LIFE HISTORY OF THE WHITE-WHISKERED SOFT-WING MALACOPTILA PANAMENSIS.

By ALEXANDER F. SKUTCH.

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The Bucconidae, or puff-birds, are small to middle-sized arboreal birds, most closely related to the jacamars. The English name has reference to the full, lax plumage, which, covering a short-tailed, large-headed bird, imparts to it a chubby or puffy appearance, as in the puffins. This plumage is usually brown, olive, blackish, or some other dull shade; but a few species are clad in a bold pattern of black and white. The puff-birds' bills are short or of medium length, usually decurved or hooked at the tip, and their feet have two toes directed backward. Puff-birds are most often found perching quietly in the shade of the woodland, alone or in pairs. But the nun-birds (*Monasa*) are more gregarious; and the swallow-wings (*Chelidoptera*) rest conspicuously at the very tops of tall and often leafless trees, whence they dart far into the air to snatch up flying insects, much in the manner of one of the larger American flycatchers. The approximately 30 species of Bucconidae are restricted to continental tropical America, where most are found in the Amazon Valley and Colombia. They occur chiefly in the warm lowlands.

A decade ago, at the suggestion of Dr. Josselyn Van Tyne, I prepared a paper giving all that I had been able to discover, from personal observation or reading, about the habits of these little-known birds (Skutch 1948). My fullest account was of the Black-breasted Puff-bird *Notharchus pectoralis*, of which I was able to present observations on the carving of the nest chamber in a hard, black termitary and on incubation; but I had not seen the nestlings. Of the subject of the present paper, the White-whiskered Soft-wing *Malacoptila panamensis*, I had at that time found only a single nest, which was prematurely lost. In subsequent years I have discovered five additional nests of this species, three of which were successful, and two of which were watched for many hours while they contained eggs and young.

APPEARANCE AND GENERAL HABITS.

The White-whiskered Soft-wing is a stout bird about seven inches in length, with a large head and a short, narrow tail. The male is much

brighter than the female, although in the dim undergrowth of the high rain-forest they may be difficult to distinguish. His head, upper plumage, and tail are warm chestnut-brown or bright cinnamon; his throat and chest are cinnamon or tawny-buff; while the more posterior under-parts are paler buff to whitish. Both dorsally and ventrally the plumage of the female is decidedly more olive and grayish, less rufescent; but sometimes her breast is tinged with cinnamon. Both sexes are liberally spotted and streaked with tawny and buff on the head and upper plumage, while the feathers of the breast and sides are broadly edged with brown and dusky, forming conspicuous streaks, at least in the southern race *M. p. panamensis*, which is the subject of this study. Both sexes wear long, slender, slightly curved, white or whitish malar tufts. Although they do not normally project from the contour plumage, their contrast with its darker colour makes them so conspicuous that they seem to stand out like old-fashioned drooping moustaches, and they even remind one of miniature walrus-tusks. There is also a less prominent whitish tuft on the forehead, just above the base of the bill. In some pairs these curious facial ornaments are equally conspicuous on both sexes. In both male and female the remarkably large eyes are dull red, the upper mandible blackish, the lower mandible bluish horn-colour, and the legs and feet pale gray. The name White-whiskered Soft-wing, of which the substantive part is a loose translation of the generic name, was used long ago by Sclater (1882), but has been largely ignored by later writers.

This species ranges from western Ecuador through Colombia and Central America to southern Mexico. An inhabitant of the lowland rain-forest, it is still fairly abundant in the surviving primary woodland of the valley of El General at 2500 feet above sea level; and once I met it in this area at 4700 feet. El General is on the Pacific slope of southern Costa Rica; but farther north, where the rainfall on this side of the continent is lower and the woodland lighter, the soft-wing appears to be restricted to the wet Caribbean side of Central America and Mexico.

Within the tall rain-forest soft-wings spend most of their time at intermediate levels. I have never seen them in the brilliantly illuminated forest canopy and, except when they are attending nests, I have seldom met them in the low, bushy undergrowth. Usually they are found at heights of 15 or 20 feet and upward; but just how high they range is difficult to learn. Often I have tried in vain to espy a soft-wing whose notes descended from some point amidst the trees well above me, where the far-from-brilliant bird was doubtless perching with habitual immobility. When disturbed at their burrows, soft-wings usually fly directly up into the trees. At times they come out of the forest to forage in adjoining shady pastures or other clearings; and like a number of other species whose home is the interior of the heavy woodland, they most often do this in the dim light of early morning or late

afternoon, or in spells of wet and gloomy weather. Soft-wings never flock and are usually seen singly or in pairs, although once I met three keeping company in November. Sometimes one attaches itself to a mixed party of other small birds.

Although soft-wings sometimes make short excursions beyond their native forests, they do not venture forth often enough to become familiar to the birds of the clearings. I can remember having seen a soft-wing only once in the tree-shaded acre which surrounds our house and abuts at its southern end on the forest where they nest. Late one morning in August, my attention was drawn by a great commotion among the birds in the door-yard. Dropping my writing, I hurried out to investigate, expecting to find nothing less than a hawk or a large snake. With my eyes set for some bigger creature, it was long before they detected the inconspicuous cause of all this excitement—a soft-wing from the neighbouring forest. While the brown bird rested motionless in its usual fashion, it was surrounded by a crowd of scolding or merely inquisitive feathered onlookers. Whenever it darted suddenly to another tree, the Grey-capped Flycatchers *Myiozetetes granadensis* cried out harshly, and the hummingbirds of several kinds rushed after it making low rattling sounds, as when a hawk flies by. Then the whole crowd would gather to scold the visitor in its new position. Finally, it flew across a corner of a pasture into a coffee grove, its persecutors still attending it. The big-headed soft-wing somewhat resembled a pigmy owl, and perhaps for this reason excited the other birds—yet these birds had no experiemce with small owls, which are absent from this area. In the forest where the soft-wing is at home, I have never seen birds of other kinds pay particular attention to it.

Like other puff-birds, the soft-wings conserve their energy by perching motionless on a more or less exposed perch until they sight their prey, clinging or creeping on leaf or bark, sometimes on the herbage close to the ground. The ensuing swift, direct dart surprises the observer who for many minutes has watched the chubby bird sit in apparently lethargic immobility. The prey is seized with a loud " clack " of the heavy bill and carried back to the same or another perch to be devoured at leisure. As far as I have seen, soft-wings subsist exclusively on animal food, including many large orthopterons, moths, other winged insects, large caterpillars, spiders, and lizards which are at times as long as itself. Its large eyes enable it to forage in the dusk, after most diurnal birds have gone to rest.

