LIFE HISTORY OF THE OLIVACEOUS PICULET AND RELATED FORMS *.

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In the tropics of both the Eastern and Western Hemispheres are found pigmy woodpeckers which are among the smallest of all birds. The dwarf woodpeckers of the New World are included in the genus *Picumnus*, which is represented in South America by about thirty-five species, but north of the Isthmus of Panamá by only a single species, the Olivaceous Piculet *P. olivaceus*. This birdling measures somewhat less than 3½ inches in length. In the male the top of the head is dull black, finely streaked with orange on the forehead and crown, and behind this minutely dotted with white. The remaining upper plumage is largely olive. The tail is dull black, with a broad stripe of pale buffy yellow along its centre when folded. The sides of the head are buffy olive, and there is a row of whitish spots above the ear-coverts. The throat and upper breast are buffy olive, the more posterior underparts buffy yellow with broad, poorly defined streaks of greyish olive or olive. The female differs from the male only in the markings of her forehead and crown, which are without orange streaks and sparsely dotted with white like the hind head. The bill, eyes and feet are dark.

The species occurs in the humid lowlands from the Caribbean littoral of Honduras southward through Central America to Colombia, and is represented by several races. Its distribution in Central America is curiously and inexplicably discontinuous, for in Honduras and Nicaragua it is recorded only from the eastern lowlands (where represented by the race *dimotus*), whereas in Costa Rica it is unknown on this side of the Cordillera and is present only on the Pacific slope south of the Gulf of Nicoya, where the

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Veraguan Olivaceous Piculet (*flavotinctus*), the subject of the present study, is abundant. In this region it is a common resident up to at least 3000 feet above sea-level. It inhabits light but often densely entangled second-growth vegetation rather than the lofty rain-forest. Some writers (Carriker 1910 : 594 ; Peters 1929 : 438) have detected a preference by the piculet for tangles of vines, bushes and small trees on low ground in the vicinity of water ; but I have found it not uncommon far up on hillsides where the second-growth vegetation was lush. It is fond of shady pastures and has even nested in my front yard. Occasionally it enters the primary forest, but I have never found it far from the edge. The piculets live in pairs or family groups at all seasons. They are not so shy of man as most of the bigger Central American woodpeckers, and permit a close approach.

FOOD AND MODE OF FORAGING.

Although nearly all woodpeckers creep in an upright position over the trunks and thicker branches of trees, supporting themselves with their rigid, spiny-tipped tail-feathers, the piculets, so far as I have seen, neither hunt nor rest on thick limbs or trunks, but climb over thin terminal twigs of bushes and low trees, or slender dead vines, clinging with their feet but never propping themselves with the tail-feathers, which lack acute and rigid tips. Often they perch upright on a twig like any finch or tanager. Although their bills are so short, and do not appear to be particularly sharp, the piculets, like the true woodpeckers they are, peck constantly in search of food, confining their attention to branchlets that are usually far thinner even than themselves. Such slender twigs are almost never investigated by the larger woodpeckers, and the piculets have almost a monopoly of the good things that hide within them. Only the curious little Minute Xenops *Xenops minutus*, a brown member of the ovenbird family (Furnariidæ) not much bigger than they, competes with them for the forms of insect life that lurk within these thin dead twigs and vines, which it pecks and pries open with a short, narrow bill having the lower mandible most strangely tilted upward. It is a curious fact that this passeriform bird, so different from the piculet in lineage, but so like it in manner of foraging, should resemble it also in voice and nest in its abandoned holes. Another bird which the piculet resembles, at least in its habit of clinging to slender twigs in all conceivable positions while it pecks at them, is the chickadee (*Parus* spp.); and I doubt not that if the chickadees of the north mingled with the piculets of the tropics they also would find the holes carved by the little woodpeckers convenient for their own nests.

Like so many other woodpeckers, big and little, piculets are very fond of ants, and specialize on those which make their homes in the pith of slender dead branches. When the bird has, with repeated strong, hammer-like strokes, perforated the wood and the ants run out of their retreat, it eagerly

picks them off and devours them, then busily extracts the white larvæ and pupæ, interrupting this activity from time to time to snatch hastily up additional adults which have sallied forth from their desolated home and might otherwise escape. The immature stages of ants form the principal food of the nestling piculets, almost their sole nourishment until they are feathered. In addition to ants and their offspring, piculets remove insects of other sorts from the dead twigs and vines where they lurk, and occasionally even uncover some edible morsel in the heart of a green leafy shoot. They also at times peck into the petioles of great leaves, such as those of the guarumo *Cecropia* and chumico *Pourouma*, that have caught up among branches or vine-tangles after becoming detached from the parent tree. The tiny birds know in some mysterious fashion just where they must perforate the dead petiole in order to extract the grubs that lurk in its core *.

VOICE.

In the piculet the typical picarian *churr* has been reduced to a fine, rapid twitter or trill, which is at times somewhat insect-like and shrill, but at its best is clear, soft and melodious in a small way. Another utterance of the piculet is a clear, sharp monosyllable. I have never found this little woodpecker beating a tattoo on resonant dead wood, in the manner of so many of its larger relations.

