Observations on Rufous-necked *Aceros nipalensis* and Austen's Brown *Anorrhinus austeni* Hornbills in Arunachal Pradesh: natural history, conservation status, and threats

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In 1997–1998, Ravi Sankaran had spent three months studying the most interesting, and intriguing, hornbill species found in India, with the smallest global range—the Narcondam Hornbill Aceros narcondami *—restricted to a 6 km² island of the Andaman Islands archipelago. While others before him had spent time on the island and made observations, his were the first systematic and meticulously collected data of a study carried out throughout the breeding season, on a large number of nests. Unfortunately, he never wrote up the work as a publication, but he put his research to good use for conservation action and managed to get the goats that were affecting the regeneration of many hornbill food plants, removed from the island. My paper, in this memorial issue, is about my limited observations on two of the lesser-known, and threatened hornbills of north-eastern India.*

Abstract

Among the five species of hornbills that occur in north-eastern India, the least studied are the endangered Rufous-necked Hornbill *Aceros nipalensis*, and the Brown Hornbill *Anorrhinus austeni*[1], which has a restricted distribution in India. Based on field surveys conducted in Namdapha National Park, and several forest divisions in eastern Arunachal Pradesh, during 1996–1999 and 2002–2004, I present information on their distribution and relative abundance. I also present some information on diet, flock sizes, canopy levels used, breeding biology, and nesting records for both these species.

Introduction

India is home to nine species of hornbills (Bucerotidae). Apart from the Great Hornbill *Buceros bicornis*, and Oriental Pied Hornbill *Anthracoceros albirostris*, which also occur in other parts of India, three species—Wreathed *Aceros undulatus*, Rufous-necked *A. nipalensis*, and Austen's Brown *Anorrhinus austeni* Hornbills—occur in north-eastern India.

Collar *et al.* (1994) listed ten globally threatened hornbill species, of which two occur in India, the Rufous-necked, and the Narcondam *A. narcondami* Hornbills, while three —Malabar Grey *Ocyceros griseus*, Malabar Pied *A. coronatus*, and Austen's Brown Hornbills—are listed as 'near threatened'. All these species also have restricted distributions.

Among the species occurring in north-eastern India, the Rufous-necked Hornbill is listed as 'vulnerable' by IUCN (2006), while the Great and Austen's Brown Hornbills are listed as 'near threatened' IUCN (2006). The two main factors that affect Austen's Brown and Rufous-necked Hornbills in north-eastern India are hunting and habitat loss.

The two *Aceros* species are more widely distributed within north-eastern India than the smaller, co-operatively breeding, Austen's Brown Hornbill, which is restricted to upper Assam and eastern Arunachal Pradesh, south of River Brahmaputra. The current distribution of Austen's Brown Hornbill is inadequately known and the factors responsible for its localised occurrence within north-eastern India, and its present rarity, would be interesting to determine. It is uncommon in deciduous forest and locally common in evergreen forest (Ali & Ripley 1987), and was reported to be very common, about 80 years ago, in the plains of eastern Assam (Baker 1927). Chowdhury (2000) provides sighting records in various small reserve forest patches in eastern Assam, Manipur, and Nagaland. Pawar & Birand (2001) have also reported its occurrence in the Barail Range.

Hunting of all hornbill species, by most tribal communities, is a major threat, and a primary cause for hornbill decline in many areas. The breeding biology, nest site selection, diet, and roosting patterns of the Great, Wreathed, and Oriental Pied Hornbills, and their functional role as seed dispersers have been studied in Arunachal Pradesh (Datta 2001; Datta & Rawat 2003, 2004). However, there is limited information on the natural history, breeding biology, and diet of the Rufous-necked and Austen's Brown Hornbills, in India, apart from anecdotal observations that breeding occurs between March and June (Ali & Ripley 1987), although there have been long-term studies in Thailand (Poonswad 1995; Poonswad *et al.* 1987, 1988, 1998; Poonswad & Tsuji 1994; Chimchome *et al.* 1998).

In this paper, I present information on diet, flock size, habitat use, distribution, and nesting of Rufous-necked and Austen's Brown Hornbills, collected between 1996 and 2004 in eastern Arunachal Pradesh. The threats to these species, due to current habitat loss, and hunting practices, are also outlined and discussed.

[1] Rasmussen & Anderton (2005) place it in the genus *Ptilolaemus*.

Photo: *Aparajita Datta*

A male Rufous-necked Hornbill *Aceros nipalensis* (about 2 years old) in Namdapha National Park.

