

## BREEDING BIOLOGY OF SILVERY-CHEEKED HORNBILL

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## INTRODUCTION

SOME account of the breeding of this hornbill has already been given (Moreau, 1936), with special reference to the building process. It was based on observations, totalling about four hundred hours, made at two nests in the evergreen forest of the East Usambara Mountains, Tanganyika Territory, latitude about 6° south. Since that account was published, and the information it contained compared with that available for other species of African hornbills (Moreau, 1937), further information, which provides a more nearly complete picture of the curious breeding biology, has been accumulated as a result of three more years' experience of the birds. During that period six hundred hours' records have been amassed, mainly by African observers working under our direction at the two original nest-holes and one other. The value of such Africans, able to write Swahili and costing little more than one penny an hour, has been stressed elsewhere. Their standing instructions are to note only the simplest routine items, such as the times of arrival and departure at the nest, but as they get interested they make on their own initiative other notes that often lead to an extension of the original investigations.

It may be useful to recall certain facts already recorded about this hornbill, which is an arboreal species characteristic of the mountain forests of eastern tropical Africa. The male, comparable in size with a Muscovy Duck, is distinguished from the smaller female also by his prominent casque, which is parchment-like in both color and consistency. For breeding, the birds which appear to pair for life, select a hole high up in some great tree and, like the other arboreal hornbills of Africa, constrict the entrance with plaster until only a slit wide enough to admit the bill is left. In *Bycanistes cristatus* all the actual plastering is done by the female, sitting inside the hole and using material produced by the male in the form of regurgitated pellets of soil. These he presents to her one by one in the tip of his mandibles, in sequences of up to four dozen at a visit. The pellets are apparently prepared in the male's gullet, with the aid of copious salivation, but the actual process is one that needs to be elucidated because it has been shown that the lumps of soil swallowed must be divided, and not merely rounded, after the male has swallowed them. Dr. P. R. Lowe has recently been good enough to make an anatomical examination of the necks of specimens obtained for the purpose, and he informs us

that he finds no specialization in the esophageal or laryngeal muscles or other structures.

During the nest-building the pair work continuously for several hours each day, the female remaining in the hole throughout the entire spell. Each afternoon she emerges and flies off with the male to roost elsewhere. Each morning she returns, and toward the end of the building has to struggle hard to pass through the narrowed hole, until the day comes when her morning's work has made it impossible for her to get out again without breaking the plaster away. Then she settles down in the nest to nearly four months of inactivity. We take the opportunity of countering once again, and with the greatest emphasis, the implication so repeatedly made in casual references to hornbill nesting, that the female is in any way compelled by the male to enter the hole or to stay there. In this species she does in fact normally remain until her offspring is fledged, and then she breaks away enough plaster to permit of exit; but exceptionally she has been observed to do the same thing after spending only a few weeks in the nest, without the male's showing any sign of disapproval.

During the whole period that the nest is occupied the male unaided is responsible for feeding the inmates. He brings cargoes of fruits, regurgitating them and passing them through the slit in the plaster one by one.

#### BREEDING DATES

As described elsewhere (Moreau, 1935), the East Usambara Mountains possess an equable tropical climate with a remarkable uniformity of conditions in the local evergreen forest throughout the year. The aspect of the foliage is unchanged and fruit of one sort or another is always available. In these circumstances it has been interesting to find that the breeding of the forest bird community as a whole is practically confined to less than half the year and egg-laying mostly to one quarter, with a peak about October (Moreau, 1936a). So far the hypotheses of a factor controlling the general seasonal breeding all seem open to fatal objections; but it has had to be admitted that we know nothing of the specific composition of any of the birds' food at any stage of the breeding cycle. In this connection it is of especial interest to ascertain how far the hornbills fit into this scheme of a short breeding season, because we now have evidence (see below) showing that nestlings can be reared by the parents on very different staple foods.

