

Breeding behaviour and nest tree use by Indian Grey Hornbill *Ocyrceros birostris* in the Eastern Ghats, India

E. SANTHOSHKUMAR and P. BALASUBRAMANIAN

The breeding ecology of Indian Grey Hornbill *Ocyrceros birostris* was studied during 2007 and 2008 in Sathyamangalam Forest Division, Eastern Ghats, India. In the breeding season, 32 active nests of Indian Grey Hornbill were recorded. Nesting started early in March and ended in late June. The nesting period averaged 87 days, with the female sealed in the nest cavity for an average of 76 days and the nestlings fledging an average of 13 days after the female emerged. Nest-sealing materials used include the hornbill's own faeces, mud, cattle dung and tree bark. An average of two fledglings from each nest was recorded. Two of the 32 active nests were predated, a nesting success of 94%. Six tree species belonging to five families were used for nesting; the majority (44%) of nests were in *Melia dubia* (Meliaceae) making it the most preferred nest-tree species (Ivlev's selectivity index $PI = 0.27$). The nest tree dimensions (tree girth at breast height 3 ± 1 m, tree height 23 ± 7 m, nest height 14 ± 7 m, girth at nest height 2 ± 0 m) indicate the average requirements of Indian Grey Hornbill for a suitable nest site. All nests were located in the riverine habitat and hence protection of riverian habitat is emphasised.

INTRODUCTION

Hornbills Bucerotidae are one of the most recognisable groups of birds in the Old World tropics. There are 54 species of hornbills in the world (Kemp 1995) and nine species occur in India (Ali & Ripley 1987). The Indian Grey Hornbill *Ocyrceros birostris*, also known as Common Grey Hornbill, is reported to occur in India, Pakistan and Nepal (Ali & Ripley 1987). In India it is distributed throughout the country, excepting for Malabar, parts of Rajasthan and Assam (Ali 2002). In southern India, this species is reported to occur in the dry deciduous tracts of the Eastern Ghats and foothill forests of the Western Ghats (Balasubramanian *et al.* 2005). Hornbills are secondary cavity nesters, using natural cavities or those excavated by other birds (Kemp 1995). The breeding habits of hornbills are unique in that the female of most species seals herself into a nest cavity and leaves only a narrow slit through which the male passes her food until the nesting period is completed (Kemp 2001). Hornbills often show high nest-site fidelity, returning to the same nest cavity year after year (Kemp 1978). Patil *et al.* (1997) provided some information on the nesting of Indian Grey Hornbill, but a review of literature reveals the absence of detailed studies on breeding ecology. The present study was undertaken to assess the breeding behaviour and nest tree preference of Indian Grey Hornbill in a forested landscape in the Eastern Ghats.

STUDY AREA AND METHODS

The present study was conducted during the two successive breeding seasons of March to May in 2007 and 2008, in the Hasanur range (940 m asl) of Sathyamangalam Forest Division ($10^{\circ}29' - 11^{\circ}43'N$ $76^{\circ}51' - 77^{\circ}27'E$), Eastern Ghats, India. The Eastern Ghats forms an important habitat for diverse biota across the east coast of India to traverse the states of Orissa, Andhra Pradesh, Tamil Nadu and parts of Karnataka, areas located within $11^{\circ}30' - 22^{\circ}N$ and $76^{\circ}50' - 86^{\circ}30'E$ along a north-east to south-west strike and covering a total area of c.75,000 km² (Murthy *et al.* 1982). The climate regime is tropical monsoon, with an average annual

rainfall of 1,000–1,600 mm and mean temperatures of 20–25°C during winter and 30–32°C in summer. Vegetation in the study area varies considerably with altitude, but dry deciduous and riverine forests predominate at the study site.

