

DISTRIBUTION OF NEST PREPARATION TASKS BETWEEN MATES OF THE REDBILLED HORNBILL *TOCKUS ERYTHORHYNCHUS*

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SUMMARY

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The Redbilled Hornbill *Tockus erythrorhynchus* is not well known from a systematic and ethological point of view even though it ranges over a large part of sub-Saharan Africa. A study in Senegal involved 80 hours of observation on the two main stages of nest-preparation : bringing of materials and partial sealing of the nest entrance. During the first phase of nest preparation, the male spent more time inspecting, feeding and preening ; the female took more material into the nest than the male. In the second phase of nest preparation, the female sealed the nest entrance by herself and rested less than the male. It is the role of the male to choose the breeding site and to defend the nest. The female's primary role is to choose the materials for the interior of the nest and also to block the entrance with mud. The male brings various lining or building materials which the female may choose to use or to reject. A few days before the female seals herself into the nest, she opens up and re-closes the nest entrance, once from the outside and once from the inside so as to be able to exit and enter the nest at will.

RÉSUMÉ

Le Petit Calao à bec rouge, *Tockus erythrorhynchus*, bien qu'abondant et largement réparti dans une grande partie de l'Afrique sub-saharienne, est encore mal connu du point de vue systématique et éthologique. Pendant la période de reproduction les tâches sont bien réparties entre conjoints. Nous avons effectué au Sénégal 80 heures d'observation pendant les deux principales étapes de l'aménagement du nid : apport de matériaux et fermeture partielle de l'entrée du nid. Durant la première étape de préparation du nid, le mâle a passé plus de temps à l'inspection du nid, au toilettage et à son nourrissage ; la femelle a apporté plus de matériaux au nid. A la seconde étape de préparation, la femelle a fermé presque seule l'entrée du nid et s'est reposée moins que le mâle. Il revient au mâle de choisir le site de reproduction et de défendre le nid. Le choix des matériaux pour tapisser l'intérieur du nid et le colmatage de l'entrée avec de la boue sont dévolus presque entièrement à la femelle. Quelques jours avant sa claustration, la femelle ouvre et referme l'entrée du nid une fois de l'extérieur, une autre de l'intérieur pour entrer ou sortir.

INTRODUCTION

The habitat of the Redbilled Hornbill *Tockus erythrorhynchus* is open savanna. It is present in nearly all the shrubby zones of the arid savanna (Bouet 1961; Snow 1978; Morel & Serle 1979). In Senegal, *Tockus erythrorhynchus* is one of the birds most commonly found throughout the country ; however, observations in the Niokolo-Koba National Park and in Lower Casamance reveal that it avoids the densely wooded areas (Morel & Morel 1990).

The systematics of this species remains complex (Kemp 1994) particularly in view of the significant differences recently observed in the color of the eyes and of the peri-orbital skin, depending on the geographical distribution. Birds in Senegal, all with brown eyes and black peri-orbital skin, may belong to an as yet undescribed taxon (Kemp 1995).

Hornbills, particularly the large Asian species, are threatened by their dependence on the natural cavities found in large trees (Reilly & Sheppard 1994). In the ORSTOM experimental ecological reserve in Mbour (Senegal : 14 23 N ; 16 58 W) where observations were begun four years ago, the cavities of two trees (*Casia siamea* and *Adansonia digitata*) have been regularly occupied by *Tockus erythrorhynchus*. This species has made great use of the nest-boxes set up in the 70-hectare reserve (Diop & Tréca 1993). Since 1991, 55-70 % of the 10-18 nest-boxes are occupied

each year by female *Tockus erythrorhynchus*. Observations of several pairs of *Tockus erythrorhynchus* have shown that it is the male who selects the nesting site. If the female approves, the mates then prepare the nest, bring lining material, rearrange this, bring sealing material and seal the nest entrance, with each one performing specific tasks depending on the phase of construction. Copulations occur frequently at that time.

The present paper describes the role of one male and one female by timing the different activities of each of the mates during the two major nest preparation phases.

METHODS

Nest preparation comprises two major phases. The first phase includes the period between the first bringings of materials inside the nest and the start of plastering mud in nest entrance. The second phase covers all the period of partial sealing up of nest entrance.

During the nest preparation period, we established the time budget of one pair of Redbilled Hornbills around the nest. The main activities were nest preparation, nest inspection, feeding, preening, vocalizations, display and mating, absence and resting. By nest preparation, we mean that the pair brings lining material or pastes mud at the entrance of the nest.