Puff-birds of several kinds have frequently been called " stupid " because, fearless of man in regions where they have had little experience of him, they often remain perching quietly while one approaches fairly close to them. But this appearance of dull apathy is most deceptive. One need only attempt to study the soft-wing at its subterranean burrows, using all one's ingenuity

to overcome its distrust, to realize what a keen-sighted, wary creature it can be.

VOICE.

Puff-birds are among the most silent of the birds of the tropical forests of America, and none of the species that I know has either a loud or a beautiful voice. The usual utterance of the White-whiskered Soft-wing is a high, thin whistle or "peep", which varies considerably in length and intonation. Sometimes its note is a long-drawn, weak, plaintive "tzeee", that seems to taper off to a sharp point. The soft-wing's calls are such as a man can produce by whistling through his teeth rather than with his lips.

Parents with nestlings still in the burrow, or those whose young have recently flown, greet the approach of a human with these weak, complaining notes, which they repeat interminably as long as he remains in sight, the while perching well above his head, sometimes beyond view in the crowns of the lower trees, and at intervals twitching their narrow tails nervously from side to side. At the end of a sidewards jerk they not infrequently hold the tail motionless, at an angle with the body, just as the motmots do with their far longer and more graceful tails. Once, on hearing such persistent complaints, I hunted for a burrow and found it rather promptly, but on other occasions I have searched over the surrounding leaf-strewn ground for a long while without success; and I have never so much as glimpsed the fledglings, newly flown from a neighbouring burrow, whose proximity was proclaimed by the parents' ceaseless notes of anxiety.

A more elaborate vocal performance was given by a male soft-wing who perched motionless for hours at a time while I sat in a hide close in front of his burrow, which then contained nestlings. This was a rapid, undulatory twittering, sometimes almost a sizzling, in a high-pitched, weak voice: "Tweee, tweee twit a whit a whit, tweee tweee. . . ." This performance was often continued for many minutes without interruption. I can best convey some notion of its character by telling that when I first heard it I took it to be the insistent pleading of some hungry fledgling—probably a member of the Furnariidae or Dendrocolaptidae—and I peered long through all the slits in the hide trying vainly to see it. The male soft-wing was himself in plain view; but since I could detect no movement of his bill, I could not believe that he was the author of an utterance so unlike anything that I had hitherto heard from a puff-bird. But a few days later, while he perched close to the hide holding an insect in his bill, I again heard this queer sequence of notes, and this time I detected the slightest vibration of his mandibles. The low twittering appeared to be an expression of anxiety or impatience on the part of a bird who had long delayed to take his food into the burrow so close

to the hide, although on previous occasions he had done so, usually after similarly protracted delays. This fledgling-like utterance, along with the endless complaining of parents anxious for their offspring, suggest that despite their apparent stolidity soft-wings are no less emotional than other birds.

While in the nest young soft-wings are usually silent, but if when very hungry they hear the wing-beats of a parent or some other bird near the mouth of their burrow, they may set up a high-pitched, rapid, rather plaintive trilling, which exceptionally is continued for several minutes. Sometimes this utterance is given at meal-time; but I have heard it only from well-feathered nestlings, almost ready to fly.

THE NEST.

All the nests of the White-whiskered Soft-wing that I have seen were situated in primary rain-forest, or in one instance in tall secondary growth closely adjoining it, on our farm in El General, at about 2500 feet above sea level. They indicate a breeding season which extends from the middle of March into June or July, with its peak in April and May. Since the usually short dry season, which here begins in January, continues until late March or early April, the soft-wings breed in both dry and wet weather; but most of the nestlings are hatched in May, or even later, when heavy afternoon rains are frequent and the earth around them receives an almost daily soaking.

In view of the small number of nests that have been found, I shall give first the salient facts for each. This should help the reader to follow the subsequent account.

Nest 1 was found on 8 June 1943, when it contained two eggs. These hatched on 17 June, but two days later the nestlings had vanished. This is the nest described in my earlier paper.

Nest 2 was found on 15 April 1948, when it contained three blind nestlings, with pin-feathers just sprouting. Two days later they were dead in the burrow. This nest was discovered by my cook during the political revolution of 1948, when she went into the woods to hide some utensils which she feared might be carried off or destroyed by President Calderón's Nicaraguan mercenaries, who were then pillaging and burning through the valley of El General.

Nest 3 was found on 23 April 1953, when it contained two eggs, which hatched on 30 April. The last nestling left on 20 May, when 20 days old.

Nest 4 was in the same burrow as nest 3, a year later. A fresh lining of leaves, and a new frame of petioles around the doorway, were first noticed at this old burrow on 20 April 1954. The first egg was laid on or a day or two before 28 April. On 29 April I could not see the egg among the

leaves, but the following day there was again a single egg. Another egg was laid on 1 or 2 May, but by 7 May both eggs had vanished. Thereafter I detected no more activity at this burrow, in either this or the following year.

Nest 5 was found in the forest within 100 yards of our house on 23 April 1957, when it contained two eggs. They hatched on 7 May and both nestlings departed in the afternoon of 27 May.

Nest 6 was discovered on 16 May 1957, when it contained a single nestling, its feathers just beginning to expand, and one unhatched egg. The young bird left between 22 and 26 May, and the complaints of the parents when I visited the burrow on the latter date suggested that it was among the neighbouring trees.

The White-whiskered Soft-wing breeds in a burrow in the leaf-strewn floor of the forest, usually in slightly sloping ground. Only one of the five burrows was in a steep slope, but this was far from precipitous—a man or a horse might have walked straight up. Two of the burrows opened upon slight depressions in the ground made by the uprooting of a large tree, every trace of which had long ago decayed, leaving only a low mound composed of the earth which had been lifted up by its roots. Both the mound and the adjoining hollow were carpeted with ground-litter like the rest of the forest floor, and the doorway of the tunnel faced the hillock across the depression. Nest 5 was in slightly sloping ground near the forest's edge, and about a yard in front of it lay a great log, the top of a neighbouring lightning-riven campana tree.

From a round opening in the forest floor the tunnel slopes down at a moderate angle of about 30 degrees with the horizontal, or sometimes less. The five burrows which I measured ranged from 18 to 22 inches in total length, but three of them were 19½ to 20½ inches long. At the doorway the tunnels were from two to three inches in diameter, and they continued inward with about the same bore until they dilated into the roomy nesting-chamber at their lower end. All were so straight that I had no difficulty in seeing the contents of the chamber with my eyes at the burrow's mouth. This chamber was in every case well lined on the bottom and more or less on the sides with large pieces of brown dead leaves, upon which the eggs rested. Surrounding the entranceway was a low collar or frame composed of coarse dead petioles, rachises of compound leaves, twigs, or all together. Mixed with the sticks and overlying them were usually a number of dead leaves, some fairly large; but at the end of the dry season the forest floor is nearly everywhere so thickly carpeted with fallen leaves of all sizes that it is difficult to decide whether the soft-wings place any around their doorway or make an attempt to arrange those which lie in the vicinity, other than to keep their entrance free of them. The birds enter and leave by passing through this frame or collar of sticks, which blends with the ground litter

and helps to conceal the small opening in the forest floor. Only one of the burrows lacked an ample collar of sticks or petioles, and this had a few surrounding the doorway.