As hornbills depend on tree cavities for nesting, an intensive search for nest cavities was carried out during breeding season. Cavities of trees being actively used by hornbills are identified by following breeding pairs of hornbills or breeding males carrying food to the nest, as well as by examining midden deposits of seeds below the nest cavity. Out of a total of 32 active nests located in two years, 10 were selected for monitoring the activities of the hornbills at the respective nests from 06h00 to 18h00, giving a total of 720 hours (72 hours per nest) spent at the nest sites. Details such as number of visits made by the male and quantity of food items delivered per visit were also recorded from an observation hide situated 10–20 m away from the nest, using a pair of 10×50 binoculars. The food items delivered were classified as vegetable or animal food. Seeds from 10 middens below other nests were also collected at regular intervals to identify food items delivered to the nest inmates and for use in further studies. Tree species harbouring the nests were identified by using the local floras and later confirmed at the Botanical Survey of India, Coimbatore, India. Nest tree features, such as tree girth at breast height, tree height, nest height and girth at nest height, were recorded for all the identified nests.

A preference index (PI) of the nest trees used by Indian Grey Hornbill was calculated using Ivlev's Index of Selectivity (Ivlev 1961) ($PI = U - A / U + A$, where U denotes utilisation of the species and A denotes availability of corresponding species). Values of PI range between -1 and +1, where -1 indicates avoidance while +1 indicates highest preference. Availability of the tree species was determined within a 1 ha belt transect (10×1,000 m) (used as an alternative for a 1 ha square plot). Availability denotes the number of individuals of a species occurring in the 1 ha plot. To find out the availability of nest tree species, the belt transect was located along the riverine habitat of the study area. The 1 ha belt transect was divided into 100 (10×10 m) plots. All the trees within the belt transect with girth at breast height (gbh) more than 20 cm

were recorded. Utilisation indicates the number of individuals of nest tree species used by the hornbills.

RESULTS

Nesting behaviour

The nesting season lasted for three months, from March to June. The hornbills started to prepare themselves for breeding in early December, when such pre-nesting behaviour as nest-cavity searching, mating and courtship feeding were recorded. Both male and female hornbills were noticed peeping into tree cavities, one after the other, and this was often noted and continued until the female entering into the nest cavity. The male hornbill feeding the female hornbill with food items was recorded, where the female sat near the nest cavity or perched in some tree, giving loud calls until the male arrived and offered her some food items, and this was also recorded in a fruiting tree. Other rare observations made at the nest tree included the male and female flying some 30 m down to the ground, holding tightly onto each other's bill and with a loud clapping sound of their wings. Mating behaviour involving three different pairs of hornbills was observed during the study. In all the cases mating took place while perching on the nest tree, and it happened before the female entered the cavity. Once we recorded a female peeping into a cavity, from where the male pushed her back with his bill, until finally she struggled, entered the cavity, peeped out and then the male offered her some fruits and perched on the next branch. The female stayed in the cavity for 20 minutes (17h15–17h35) and then, with a loud call, came out and joined the male. The next morning, the female occupied the nest and the male fed her with fruits. In the study area, females entered their cavity in the first week of March and some late nests were also recorded in April. As soon as the female entered the cavity she started cleaning the nest, and we observed her throwing out all the waste materials left in by the previous user. Later, the female in the cavity was observed to toss out the excreta of the chicks with her beak through the nest slit, and herself to turn around and eject her own excreta through the slit to form part of the nest midden. The very next day, the female started sealing the cavity entrance with her bill using mud, cattle dung and dry tree bark delivered by the male, and her own fecal matter.

For the observed 10 nests of Indian Grey Hornbill, the nesting period averaged 87 days. Begging calls of the nestlings were heard on an average of 40 days after the female entered the cavity. Clutch size could not be recorded. The female emerged on average 76 days after sealing in and the nestlings fledged an average of 13 days after the female emerged. Two fledglings from each nest were recorded; the newly fledged chicks were smaller in size than the adults, with fresh plumage and undeveloped casques. After their emergence, we observed the chicks making calls and sitting in the top branches of the nest tree or in the neighbouring tree with the adult female, in six of the observed nests. The male brought fruits and fed these to the chicks but after a few minutes both adults left to forage and returned with fruits that they delivered to the chicks, and then the chicks flew from one branch to other in the same tree. The next day we observed the chicks in the nearest fruiting tree of the nest tree, trying to forage for themselves on the fruits and flying from tree

to tree. The adults fed the chicks for more than a week, but later they started to feed themselves and flew long distances following their parents.