NEST-BUILDING.

For a long while after I became acquainted with the piculet I wondered whether so short and relatively thick a bill could be an efficient tool for carving a nest-cavity, and it seemed more likely to me that it laid its eggs in some hole found ready made. But in this suspicion I was unjust to the piculet, which in spite of its small size is every inch a woodpecker, and chisels out its own nest-chamber according to the best traditions of its ancient and respected family. Yet there are limitations in the uses to which so diminutive a chisel can be put. Just as the piculet finds its food in twiglets too thin to be worthy of the notice of its bigger relations, so it must carve its holes into wood softer than many of the woodpeckers would be content to use. And since the stubs of trees with very soft wood, or those far advanced in decay, are likely to topple over if high, the piculet contents itself with a nest near the ground.

* Since this paper was written, A. H. Miller (' Auk ', 64 (1947) : 363) has published some interesting observations on the habits of the nominate race of the Olivaceous Piculet as he observed it in streamside woodlands in the arid upper Magdalena Valley of Colombia. It seems to be somewhat more versatile in its mode of foraging than the Veraguan race, performing " like nuthatches, titmice, or woodpeckers, often in rapid succession, as occasion demands ". They can progress head downward on a trunk. Possibly the more arid environment of this region has influenced the piculets to adopt nuthatch-like modes of hunting they do not find it necessary to employ in humid southern Costa Rica.

In the valley of El General a favourite site for the piculet's nest is a dead, decorticated stub of the burío *Heliocarpus*, a tree whose wood is almost as soft as that of the more widely known balsa, and which is far more common in the upper portions of the tropical zone, where it springs up quickly and in abundance in abandoned clearings. Decaying fence-posts are also frequently used for the nest if the fence-line is near sheltering thickets. Nine nests that I have seen varied in height from 35 inches to 12 feet above the ground. Five of the nests were less than 5 feet up.

On 21 April 1937 I found that a pair of piculets had begun a hole in a low stump of a burío tree in a weedy clearing at the forest's edge. The entrance of this new hole was only 8 inches above that of an older one which during the preceding October and November had been used as a dormitory. Although when first discovered the fresh excavation scarcely extended below the round orifice that would serve as doorway, the task of carving out the soft wood went so swiftly that after two working days it was deep enough to contain the male and female piculets together. When it had reached this stage I set up a blind and watched the little woodpeckers at work.

At 06.40 on 24 April the female piculet arrived and entered the hole, and a minute later her mate followed her in. While together in the cavity they conversed in very low, dry trills, such as I also heard from a pair with eggs while they lingered together in the nest in the early morning. Presently the male stuck his head through the doorway with his bill full of wood chips, which he was slow in dropping. Probably pushed by his mate from below, he flew out after this ; then she threw out many billfuls of flaky wood particles, bringing them up in rapid succession, and merely sticking her head through the orifice in order to drop them. For the next half-hour she continued alternately to chisel and to throw out the particles she had loosened. The carving proceeded rapidly, and after a few minutes of tapping inside the hole she had much loose débris to eject. Once she removed fourteen billfuls in quick succession.

At 07.13 the male returned to do his share of the work and the female flew away. He did not labour so energetically as his mate, but hammered less and threw out fewer billfuls of chips. When he appeared in the doorway with his bill and mouth quite full of wood flakes, he often held them awhile before releasing them ; then he would linger, looking dreamily out instead of promptly descending for more in the efficient manner of the female. After he had laboured in this leisurely fashion for 35 minutes, he flew off without awaiting the female's return.

For 37 minutes the hole remained deserted, then the male returned to resume the task. He worked, still unhurriedly, for eleven minutes, when his mate arrived to relieve him. She joined him inside, and there was a low trilling such as I had heard earlier in the morning. Then for a while the male trilled with his head in the doorway. Next he slipped out and lingered

in front, obstructing the entrance. The female, who was eager to resume operations, hurried him off with a few gentle pecks, then began to throw out chips. She toiled for 26 minutes, then departed without waiting for the male to return.

Five minutes later he flew up and promptly resumed the work of excavation. He laboured harder than early in the morning, and remained at his task for thirteen minutes. Then he left without waiting for his mate.

This hole was finished in four or five days. It turned out to be not a nest, but a dormitory occupied by three piculets ; but probably the cavities are carved in the same manner for whatever use they are intended. The completed chamber is ovoid in form, widest near the bottom. A typical hole extended to a depth of 4 inches below the lower edge of the doorway. Its greatest diameter was $2\frac{3}{8}$ inches from side to side. Another cavity was only $3\frac{1}{2}$ inches deep and $2\frac{1}{4}$ inches in diameter. The doorway varies from $\frac{7}{8}$ to $\frac{15}{16}$ inch in diameter. The chamber is not lined for the reception of the eggs, which rest upon loose chips in the bottom, as with other woodpeckers.

