Nest construction process in Streaked Weaver *Ploceus manyar*

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Abstract

Amongst the weaver birds (Ploceidae), the nest building ability is believed to be a key determinant to a male's reproductive success, and hence, studying nesting sequences and outcomes is important in understanding the significance of nest architecture. We studied sequences of the nest building process, such as nesting site selection, nest weaving, female's inspection, and nest dimensions in the Streaked Weavers *Ploceus manyar*. Out of 11 nests initiated, six nests were constructed till elongated entrance stage; only three nests were successful with fledging. All nests were attached to either *Typha* or *Phragmites* or both and were located 1.5 to 2.1 m above the water. In one case, a male constructed a second nest after a female rejected the first at the helmet stage. Bigamy was also observed, where one male constructed nests for two different females. Out of the total nesting materials used, *Phragmites* constituted (22.3 to 67.9%) followed by *Typha* (3.4 to 45.9 %), *Vetiveria* (14.34 to 35.3 %) and *Cyperus* (2.5 to 10.51%); the remaining materials were mud and cow dung. In all cases two main trunks of *Phragmites* were used in nest construction and the total length of main supportive stems varied from 195–263 cm. In general 10–18 leaves were attached externally with the nest from 09–12 stems. Courtship was observed during the initial helmet stage of nests. Males from various nests made one to five attempts of successful courtships. Males were observed to guard nests and look after the nestling when females came out of the nest. The female's contribution in the final stage of the nest building is recorded for the first time.

Introduction

It has been shown that the nest site selection of many birds is affected by different biotic and abiotic factors in the environment (Collias & Collias 1964; Collias & Victoria 1978). Successful incubation and fledging of chicks, depends upon nesting sites and nest architecture. Nest types in birds are species-specific and adapted to the particular habitat and/or to reproductive requirements and, therefore, nesting success may be considered as an indicator of the suitability of a habitat in terms of acceptability by females (i.e., when a female chooses to form a breeding pair), and breeding success in the avian world (Collias & Victoria 1978; Jose *et al.* 1998; Quader 2006).

Weaverbirds (Passeridae: Ploceidae) constitute a diverse group comprising 115 species (Dickinson & Christidis 2014), including the genus *Ploceus* (64 species). However, only four species are recorded in India (Hosetti 2003), all of which, the Baya Weaver *Ploceus philippinus*, the Black-throated Weaver *P. benghalensis*, the Streaked Weaver *P. manyar*, and Finn's Weaver *P. megarhynchus* have been reported from Delhi (Tak & Sati 1997; Urfi 2003; Vyas 2019).

In weaverbirds, males initiate nests, and their weaving skill is decisive in attracting a female for breeding. A large majority of all weaverbird species, found in Africa and Asia, build intricately woven nests. Nest architecture and building material vary from species to species depending on the latter's availability, which generally include leaves, plant fibres or twigs, palm frond strips, string, grasses, mud, and cow dung. On completion of the nest up to the helmet stage, males announce their handiwork by fluttering their wings whilst perched on the top of the nest. The nest is completed only when a female accepts it. In a majority of the species, each pair builds an independent nest, although aggregate sociable nests, with hundreds of pairs are also observed in this family, e.g., the Sociable Weaver *Philetairus socius* (Covas 2002). Although a nest's attributes and nesting ecology have been extensively studied for the Baya Weaver (Asokan *et al.* 2008; Quader 2006) only anecdotal information, on these aspects, is available on the remaining three weaver birds (Crook 1963a).

Ploceus females do not participate in nest construction (Collias 1964; Crook 1963b), rather, they select males on the basis of nest attributes (location and structure). In such cases natural selection would favour those females that are able to weigh factors associated with reproductive success (Clark & Shutler 1999; Martin 2001), and males that act according to female choice (Emlen & Oring 1977). Since females are not present when males decide about the nest location, males need knowledge of a female's choice of nesting materials and architectural design. In other birds the ornamentation on the male's body (such as the train of an Indian Peafowl *Pavo cristatus*) plays a role in determining the female's choice. However, in case of weavers, the ability and quality of the male as a mate, and the degree of parental care he may invest, is reflected through his skill in nest construction (Jose *et al.* 1998). This shows that the nesting behaviour of a male is important to showcase its fitness to the female; and so the weavers make an excellent system to study the role of sexual selection in the evolution of a learned skill (Quader 2003). In case of weaverbirds, in addition to nest architecture design, the nest site selection by males becomes extremely important for female choice to form the breeding pair (Meek & Barclay 1996; Mitchell *et al.* 2001).

