick bill is dark grey with a whitish tip and culmen, and the lower mandible is pinkish. The legs and toes are pink, with whitish toenails, and the two inner (first and second) toes are already turned backward, as in adults. The heel is densely covered with very fine, whitish projections, which make it rough to the touch. This papillate heel pad, which is typical of nestlings that grow up in unlined cavities, prevents abrasion as they move around on their rough floor.

When the nestlings are two days old, the remiges and rectrices project from the skin of the wings and uropygium as minute white papillae; but no other feather rudiments are evident. At four days, the buds of the contour feathers are visible in dark lines beneath the skin of the head and body. The lower mandible and the ridge of the upper mandible have darkened. The eyes are still tightly closed. In the next few days, the pinfeathers begin to sprout from the body. When the nestlings are a week old, the sheaths of their remiges are notably long, but those of all the other feathers are still very short. At nine days, their eyes are half open, and a day later they are fully open. After a few more days, the young trogons bristle with long pinfeathers, which on body, wings, and tail begin to open and permit the plumage to expand when the nestlings are 13 days old. This process is rapid, and two or three days later the young trogon is fully clothed in dark plumage. Yet it remains in the nest for about ten days longer.

Voice.

While in the nest, the young trogons use their voices rather freely, and I heard a variety of notes. When newly hatched, they utter hoarse little grunts. When I held a

two-day-old nestling in my hand, it turned up its head and rhythmically repeated a low, soft note that suggested the " cow cow " of the adults, and it also made a sizzling sound such as is given while taking food. Week-old nestlings voiced soft, long-drawn notes in addition to the " cow cow ". When hungry, older nestlings call rhythmically, repeating a note that is deep, mellow, and suggests melancholy. This note changes to a whining, sizzling cry while food is being swallowed, to be resumed after the throat has been cleared, if the young bird is still hungry. A three-week-old nestling repeated the mellow hunger call at the rate of about 34 times per minute.

Parasites.

About the time its feathers began to unsheathe, the nestling in the forest was infested with no less than 12 *tórsalos*. Each of these larvae of a dipterous fly made a relatively huge swelling under its skin; yet the young trogon was otherwise in excellent condition, and appeared to suffer from its parasites as little as from the filthiness of its abode.

Departure.

When this nestling was two weeks old and rapidly becoming feathered, I found it perching on the ridge of wood that separated the nest chamber from the entrance tube, through which it could look obliquely downward on a small circle of the outer world. At my approach, it backed down into the chamber. Early on the morning of 4 July, I heard the plaintive hunger calls of this young trogon emanating from its nest. At four o'clock in the afternoon of the same day, the nest was empty. The nestling period was thus 25 days, eight to ten days longer than that of the other small and middle-sized trogons that I have studied, and as long as that of Quetzals when they are raised in a low cavity. The long nestling period of the White-tailed Trogon, compared with that of the Black-throated Trogon and the Mexican Trogon, seems to be correlated with the greater security provided by its well-enclosed nest.

Except on the day when this nestling and its sibling hatched, I did not see the female bring food to it. At two other nests of trogons of different species, I have known the male to take sole charge of the young after his mate disappeared, but for shorter periods. A female Black-throated Trogon ceased to feed her nestlings at some time between their sixth and eleventh days; that she was still alive was evident from the fact that she brooded them by night until they were 12 days old. Only the male was seen at the nest during the three additional days that the young remained in it. At a late nest of the Quetzal, only the male fed the young during their last six days in it. These two females apparently abandoned their broods because of the waning of their parental impulses, but I suspect that the female White-tailed Trogon had lost her life.

Acquisition of adult plumage.

I have only one record of a young male in transitional plumage. One that I saw in the forest on 11 April 1948 had green and violet dorsal plumage, much as in the adult. His breast was brown and his abdomen vermilion. The exposed portions of the outer rectrices on the right side were pure white, but the corresponding feathers on the left side were barred somewhat as in the female, forming a queer contrast. This male was examining some old woodpeckers' holes in a massive rotting stub and apparently was alone.

SUMMARY

In southern Costa Rica the White-tailed Trogon inhabits the upper levels of heavy forest, from sea level up to about 3,500 feet. It is found alone or in pairs, never in flocks. It subsists on insects and fruits plucked while hovering on wing, and occasionally it catches a lizard on the ground. Its song, an accelerated series of soft, melodious notes, serves to distinguish it from associated trogons.

The preparation of nests begins in the dry month of March, the male taking the initiative. The cavity is carved in the soft wood of a decaying trunk, in or near the forest, by both sexes working alternately. An ascending shaft leads into the top of an ellipsoidal chamber placed deep in the wood. In other regions similar chambers are carved in termitaries.

Laying occurs from mid-April to August. Two or three white eggs are deposited, at intervals of two days, on wood particles which cover the floor of the unlined nest.

The eggs are incubated almost constantly by both parents, sitting alternately. Each day the male takes one long session lasting six to eight hours, and the female sits the rest of the time, including the night. At one nest, the male sat through the middle half of the day. At another nest, he often began to incubate before sunrise, and the female returned to relieve him soon after noon. The incubation period is 16 or 17 days. Eggs which failed to hatch were attended for 51 days, until they disappeared.

The nestlings are hatched with naked, pink skin. Both parents feed them infrequently but with very substantial portions. Two unfeathered nestlings were fed only two to four times in the first six hours of the day. A single older nestling received only nine meals in 11 hours. In the first days after hatching, the nestlings are brooded a little by both parents, but daytime brooding ceases long before they are feathered. One female covered her nestlings by night until they were 11 days old. At one nest, the female vanished soon after the eggs hatched, and the male alone then reared the nestling.

There is no nest sanitation.

Although feathered at the age of about two weeks, a nestling remained in the nest until it was 25 days old.

REFERENCES

BELCHER, C. & SMOOKER, G. D. 1936. Birds of the colony of Trinidad and Tobago. Part IV. Ibis (13) 6 : 792–813.
EISENMANN, E. 1952. Annotated list of birds of Barro Colorado Island, Panama Canal Zone. Smithsonian Miscel. Coll. 117 (5) : 1–62.
SKUTCH, A. F. 1942. Life history of the Mexican Trogon. Auk 59 : 341–363.
SKUTCH, A. F. 1944. Life history of the Quetzal. Condor 46 : 213–235.
SKUTCH, A. F. 1945. The magnificent Quetzal. Nature Mag. 38 : 299–302, 330–331.
SKUTCH, A. F. 1947. Life history of the Quetzal. Ann. Rep. Smithsonian Inst. for 1946 : 265–293. (Reprint of Skutch, 1944.)
SKUTCH, A. F. 1948. Life history of the Citreoline Trogon. Condor 50 : 137–147.
SKUTCH, A. F. 1953. The elusive Massena Trogon. Animal Kingdom 56 : 167–172.
SKUTCH, A. F. 1956. A nesting of the Collared Trogon. Auk 73 : 354–366.
SKUTCH, A. F. 1959 a. Life history of the Black-throated Trogon. Wilson Bull. 71 : 5–18.
SKUTCH, A. F. 1959 b. Trogons and wasps' nests. Nature Mag. 52 : 465–468, 500.

Alexander F. Skutch, San Isidro del General, Costa Rica.