The piculets must often try again and again before they find wood of just the proper degree of hardness for their nest-cavity. One fence-post that contained a hole in which a pair were incubating held also five other cavities which apparently had been made by the same pair in vain attempts to complete a chamber. The most advanced of these abandoned diggings penetrated the wood for two inches. In other posts of the same row were a number more of these uncompleted cavities, some of which had been barely begun. The little birds must have made many futile attempts, and laboured much in vain, before they found a spot in the posts which met their requirements.

THE EGGS.

The piculet nests early, and in the basin of El General in Costa Rica, 3000 feet above sea-level, I have seen a set of eggs with well-formed embryos as early as 24 January (1937). In one nest the three eggs were laid on consecutive days, the last before 08.30. Of the 9 nests I have examined, 6 contained sets of three, 2 sets of two, and one held a single nestling. The eggs are pure white and glossy, and those in one set which had been abandoned measured 16·3 by 12·7, 17·5 by 12·3 and 15·9 by 11·9 mm. In studying the nests of the piculet I examined the interior with a tiny mirror pivoted with adhesive tape on the end of a thin wire bent into an L, at the same time illuminating them with a small electric bulb attached to wires which on the other end plugged into the socket of an electric torch. I never opened occupied chambers.

The distribution according to the month of laying (as observed or computed from subsequent study) of 9 nests in the basin of El General, Costa Rica, 2000 to 3000 feet above sea-level, was as follows :—January, 3 ;

February, 2 ; March, 1 ; April, 2 ; May, 1. Thus the piculet nests chiefly in the dry season, which in this region extends from December or January until March or early April.

INCUBATION.

Male and female sleep together in the nest-cavity before the eggs are laid. On 15 January 1939 I found a piculets' hole 10 feet above the ground in a decaying stub in a grove of coffee and bananas, but close to the forest's edge. There were still no eggs. The male was usually the first to retire into the cavity in the evening. On several occasions I saw his elfish little face framed in the doorway at about sunset. One evening I found him looking out at 17.10, and he lingered constantly in this attitude until his mate joined him for the night at 17.48. He was very tame and did not leave his chamber when I stood close beside the low stub. The first egg was laid on 27 January, after the pair had been sleeping in the hole for twelve days or more. I had a similar experience with another nest later in the season.

After incubation has begun, the pair, as I have seen at several nests, continue their habit of sleeping together in the nest-chamber, and by day sit alternately, in the manner of all other woodpeckers of whose incubation habits I have been able to learn anything, either from personal observation or from reading. In 1937 I watched a nest where incubation was in progress, beginning at 13.10 on 28 January and continuing until 18.00, then resuming my vigil at dawn (05.30) on 29 January and continuing until 12.06. The female was the last to enter on the evening of 28 January, joining her mate in the hole at 17.10 ; and next morning the male left first, at 05.51. Considering only the portions of my record which fell before or after these events, which may be taken as the end and the beginning of diurnal activity, each member of the pair took five sessions on the eggs, alternately. The male's completed sessions ranged in length from 40 to 112 minutes, and averaged 66 minutes. The female's turns in the nest ranged from 30 to 60 minutes, with an average of 50 minutes. The male's total time in the nest was 331 minutes, the female's 251 minutes. The nest was continuously attended. Since each member of the pair remained in the hole until its mate returned to replace it, its own time in the nest was determined by the mate's eagerness to return, rather than by its own willingness to sit. Largely because the female enjoyed the longer recesses, the male spent considerably more time on the eggs than she.

Although I began my watch at dawn when other birds were becoming active, for the next 20 minutes everything remained still about the chamber in the fence-post where the piculets nested and slept. Then at 05.50 I heard low trills issuing from the little round doorway, and almost at once the male looked out. A minute later he flew away ; then the female peered through the orifice, but promptly went down again to keep the eggs warm. After an absence of a little over half an hour, the male returned at 06.23 and

entered the nest, without giving his mate time to leave. She delayed for three minutes, looking through the doorway, before she went for breakfast. She took longer at her meal than the male, and was absent for three-quarters of an hour. Returning at 07.09, she alighted beside the doorway, gave a low, short trill, entered, then looked out several times before disappearing inside. Now the male looked out and soon flew away.

Thus in their mode of replacing each other on the eggs, the piculets departed from the custom of the majority of the woodpeckers, which do not enter the hole until the mate has left. But they behaved like the Golden-naped Woodpeckers *Tripsurus chrysauchen*, male and female of which also sleep together in the nest, and which likewise may stay inside together for brief periods as they exchange the duty of incubation during the day. Usually the two piculets were in the hole together for only a minute or two as they exchanged places on the eggs, but once the female lingered inside for eight minutes after her mate had entered to relieve her. At other times the member of the pair who had been incubating slipped out and flew away, while the newcomer clung to the outside of the post near the doorway, thus effecting the change-over in more conventional woodpecker fashion.