At the Ngua nest a female entered (finally sealed herself in) on November 10, 1934, and broke out on December 5; entered on Novem-

ber 6, 1935, and emerged with young on February 23, 1936; entered on October 27, 1936, and emerged with young on February 27, 1937.

At the Amani nest a female entered about November 7, 1936, and emerged on February 1, 1937; entered on November 6, 1937, dropped the shells of two eggs out of the slit on December 13, 1937, and deserted ten days later. Another entrance took place on November 3, 1938, and the female emerged on February 21, 1939.

In addition to these nestings of which the histories are known fully, we have notes of emergences at other nests on February 5 and March 13. Reckoning on a period of 107 to 120 days in the nest (derived from the records in the preceding paragraphs), we get again dates of entrance in October and November. Moreover, a young bird taken still naked from a nest-hole on January 6, 1937, was estimated to be ten days old, which, on the forty-day incubation basis suggested by the 1937 Amani nesting above, would give the date November 16 for the female's entrance.

Thus in the above eight nests the females' entrances all fell within a period of about three weeks centering around November 5, a remarkable phenomenon considering the uniformity of the environment. We have, however, an indication of occasional abnormality. On December 26, 1936, we saw a pair of these hornbills on the wing with two fledged young which must have come from eggs laid not later than mid-September. Even including this case, however, the egg-laying will all be covered by about ten weeks.

#### BREEDING SUCCESS

In the earlier account of this big hornbill's biology the question of the checks on its population was considered and the tentative conclusion was reached that they must be imposed by internal rather than external factors. Our further evidence strengthens this view. There is still no evidence that either predators or parasites take toll of the species. Shortage of big-enough holes might possibly impose some limitation, though in an extensive primary forest of very large trees this effect must be minimized. The results, summarized below, of five seasons' attempts to breed at one nest and three seasons' at the other indicate clearly that internal factors provide an important check. In all these cases the possibility of human interference can be eliminated and, moreover, we know that when the females had sealed themselves in, the males were not neglectful in bringing food.

#### *Amani nest*:—

1934. Pair built during most of November and then deserted.

1935. Sequence of events exactly as in 1934.

1936. Female was inside more than twenty days less than usual, so that probably no young were fledged. (The emergence, which took us by surprise, was not witnessed.)
1937. Female deserted ten days after eggs hatched.
1938. One young fledged.

*Ngua* nest:—

1934. Female deserted three weeks after she had entered.
1935. One young fledged.
1936. Two young fledged.

Thus, in five years at one nest only one young was certainly reared to fledging, though a total of three is possible; in three years at the other nest, three young were fledged. In view of the restricted egg-laying period demonstrated above for this species, it is certain from the dates on which unsuccessful attempts came to an end that the respective pairs had failed conclusively for the year; and hence it can be asserted that in eight pair-years only four to six young were raised to fledging. In the Amani attempts of 1934 and 1935, the breakdown seemed to be due to the fact that the breeding impulse was not strong enough to carry the pair through the labor of building and the male is suspected to have been the weaker agent of the pair (Moreau, 1936). The female was apparently responsible for the failure at Ngua in 1934 (unless she had been able to detect that she had infertile eggs and the fault was in fact the male's); and the female may have been responsible for the failure at Amani in 1937 (see description of behavior after emergence, *postea*).

#### NATURE OF THE FOOD BROUGHT TO THE NEST

The food of this species of hornbill at all ages is practically all fruit. As previously reported, at the Ngua nest in the seasons 1934–35 and 1935–36 most of the food brought by the male consisted of small stone-fruits, mainly *Sersalisia usambarensis* with some *Polyalthia oliveri* and a little of other fruits of different species and types. The following season witnessed a wholesale change in the staple fruits brought. At Ngua most of food remains that could be picked up under the hole were figs (*Ficus* spp.), varying in thickness from one-half to one and a quarter inches. Two of the bigger ones air-dry weighed 19.5 grams. Species occurring once or twice were: *Myrianthus arboreus* (a hard round compound fruit 1.5 inches thick), berries of *Harongana madagascariensis* (the size of haws), and the cultivated passion-fruit (*Passiflora edulis*).