Inspection happens when they watch or inspect the interior of nest. Feeding means that the birds eat something. Preening signifies they preen feathers or scratch some part of their body with their beak or their feet. Vocalizations refer to their singing or calling. Absence is noted when the observer, staying in view of the nest, cannot see the birds around. During their display the male and the female jump on branches and the male pursues the female; finally, mating occurs in which the male mounts the female and copulates. As mating is very brief, it has been included under display in the figures. Resting means that the bird is perched, not carrying out any of the above activities.

The pair of Redbilled Hornbills which we have focussed on in the present study used the nest-box G as described by Diop & Tréca (1993) : size 20 x 19.5 x 55 cm with a round 10 cm diameter entrance. The nest-box was fixed at a height of about 4 meters above ground. Observations took place on 14 days between 25 July and 31 August 1991, in total 80 hours and 36 minutes.

Observations were made with binoculars (10x40) or a telescope (x40) from a hide offering the broadest possible view of the nest-box G. The observations lasted for 3 to 5 hours each day, at different times between 07h00 to 19h30. They were made continuously, except for some short breaks, and were recorded every two minutes on a data sheet. At the end of each period we calculated the amount of time each bird had spent on different activities.

Cumulation of data for the same hour from different days has been limited to the first 30 observations, in order to conform with statistical requirements. Variance analysis (ANOVA) and the Newman-Keuls test (5%) were used to compare the different activities of the male and the female.

RESULTS

First phase of nest preparation

Inspection of the nesting site

As the rainy season is approaching, humidity increases from 24-90 % in May to 61-95 % in June (data from national meteorological office). At that time most trees start to grow their leaves. Around mid-June, *Tockus erythrorhynchus* which previously moved in groups of 5 to 15 birds, pair off and stay close to the nest-boxes or natural cavities, rarely venturing far. By mid-July, after the first rains, they are more and more frequently observed in pairs. The pairs (*T. erythrorhynchus* in general) examine the nest-boxes or natural cavities. During this period, males are always the first to land on a branch close to the nest-box or the cavity they have chosen. They are also the first to check the surroundings and the interior of the cavity or nest-box before being joined by the female who then conducts the same behaviour.

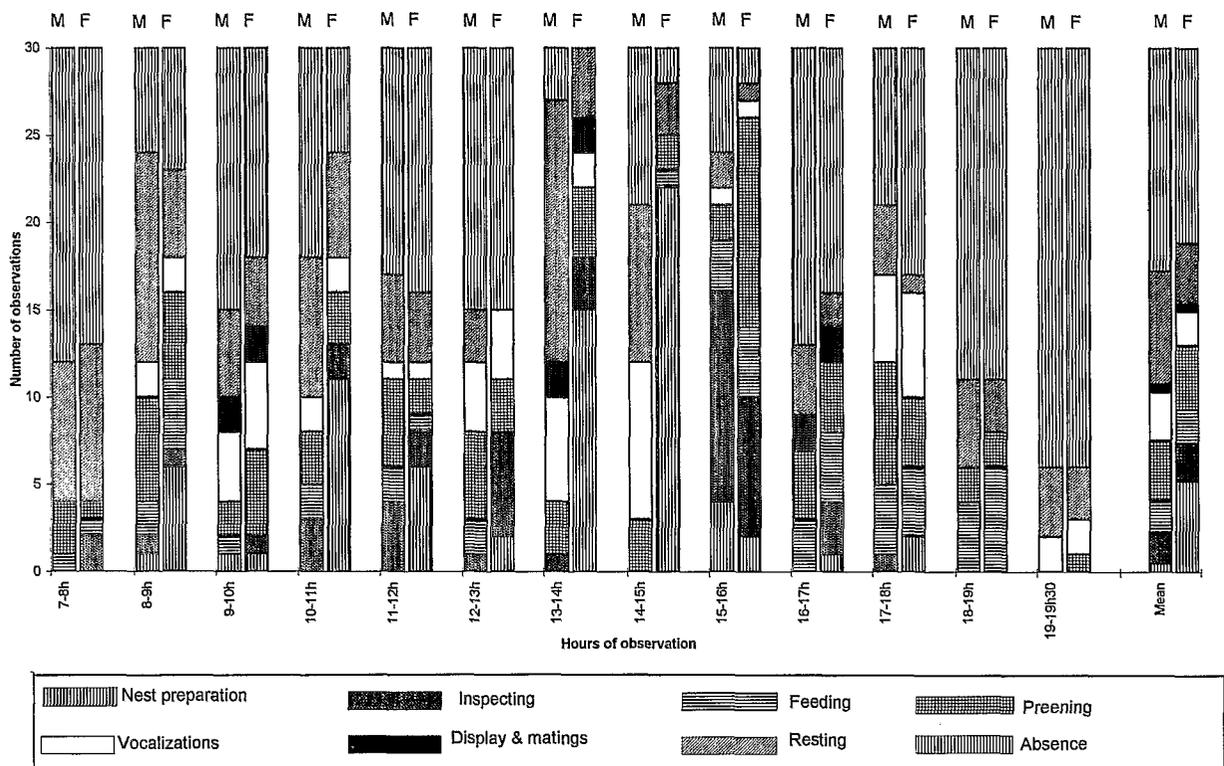
Once they had selected the site, the observed mates using nest-box G stayed around for more than 50 % of the day. They did not allow another *Tockus erythrorhynchus*, not even a female, to approach the nest. Nevertheless, the pair remained indifferent to a bird of any other species which perched on the tree.