Usually the piculet arriving to enter the nest delivered a low, musical trill while clinging in front of the doorway, then slipped inside. They were not so cautious in entering their hole as are many of their larger relations and many hole-nesting birds of other families. Even when they returned to the nest and found it unoccupied by the mate, they did not cling below the entrance and delay whole minutes while alternately looking about them and peering inside, to make sure that no enemy was lurking within or watching them from outside, but they slipped fairly promptly into the little cavity. Frequently, however, they interrupted their sitting to climb up to their doorway and survey the landscape, often continuing to look out for several minutes together. When the female returned for the night, at 17.10, the male, who had been on duty since 15.55, did not fly forth for supper. But as the sun set he came frequently to gaze through the doorway, while his mate remained hidden from public view, evidently warming the eggs. Finally he, too, retired into the bottom of the chamber as the light faded, and all remained quiet at the nest.

A few days later this nest was discovered by somebody who cut out the side, exposing the cavity, but leaving the eggs unharmed. I replaced the slabs which had been split from the wall of the chamber and tied them in position, but they did not fit closely. The pair of piculets continued to occupy their nest for a day or two, but then their eggs vanished. Still the birds continued to sleep in their ruined nest for two or three nights more, after which their post was pushed or fell over.

At nest 4 the three eggs were laid on 27, 28 and 29 January. One hatched on 10 February. By the following day another egg had hatched ; but one of the nestlings lay dead in the bottom of the nest. By the early morning of

12 February both nestlings were dead in the nest beside the still unhatched third egg. The cavity had been invaded by small ants, which crawled over the bodies of the newborn piculets and apparently had been the cause of their death. Nocturnal incubation at least had begun with the laying of the first egg. Assuming that, but for the interference of the ants, the third egg would have hatched on the day after the second, that is on 12 February, the incubation period was 14 days. Unfortunately I have not had an opportunity to make another determination of this period. The incubation period of the larger Golden-fronted Woodpecker *Centurus aurifrons* is about 13 days.

THE NESTLINGS.

At another nest of the piculets, more successful than the last, two of the three eggs hatched, on successive days, while the third, or possibly the nestling that had emerged from it, disappeared from the hole. The newly hatched piculets had perfectly naked pink skins and tightly closed eyes. The parents were not prompt in removing the empty shells. Looking into the nest with light and mirror four days after the last egg had hatched, I saw a blind nestling trying to swallow a piece of shell ; but it did not succeed while I watched. The shells gradually vanished, and perhaps this observation furnishes the clue to their mode of disappearance. There were still fragments of shell in the nest five days after the last egg hatched. Except for the shells, the parents removed all waste, and at all times kept the cavity irreproachably clean.

On 18 April 1939, when the nestlings were respectively nine and ten days old, I watched their nest from dawn until eight o'clock. As the light grew stronger, the female piculet was the first to look through the doorway. After lingering for fifteen minutes with her head framed in the orifice, she drew back inside. After four minutes more she looked out again, and now delayed eleven minutes gazing upon the outer world. Finally, at 06.05, a whole hour after the early birds had begun to sing in the grey dawn, she sallied from the nest to begin her day's work. Her mate then took possession of the doorway. Although she began her hunting late, she was efficient ; for after only three minutes she returned with a billful of white ant-pupæ, only slightly less than she was accustomed to bring later in the day. As she came to the doorway the male tried to leave, but her breast blocked his exit. Finally he managed to slip past her and wing away. Then she entered, doubtless fed the youngsters down inside where I could not see them, and stayed to brood. After fifteen minutes inside she emerged with a billful of waste material and carried it away. After another fifteen minutes, male and female came together with bulging billfuls of white larvæ or pupæ. The female entered after slight hesitation ; but the male, when he saw me sitting without concealment at no great distance from the nest, went off and did not go to the doorway until four minutes later. He was always more shy than she ;

and if he happened to be in charge of the eggs or nestlings when I came to make my inspections, would fly away and remain out of sight. The female, on the contrary, would flit around within a yard or two of her huge visitor while he looked into her chamber.

The female piculet, as was to be expected from her greater devotion to the nest, brought food much more frequently than her mate, five times to his twice during the first two hours of morning activity. She showed scarcely any hesitation about entering in my presence ; he often hung back for several minutes, yet not long enough to account for his far less frequent visits with food. This had always the same appearance, both this morning and at other times when I saw the parents bring it to the nest. They came always with bill and mouth laden to overflowing with elongate white bodies that projected on both sides, forming a grape-like cluster in miniature. Although it was not possible to make a positive identification of these objects, from having watched piculets extract bodies of the same appearance from ant-infested slender branches, fill their bills with them and fly off as though to a nest, I have little doubt that they were larvæ and pupæ of ants, which appear to be the principal food of nestlings of all ages, and almost their sole nourishment during their first ten days of life. The nestlings, still in pin-feathers, were brooded thrice by their mother, for 15, 18, and 11 minutes and once by their father for 16 minutes—a total of one hour during my two-hour watch.