The habit of surrounding the entrance of the burrow with sticks is far more strongly developed in certain other puff-birds. According to Cherrie (1916) the Black Nun-bird *Monasa niger* of the Orinoco region may heap above the mouth of its tunnel half a bushel of coarse dead twigs. The burrow itself is reached through a rounded passage-way that runs along the ground beneath the mound of decaying sticks.

Unlike the burrows of certain kingfishers, motmots, swallows, and other birds in vertical cut banks, the openings of which are usually not screened in any way, those of the soft-wing are readily accessible to every creature that creeps or walks over the forest floor. Although the Rufous-tailed Jacamar *Galbula ruficauda* sometimes digs its burrow into the leaf-strewn ground, this is in my experience always on a much steeper slope than the soft-wing chooses; and the jacamar prefers a vertical bank when this is available. In no case did I find any loose earth in front of the soft-wings' burrows. This suggests that they do not dig these tunnels but merely select, and possibly clean out, holes already present in the forest floor; but the uniformity in the size of the burrows that I have seen weighs against this view. More probably the puff-birds carry away in their bills or mouths the soil that they excavate; as Prong-billed Barbets *Semnornis* (*Dicrorhynchus*) *frantzii* and sometimes tits *Parus* spp. remove to a distance the chips which they loosen in carving their holes in trees. An objection to this theory is that to carry away the loosened earth would make the excavation of the burrow a very laborious and time-consuming undertaking. The point cannot be settled without actual observations which, because of the soft-wings' great shyness at their nests, are not likely soon to be forthcoming.

THE EGGS.

Of my six nests, four contained two eggs or nestlings and one, the earliest of all, held three nestlings. Possibly three eggs were laid in nest 4, although I never saw more than two together. The eggs are immaculate white, short and blunt, with little difference in shape at the two ends. The unhatched egg which I removed from nest 6 after the departure of the young measured 27·8×21·8 millimetres. After incubation begins, the eggs are not covered by the dead leaves but lie upon them during the intervals when the parents are absent from the burrow; and as far as my observations go, this is usually if not invariably true of the period of laying.

INCUBATION.

Because of the soft-wing's keen vision and great wariness in approaching its nest, the study of its behaviour while incubating and rearing its nestlings

presents peculiar difficulties, not encountered while watching other small birds of the tropical forest. My observations were made from a " wigwam " hide, constructed of brown cloth supported by three long sticks tied together at the top, as described in ' The Ornithologists' Guide ' (Hutson 1956). At nest 2, I set this hide at noon on a little shelf on the slope below the burrow's mouth, 11 feet from it, and the following dawn I entered to begin my watch. As the light increased beneath the trees, a fairly large snake gradually took shape before me, where it lay motionless, stretched across a rotting log not two yards from the burrow. It vanished when I emerged from concealment to get rid of it. Going then to look into the burrow, I found one of the nestlings lying cold and dead in front of the doorway. The floor of the tunnel and chamber were covered with earth, and the orifice was partly closed. Beneath this freshly loosened soil I found the other two nestlings, likewise dead. All three had sprouting pin-feathers but were nearly naked. Since it began to grow light, I had heard the thin, plaintive whistles of the parent soft-wings in the trees above me, but I did not once see them. It was difficult to decide whether this tragedy was to be attributed to the presence of the hide, to that of the snake lurking in the vicinity, or perhaps to some small animal that had dug into the burrow during the night. But if the last is the true explanation, one wonders why the marauder failed to devour the nestlings.

With this disaster in mind, when I discovered my next burrow, five years later, I decided to watch from a greater distance, and I set up my hide about 20 feet from its mouth. At this distance I needed binoculars to observe details of behaviour, and consequently the windows in the hide had to be left more widely open than when one watches with unaided eyes. The soft-wings appeared to be aware that I was in the tent; and although they entered their burrow to incubate and feed their nestlings in my presence, they often delayed very long before approaching it. Thus after the nestlings were feathered, and the parents had already fed them many times in front of the hide, on one occasion they did not once bring food during five morning hours while I sat in it, although I often heard their weak notes of complaint floating down from the neighbouring trees.

At nest 5 I could find no satisfactory spot for setting the hide except close beside the burrow, where the forward edge of the cloth was only seven feet from its mouth. At this distance I did not require binoculars to see what was happening at the burrow, although sometimes I needed them to distinguish what a parent was holding in its bill as it perched some distance away. But I consistently kept the observation windows contracted to the narrowest slit through which I could peer with my naked eyes. Nevertheless, the soft-wings seemed to know when I was within, even if they had not been in sight when I entered. Even after the little tent had stood for many days in the same spot, they would delay for long periods, often exceeding an hour

and sometimes several hours in length, holding food which they had brought for the nestlings. Although it is probable that they normally spend a short period scrutinizing their surroundings from some convenient perch before they approach their burrow, and the value of such reconnaissance is obvious, the excessively long delays which I frequently witnessed seemed to be caused by my presence in the hide. To learn something about the domestic arrangements of these puff-birds became a battle of patience a contest in which victory went to the one who could sit still for the longest period.

The eggs are incubated by both sexes, according to a very simple schedule. The male soft-wing enters the burrow soon after midday and stays continuously until the following dawn, when he flies forth while the light in the undergrowth of the forest is still faint, usually too dim to reveal his colours. The eggs are then left unattended until the female enters the burrow after an interval of from half an hour to an hour, and sometimes two hours. After sitting for five to eight hours without intermission she flies forth, and then the eggs remain uncovered for a period which may be an hour or more, until the male returns to take charge of them. Thus each parent leaves the burrow before the other comes to replace it. Probably the one who has been free stays off in the forest until its mate coming from the eggs finds it and only then goes to the nest. The only exception which I noticed was on the day when the eggs hatched in nest 5. Then the female sat in the burrow unusually long, not leaving until nearly half an hour after the male came to perch in front of it. In this period of patient waiting, he uttered no sound which reached me where I sat seven feet from the burrow's mouth.