During the same season an almost daily search was made for fruits

dropped at the foot of the Amani nest tree. After October 27, *Sersalisia* began to appear in the gatherings, and once *Polyalthia*, but the staple was obviously figs, especially a small one, apparently *Ficus natalensis*, a species very attractive to passerine fruit-eaters. Other native species that could be identified were: *Chrysophyllum msolo* (pulpy berry), *Parinarium Goetzeanum* (sphere about 1.5 inches thick, with a good deal of firm flesh), *Rauwolfia obliquinerva* (like a cherry), *Sapium ellipticum*, *Eugenia* sp. and *Odyndea Zimmermannii*. The last species, represented by a large ovate nut about 2.5 inches long and devoid of surrounding pulp, has several times been found under hornbills' holes, usually with the skin more or less bitten off. It seems doubtful whether such a 'fruit' could ever be digested. Two exotic fruits from the Research Station plantations had also been taken to the Amani nest, namely, *Dichopsis gutta* (gutta percha, a cherry-like fruit but with very little flesh) and the more nourishing *Maesopsis Eminii*. At the date this latter was brought (end of November) it was probably derived from the last fag-end of the annual crop of a plantation which each year in July and August affords the staple food of scores of these hornbills day after day. We have yet to prove that any other bird eats them and consequently it seems certain that to these hornbills must be attributed the distribution of this good timber tree (originally from Uganda) through the southern part of the East Usambara forests during the last dozen years. Occasionally small white objects that were not fruits have been seen passed into a nest. From one that was dropped it appears that they were the fleshy sweet-scented flowers of *Conopharyngia Holstii*, which may be acceptable as food.

We are indebted to Messrs. P. J. Greenway and F. M. Rogers, of the Research Station at Amani, for the identifications quoted above. A point of general interest is that in successive years broods were raised on widely different staple fruits.

#### SUPPLY OF FOOD BY THE MALE

Whatever the size of the fruits brought to the nest by the male, he always regurgitates and passes them through the slit one by one. The number carried at a single visit varies widely, irrespective of the size of the fruit, except that he cannot accommodate many of the larger at once. Any number from one to about twenty-five is a common cargo for him to arrive with, but much bigger numbers are not infrequent. The most ever recorded is 69 (small figs). It is not surprising that during this sequence the bird showed signs of wear-

ness, several times stopping to rest for a few moments and then resuming after a shake of the head.

At the only nesting previously recorded in detail (Ngua, 1935-36) the male's visits averaged twelve a day for the first seven weeks after the female's entrance, i.e., until shortly after the young probably hatched; then for about three weeks increased steadily, until in the fourth and fifth weeks before the female and single young one flew, an average was attained of 21. Over their last three weeks in the nest the visits averaged only 18, with 310 fruits (Moreau, 1936).

At the same nest in 1936-37, a dawn-to-dusk watch was kept one day a week for the last ten weeks before the female emerged with two young. The male's working day tended to be a little longer than in the preceding season, for he brought the last feed about eleven hours after the first, but he made appreciably fewer visits, as shown in Table 1. (In this table each figure is the complete day's total actually recorded, except those for February 7, which have been estimated from nine hours' observations. On that day the observer noted that he had vacated his post for a time owing to the appearance of a leopard.)