The nestlings, it will be recalled, were blind and perfectly naked when they escaped the egg-shells. When they were five days old, the black buds of the pin-feathers were sufficiently prominent beneath the skin to be noticed in the mirror that I used for examining them. When they were eight days old the pin-feathers were growing out and their eyes opening. At this stage the youngsters, when I stuck a finger into their nursery, would reach up almost to the doorway and make a continuous buzzing sound—doubtless they did the same when their parents came with food. When sixteen days old their feathers began to unsheath, and at eighteen days the young piculets were decently clad with plumage. The oldest was twenty-two days old before I saw a nestling's head in the doorway.

On the morning of 2 May, when the young piculets were twenty-three and twenty-four days of age, I again watched the nest. When I arrived in the half-light at 05.34 the mother was looking through the doorway. She continued in this position for six minutes, when some small animal shook the vines that hung close about the nest and sent both parents prematurely into the open. As soon as they left the doorway clear a youngster looked out, but withdrew into the interior at once. Nearly an hour passed before, at 06.35, the father arrived with a billful of ant pupæ. A nestling was in the doorway and called with sharp little notes when it saw the parent approach. The father clung below the doorway and passed the food to the nestling.

Then he hastily flew off, for the youngster pecked hungrily at him for more. At 06.44 the mother, whose hunting had apparently been unproductive, arrived with empty bill. She seemed about to enter, but the youngster pecked so vigorously at her that she desisted, and promptly fled. She did not bring food until 07.14, when the father had already fed the nestlings twice.

Although a fortnight earlier the mother had fed the nestlings five times to twice by the father, now during the first two hours of activity the male fed the nestlings five times and she only four times. He had overcome his distrust of me, and was scarcely more shy than his mate in approaching the nest in my presence. To-day for the first time I saw the piculets bring anything other than white ant pupæ to their nestlings. The black bodies that I saw in their bills were apparently mature ants ; but one dark object that was passed to a nestling seemed too long and slender to be an ant, and was probably a larva of some kind from the interior of a dead twig or vine. Yet ant pupæ still accounted for the great bulk of the nestlings' diet.

All of the food was delivered to the nestlings while the parents clung in front of the doorway ; they did not once enter the nest while I watched. The young piculets, instead of gaping widely and waiting passively for the parent to place the food into their open mouths, after the manner of so many nestling passerine birds, snatched the morsels from the bills of their attendants with rapid grasping movements of their own bills, which at a little distance resembled pecking and biting. They continued these movements—sharp forward thrust of the head, closing of the opened bill—after they had taken all that had been brought for them ; and it appeared that they were vigorously pecking and maltreating their parents in most unfilial fashion. Frequently, after having delivered all the food, the parent moved its body a little higher, bringing its breast opposite the doorway ; then, through the binoculars at close range, I could see that the nestling plucked rapidly and vigorously at the breast feathers, as though trying to eat them, but did not actually peck. This treatment was not at all grateful to the parents, who fled the moment the last morsel had been delivered up—and sometimes before. Once when the mother had brought a billful of ant pupæ and delivered most of them, the nestling's plucking at her breast feathers caused her to retreat before she had given it the last morsel. She rested for a moment on a neighbouring vine, brought forward to the tip of her bill a white object which had evidently been far back in her mouth, then returned to the doorway and quickly passed it to the hungry youngster.

It has already been told how, when she came to the nest with empty bill, the eager plucking of her offspring caused her to desist from entering. I have seen similar behaviour at meal time on the part of other species which are fed with morsels carried in the bill rather than by regurgitation. Once under these conditions I witnessed a young Golden-naped Woodpecker actually pull a feather from its parent's breast. But this low nest of the

piculets gave me the best opportunity to observe just how young woodpeckers take their food.

By noon on 3 May both young piculets had left their nest, one certainly not more than 24 days old, the other either 24 or 25 days of age. They remained in the nest about a week less than woodpeckers the size of *Centurus* and *Tripsurus*. (The nestling periods of British woodpeckers, as given in Witherby's ' Handbook ' (1938, 2 : 276–296) are all so very much shorter than those of the Central American species that I have studied—including *Dryobates villosus extimus*—that we must either postulate accelerated development by the young of the northern forms, or suspect that they left the nest prematurely because of handling or too close approach by the observers.) In plumage both of the young piculets resembled their mother, except that the spots which were thickly sprinkled over their forehead and crown were grey instead of white ; and the ground-colour of the crown being a lighter shade of brown, they did not contrast so conspicuously as on the adult female. After the departure of its occupants, I found the nest perfectly clean.

FAMILY LIFE AFTER THE YOUNG ARE FLEDGED.

In the late afternoon of the day these young piculets took wing I watched the cavity from which they had departed. At 16.10 the father of the family came alone to the vicinity of the nest. He repeated over and over a clear, sharp monosyllable and more rarely he trilled, the while flitting among the vines before the doorway, nervously twitching up his wings, and at times pecking on a vine or twig. He lingered alone near the nest until 16.35, when the youngsters appeared ; but soon all drifted off through the thicket again.