At nest 3 I began to watch in the dim light of dawn at 5.45 on 29 April. The male had evidently already left the burrow; and I saw neither of the soft-wings until an hour later, when the female flew up through the forest and came to rest on a twig five or six feet above the ground and about 20 feet in front of the burrow. For more than an hour she stayed continously in the same spot, never darting out to catch an insect, and uttering no sound audible to me. Apart from turning her head slowly from side to side, she scarcely moved during this long period. At the end of the hour she turned her head more emphatically and nervously twitched her tail many times from side to side—movements which usually announce that a soft-wing is about to fly. At 7.54 she suddenly darted forward in a smooth, slightly curving course which took her direct to the burrow's mouth, into which she plunged with hardly a break in her uniform motion. All this was done in perfect silence.

Then for nearly five hours I saw or heard nothing of the soft-wings. Finally, at 12.51 p.m., a big, brown, white-moustached head suddenly pushed out from among the dead leaves that covered the slope about the

burrow's mouth. With her head and shoulders outside and her hindparts in the tunnel, the bird paused a minute or two to look around with wide, dull red eyes. Then, at 12.53, she darted out and away. By 13.00, when I left, neither member of the pair had appeared. The following day the eggs hatched.

My most complete study of incubation, as of the care of the young, was made at nest 5, which faced a little opening that a fallen tree had made. This gap in the high sylvan canopy admitted more light, which favoured observation; and the nest was, moreover, conveniently close to our house. The female left this burrow when I looked in at noon on 1 May, just before I entered the hide. I did not see the male until 12.57, when he alighted on his preferred perch, a nearly horizontal branch of a small tree, about 15 feet above the ground and 50 feet in front of the burrow, from which it was separated by the open area. Both parents spent much time in this tree, and especially on this perch, while waiting to enter the nest. After a long delay here, the male advanced toward the burrow with two rests at intermediate points, then stood for about a minute on the ground beside its entrance. At 13.32 he walked in, and I watched until nightfall without seeing him again. His mate likewise stayed out of sight.

At 5.18 next morning, while the light was still very dim, the male flew from the burrow, where he had been constantly for nearly 16 hours. At 5.50 the female arrived on the preferred perch. After several advances and retreats, evidently caused by mistrust of the hide or by seeing my eyes at the aperture, she entered at 6.24. Then, although I watched constantly, I saw nothing of either parent until she emerged at 12.35 p.m., after incubating for six hours and eleven minutes. The male had not appeared by 13.00, when I left the hide to chase away a Ghiesbreght's or White Hawk *Leucopternis albicollis*, who was perching close by and, I suspected, delaying the soft-wing's arrival. I did not see the male soft-wing until 13.29, but after perching in sight of the hide for ten minutes he disappeared. Evidently the excitement in the neighbourhood of the burrow had made him distrustful.

Next morning, 3 May, I watched a soft-wing, evidently the male, leave the burrow at 5.20. The female arrived at 5.34 and entered at 5.50, so that the eggs were unattended for only 30 minutes. On 6 May, a cloudy morning, the male flew out at 5.29, when there was barely enough light to distinguish the cinnamon hue of his foreparts that betrayed his sex. The female arrived at 5.43 and entered at 6.12, 43 minutes after his departure. On 7 May, the male left at 5.22; his mate arrived at 5.37 and entered at 5.50. On this morning the eggs were left alone for only 28 minutes, the shortest interval that I noted.

After the female soft-wing went to the eggs at 5.50 on 7 May, I set a little twig upright in the mouth of the burrow, in such a fashion that no bird could pass in or out without pushing it over. When I returned to enter the hide at 11.50, this sentinel indicated that the female had remained constantly within. At 13.18 the male came to his favourite tree, where he rested for the next half-hour, making no sound audible to me. Finally, at 13.47, the female flew forth, having been continuously in the burrow since 5.50—nearly eight hours. At 14.01 the male flew from his favourite perch and I lost sight of him. Emerging then from the hide, I looked into the burrow and saw two nestlings, which had hatched since dawn. Sightless and perfectly naked, they lay between the parts of the neatly divided shells. The male complained from a perch behind the burrow, where he had been hidden from me by the foliage.

On this morning an event occurred which proved that the great caution that the soft-wings took in approaching their burrow was not superfluous. About two yards from the mouth of their tunnel was a nest of the Lowland Wood Wren *Henicorhina leucosticta*, a small roofed structure placed a few inches above the ground, in a pile of fallen sticks and palm fronds, with whose colour it blended. I found the wren's nest first, but only after I had made several visits to it, each time walking close by the soft-wings' burrow, did I notice the latter, and then only because one of the puff-birds flew out as I went past. The eggs of the wrens hatched first, and their ringing songs and visits with food helped enliven the long hours when I sat watching the burrow without seeing the soft-wings. At daybreak on the morning when the puff-birds' eggs hatched, the young wrens were safe in their nest; but when I returned at noon they had vanished, taken by a snake or perhaps the weasel which I had seen in the vicinity some days earlier. But the puff-birds' burrow escaped a fatal visitation both on this occasion and throughout the three weeks that the young were in the nest.

While incubating their eggs or brooding their young, soft-wings sometimes fly from their burrow as a man walks by, frightened forth by the sound or vibration caused by his footfalls, if not by sight of his legs as he passes directly in front of it. If the birds sat more steadfastly, even fewer of their nests would be discovered by ornithologists. But often the parents remain with their eggs or young while one kneels in front and, placing his head near the burrow's mouth, peeps in, at the same time directing inward the beam of an electric torch, without which he can see nothing. The bird's wide red eyes stare steadily into the rays, and often it shrinks to the back of the chamber. Sometimes it flies out as soon as this doubtless terrifying visitation is over, but frequently it stays in the burrow. With repeated visits of this sort, it is more likely to remain at its post; but probably growing attachment to the nest, no less than habituation to the disturbance, is responsible for this increased steadfastness.

At the nest of the Black-breasted Puff-bird which I watched on Barro Colorado Island, Panama, in 1935, the sexes alternated on the eggs just as in the soft-wing, but they sat for far shorter periods and replaced each other more frequently. The longest diurnal session which I timed lasted 2 hours 42 minutes, and the average length of five sessions was only 58·2 minutes. Since their chamber in a black termites' nest well up in a tree appears to be less accessible to predators than the soft-wing's burrow in the ground, the Black-breasted Puff-birds can afford to come and go more often, even though their flights to and from the nest would inevitably reveal its position to any lurking enemy which happened to have them in its field of vision. Because of the similarity of the sexes in this species, I could not learn which parent was in charge of the eggs by night. Of all the birds whose pattern of incubation I have studied, that of the Pale-billed Woodpecker *Phloeoceastes guatemalensis* most resembles that of the soft-wing. At one nest of this big woodpecker, the female sat on the eggs for four and a half hours in the morning, the male for all the rest of the 24 hours.