TABLE 1

<i>Date</i>	<i>Number of Days before Emergence</i>	<i>Number of Visits</i>	<i>Number of Fruits</i>
Dec. 13.....	72	13	166
Dec. 20.....	65	13	175
Jan. 3.....	51	14	201
Jan. 10.....	44	12	243
Jan. 17.....	37	15	276
Jan. 24.....	30	17	309
Jan. 31.....	23	18	307
Feb. 7.....	16	20	280
Feb. 14.....	9	18	165
Feb. 21.....	2	15	152

The numbers of fruits brought in this second year were also smaller than in the first, but they were not fully comparable because, as stated in the preceding section, the staple species were different. There is, however, no doubt that the *Ficus* spp. bulking so large in the 1936-37 food would have a much smaller proportion of waste than the stone-fruit that was brought in larger numbers in 1935-36.

The data indicate that while there may have been a reduction in the male's industry toward the end of the fledging period it was not so obvious as in 1935-36; but the records in Table 2 obtained in 1937 at another nest, which may be called C, suggest that such a

reduction is a usual feature with this hornbill. The female and single young bird emerged on March 13 and on each of the preceding thirty days observations were made for either the half or the whole day, to a total of 250 hours altogether. To arrive at the data for the table the half-day totals have been doubled, a procedure that is safe since the whole-day records show no diurnal rhythm in the male's degree of industry.

TABLE 2

<i>Period</i>	<i>Days before Emergence</i>	<i>Average Number of</i>	
		<i>Visits</i>	<i>Fruits</i>
Feb. 11-26.....	30-15	19.5	181
Feb. 27-Mar. 5.....	14-8	18	148
Mar. 6-12.....	7-1	11.5	111

The maximum and minimum daily number of visits in the first period were 25 and 13; in the second, 22 and 14; in the third, 16 and 9. In this instance the definite nature of the male's slackening is emphasized by the fact that from March 6 onward he made one or two visits a day without bringing any food, a thing not recorded of him at any earlier date. The impression that he was getting tired and impatient was further heightened by the fact that beginning on March 5, he was several times observed to rap on the plaster.

At the Amani nest in 1936-37, five complete days' observations were made during the period before the young were hatched (about December 15). The male's visits then averaged 16 (maximum 18, minimum 13) and the number of fruits 223. Thus the number of visits made to the female alone was about the same as to the female with two young in the Ngua nest this same season. After the young had been hatched the male's visits did not at once increase (thus agreeing with the other data for the same stage, those from the Ngua nest 1935-36); for on December 22 and 24, the complete days' visits totalled 14 and 19, respectively. Thereafter, however, the male's industry increased. In eight complete days' observations during the next five weeks, which ended with the opening of the nest, the visits averaged 22 a day (maximum 27, minimum 14) and the number of fruits 191. The visits were more numerous than at the same stage of the other nestings recorded and, moreover, there was no reduction in the male's industry toward the end. But in this respect the nesting is not comparable with the others: the hole was found open only 84 days after the female had entered, i.e., the male had been on duty for 23 to 36 days less than usual. Indeed, as already stated, it is doubtful whether any young could have been reared.

On a review of all the available data on the activity of the male it appears that:—(1) the male's visits become more frequent after the hatching of the eggs, but not immediately; (2) the number of visits in a day shows no close correlation with the number of birds that are being fed. The daily total when the female is alone has varied from 10 to 18, when she has one young from 9 to 25 and when she has two young from 14 to 27. (3) The male's industry slackens in the last fortnight of 15 to 17 weeks' labor.

In connection with the foregoing results it is worth emphasizing that males of the Bucerotidae (except the Ground Hornbills, *Bucorvus* spp.) are in a peculiar position, perhaps unique among birds, as regards the receipt of stimuli from the family for which they are providing. The narrowness of the slit must often combine with the internal depth of a nest to prevent the male from seeing his offspring for at least several days after they are hatched. However, at any rate at first, they must receive their food from the female; but they develop an upright tripod pose quickly, before a single feather appears, and thereafter they would not necessarily be incapable of receiving food direct from the male parent. It may be remarked parenthetically that the young hornbills have no sort of 'directive marks,' no brightly colored gape nor patterned tongue.