Collection of materials by the male and female

After the first rains (10, 13, 17, 22 July 1991), the pair which had selected the site began to stock building materials from time to time. We saw this particular pair and other hornbills behaving the same way at the same time. They brought lining materials consisting of balls of sand, sea-shells, twigs, dry leaves, bark of dead trees, pods of *Albizia lebbek* or even broken glass.

Observations were facilitated by the fact that during

FIGURE 1
Activities of the male and the female during the first phase of nest preparation



the first 15 days of the material-gathering phase (from 25 July on), both the male and female remained active around the nest-box for the greater part of the day. Figure 1 shows the various daily activities of the male and the female and compares the time spent on each one.

The female was more active than the male in bringing materials to the nest: daily means 9.08 min/h (female) against 3.7 min/h (male); according to Newman-Keuls' test this is a significant difference at the 5% level. The male inspected the nest significantly more (12.46 min/h) than the female (7.70 min/h). Nest inspection occurred at every hour of the day except for the female after 19h00. On average, the pair spend almost the same time feeding: 7.38 min/h for the male against 6.62 min/h for the female. However there is a significant difference in the time spent feeding during some hours of the day (11h00-12h00 and 18h00-19h00).

There are no significant differences between sexes with respect to vocalizations. Observation of other pairs shows that hornbills may call at all times of the day. Duration of rest periods is also similar (means: 7.24 min/h for male against 6.46 min/h for female). Figure 1 shows that these activities were performed at every hour of the day. The female is more frequently absent (23.84 min/h) than the male (19.08 min/h), a significant difference. The male, however, checked the interior of the nest, fed and preened more often than the female. He continued to watch over the nest while performing these activities. During the period of collection of nesting material, the mates have never been observed displaying or mating in the vicinity of the nest.

Prior to the breeding period, the hornbills used to rest between 12h00 and 15h00, but during the first nest preparation period, the mates of nest-box G became more active at this time of the day and spent more time around the nest.

Second phase of nest preparation

Partial closing of the entrance by the male and female

Once the rainy season was underway and the soil became damp, the second phase of construction began. This phase was launched 10-15 days after the pair began to stock materials (i.e. August 5-10).