At nest 5 of the White-whiskered Soft-wing, both eggs were already present when the burrow was discovered on 23 April, and they hatched on 7 May, indicating that the incubation period is 14 days or more.

THE NESTLINGS.

Development. Since I never held a young soft-wing in my hands, but saw the nestlings only by looking in at the mouth of the burrow while it was illuminated by an electric torch, I can give no minute description of them. When newly hatched they have pink skin which is absolutely naked, with no down nor vestiges of feathers. Their eyes are tightly closed, and their short, sharp bills curve downward at the tip. Unlike newly hatched kingfishers and woodpeckers, their lower mandible does not protrude beyond the upper. They already move about actively on their bed of dead leaves, as though trying to escape the light in which they are viewed.

When they are six days old the nestlings' sprouting pin-feathers are becoming prominent, especially on head and wings. Two or three days later they bristle with the long, unopened feather-sheaths. When the nestlings are ten days old their feathers begin to break out of the horny sheaths, expanding at the tips. At this age I first saw one with open eyes. The bill is now whitish. During the next two or three days their feathers unsheath rapidly, and when 14 days old they are well clothed with plumage rather like that of the parents. At the age of 18 days they show traces of the " moustache ", and before they leave the nest they have a conspicuous white " walrus tusk " on either side of the chin, and a small white tuft on the forehead, just above the base of the bill.

At nest 3, I last saw both nestlings when they were 16 days old, but it is possible that on my subsequent visits one was hidden behind the other.

At least one of them stayed in the burrow until it was 20 days old. From the condition of the burrow after its departure, and the behaviour of the parents, I have no doubt that it left spontaneously rather than in the mouth of a predator. From nest 5 both youngsters departed in the afternoon of 27 May. They had hatched in the morning of 7 May, and were accordingly slightly over 20 days old.

Brooding. During the first few days after their young hatch, the parent soft-wings divide the labour of attending them in a manner which is, as far as I know, unique among birds. The father alone broods them, the mother brings all the food. He continues to leave the burrow in the dim light of dawn, when one can scarcely see him; but soon he returns and spends the rest of the day in the nest, either fasting or eating some of the food which his mate delivers at the doorway—a point which I could not settle by my observations. This schedule is maintained for two or three days. After that the male broods less by day, and soon he brings at least a little food. But he attends the young at night until they are eight or nine days old, still leaving at peep of day.

At nest 3 on 1 May, the day after the young hatched, the male apparently omitted his usual early morning recess from the nest; or if he took it, he returned while the light was still so dim that I failed to notice him. Watching from 5.25 a.m., when the illumination in the depth of the forest was still faint, until 11.50, I saw only the female, who brought food at intervals. Emerging then from my hide, I found the male sitting in the nest, where he had been continuously for more than six hours, and probably since the preceding day.

Early next morning, the second after the nestlings hatched, I heard a flutter of wings and saw a big leaf in front of the burrow begin to sway in the still air of the underwood. Apparently the male soft-wing had flown from the burrow while the forest birds were voicing their earliest notes, but I failed to see him in the dim light. At 6.55, after an absence of over an hour, he returned to the nestlings. I watched until 16.15, beneath a shower most of the afternoon, but I did not again see the male, who stayed in the burrow.

Arriving at this nest by moonlight on 3 May, I watched carefully without seeing the soft-wing fly forth, and suspect that he did so before I came. He stayed away until 8.22, when he came to the burrow's mouth, delayed there a minute or so while he peered around, then flew off, possibly because he was suspicious of the hide. I did not remain to see whether he returned later in the day. As I judged from the shaking of the foliage in front of the burrow in the morning twilight on 8 May, the male had brooded through the preceding night; but at the end of this day I failed to see him enter the burrow. Thus he attended the nestlings by night until they were eight days old.

At nest 5, where the young hatched on 7 May, the male left the burrow at 5.25 on 8 May, returned at 6.21, and stayed within all the rest of the morning, while I watched. I made no observations in the afternoon of this day. On 10 May he left at 5.17, returned to his preferred perch at 6.24, but did not enter the burrow until 8.04. He remained within while I watched continuously until 11.17, and he was present when I looked in at intervals of about an hour through the remainder of the day. Now he never flew out when I visited him. On 11 May I did not watch from the hide, which had been removed from the forest for a much-needed drying, but I found the male soft-wing brooding the nestlings at 8.07. They were alone, however, at 11.00 and 12.05. At the second of these visits their father was waiting to return to the burrow, and he was brooding them each time I looked in during the afternoon. On one occasion I saw the nestlings' heads protruding from his breast feathers, but at other times they were invisible. On 12 May, when the nestlings completed their fifth day out of the shell, the male was brooding them at 10.15 and on six other visits through the remainder of the day.

The next day, 13 May, the father of the nestlings left the burrow at 5.23 and stayed out of sight all morning, while I watched from the tent. That afternoon I, for the first time, saw him perching near the nest with food in his bill, but the nestlings were unattended each time I looked in. Thus when six days old they were apparently not brooded in the daytime. Next morning, however, I found the male covering the week-old youngsters at 9.15. Possibly he had come to feed them and from habit stayed to brood for a short time, for this was the last time that I saw him in the burrow in full daylight. He was absent at 10.20 and 12.10 on 14 May. That afternoon, while I watched from the hide from 14.20 until nightfall, he spent most of the time perching idly in the surrounding trees. At 18.00, when the light was failing, he entered for the night. Possibly he brooded for one or two nights more; but after nightfall on 17 May, when the nestlings were ten days old and their feathers just beginning to expand, he was absent, as on all subsequent nights when I visited the burrow.

The screen of leaves. On my nocturnal visits to the nestlings after their father ceased to cover them, I noticed a most curious phenomenon, such as I have seen at the nest of no other kind of bird. The nestlings were hidden behind a screen of dead leaves, which separated their chamber from the tunnel that led into it. At its best, this screen reached nearly to the ceiling and almost completely closed the brood chamber. The dead leaves, which when the eggs were laid covered the floor and at least the lower part of the sides of the chamber, were gradually broken into fragments by the birds' movements, a process no doubt hastened by the dampness of the burrow in the rain-soaked earth. At nest 3 I noticed this barrier of leaves at dawn on 15 May, when the young were 15 days old; but I made no study of this matter at this burrow. At nest 5, I first observed the screen after nightfall on 17 May, when the nestlings were ten days old and no longer brooded. The following night the screen was higher and completely concealed the young soft-wings.