There is little information on the nesting ecology of the Streaked Weaver *Ploceus manyar*, except for some accounts of behavioural studies (Crook 1963a; Ali & Ripley 1987). In this paper, we present a detailed account of the process of nest construction, nest characteristics, pattern of sequential decisions in the nest building process, and nest survival duration in Streaked Weavers.

Methods

Study area

This study was carried out in the Yamuna Biodiversity Park (henceforth, YBP) situated in Wazirabad, Delhi, India (28.73°N, 77.21°E), which is spread over 185 ha of land in the flood plains of the Yamuna River. The area was a highly saline area with mostly sandy soil (pH ~ 9.2) without vegetation, except for some halophilic bushes. The area has been restored by implementing some principles of restoration ecology and now consists of many plant communities established by assemblages of species, grassland, and highly productive wetland ecosystems (Niangthianhoi & Khudsar 2015). Our study site was a lily pond (28.59°N, 77.21°E) located in the Medicinal Plant Garden in the YBP (Fig. 1). The Lily pond was surrounded mainly by reeds and sedges like *Phragmites karka*, *Typha angustifolia*, *Cyperus* spp., and *Vetiveria zizanioides*.

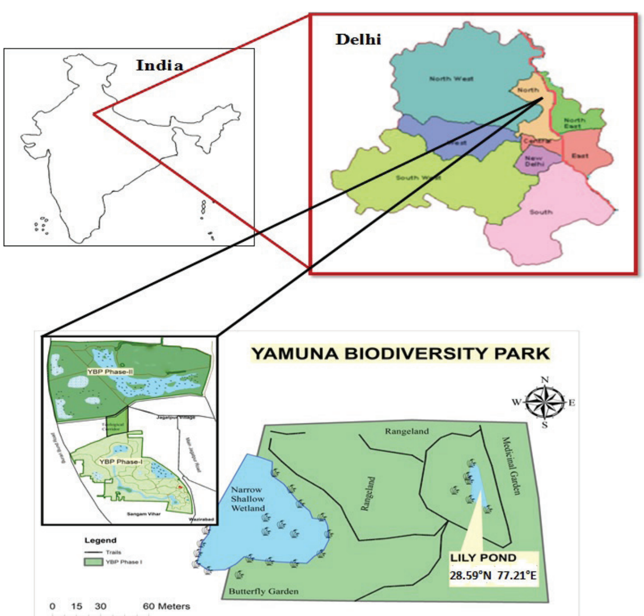

Fig. 1. Map of the study area (YBP) and the nesting site in the YBP.

Behavioural observations

Our study of Streaked Weavers was initiated in 2009, when our observations were confined only to counting, and periodicity of nests. Based on earlier observation on periodicity of nest construction, extensive behavioural observations were made on their nesting, from 13 May–11 July 2012, starting from 0530 h through 1800 h, continuously. In all, 11 nests were observed and data recorded from a reasonable distance (*c.*10 m) using a 8x40 binocular, without disturbing the birds. A still camera (with a 70×400 mm zoom lens) was used to capture the relevant behavioural activities. Individual males were ascertained through continuous monitoring from early morning to the late evening, which allowed us to see some of the distinct characteristics in plumage patterns, varying from a yellow crown to forehead to black supercilium extending towards forehead. These characteristics helped identify different males.

Nesting habits were studied following available literature (Crook 1963a,b; Ali & Ripley 1987). The nests were coded N1 through N11 according to the sequence of nest initiation. We recorded the daily aerial temperature and humidity of the site using a MRC (HTC-1) SIGMA Hygro-thermometer.

Uninterrupted day-long observations for two months were carried out to elucidate the following:

(a) **The nest building process:** We recorded the materials used by the Streaked Weavers in the nest construction. Photographs of each stage of nest construction were taken for a clear understanding of the nest building process **[223A–F]**. Females were observed visiting a helmet stage (a stage during nest construction), when the nest was oval in shape and the anterior portion above the entry point was heavier and thicker than the posterior half. The female inspects this stage prior to completion of the nest **[224D,E]**, and subsequently brood chamber is constructed and final finishing (plastering, sealing, etc.) was done.