It would seem that in *Bycanistes cristatus* vocal stimuli can be of little or no importance. In our experience the young at any stage in the nest utter their hunger call infrequently and then, so far as we can tell, practically only when the male has arrived at the hole. In any case a male spends nearly all his time out of earshot of this call. Moreover, the female's braying, which carries much farther, is rarely uttered in the nest. She does not as a rule respond to the call of her mate or of other hornbills, if it happens to be uttered near. On the other hand we know of two occasions, both at nest C, where the male made a definite response to the female's call. He had taken food to the hole and was sitting in the upper branches of the nest-tree when she brayed. At once he dropped down to the hole and began peering inside, though apparently nothing else happened. At other times in similar circumstances he and other males have seemed entirely unresponsive.

#### SUPPLY OF INEDIBLE ITEMS BY THE MALE

It has already been described how at the Ngua nest 1935-36 the male went to a good deal of trouble to knock off pieces of bark from neighboring trees and bring them to the nest-hole. Before the young were hatched this happened only occasionally, and by no means every



day, but thereafter the number brought averaged three a day and it was only in the last ten days before the young flew that the male failed to supply his family with any bark. We now know that this habit is characteristic of the species, but at most nests the bark seems to be brought less regularly and in smaller quantities than was described above. At the same (Nguá) nest in the new season six pieces were recorded in ten full days' watching. At nest C they averaged about two a day till a fortnight before the young flew and then ceased. (This is what happened in the Nguá nest 1935-36 and is evidently another symptom of the male's weariness after over one hundred days of supply duties.) At the Amani nest 1936-37 one piece of bark was brought nearly every day (only once two), both before and after the young hatched. Occasionally, as might be expected, a male miscalculates the size of the piece he can pass through the slit. Then we have seen him break it up, drop the surplus, and pass the remainder. At all the nests we have studied the male only occasionally brings a stick and passes it in.

We still do not know for what purpose these inedible items are carried to the nest. The female does not hesitate to accept them. (And in this connection it is noteworthy that so far as we can tell the male is never content merely to drop through the slit anything that he has brought, whether it be food or not; if for any reason the hen inside is not ready to take fruit or a pellet of building material he will offer it again and again.) From the debris removed from a nest that was opened (see below), it appears that no large pieces of bark are retained in the nest, and there is no reason to believe that bark plays any part in nest-sanitation; but we think it likely that some of it is broken up very small indeed by the inmates. We are inclined to suggest that the bark, the sticks and the big *Odyendya* nuts (see *antea*) may be supplied simply as playthings, for we have seen a male on a treetop play with a lump of bark, tossing it and chewing it until it was all broken up and then going to get another piece, which he carried straight to the nest.

#### OTHER POINTS IN THE MALE'S BEHAVIOR

The surprisingly sanitary state of the nest interior (see below) is evidently due to several causes, among them to expulsion of feces through the slit and the fact that 'cast' fruit-stones and other rubbish are thrown out periodically by the female. The male sometimes assists. During one of the female's bouts of cleaning, the male sat outside the hole, received the rubbish through the slit piece by piece and dropped it to the foot of the tree (it turned out to be bits of

rotten wood). Such assistance was clearly gratuitous; it cannot have been in the least necessary or even helpful; but, as noted in the original account of these birds' breeding, the collaboration of male and female in the nest-building is peculiarly close and their awareness of each other at all times (they evidently pair for life) seems exceptional. In this connection it is noteworthy that we have practically never yet seen a male enter a hole. He will take the keenest interest in an interior, thrusting in his entire head and neck and peering about inside for minutes at a time, both before the nest has been plastered and also after it has been vacated, but further than that he will not go, although there is plenty of room for him to do so. The same thing happens on the occasional inspection of a hole that a pair may make at any time of the year.