This screen of leaves is raised up by the young themselves rather than by their parents. On 20 May I watched nest 5 from the hide from 15.32 until nightfall without seeing a parent. When I left in the dim light at 18.20, the chamber was completely open, with no screen of leaves. Returning in the dark an hour later, I found that the leaves had been raised until they almost touched the ceiling. Since it was most unlikely that a parent had come after all other diurnal birds had gone to rest and enclosed the youngsters in their nursery, I concluded that they themselves had somehow arranged the screen. The following evening, beginning at 18.15 when the daylight was rapidly fading in the dripping forest, I looked into the burrow with the aid of an electric torch at five-minute intervals for the next 25 minutes, hoping to watch the progress of the screen. On one of my earlier inspections I noticed the nestlings making vibratory movements of body and wings, such as might, if aided by the feet, have served to fluff up the fragments of leaves on the floor of the chamber. By 18.40, when the darkness in the woodland was almost complete, there was hardly any screen. Returning at 19.50, I found the youngsters still wholly exposed, with no shielding barrier of leaves as on other nights. Apparently the shining of the light at the critical period interfered with their normal activity; and thereafter, when the darkness in the burrow must have been almost absolute, they fell asleep exposed to the outer air. Since I did not know how necessary for their safety this screen of leaves might be, I did not again disturb the young soft-wings at nightfall. During their last nights in the burrow it was not as high as formerly, probably because of the further fragmentation and decay of the leaves.

The purpose or protective value of this screen, present only in the hours of darkness, is far from obvious. Even with the brightest moon shining above the roof of the forest, the light in this burrow in the woodland floor would seem to be insufficient to reveal the nestlings to any predatory creature that hunted with its eyes. But most nocturnal prowlers apparently find their prey with the aid of some other sense, usually scent in the case of mammals. It is difficult to understand how the loose screen of leaves, which have been in such intimate contact with the soft-wings, could conceal their odour from a weasel or other small mammal—assuming that the puff-birds have an odour, which I did not detect. Possibly, however, with a snake that hunts by night with its tactile sense, or a great, hairy " bird-spider ", the screen is effective. Its very presence argues that it has some use, however obscure this may be to our dull senses. Although my six nests are too few to permit conclusions in a matter for which statistical evidence is required, the fact that half of them

produced fledged young suggests that the soft-wing's burrow, despite its ready accessibility in the forest floor, is pillaged less often than the great majority of nests in tropical woodland. By day, the nestlings' habitual silence and their parents' extreme caution help it to escape detection, while by night the screen possibly increases the youngsters' safety.

Feeding. As with other aspects of the behaviour of the soft-wings, their mode of nourishing their young presents some surprising features, including the large size of the objects given to newly hatched nestlings, the great irregularity in the rate of bringing food, the feeding by the female alone during the first few days, and the fact that even at first the food is always delivered at the burrow's mouth, never taken into the nest.

As far as I saw in 73 hours of watching at two burrows which sheltered young, they received only animal food, among which were small lizards; green, brown and sometimes pink winged-insects, including mantids and moths; caterpillars and spiders. Except the lizards, the majority of the objects brought to the nest were so badly torn or mashed that recognition was difficult; but most seemed to be such as would be plucked from bark or foliage rather than caught in the air. On one occasion a lizard (*Anolis*) estimated to be four or five inches in length was brought to nestlings little over two days old; and a number of other times the young birds received lizards which, although somewhat smaller, were still longer than themselves.

To deliver the food, the parent stood on the ground in front of the burrow with just its head, or head and shoulders, inside, although rarely it went nearly halfway in. With the bird in this position, it was impossible for me to witness the actual transfer of the food to the young, invisible in the burrow. Since, during the first few days after the nestlings hatched, their father was almost constantly with them, I at first supposed that he came to the entrance, received the food from his mate, then carried it down into the chamber for delivery to his little ones. When a lizard or other object longer than the young was brought, I thought that the parents might tear it between them before the male delivered it to the nestlings.

Continued watching soon disclosed facts that cast doubt upon these conclusions. Thus at nest 3, before the male re-entered to brood on 2 May when the nestlings were about two days old, a parent seemed to deliver food at the burrow's mouth, although in the dim light before sunrise I could distinguish neither the bird's sex nor the food in its bill. But the following day I clearly saw the female deliver a small object at the doorway while her mate was absent. At nest 5, two facts which I noticed on the morning after the nestlings hatched strengthened my growing conviction that they, from the first, took their food from their mother at the doorway, even while their father was with them: (1) She sometimes spent a minute or so delivering the food, holding her head low and making a number of movements. To have passed to her mate a small object which they did not tear between

them, a single rapid movement would have sufficed; and she need not have held her head so low. (2) After taking to the doorway a very large insect, apparently too big for a nestling to swallow, and presenting it for about one minute, she carried it away in her bill. Had she passed it to her mate, he might have eaten it in the chamber after the nestlings' failure to gulp it down.

Two days later, when the nestlings in this burrow were three days old, the female thrice fed them at the entrance while her partner rested among the neighbouring trees. Thus observations at both nests make it impossible to doubt that when only three days old the blind, naked nestlings somehow walk or shuffle up the inclined entrance tunnel, for a distance of about 14 to 18 inches, to receive food from the parent; and it is probable that from the very first they take all of their food in this fashion. Even when a day old they move around rather actively if a beam of light is thrown on them. And if this conclusion is correct, while their father stays in the burrow, he merely broods and does not help them with their meals. Probably he fasts while brooding.

When the female came to the burrow to deliver food, I sometimes heard her utter faint, high notes, which doubtless served to bring the nestlings to her for their meal. Often, however, I failed to detect these notes, even when only eight feet distant from her. Either her notes were too low to carry so far, or they were unnecessary because some other stimulus brought the nestlings forward. Possibly when they were hungry and alert, the darkening of the doorway by her body, or even the sound of her wings as she flew up, notified them of her arrival. One morning after they were feathered, when they seemed to be very hungry, they began to call when a bird of another kind flew past the burrow's mouth. I tried by making a few experiments to learn more about the stimulus which brought the nestlings to the doorway; but no sound that I could produce, with either my lips or a mechanical " bird call ", obtained a response; and they would not come forward when I darkened the burrow's mouth with my hand. The danger of drawing disastrous publicity to a nest on the floor of the predator-ridden forest discouraged long-continued or thorough experimentation on this subject.

Early in the morning of the day after the nestlings hatched in nest 5, the female was resting on the favourite perch with food in her bill when her mate alighted on the same branch, his bill empty. Soon she moved nearer to him. When he rose to a higher limb of the same tree, she followed and came to rest close beside him. Then he flew still higher and she again followed, still bearing the morsel. Apparently she wished to pass the food to him, but he showed no interest in it. Shortly afterward, when the two rested close together on the stipe of a palm frond near the nest, the female seemed again to be trying to pass her food to her mate, but he refused it. Two days later, when the male returned to his favourite tree after his early morning excursion, he found the female resting on a lower limb with food in her bill. She

promptly flew up and alighted a few inches from him, facing him and apparently offering him her morsel; but he remained indifferent to it.