After ten minutes more the whole family returned. The mother went to the doorway of the nest to look in, and while she was there a fledgling followed and clung to her back. Both dropped away ; but when the mother again went to the doorway, the fledgling followed once more and entered without difficulty at 16.58. The mother then went in too ; and soon the second fledgling flew toward the nest, but struck the trunk well above it. It then dropped down too far, and toilsomely worked its way upward to the entrance, while with her head in the doorway the mother looked down as though to encourage it, and the father flew to the orifice to show its position. When it reached the opening both made way for it, and it went through without further delay, at 17.02. Soon after the second youngster had entered, the mother flew out and away. Then the father went in and threw a few particles of wood through the doorway. At 17.07 he also flew away.

At 17.16 the mother returned and entered for the night, but she looked much through the doorway until her mate arrived at 17.40. As he came to the entrance, one of the fledglings, sticking forth its head, plucked hungrily at the feathers of his breast. The youngsters were not fed after they entered.

Next morning I watched the piculets begin their day. At 05.30 the mother's head appeared in the doorway, and a minute later she left. Then the father promptly took possession of the aperture, continuing there for six minutes. After his departure at 05.37, a fledgling looked out. Two minutes later the parents trilled among the vine-tangles near the nest ; the fledgling answered with sharp monosyllables and flew forth to join them. At 05.41 the second youngster followed. Then all four flew away to seek breakfast. On going to look into the nest with light and mirror, I found it perfectly clean, although the parents had removed nothing since the preceding evening. Later in the morning I saw the fledglings pecking on slender branches, but they found nothing edible while I watched.

During the four weeks which remained of the month of May, the two young piculets continued to pass the nights with their parents in the hole where they were hatched. One afternoon when a light rain was falling I found both parents and both youngsters in the chamber at 17.25, although it was still broad daylight, an hour before dusk. In June their slender dead trunk toppled over and leaned against a neighbouring one, then the piculets abandoned it as a dormitory.

In 1945 a pair of piculets nested in a decaying fence-post in front of my house. Their single surviving fledgling took wing on 22 March. From then until at least the following 5 July, or over a period of three and a half months, the youngster continued to sleep in the hole in this post along with his parents. Upon quitting the nest the young piculet resembled the two in the nest which has chiefly claimed our attention, and all other fledglings that I have seen ; he lacked orange streaks on the forepart of the crown and resembled the adult female. But by mid-May, two months after he could fly, he had an orange-streaked crown like his father. Among woodpeckers it is apparently more usual for the young at the time of leaving the nest to resemble the parent of the same sex ; or all, including the young females, may more or less resemble their father, as with the flickers. The piculets are exceptional in that both sexes in the first plumage resemble the adult female.

On 23 April 1936 I discovered, among rank second-growth near the forest's edge, a piculets' hole about 10 feet up in a weak, tottering stub. Watching at the following dawn, I saw four piculets leave this cavity, in which they had slept. One was a male, and at least two had the heads white-spotted as in the females and young ; the fourth popped out so quickly that I did not enjoy a good view of it. I continued to keep vigil, and at 06.26 a female returned, remained in the cavity for eighteen minutes, then suddenly darted forth, bearing in her bill something large—for a piculet—and white. Although I did not have a satisfactory look at this object, I could not imagine what it might have been if not an egg. On several return visits during that day I failed to find the hole occupied, and no piculet arrived to sleep in it that evening. Such behaviour was difficult to account for. Possibly the egg was thrown out because it was unseasonable or infertile—I have seen a Pucheran's Woodpecker *Tripsurus pucherani* remove a yolkless egg from the nest, and Moreau (1942 : 39) reports that a White-rumped Swift *Micropus caffer streubelii* ejected an infertile one that had been incubated for a week. But I cannot surmise why the family abandoned their dormitory after this episode.

Piculets may carve their dormitory holes at any season. About a hundred feet distant from the stub where, in April, four individuals had slept and then mysteriously vanished, I found, on the following 25 October, another hole in a low stump in a newly made clearing at the edge of the forest. The doorway was only five feet above the ground, and the cavity, from the bright colour of the wood surrounding the orifice and the fresh chips that littered the herbage below, gave every sign of having been freshly carved. Next morning, after the light had grown bright, I watched a male, then a female, evidently a mated pair, emerge from this cavity and fly across to the neighbouring forest. On the morning of 14 November a male and then two female piculets came out of this hole, where they had slept. At daybreak on 25 December only a single piculet, a female, emerged from this hole. Looking about for a possible new sleeping place, I discovered a freshly carved hole in the stump of a burío tree fifty feet from the old one. This was low, only five feet above the ground. On the morning of 30 December I watched two piculets leave this new sleeping place. The old hole was now abandoned. By 25 January this new cavity was also deserted, and I tried in vain to discover where the pair took shelter from the cold air which now, early in the dry season, flowed each night down the valley from the high Cordillera at its head.