It seems rare, too, for a male to roost in his nest-tree. As a rule he goes right away after bringing his last feed, well before sunset, and he makes his first appearance in the morning from a distance. Probably he joins a roosting party. These are, however, at their greatest at the end of the breeding season, when we have counted 159 of these big birds arriving down one of two convergent valleys to pitch in a tall *Albizzia*.

The attitude of the males to predacious birds varies greatly with the species. They show fear of the powerful but clumsy Vulturine Fish-eagle (*Gypohierax angolensis*) and if they are at the nest-hole when one passes they take cover. Incidentally, Amani is probably the only place in Africa where these two species can ever meet. The big Harrier-hawk, *Gymnogenys typicus*, is ignored by the hornbill. It is a feeble species, but one that takes a most unhealthy interest in nestlings in holes in trees, an investigation facilitated by the naked sides to its head. We once saw one at an occupied hornbill's hole while the male was away, but it was baffled by the extent to which the entrance had been narrowed by the plaster; and in any case the brooding female would have been able to put up a strong defense. A small brown eagle, probably *Aquila wahlbergi*, is always angrily driven off by a male hornbill. We have never seen an encounter with the most formidable bird of the forest, *Stephanoaëtus coronatus*. At the other extreme, it may be mentioned that this hornbill is a perennial butt of the pugnacious drongos, both *Dicrurus adsimilis* and *D. ludwigii*, which can be a nuisance to a busy hornbill. He is incapable of making any retaliation and the attacks seem entirely unjustified. We have no evidence that this hornbill attacks small birds' nests as many other species of the family do.

Hornbills other than the working male do not visit a nest-hole and, so far as we can tell, they settle in a nest-tree only by accident. At nest C this happened rather often during the last month the nest was occupied. The owner was never seen to take any notice of a visiting female or of an itinerant party, but he always attacked a solitary male. This was witnessed on February 17; on February 19, when he launched himself silently at the stranger and drove him away yelling; on February 25, when the intruder stood his ground better and the two birds met for a moment with a noise from their great bills; and on March 7, when the stranger was chased down into a neighboring valley. Finally, on March 11, two days before the family emerged from the nest, the owner was sitting on a neighboring tree when a stranger alighted in the branches well above the nest. At once the owner went for him with such fury that, according to the African observer, the stranger in his headlong flight struck the telephone wire. The owner then flew to the hole and presented one fruit.

#### EMERGENCE FROM THE NEST

An African observer has given a brief description (Moreau, 1936) of how the female and young flew out of the Ngua nest at 09.04 on February 21, 1936. A similar account was given to us by another African who witnessed the flight from the same nest at about 08.00 on February 23, 1937.

Another African account obtained at nest C on March 13, 1937, and recorded in Swahili, is worth giving in condensed form. At 06.20 the male arrived, gave a tap on the plaster (a thing he had done at intervals for the past three days) and flew away again without offering any food. Between 07.12 and 07.18 the female knocked the plaster away and then sat on the rim of the hole until the male came back at 07.24. They then flew away together. Almost at once the male returned to the hole, the baby put its head out and then, apparently without any persuasion, it flew out in the wake of its father as he went to join the mother. At 07.40 both parents flew off out of sight, leaving the baby where it had perched. Five minutes later they returned, the male to feed the baby, the female to sit on a neighboring tree. At 08.03 the male went to look into the hole and for ten minutes continued to peer inside. From then till 08.50 the male paid several visits to the baby and to the female, still each sitting in a different tree. Eventually, at 08.50, she flew away, the baby followed her and the male brought up the rear. They do not seem to have returned to the hole at all.

Finally we ourselves were able to watch the opening of the Amani nest (eighty feet up in a *Parinarium* tree) on February 21, 1939:—

07.20. Female began to knock away the plaster. Male came near and called from time to time, but brought no food. (As usual the female worked only until she had knocked away enough plaster to give her room to get out.)

08.15. Female emerges (having been in for 111 days) and at once flies to a tree a few yards away. A baby comes to the entrance of the nest and sits with its head out.