These observations suggest that the female passes food to her mate at the burrow's mouth, at least during the first two or three days after the nestlings hatch; but since the male did not respond, they are inconclusive. I am inclined to believe that from the first the young take all their food directly from the parent who brings it, as they are certainly capable of doing at the age of three days, if not earlier.

As already mentioned, while the nestlings are very young the female is the sole provider. At nest 3 I first saw the male deliver food when the young were eight days old. At nest 5 I first saw him do so when they were seven days old, although on the preceding afternoon I found him resting near the nest with a morsel in his bill. I was not then in the hide and do not know whether he finally took it to a nestling. But even after he begins to feed, the male brings far less than the female. In a total of 36 hours of watching at nest 3, from the first to the fifteenth day after the young hatched, I credited the female with 25 feedings, the male with 3. There were also two feedings by an unidentified parent, making 30 in all. At nest 5, where I watched for 37 hours, well distributed throughout the period while the young were in the nest, I saw the male deliver food only 3 times, the female 32 times, making 35 meals in all.

One reason why the female brought food more often than the male, even after he ceased to brood, was that, long as she often delayed holding a morsel in her bill, he procrastinated far longer, especially at nest 5. She often rested near the nest from half an hour to an hour with food in her mouth, but one rainy afternoon he did so for nearly three hours. When I first noticed him at 14·56 on 14 May, he held something in his bill. As the hours dragged by he moved from place to place, so that I did not always have him in view; but whenever I could see him he bore a fairly large object, and finally, at 17.40, he gave a nestling such an object—the same, I believe, that he had held most of the afternoon. On the morning of 21 May, he sat around on various perches for more than two hours with a green insect in his bill, and he was still clutching it when I left. On the morning of 27 May, this male arrived with food at 7.10. By 9.05 it had disappeared, apparently eaten by him; and when I left the hide at 9.30 he still had given nothing to his nestlings. Kingfishers and trogons sometimes hold food in their bills for an hour or more, but no bird that I have watched has done this so long and consistently as the male soft-wing. To what extent shyness of the hide was responsible for this behaviour, it is difficult to tell. The little tent of brown cloth had already been in the same position for many days, and both parents had repeatedly entered their burrow close in front of it. But then, as I earlier remarked, I received the impression that, although I kept the windows narrowed to the half inch or so indispensable for observation, the

soft-wings usually knew that I was within, even if they had not been in sight when I entered.

The rate of bringing food to the nestlings was surprisingly variable. The highest rate which I witnessed occurred at nest 5 on 10 May, when the two nestlings were three days old. Torrential rains had fallen in the middle of the afternoon, then the sun shone, and later the sky clouded over again. At 16.53 I entered the hide in the dripping forest. At 17.14 the female soft-wing brought a small object to the burrow, and by 18.01, when the light was failing and she ceased feeding for the day, she had brought eight such objects, all in 47 minutes. These items seemed to be found close at hand rather than at a distance from the burrow, as was true of the larger objects brought earlier in the day. Now there was no long delay while the female warily scrutinized the vicinity from some convenient perch, as she customarily did when the light was brighter; but I first became aware of her as she approached the nest, from diverse directions; and she flew up and delivered the food so suddenly that I was usually unable to recognize the inconspicuous objects she carried. On the day after the nestlings hatched in nest 3, one of the parents went to the burrow's mouth twice in the space of three or four minutes, after the Great Tinamous *Tinamus major* and other birds had sung their evening songs and the darkening forest was falling silent. I could scarcely distinguish the soft-wing in the dusky undergrowth, and it was impossible to see whether it carried anything in its bill. But apparently the puff-bird's large eyes permitted it to forage after nearly all other diurnal birds had gone to rest, and it was giving its nestlings a final meal.

These observations at two nests suggested that the soft-wings habitually brought food at an accelerated rate as the day ended, but further watching showed that this was far from being their regular practice. At nest 3 on 8 May there was only a single feeding in the twilight, before rather than after the tinamous' grand vesper chorus swelled through the forest. At nest 5, where on 10 May the female had brought food so actively during the last hour of daylight, the nestlings were on 14 May fed only four or five times after 17.00, thrice by the female and once or twice by the male. On 20 May, however, neither parent came near the nest between 16.00 and nightfall, and on 21 May neither came after 17.20.

In the morning, I never witnessed such rapid feeding as occasionally, but by no means always, took place at the day's end. The highest rate over a long period in the forenoon was 9 feedings in the seven hours from 5.30 to 12.30 at nest 3 on 8 May, when the two nestlings were eight days old. At nest 5 the two nestlings were fed 6 times in the first six hours of the day on 10 May when they were three days old, and 5 times in the four hours from 7.00 to 11.00 on 26 May, when they were 19 days old. At the other extreme, at nest 3 on 15 May, when I watched from 5.30 to 11.00, the nestlings were fed at 6.03 but not once in the next five hours. In 73 hours of watching at

both nests, at all ages of the nestlings and all times of day, the young were fed only 65 times, or well under once per hour for two nestlings.

The great variability in the soft-wings' rate of feeding is no doubt to be attributed, at least in part, to the extensive range in size of the articles delivered to the nestlings, which were sometimes small insects or spiders and at other times lizards four or five inches long. One of the latter would seem to satisfy a nestling for several hours. I received the impression that the parents, especially the mother, were extremely sensitive to the condition of the young, bringing them food promptly when they were eager for it, but staying away for a long while when at the last visit they were satiated.

Sanitation of the nest. I never saw a parent carry waste matter from a burrow. Despite the lack of sanitation, the nestlings always looked clean; and with my face at the burrow's mouth, I could never detect any odour save that of mouldering vegetation. Once when I looked in at the front of nest 3, I saw that the rear wall of the chamber was plastered with little white bodies that resembled droppings, but I did not notice this at nest 5. After the young flew from nest 3, I scraped out the litter from the bottom for examination. The leaves which covered the floor had been broken into many small fragments, amidst which crept numerous fat, white maggots, the larvae, apparently, of a dipterous insect, about as large as a house fly, which had earlier been conspicuous upon the eggs. When I put my nose close to this litter a strong scent of ammonia was evident, but this had not carried to the entrance of the burrow. There was no evidence of droppings on the bottom or walls of the chamber, and there was scarcely any accumulation of the regurgitated shards and other hard parts of insects, such as becomes so prominent in the burrows of jacamars and motmots. Possibly the white larvae hastened the disintegration of the waste matter in the bottom of the nest, preventing its becoming large in amount and offensive in odour.