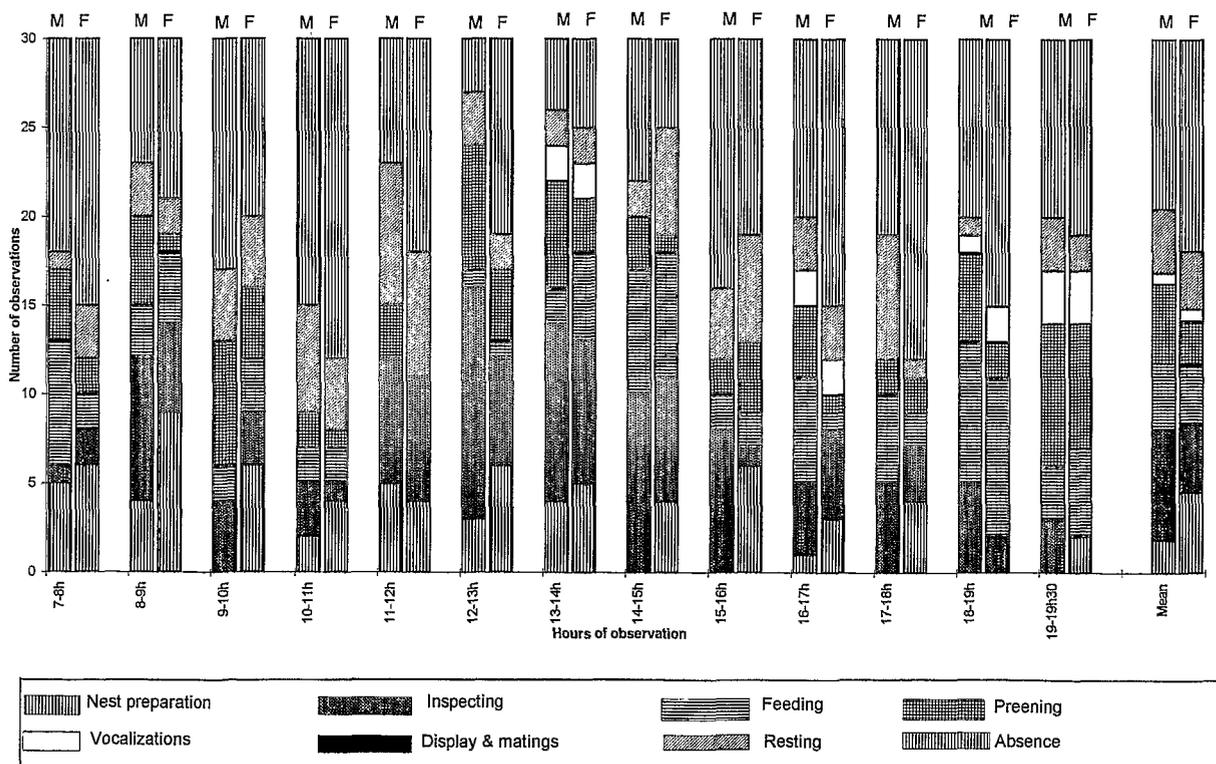
When nest-boxes were used, the hornbills such as the pair of nest-box G began to scrape off the paint around the entrance using their beaks, apparently to make the edges rougher and expose the wood. No scratch marks were noted around the entrance of natural cavities.

The pair at nest-box G reduced the diameter of the nest entrance with mud collected from spots dampened by rain. The mud was often mixed with fruits of *Capparis tomentosa* or *Azadirachta indica* or myriapods (*Iulus sp.*) that the bird crushed between its powerful mandibles in order to make the mixture more sticky.

When closing of the nest entrance began, the female entered the nest-box, plastered mud on the wood and exited immediately thereafter. Later, however, she most often remained outside to perform her work. The pair rarely entered the nest but often stuck in their heads to inspect the interior.

The pair (sometimes the male but most often the female) used their beaks to place the mud on the wood with alternating left-right and up-down strokes. As soon

FIGURE 2
Activities of the male and the female during the second phase of nest preparation



as the mud had been plastered on, the bird quickly flew away to find more and continue work. This mud-gathering or plastering was a time-consuming activity for about 10-15 days. Once the entrance had been narrowed sufficiently, the male and female (still on the outside) interrupted the building for about 2-3 days. From time to time they placed material within the nest, keeping a close watch over it.

Figure 2 shows the activities of the male and female of nest-box G from the start of the partial closing of the entrance until the temporary cessation of all work. The male rarely built when the female was present. Daily means for nest preparation were 10.46 min/h for the female against only 0.92 min/h for the male (highly significant difference). Most of the work at that stage consisted of plastering mud on the nest entrance and this was often done by the female. In fact, if the male returned with material or mud and found the female at the entrance of the nest-box, he turned them over to her to decide where they were to be placed. Consequently the male was absent (25.54 min/h) more frequently than the female (22.30 min/h). During this period, if the birds left the nest, the first one to return often started to call and within a few minutes, the mate appeared.

Both male and female inspected the interior of nest mainly between 15h00-16h00. They spent almost the same time feeding: 3.70 min/h for the male against 3.84 min/h for the female, and preening: 6.30 min/h for the male against 8.00 min/h for the female. There was also no significant difference between the sexes in vocalization even though daily means were 5.54 min/h for the male and 3.54 min/h for the female. There is a significant difference in the time spent at rest: means 6.92 min/h (female) against 12.92 min/h (male).

The greatest disparities between the activities of the male and of the female were in nest-building and periods of resting. In the timing of different activities during the day (Figure 2), breeding-related activities occurred between 08h00 and 18h00, with peaks from 13h00 to 16h00. The male assisted with building tasks throughout the day from 8h00 to 10h00 and 15h00 to 16h00. The female did most of the building from 13h00 to 15h00.