08.16. Male arrives, gives baby three fruits and departs; female sits on her tree and calls.

08.22. Both old birds perch alongside the hole. They keep putting their heads in and stroking baby's head and neck with their beaks. Male knocks off a lump of plaster and passes it to female who drops it. Male keeps putting his open beak at the base of baby's and stroking it heavily toward the tip. Three times baby nearly overbalances but not quite. At last male reaches in over baby's back and apparently pulls on its rump, upsetting its balance. As it falls outward the male flies off and baby follows. It flies unevenly though not losing height; but when male alights on a branch thirty yards from the hole, baby is unable to do so and continues for as far again before making a clumsy landing on another branch.

08.40. Both parents return to the hole, leaving baby where it alighted. The mother seems weak, sits with her wings drooped to catch the morning sun on her back while he peers repeatedly into the hole. She looks shabby and does not seem to be in new plumage.

08.50. Both join baby. Eventually they all fly off together. (As in other cases all the evidence is that the family never returns to the nest.)

When the female deserted the Amani nest in 1937 ten days after the eggs had hatched, she broke her way out between 08.00 and 12.30, when no one was observing. There was no means of knowing whether the young were alive or dead, but all that day the parents were about. At 13.50 the male was on the boss above the entrance, continually bending down and pushing his head inside, but apparently not regurgitating. Two minutes later the female arrived, flying normally, sat on the boss opposite the male, and they 'kissed.' The female then regurgitated two fruits, one after the other, which the male took and apparently proffered in the hole. It could not be seen what happened to them. Just afterward he regurgitated a fruit which she tried to take from the tip of his bill. He refused to let her have it and swallowed it himself. This happened twice before they flew away. At 14.38 and 15.16 the birds visited the tree again; on both occasions the male spent some time peering about with his head and neck inside the hole, while the female adopted a more detached attitude on the branches above. However, when at 15.40 and 16.20 they visited the tree again, the female both times went right inside the hole and stayed there for over ten minutes. At 16.40 they appeared

again, calling loudly. This time, while the female sat in the crown of the tree, the male, after repeatedly peering into the nest, started pulling out what looked like scraps of bark and stick. Later, both the birds sat on the boss, 'kissing,' peering inside and bringing out oddments, which they dropped. Eventually they flew away, and neither slept in the nest. The following morning, however, they visited it twice between 07.00 and 12.00, the male poking about in the hole as before, the female sitting higher up in the tree. Thereafter they lost all interest.

Certain generalizations of interest may be derived from these accounts:

(1) The emergences take place in the early morning. Including the Ngua nest desertion in 1934 we have five accurately timed emergences and all happened between one and three hours after sunrise.

(2) The females, after over 100 days' inactivity, the young birds from the moment of leaving the hole, fly well.

(3) The males show a keen concern for the young and also the greatest interest in the opened nest-hole, although they never enter it.

#### THE INSECT FAUNA OF A NEST

When a nest was opened to extract a young bird, all the loose material was scooped out and bagged. It consisted almost entirely of fragments of more or less rotten wood, certainly off the walls of the hole, and a few scraps of bark, but with no obvious dung, nor food remains; it was dry, inoffensive and in fact nearly odorless. It was carefully sieved and sorted and as many insects as possible were picked out. Through the kindness of Mr. N. D. Riley these have been identified at the British Museum (Entomology Department) by Mr. E. B. Britton, who has reported as follows:—

HEMIPTERA-HETEROPTERA: 86 adults and 37 nymphs of *Chilocoris laeicollis* Horraath (Cydnidae). The only members of the family Cydnidae of which any biological facts are known are phytophagous, living on the ground or burrowing into the soil at the roots of grass, etc. No explanation can be offered of their breeding in the hornbill's nest.