During the 720 hours spent at 10 nests to monitor the nesting behaviour over two breeding seasons, males visited the nests 1,015 times to feed the nest inmates, an average of 17 times per day. At a later stage, after the emergence of the female from the nest cavity, she joined the male to feed the chicks in the cavities. We recorded the male feeding the nest inmates from just before sunrise at 05h45 until after sunset at 18h07. We grouped the observations into four quarters, 06h00–09h00, 09h01–12h00, 12h01–15h00 and 15h01–18h00. Of the total 1,015 visits made by males to the nest, in the first quarter males visited 374 times (37%), 206 times (20%) in the second, 183 times (18%) in the third and 252 times (25%) in the fourth. The number of visits was highest in first quarter (37%) followed by the fourth quarter (25%), at the start and end of the day. Food items like fruits and insects were regurgitated, brought to the tip of the bill and then delivered, whereas animal items like lizards were carried in the bill and delivered directly.

A total of 13,680 food items was delivered to the nest inmates at the 10 focal nests. The food items delivered to the nest inmates included both vegetable (64%) and animal (36%) matter. Vegetable matter delivered comprised fruits of 26 plant species belonging to 16 plant families, among which 14 species were identified while monitoring the nests for fruit deliveries by the male and 12 species from the middens of other nests. Animal matter delivered included lizards, birds' eggs, juvenile birds and various kinds of insect.

Indian Grey Hornbills compete among themselves for nest cavities and we observed a pair chasing another pair during nest searching. The other nest competitors in the study area were Rose-ringed Parakeet *Psittacula krameri*, Golden-backed Woodpecker *Dinopium javanense*, Common Myna *Acridotheres tristis*, Jungle Myna *Acridotheres fuscus* and Indian Palm Squirrel *Funambulus palmarum*. All these species were noted to disturb hornbills during their nest searching and also while the female was inside the nest cavity. Nests of Rose-ringed Parakeet, Common Myna and Golden-backed Woodpecker were recorded in different cavities of the same nesting tree used by Indian Grey Hornbill. All the nest cavities were found to be occupied later by the competitors after the hornbills had bred. In addition, Large Brown Flying Squirrel *Petaurista philippensis* and honeybees *Apis* sp. were recorded in two cavities each, after the use by Indian Grey Hornbill.

Two of the 32 nests were predated during the early stages, after egg laying, with both eggs and incarcerated female being taken, but the predator was not known. In both the cases, feathers of the female, eggshells and broken sealing material were found in the middens. Thirty of the 32 nests were successful.

Nest tree features

All 32 active nests identified were in live trees. All nest trees were in stream/riverine habitats. The majority of the nests were in *Melia dubia* (14) followed by *Syzygium cumini* (9), *Albizia odoratissima* (5), *Mangifera indica* (2), *Terminalia arjuna* (1) and *Terminalia bellirica* (1). Ivlev's selectivity index indicated that the most preferred nest tree species was *Melia dubia* (PI = 0.27) (Table 1).

Table 1. Preference index of the nest trees utilised by Indian Grey Hornbill.

Plant species	Family	Number of nests			Total no. of nests	Number of trees available / ha	Preference index PI = U-A/U+A
		First year	Second year	Re-used			
<i>Melia dubia</i>	Meliaceae	5	9	4	14	8	0.272727
<i>Syzygium cumini</i>	Myrtaceae	1	8	1	9	15	-0.25
<i>Albizia odoratissima</i>	Mimosaceae	3	2	2	5	6	-0.09091
<i>Mangifera indica</i>	Anacardiaceae	–	2	–	2	37	-0.89744
<i>Terminalia arjuna</i>	Combretaceae	–	1	–	1	64	-0.96923
<i>Terminalia bellirica</i>	Combretaceae	–	1	–	1	13	-0.85714

Table 2. Characteristics of the nest trees and cavities utilised by Indian Grey Hornbill.