(b) **Determination of nest and nest site characteristics:** Nest site characteristics like distance between two nests, height of each nest above the water/ground were recorded during the initial observations without disturbing the birds. Measurements of the thickness of stems used or incorporated into the nest were taken after the nests were abandoned. Morphometric measurements of the nests and the eggs were systematically taken from abandoned or successful nests, after the breeding season, with the help of a measuring scale. The following nest attributes were measured: Nest length (cm), diameter of the entrance tube (cm), length of the brood chamber from top, circumference of the elongated entrance tube (cm), circumference of nest at broadest point (cm), depth of brood chamber, diameter of brood chamber, thickness of the nest above the brood chamber, and base of brood chamber for the abandoned nest (Fig. 2).

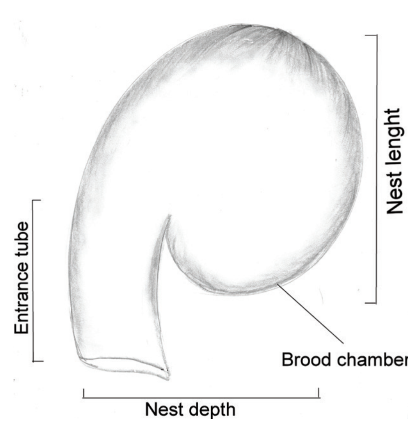

Fig. 2. Diagrammatic representation of attributes of the nest of Streaked Weaver birds, measured for the present study.

223A–F. Various stages during nest construction by Streaked Weaver. (A) Base construction by the male; (B) Initial wad stage; (C) Ring stage; (D) Initial helmet stage; (E) Final helmet stage; (F) Complete nest.

(b) **Nesting materials:** Materials collected from nearby areas were noted and numbers of trips made by the bird for nest building were also recorded.

(c) **Female preference:** Nest stage and inspection, selection/rejection of nests by female Streaked Weavers were noted and also recorded photographically. A nest was considered selected when a female settled down in the same nest after inspection, whereas it was considered rejected when she flew away after inspecting it.

(d) The activities of males responding to female behaviour were also noted**.** Nests, recording hatching of eggs and fledging vocalisations were considered successful.

224A–F. The activities of Streaked Weaver: strip collection (A), weaving (B), (C) Using cow dung at initial helmet stage, (D) Female inspecting initial helmet stage (E) Male binding the leaves with the nest, and (F) Male clearing the leaves near the nest during nest construction.

(e) **Diurnal variations in nesting activities** (nest weaving, courtship, and nestling feeding): Various activities performed by the male and female Streaked Weavers, at different times of the day, were recorded for 16 consecutive days for each of the eight study pairs. Accordingly, the diel patterns of various activities were derived from the data.

(f) **Duration:** The number of days taken for nest construction, in which both, male, and female participated, till the first calls of hatchlings were heard, was recorded audio-visually without disturbing the birds. Because the nest is closed only indirect evidence of hatching was elicited from noise of chicks heard, and female behaviour. So the egg hatching date was determined from the first day a female was seen carrying food into the nest, or chicks were first heard; and in all three nests male became more vigilant outside the nest. Usually in the forenoon, between 0900–1000 h, chicks were noisy, especially whenever females approached the nest. When this happened we could hear the chicks from the edge of the waterbody.

(g) Unhatched eggs, from abandoned nests, were measured using a digital Vernier Callipers.

Results

The nest building process- Eleven nests were constructed by eight different males, of which only six were completed till the elongated entrance tube stage. The other five nests were either abandoned, or dismantled, mainly at the initial helmet stage.

A fully constructed nest is a loosely woven structure with rough finishing. It is suspended by coarse grass strips that are intervowen on the outer wall of the upper side (opposite to the entrance tube), and directly attached to the trunk of the plant **[223]**. All nests have an egg chamber and a short, or sometimes no, entrance tube.