Miscellaneous observations. Although Cherrie (1916) recorded that half-grown swallow-wings, still in pin-feathers, bask in the sunshine at the mouth of their burrow while awaiting the visits of their parents with food, to scuttle backward into the tunnel when alarmed, the young soft-wings never exposed themselves in this fashion. Even while watching from the hide on their last morning in the nest, I did not see them come to their doorway to sun themselves or look around with only the head exposed; at most I received a fleeting and partial glimpse of a youngster's head as it took food from the parent resting in front of it. The young soft-wings keep themselves well hidden in their inconspicuous burrow until the time for their departure arrives, or at least until this critical moment is close at hand.

Just as they provide no visual clues to their presence underground, so the young soft-wings afford scarcely any auditory clues. Although I spent so many hours watching less than three yards from nest 5, I did not become aware of the nestlings' voices until 26 May, the day before they left. When

an Orange-billed Sparrow *Arremon aurantiirostris*, who had been foraging over the surrounding ground, flew close by the burrow's mouth, the youngsters set up a high-pitched, rapid, rather plaintive trilling, which continued for several minutes. Probably they mistook the sound of the sparrow's wings for that of one of their parents approaching with food. This trilling was renewed when their mother fed them some minutes later. After a while they called once more when a Lowland Wood Wren sang close in front of the burrow, and at their next meal they also trilled. The following morning, their last in the nest, they called briefly after three of their meals, and on one other occasion. Otherwise, I heard no note from them. The nestling soft-wings' habitual silence contrasts sharply with the loquacity of nestling Rufous-tailed Jacamars, who likewise grow up in a short burrow in tropical woodland.

On several occasions I saw an innumerable swarm of small, blackish army ants flowing over the ground near nest 5, accompanied by the avian hangers-on that these foraging ants usually attract. On visiting this nest at midday on 27 May, I found the ants very close to the burrow and moving toward it, preceded by the usual crowd of small fugitive insects driven up from their hiding places in the ground litter, and accompanied by Bicolored Antbirds *Gymnopithys leucaspis*, Chestnut-backed Antbirds *Myrmeciza exsul*, Orange-billed Sparrows, and other birds. Since I did not know how to divert the hunting ants from the nest, I entered my hide to see what would happen. Soon they swarmed around the mouth of the soft-wings' burrow; and I expected that they would drive out the nestlings, who were well feathered and ready to take wing. After I had watched for about ten minutes, the vanguard of the army reached my hide and I prudently retreated.

Going then to look into the burrow, from which the ants had passed on, I found the young birds unharmed. Despite the haste with which the avian followers of the army ants remove themselves from the midst of the swarm into which they have jumped to snatch up some fugitive insect, I have never known these ants to attack feathered birds. Yet I have watched those of another species swarm over a nest in which a Variable Seedeater *Sporophila aurita* incubated, and stream across the feet of an Ocellated Ant-thrush *Phaenostictus mcleannani* who clung to a twig along which they were marching. More surprising than the immunity of the nestling soft-wings was that of the larvae which battened in the debris on the floor of their nursery. Although army ants frequently carry off the soft larvae of wasps and of other kinds of ants, they apparently had not touched these inquilines of the puff-birds' burrow. I also found army ants of the same kind swarming close to nest 6, a few days after the nestling left it. It is fortunate for the soft-wings that they are not appetizing to these ants.

One morning I saw the female soft-wing of nest 5 drive off a Gray's Thrush *Turdus grayi* who had come close to the tree where she and her

mate habitually rested before proceeding to the burrow. This was the only defensive behaviour that I witnessed at any of the nests. When I appeared, the soft-wings never gave a distraction display to lure me off nor made any feint of attack. Yet they were exceptionally watchful parents. At nest 3 they were usually out of sight when I arrived but, especially after they ceased to brood the nestlings, I could seldom approach their burrow without hearing a duet of thin, irritated whistles floating down from the neighbouring trees, and these would continue interminably until I walked out of hearing. Rarely on these occasions I glimpsed a parent perching well above me, twitching its short, narrow tail nervously with a lateral motion, and often holding it tilted sideways at the end of a swing. The parents of nest 5 habitually perched lower, and when I went to look at the nest I often saw them behaving in the same fashion. Even after the young took wing, I frequently heard these long-continued complaints as I passed near a recently abandoned burrow or through a neighbouring part of the forest.

The safety of the soft-wings' burrow depends in the first place upon its excellent concealment beneath the leaf-strewn floor of the rain-forest; upon the parents' extraordinary circumspection in approaching it; upon the fewness of their visits, which they have reduced to the minimum compatible with the attendance of eggs and young; upon the habitual silence and invisibility of the nestlings; upon the absence of a strong odour emanating from the tunnel; and perhaps also upon the screen of leaves behind which the nestlings sleep after they are no longer brooded. The undemonstrative soft-wings are excellently adapted to life in the lowland rain-forest with its many perils; and one wonders how many thousands or millions of years were required to fit them so well to the circumstances of their existence.

Although after the young flew I made occasional visits to my three successful burrows, I did not find a second brood in any of them. Since the soft-wings may nest in a successful burrow in the following year, it is probable that if they laid again in the same year they would do so in the burrow where their first brood was reared. Hence I infer that in the valley of El General they produce only one brood in a year.

SUMMARY.

In the rain-forests of El General, Costa Rica, White-whiskered Soft-wings nest from March to July in a short, descending tunnel in slightly sloping ground. The nest chamber is lined with dead leaves on bottom and sides, and a low collar of sticks and petioles surrounds the round aperture in the leaf-strewn ground.

The two (rarely three) white eggs are incubated by both sexes, the male sitting continuously from the early afternoon until the following dawn, the female taking one long session of five hours or more in the forenoon. Usually each parent quits the burrow before its partner comes in sight, leaving the eggs uncovered for half an hour or more.

The nestlings, blind and completely naked at hatching, remain in the burrow until 20 days old, when they resemble the adults. During their first few days, the male alone broods, staying in the burrow almost constantly, while the female brings all the food, which from the first is delivered at the burrow's mouth. The blind nestlings

move up the tunnel to take their meals, certainly from the age of three days onward, and probably on the day of hatching. The male starts to bring food when the young are about six days old and no longer brooded by day, but at all times he brings far less than the female. For the whole period in the nest, feedings averaged less than once per hour for two nestlings.

After nocturnal brooding ceases, the nestlings at nightfall raise up the leaves from the floor to form a screen in front of themselves. They never expose themselves at the burrow's mouth and are habitually silent. Although the parents were not seen to remove droppings, the burrow remains remarkably clean.

In El General, a single brood appears to be raised each year.

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