Variables	Mean±SD	Range
Tree girth at breast height (m)	3±1	2–5
Tree height (m)	23±7	14–39
Nest height (m)	14±7	6–30
Girth at nest height (m)	2±0	1–3
Inner depth of the cavity(cm)	51±11	30–72
Nest entrance length (cm)	15±5	8–28
Nest entrance width (cm)	12±3	7–15

The number of nest trees used in the first year was nine involving three tree species (*Melia dubia*, *Syzygium cumini* and *Albizia odoratissima*), and in the second year 23 involving six tree species (three as in the first year plus *Mangifera indica*, *Terminalia arjuna* and *T. bellirica*). In total, 32 nests of six tree species belonging to five families were used for nesting. The majority (44%) of nests were in *Melia dubia* (Meliaceae). Re-use of nest cavities was observed in the second year (Table 1). Of the nine nests recorded in the first year, seven were re-used in the second year. The nest site characteristics were recorded for all identified nests and are presented in Table 2.

DISCUSSION

The hornbill family is characterised by an incubation period closely correlated with body size and by an unusually long nestling stage (Kemp 1995). During this study, the nesting period of Indian Grey Hornbill lasted for an average of 87 days, very close to the 86 days for the congeneric Malabar Grey Hornbill *O. griseus* (Mudappa 2000). Indian Grey Hornbills in the study area only used cavities in the live trees, similar to the observations by Mudappa & Kannan (1997) for Malabar Grey Hornbill and Datta & Rawat (2004) for Great Hornbill *Buceros bicornis*, Wreathed Hornbill *Aceros undulatus* and Oriental Pied Hornbill *Anthracoceros albirostris*. Maheswaran & Balasubramanian (2003) reported that 80% of the nest trees used by Malabar Grey Hornbills in the Western Ghats, India, were live. Re-use of nest cavities by Indian Grey Hornbill is reported in this study, and this conforms to earlier studies on Malabar Grey Hornbill in the Western Ghats by Mudappa & Kannan (1997), Mudappa (2000) and Maheswaran & Balasubramanian (2003).

Nest sanitation observed during the present study was similar to the reports made by Kannan & James (1997) and Hussain (1984) for Great Hornbill and Narcondam Hornbill *Aceros narcondami* respectively. Courtship feeding and grappling of bills with clapping wings observed in the present study are similar to observations of Kannan & James (1997) for Great Hornbill.

In the study area, Indian Grey Hornbills used tall trees (mean 2±7 m) with large girth (mean 3±1 m) for nesting. Hornbills using tall trees with large girths were also reported in various other studies. Mudappa & Kannan (1997) reported Malabar Grey Hornbill nests at an average height of 24 m and the diameter at breast height as 60–89 cm. Maheswaran & Balasubramanian (2003) reported a mean tree height of 36±6 m and 283±101 cm width for Malabar Grey Hornbills. Kinnaird & O'Brien (1999) reported a mean height 40±10 (m) and a mean width 117±41 cm in diameter for nest trees of Sulawesi Red-knobbed Hornbill *Aceros cassidix*.

Poaching of Indian Grey Hornbills was not recorded during the study. Cattle grazing and lopping of branches of hornbill food plants for feeding livestock is the major problem of the study area. Extension of agricultural activities in the riverine forests disturbs breeding sites. As all hornbill nests were located in trees that are tall, with a large girth and in riverine habitat, protection and conservation of nest trees and the lowland riverine habitat in the Eastern Ghats is recommended.

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E. Santhoshkumar and P. Balasubramanian, Division of Landscape Ecology, Salim Ali Centre for Ornithology and Natural History, Anaikatty Post, Coimbatore 641 108, Tamil Nadu, India. Email: balusacon@yahoo.com



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