Piculets sometimes sleep singly, for in April 1937 I discovered a freshly carved hole which during the next fortnight, at least, was the dormitory of a lone male. From the foregoing observations we may conclude that young piculets continue to sleep with their parents for at least three or four months after they are fledged. After the dispersal of the young, the adults sleep in pairs ; but even as late as November they will hospitably receive in their dormitory a third individual—possibly a returning child of their own, or maybe an adult which has been left alone by the loss of its mate. Piculet families apparently do not remain intact as long as those of the Golden-naped Woodpecker, which often hold together until the beginning of the following nesting season. Because their holes in low stumps of very soft wood, that quickly decays, do not last as long as the high cavities which Golden-napes carve in trees of more resistant wood, piculets must change their domicile more frequently ; and it is more difficult to follow their history throughout the year.

NOTES ON RELATED SPECIES.

On visits to South America in 1939 and 1940, I made the acquaintance of two additional species of *Picumnus*. Very different in its habitat from the Olivaceous Piculet was Sclater's Piculet *P. sclateri*, which I met among cacti and low thorny scrub in the arid country about Tumbes in extreme northwestern Peru. No bigger than the Olivaceous Piculet, this birdling had also olive upper plumage, but was easily distinguished by the heavy black transverse bars on its whitish breast, contrasting with the longitudinal stripes on the abdomen. On the opposite side of the Andes, in the Pastaza Valley of eastern Ecuador, I saw something of Lafresnaye's Piculet *P. lafresnayei*. This species inhabits clearings and secondary vegetation in heavily forested country even wetter than that where the Olivaceous Piculet is at home. I found it at points ranging from 3000 to 4000 feet above sea-level, but undoubtedly its altitudinal range is far more extensive. Both sexes bore a general resemblance to the corresponding sexes of the Olivaceous Piculet, especially in the markings of the head and the pale yellow stripe along the tail ; but the olive-green upper plumage was flammulated with black, and the underparts, which had a pale greenish tinge, were nearly everywhere heavily marked with dusky transverse bars.

On 17 August 1939, near Puyo, Provincia de Napo-Pastaza, Ecuador, at about 3000 feet above sea-level, I found a nest of Lafresnaye's Piculet. It was at the edge of light second-growth woodland, near a small stream, at a height of ten feet in just such a decorticated stub of *Heliocarpus* as is often chosen by the Olivaceous Piculet. The neatly carved hole, too, was very similar to that made by the northern species, and had a carefully rounded doorway only $\frac{7}{8}$ inch in diameter. It contained two white eggs of which the incubation had already begun. To my surprise, I found three full-grown piculets sleeping in the cavity with the eggs. One was a male with orange-red streaks on his forehead, the other two had the white-spotted brown forehead and crown of the females.

I began to watch this nest at daybreak on 20 August. At 05.59 a female began to look through the doorway, and at 06.04 she flew out. The male at once took possession of the orifice, through which he continued to gaze until his departure at 06.19, when the second piculet in female plumage promptly pushed her head through it. She lingered in the nest until 06.30, after which it remained unattended until the return of the male at 06.42. Instead of entering to incubate, he clung before the doorway and busied himself picking small objects from the surrounding wood. At 06.50 he was joined by a female, who plucked termites out of one of the galleries they had built over the outside of the stub, near the nest-chamber. Both continued their activity until, at 06.53, I approached too near in an effort to distinguish details. At 07.09 the female returned and resumed work in the doorway, plucking off small white objects and throwing them out. She

went off when the male arrived at 07.13. Clinging in front of the doorway, he picked off small objects as before. Several times he entered, but at once came out and continued to work from the outside. When at 07.30 he flew away, I set up a ladder and found a few termites in the chamber. The piculets had been ridding their nest of an invasion of these insects, whose long, irregular galleries were conspicuous over the surface of the trunk. I have seen and read of birds of a number of kinds removing ants from their nests, but this was the only time I ever saw birds freeing their home of termites—as almost every human householder in tropical lowlands is obliged to do from time to time if he would keep a roof over his head.

On 22 August I watched the piculets' nest again to learn something about the details of incubation. The rain which had fallen through most of the night continued after daybreak and delayed the beginning of my vigil until 07.40. The morning remained darkly overcast, with intervals of drizzle and slow rain. The male piculet was in the nest when I arrived and remained, often looking through the doorway, until replaced by the female at 08.09. She incubated for 61 minutes, went away, leaving the nest unattended for 20 minutes, then she (or possibly the other piculet that resembled her) returned and incubated for 42 minutes longer. Then the male replaced her and took charge of the eggs for 46 minutes. At the end of this period (10.58) a female came, relieved the male, sat for 64 minutes, and at 12.02 flew away, leaving the nest unattended. The sessions of these Lafresnaye's Piculets were of about the same length as those of the Olivaceous Piculets whose nest I had watched in Costa Rica. But these Ecuadorian birds sometimes left their nest unattended between sessions, which the Costa Rican piculets never did ; and the few times that I saw one replace the other, the piculet which had been sitting came out before the new arrival entered the hole.

My watch had neither proved nor disproved the supposition that both of the piculets in female plumage took turns at incubation. I greatly desired to continue observations on this nest, and especially to see whether all three of the birds which slept in the nest-cavity would bring food to the nestlings after they hatched. But on the afternoon of 22 August the rain set in again and lasted for more than twenty-four hours without interruption. At the end of this period I found the nest neglected and the eggs wet. The following afternoon one broken egg was sticking to the doorway ; the other remained in the bottom of the nest, which had been definitely abandoned. I searched in vain for another of the same species.