The nest was completed in four distinct stages: (i) wad stage, (ii) ring stage, (iii) helmet stage, and (iv) final nest **[223A–F]**. In all cases, only males built the nests up to the incomplete helmet stage **[2234D]**, and even after a female's visit they continued to weave small amounts of fresh fiber into their completed nests. As the nest construction progressed to initial helmet stage, **[223D]** males pasted it with mud and cow dung, from inside and, in few cases, on the outside **[224C]**. Males displayed on their nest to visiting females. Female Streaked Weavers arrived only at the initial helmet stage (except N6, which a female inspected at ring stage) and inspected the nest **[223D]**. After a female had selected a nest in its initial helmet stage (D), the male completed the nest by gradually closing the brood chamber and constructing an entrance tube **[223F]**. The nests rejected that were rejected by females were abandoned, and in a few cases even dismantled by the male. The materials from dismantled nests were never reused. In one case (N1) the male built another nest in the same vicinity, using fresh nest materials. The nest construction process took 11 to 14 days. Males constructed a nest in the same time, (Fig. 3) regardless of the nest's initiation date.

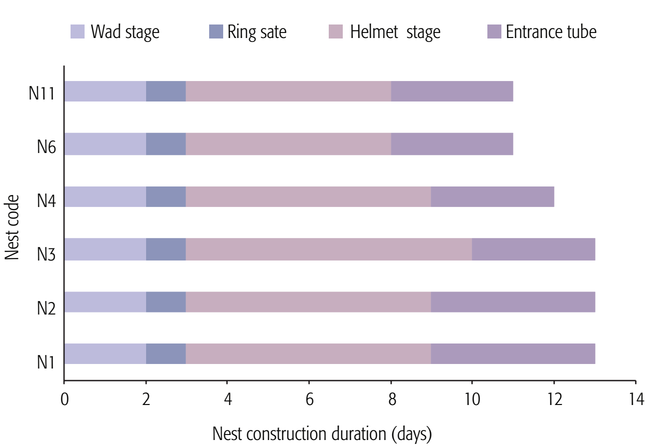

Fig. 3. Time (days) spent by male Streaked Weavers in construction of different stages of nests during pre-monsoon (May-June) of 2012.

After a female selects a nest, both sexes complete the nest. The number of trips they make, for collection of nesting materials, decreased in nests started later (06–20 June). For instance, the pairs of N1 and N2 made 521 and 558 trips respectively, whereas that of N11 made only 391 trips (Fig. 4).

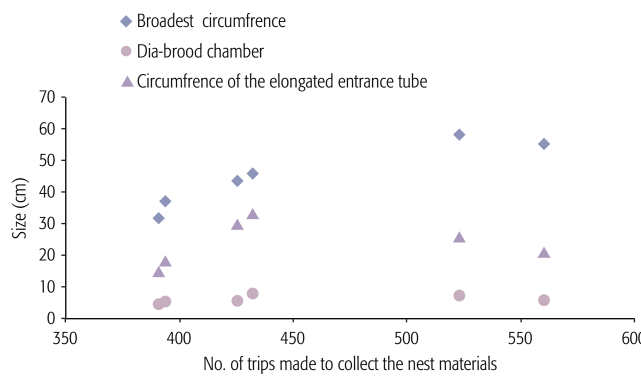

Fig. 4. The circumference of the nest at the broadest point, the diameter of the brood chamber, and circumference of the elongated entrance tube, as a function of the number of trips made by the male Streaked Weavers to collect the nesting materials.

The frequency with which females brought nesting material to a nest was significantly higher in nests that were commenced later, than those in earlier nests. A nest's characteristics were observed to understand its effectiveness. The average height of the 11 nests studied, above the water surface, varied between 172 and 179 cm. Nests were directly attached to two to three main supporting stems (main trunk) of *Phragmites* (Fig. 5). The number of leaves used to suspend a nest, varied from nest to nest.

For instance, 18 leaves from 12 stems of *Phragmites* were attached with N1, whereas ten leaves from nine stems were attached with N3. The height of the main supporting stems of *Phragmites* varied from 195 cm (N1) to 263 cm (N3).

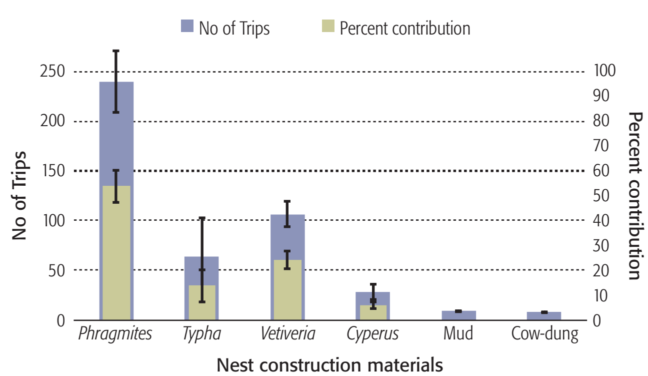

Fig. 5. Total number of times male Streaked Weaver brought nesting materials and his percent contribution of different materials.