COLEOPTERA: Carabidae (1). 2 adults of *Oecornis nidicola* Britton (Ent. Mon. Mag., 76: 110, 1940). *Oecornis* is a peculiarly isolated genus, the nearest ally of which is probably the genus *Brachynopterus* Bedel, 1898, which was described from a single individual taken in Algeria. They probably feed on insect larvae. (2). 15 larvae of one species, probably of tribe Colliurini; probably predacious. Elateridae, 15 larvae of one species, probably Synaptinae; biology unknown.

Tenebrionidae, 35 larvae of a species of, or near, the genus *Alphitobius*, probably feeding on fungi and rotten wood.

LEPIDOPTERA: Psychidae, 201 larvae. (A normally phytophagous order.)

ORTHOPTERA: 43 nymphs of *Trichomera* sp. n. or closely allied genus; omnivorous.

DIPTERA: Acalypterae, four larvae.

Thus 438 insects were recovered from the hornbill's nest-hole and at least seven of the eight species represented were breeding there. At least two of the forms were new to science and the occurrence of two of the others was unexpected and denotes that their habits must be aberrant from the normal for their families. The probable value of collecting the contents of any hornbill's hole that may be opened is amply demonstrated.

On the same date the following year the contents of the hole were again collected. It would not have been so warm and dry as when the hornbills were in residence, but the main difference in the conditions of the interior would certainly have been the absence of food remains in various forms. The insect fauna had changed entirely since the previous year. Apart from scores of adult cockroaches of the subfamily Panchlorinae, there were only a few dipterous larvae of three species and elaterid larvae of one species. The abundance of insects breeding in the hole the first year thus evidently depended on the hornbills, and the thoroughly sanitary state of the nest must owe much to their scavenging activities.

#### SUMMARY

This supplementary account is based in the main on about 600 hours' observations.

The egg-laying in the East Usambaras is practically confined to about three weeks in the year, notwithstanding the uniform evergreen environment. Moreover, the details given of the fruits brought to the nest show that the staple species vary in successive years.

The population seems to be controlled mainly by internal factors; and in eight pair-years only four, or possibly six, young were reared to fledging, with no evidence that external factors contributed to the failures.

Males' visits to the nest with cargoes of fruit vary between 9 and 27 in the day. The number shows little correlation with the number of birds in the nest, but in any one nest it always increases a fortnight after the eggs have hatched. It increases again a fortnight before the

family emerges, i.e. when the male has been working for over thirteen weeks, and he shows other signs of slackness and impatience.

All males bring inedible objects, usually pieces of bark, to the nest once a day or oftener, probably as playthings for the inmates.

A working male will not allow another male to settle anywhere in the nest-tree. His reactions to accipitrine birds vary with the species.

Exits of mother and young are described. They always take place from one to three hours after sunrise. The mother, after over one hundred days of inactivity, and the young, at the first attempt, both fly well. The male attends to the young and also shows great interest in the opened nest-hole, although at no time in the entire breeding cycle does he enter it.

The interior of an occupied nest was sanitary and almost odorless; 438 insects were recovered from it. They belonged to eight species, mostly breeding there and mostly of special interest, being either undescribed species or aberrant members of their groups. They were probably beneficial scavengers.

#### REFERENCES

MOREAU, R. E.

1935. A synecological study of Usambara, Tanganyika Territory, with particular reference to birds. *Journ. Ecol.*, 23: 1-43.
1936. The breeding biology of certain East African hornbills (Bucerotidae). *Journ. East Africa and Uganda Nat. Hist. Soc.*, 43: 1-28 (part has been translated for publication under the title 'Die Brutbiologie des Nashornvogels, *Bycanistes cristatus*.' *Journ. f. Ornith.*, 87: 272-295, 1939).
- 1936a. The breeding seasons of birds in East African evergreen forest. *Proc. Zool. Soc. London*, for 1936: 631-652.
1937. The comparative breeding biology of the African hornbills (Bucerotidae). *Proc. Zool. Soc. London*, 107 (A): 331-346.

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