Unfortunately I do not know how many broods Lafresnaye's Piculet rears in a year, nor whether this was an early or a late nest. My surmise was that the second bird in female plumage was the offspring of the mated pair by an earlier nesting, possibly during the preceding year. A similar situation would arise with either the Olivaceous Piculet or the Golden-naped Woodpecker

if the young would continue to sleep in the same chamber with their parents just a little longer than I have actually found them to do. These two species, so different in size and coloration, and apparently not closely related within the family, are surprisingly similar in their life-histories, showing a great advance in sociability over the majority of the woodpeckers whose habits have been studied, the adults of which sleep one in a hole at all seasons, and do not allow the fledglings to return and roost in the nest with them. Lafresnaye's Piculet apparently represents a stage in social development one step beyond that reached by the Olivaceous Piculet and the Golden-naped Woodpecker, being intermediate in sociability between these and the Acorn Woodpecker *Balanosphyra formicivora*. This last is the most highly social of all the woodpeckers I know, several individuals of both sexes sharing the incubation of the eggs and care of the young in a single nest (Skutch, 1943 : 363).

It is not usual among birds for both male and female to pass the night in or on the breeding nest, yet the custom is found in a few species of other families : among motmots by the Blue-throated Green Motmot *Aspatha gularis* ; among swifts by the White-rumped Swift *Micropus caffer* and the Palm-swift *Cypsiurus parvus* ; among barbets by the Costa Rican Prong-billed Barbet *Dicrorhynchus frantzii* ; among swallows by the Blue-and-white Swallow *Pygochelidon cyanoleuca*, Barn Swallow *Hirundo rustica*, House Martin *Delichon urbica* and other species ; among titmice by the Black-eared Bush-tit *Psaltriparus melanotis*, Coast Bush-tit *P. minimus* and Long-tailed Titmouse *Ægithalos caudatus*. In leading the fledglings back to sleep in the nest, the piculets agree with the Golden-naped Woodpecker, Prong-billed Barbet, the swallows mentioned, the Banded Cactus Wren *Heleodytes zonatus*, and some families of the Neotropic House Wren *Troglodytes musculus*.

SUMMARY.

1. The Olivaceous Piculet *Picumnus olivaceus* was studied in the basin of El General in southern Pacific Costa Rica. It inhabits shady pastures and plantations, second-growth vegetation and the forest edges from sea-level to at least 3000 feet. It feeds chiefly in very slender dead branches and twigs, to which it clings without using its rounded tail for support. Ants and their immature stages form an important part of its diet, which includes also other insects and larvæ.

2. The neatly rounded cavities, used both for nesting and for sleeping at all seasons, are carved in dead trunks of very soft wood (*Heliocarpus* a favourite) or in decaying fence-posts, at 3 to 12 feet above the ground. Male and female share the task, each working in the absence of the other. One hole was completed in four or five working days.

3. The piculet nests chiefly during the dry season, January to March inclusive, but laying continues until at least May. Three, or less often two, pure white eggs are laid on consecutive days.

4. During the whole period of laying, incubation and rearing the nestlings, male and female sleep together in the breeding nest, and also sometimes for two weeks or more, before the eggs are laid. By day they sit alternately for from a half to nearly two hours at a stretch. One often enters the hole before the other comes out (a difference from most woodpeckers) ; and they may then remain inside together for a few minutes. A pair watched for an entire day kept their nest constantly occupied. The eggs tend to hatch on successive days after about fourteen days.

5. The nestlings at birth are naked (pink) and blind. At eight days the pin-feathers are becoming prominent and the eyes partly open. The feathers begin to unsheath at about 16 days, and two days later the nestlings are fairly well clad. They begin when three weeks old to look through the doorway, and they emerge at 24 or 25 days.

6. The nestlings are fed and brooded by both parents. Food is brought in the bill and mouth rather than regurgitated. Immature stages of ants appear to form the bulk of the nestlings' diet, especially when they are younger. Later, mature ants and larvæ of other kinds are added. The parents keep the nest scrupulously clean.

7. The nestlings take food with a forward thrust of the head and grasping movement of the bill. This is continued after they have received all that the parents have for them, and greatly annoys the latter.

8. After their first flight the fledglings are led back to sleep in the nest-cavity with their parents, and may continue to do so for at least three or four months. The family retires early, especially on rainy evenings, and emerges late in the morning, after most birds of other kinds.

9. During the second half of the year piculets are most often found sleeping in pairs, occasionally in threes, rarely one.

10. A nest of Lafresnaye's Piculet *Picumnus lafresnayei* in the eastern foothills of the Andes of Ecuador contained two eggs. A male and two birds in female plumage slept in the hole with the eggs. By day the male, and at least one female, took turns at incubation. They spent much time ridding their nest of termites.

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