The dimensions of three successful nests, including the entrance tube, and the brood chamber are shown in Fig.8. N1 and N2, which were constructed earlier, were structurally larger than N6, which was built in the breeding season (Fig. 6). The dimensions of brood chambers did not show a clear inter-nest difference. The length and diameter of the entrance tube were smaller in N6, than in N1 and N2. Males of each nest made 07 to 11 trips to collect mud and cow dung across all days of nest construction.

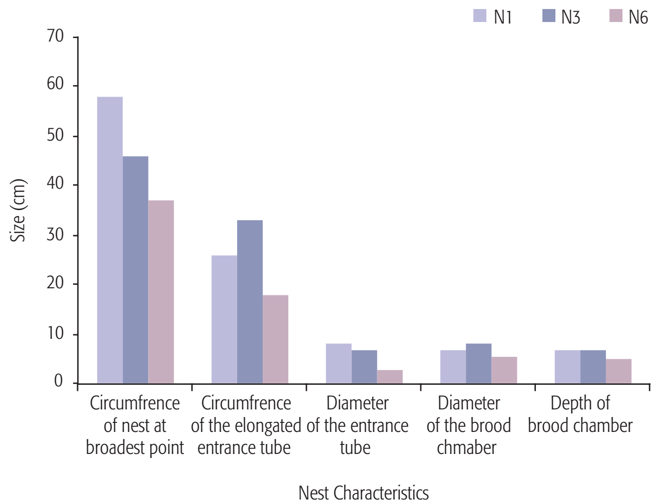

Fig. 6. Nest dimension (circumference of nest, and of elongated entrance tube, diameter of entrance tube and diameter and depth of brood chamber) of three successful nests (N1, N3, and N6) of Streaked weaver birds.

While observing nesting success and nest survival, we found that of the 11 nests in the study area, built during pre-monsoon (15 May –June 2012), five were abandoned by the male at initial helmet stage, and the remaining six, i.e., N1, N2, N3, N4, N6, and N11 were completed. However, we faced a methodological constraint in identifying successful nests because successful fledging was observed only from three nests (N1, N4, and N11). Fledglings were not seen for the remaining three nests (N2, N3, and N6). Two nests N2, and N6 were found empty after pair formation, and completion. However, in N2 we found two abandoned eggs. Based on our definitive spotting of fledglings in the present case, the nesting success was 27.3%.

Amongst the 11 nests studied, we observed two males building two nests. The male of N1 built a second nest (N3), five days after it completed N1. Both those nests were selected by different females. Male of N5 also constructed N8, but both the nests were rejected.

Discussion

Eight different Streaked Weaver males, and four females, were observed at a given time in the vicinity of the nesting site during the study period. The first nest (N1), constructed during the season, was the largest in volume and dimension of entrance tube (Fig. 8). This could be attributed to the availability of a large amount of nesting materials in the neighbourhood, which helped easy procurement and economical energy inputs. This decreased subsequently as more nests began to be constructed. Inter-nest differences in the overall size of nests, but equal size of the depth and diameter of the brood chamber (Fig. 6) suggest a potential trade-off between the size of the nest and the efforts invested in making them. Nesting materials were equally available during the observation duration although, the nest construction duration differed between earlier and later nests. Smaller nests needed less time to make and, hence, the nests constructed later were smaller in size without compromising the dimension of the brood chamber. The size of the brood chamber is required to be maintained to accommodate an adult female, chicks, and eggs (19.91x14.29 mm). This reflects that the amount of materials used in other parts of the nest may be less important for Natural Selection.