Courtship and copulations which had not been observed at the first phase of nest preparation are frequent at the second phase: one to four times per day for the same pair. Duration of mating is short (two or three seconds) but the displays which precede mating last for four to six minutes. These can take place at any hour of the day until the female has finally sealed herself into the nest-box.

End of the entrance-closing phase

After the entrance of the nest had been narrowed with mud, it became too small for the female to pass through. When she decided to enter, she destroyed a portion of the wall by tapping strongly with her beak on the dried mud. The male often helped with enlarging the opening. Once the opening again became large enough, the female entered while the male looked on. The female became very active inside the nest-box and then re-closed the entrance with mud found in the nest or brought by the male. Four to six hours after her entrance, she re-emerged, after again destroying the wall. Both the male and the female deposited building

materials without entering the nest. The female, from the exterior, sorted through the lining or building materials by picking them up with her beak, examining them and then either replacing them in the nest or throwing them to the ground.

Two to four-days after her last exit, she again entered the nest (September 4). Once again she closed up the entrance, this time for the duration of nesting, using mud mixed with the crushed fruits of *Azadirachta indica* or *Capparis tomentosa*. The mud and fruits were brought by the male. Two weeks after the beginning of building, the female completed the closure leaving only an opening 0.5 - 1 cm wide and 4-6 cm high. The female used this narrow slit to evacuate her droppings and to receive food and materials brought by the male. The material or food brought by the male, which sometimes had difficulty trying to push them through the narrow opening, may be accepted or rejected by the enclosed female. In the case of rejection, the male went and looked for other items which may be more acceptable to his mate.

Comparing the activities of each mate between the two phases of nest preparation, the male spent more time bringing materials, inspecting the nest and feeding during the first phase of nest preparation. On the other hand he rested more, vocalized more and was absent more in the second phase. The female spent more time inspecting the inside of the nest and fed more in the first phase. She spent more time building and vocalizing during the second phase of nest preparation. Meanwhile she spent almost the same time absent and preening for both phases.

Statistical tests (ANOVA), showed significant differences in the male's activities between the two phases of nest preparation at the 5% level. The female's activities presented no significant differences for nest preparation, resting and absence between the two phases of nest preparation.

DISCUSSION

Kemp & Kemp (1972) observed that the female *Tockus monteiri* was solely responsible for the partial closing of the entrance. For *Tockus erythrorhynchus*, both partners work on the partial closure. Nevertheless, the female assumes a far greater role than the male.

The female *Tockus erythrorhynchus*, which works more than twice as hard as the male in gathering materials, would appear to be more selective also. She carefully sorts through the materials brought by the male and rejects unsuitable items. Consequently during the first period (collection of materials), she spent more time on nest preparation than the male. The prolonged absence of the female could be explained by the time she invests in looking for nest materials. During the first stage of nest preparation, the male, through his presence around the nest, guards the site.

The role of the sexes in sealing the entrance varies among species. In the majority of cases, only the female seals, using mud or sticky foodstuffs when still outside and mainly her own droppings once inside (Kemp 1995). For *Tockus erythrorhynchus*, in the second phase of nest preparation (partial closure of the entrance) the major task of building was assigned to the female. At that time the male looks for building materials, brings them back to the nest and turns them over to his mate.

Consequently he is absent from the nest vicinity more frequently than the female. Scraping off the paint around the nest-box by *Tockus erythrorhynchus* enables the mud to stick to the wood better. According to Kemp (1995), aspects of a suitable microhabitat include an entrance with a rim to which sealing materials can adhere.

During the breeding season, frequent vocalization at the nest is undoubtedly for territorial defense against congeneric birds. The pair also defends their nest by threatening conspecific intruders, which never fail to retreat. According to Kemp & Kemp (1972), the songs may serve to call the partner or to defend the territory.

Kemp (1995) wrote that hornbill females spend more and more time looking into the hole, chipping away at it or applying sealing to irregularities on the exterior, sometimes with help of the male, and later entering and remaining within the cavity for extended periods. In Senegal, at the ORSTOM experimental ecological reserve in Mbour, *Tockus erythrorhynchus* repeatedly opened and sealed the nest-box entrance prior to the cloistering of the female. This behaviour may be explained by a need to protect the nest cavity against other birds or animals which would take over the site for themselves.

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