In all cases the nest construction began with the construction of the roof/ceiling of the nest with thin strips of *Phragmites, Typha,* and *Vetiveria,* directly attached to two or more stems of *Phragmites*, or many leaves of *Typha*. Nesting materials were mainly picked up from the materials available within a range of *c.*20–30 m from a nest. To further support and strengthen the nest, leaves of other reeds were also attached at different stages of its development (Fig.4). As reported in *P. philippinus*, even in *P. manyar* nest height differed from nest to nest. The N1 constructed the second nest after abandoning the first nest and the second nest was higher (263 cm) than the first one. The high nests are more protected from predation (Ambedkar 1964; Crook 1964a; Quader 2003). In the present study, males were observed to clear leaves near the nest (https://www.hbw.com/ibc/video/streaked-weaver-ploceus-manyar/nest-construction-process-streaked-weaver-ploceus-manyar). The clearing of leaves near the nest was earlier observed in *P. philippinus* (Pitman 1958; Ambedkar 1964; Crook 1964a; Quader 2003) which was attributed to attract females making the nest more visible. Furthermore, snakes easily get access to the nest by using the leaves and stems around the nest (Pitman 1958). Clearing leaves and other debris by the males may have improved the nest's attractiveness and protect eggs and hatchlings from predation (Pitman 1958; Crook 1964a; Quader 2003).

Baker (1934) had recorded that the female *P. flaviceps* participated in nest building. Our observation provides further definitive evidence of female Streaked Weavers participation in the nest building process. This was not reported for Baya *P. philippinus* (Quadar 2006). Mud and dung were not used after the helmet stage, nor was much effort made to collect mud, by the males, as they made only about 1.34% to 2.31% of the total trips made for the collection of nest materials. In an earlier study the mud/dung plastering was recorded in only bachelor nests (Davis 1973). We observed that the mud/dung was fixed firmly on the inner wall of the nest, such that it was difficult to remove it without damaging the wall of fibres.

If a female selects the nest, the male completes the structure by weaving the floor of the brood chamber and constructing the entrance tube on the opposite side. Further paternal investment was mainly limited to occasionally adding fresh leaves, strips, and guarding the nest from intruders. One male constructed a new nest nearby and attracted another female as the season progressed. Females used to periodically visit the nest after accepting the nest. Courtships were observed after acceptance of the nest by the female and pair formation.

The present work provides the first visual account of all stages of the site selection and nest construction by the Streaked Weaver.

Author contribution

FAK and RK conceived the idea and designed the protocol, DP and SLN performed observations and collected data. Manuscript preparation and data analyses were done by all the authors collectively.

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Occurrences of hornbills (Bucerotidae) in the forest fragments of eastern Assam

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Jain, A., & Sumashini, P. S., 2020. Occurrences of hornbills (Bucerotidae) in the forest fragments of eastern Assam. *Indian BIRDS* 15 (6): 174–177.
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Many Asian hornbill species are threatened by loss of habitat, forest fragmentation, hunting, and logging (Poonswad *et al.* 2005). Five hornbill species, Great Hornbill *Buceros bicornis*, Rufous-necked Hornbill *Aceros nipalensis*, Wreathed Hornbill *Rhyticeros undulatus*, Oriental Pied Hornbill *Anthracoceros albirostris*, and White-throated Brown Hornbill *Anorrhinus austeni*, are found in north-eastern India (Datta *et al.* 2018). The Great-, Wreathed-, and Rufous-necked Hornbills are classified as 'Vulnerable' (BirdLife International 2018a,b,c), the White-throated Brown Hornbill as 'Near Threatened' (BirdLife International 2018d), and Oriental Pied Hornbill as 'Least Concern' (BirdLife International 2016) under The IUCN Red List of Threatened Species. Hornbills play an important ecological role as seed dispersers in tropical forests (Naniwadekar *et al.* 2019; Kitamura S. 2011).

While there is considerable information on the distribution and ecology of hornbills from the fragmented forests in Western Ghats (Raman & Mudappa 2003; Pawar *et al.* 2018), information from north-eastern India is lacking. Digboi, Doomdooma, Dibrugarh, and Tinsukia forest divisions of eastern Assam (also referred to as the Upper Brahmaputra Valley) harbour some of the last remaining lowland tropical forests which have undergone severe fragmentation as a result of the expansion of tea plantations, coupled with agriculture, in the past century (Sharma *et al.* 2012). These forests now exist as a set of isolated fragments alongside two better-protected, large (>100 sq. km) forest patches (Jeypore Reserved Forest, and Dehing Patkai Wildlife Sanctuary). While hornbills have been reported from these two larger forest patches, information on hornbill occurrence, breeding, and diet from the smaller fragments is sparse. There were no previous