Survey areas

Namdapha National Park (Namdapha NP; 27°23′–27°39′N 96°15′–96°58′E): located in eastern Arunachal Pradesh, Changlang district, comprises an area of 1985 km², with a wide altitudinal variation from 200 m to over 4500 m at Dapha Bum, the highest point in the park. The variety of habitats found here, ranging from temperate, subtropical, and tropical rain forests, has facilitated the presence of a diverse and rich fauna. The Kamlang Wildlife Sanctuary borders it on the north. To the south and south-east lie high mountain ranges and the international border with Myanmar. There are many small streams and rivers that drain into the Noa-dihing, a tributary of the Brahmaputra, flowing east to west through the park. It is contiguous with reserve forests and sanctuaries to the south and west. Towards the eastern boundary there are community forests in Vijaynagar circle (637 km²). The area is populated by a number of communities: *Singpho*, *Tangsa*, *Chakma*, and others, to the west of the park, and *Lisu* and *Nepali*, to the east (Datta 2007).

Kamlang Wildlife Sanctuary (Kamlang WS; 786 km²; 27°40′N–28°0′N 96°20′E–96°55′E): lies to the north of Namdapha NP, in Lohit district. It has steep mountainous terrain, and is criss-crossed by numerous rivers and streams, with some high altitude lakes. The altitude varies from 550 m to 4200 m. The floral and faunal species composition is believed to be similar to that of Namdapha NP, although no research has been undertaken here. To the south of Kamlang WS, are lowland forests under the Namsai Forest Division with several reserve forests (RF)—Turung, Kamlang, Tengapani, Manabum, and unclassed state forests (USF). The main tribal communities here are the *Miju Mishmi*, and the *Khampti* in the lower areas of the district.

Jairampur Forest Division (Jairampur FD; 27°–27°40′N 95°–97°E): comprises seven RF areas that are interspersed with patches of community forests, cultivation, and villages. The area covered by the reserve forests is 307 km². These forests were operated for timber, mainly for hollong *Dipterocarpus macrocarpus*, and mekai *Shorea assamica*, till 1996, when timber extraction was banned, although some extraction occurred up to 2000. The remaining areas are USF, where villagers practice shifting cultivation. The legal status of USF areas is not defined. They are simply designated as any forest that is not included in RFs and village forest reserves. There is no specific legal provision granting rights and concessions to local people for collection from, or use of, these forests, yet it is a customary tradition and fulfils local people's needs. None of them are notified. There is no land tenure system and the government does not have any rights over USF / community land. Parts of the RFs here are almost undisturbed forests, especially towards the Myanmar border. The area has tropical evergreen forests, dominated by the two commercially important dipterocarp species. The area has 28 villages, with an estimated population of *c.* 6000. The main tribe here

Photo: *Rohit Naniwadekar*

Austen's Brown Hornbill *Anorrhinus austeni* in logged forest in eastern Arunachal.

is the *Tangsa*, which is divided into numerous clans and sub-tribes. ***Deomali Forest Division*** (Deomali FD; 305 km^2; 26°55'N–27°15'N 95°10'–95°40'E): in Tirap district. Comprises USF, and five village forest reserves (VFR; 368 km^2). Most of the area lies in the Patkai Hills, with hilly and undulating terrain, with altitude ranging from 140 m to 1,410 m. The rivers flow from south to north; and drain into the Brahmaputra in Assam. The forest types in the area include tropical wet evergreen dipterocarp forests, semi-evergreen forests, wet bamboo brakes, and pioneer Euphorbiaceae scrub. The main tribes here are the *Nocte* and *Wancho* that inhabit the north-eastern and southern parts, respectively, of the district. There are 63 villages here with 5,178 houses and 26,360 people. Village sizes are comparatively large ranging from 24 to 149 households. Tirap district has the highest population density in the state with an increase from 36 per km^2 in 1991 to 42 per km^2 in 2001. Livestock holdings are also relatively high. The main occupation here is agriculture, most of the land in the upper *Nocte* and *Wancho* areas is under *jhum* cultivation, and many areas are severely degraded, as fallow cycles are short. Until the Supreme Court ban in 1996, timber extraction, primarily of two dipterocarp species, was carried out extensively in the lower areas. Tea estates have also come up in this district over the past 15 years.

Methods

Relative abundance of hornbills was assessed by walking trails in the forests of Rima and Pangsu RFs in Jairampur FD (April and November 2002), Changlang district, while Miao RF was visited for four days in April 2002. Turung and Kamlang RF, near Kamlang WS, and Mopaya VFR in Deomali FD, were also visited in April 2002. Rains, and the lack of field guides prevented access and exploration inside Kamlang WS. During several field visits to Namdapha NP (1996–2004), all sightings of Rufous-necked and the Brown Hornbills were recorded. Distances walked, and effort put in (in terms of days spent walking/searching), were recorded to obtain a crude estimate of relative abundance. Encounter rates (numbers per km) of hornbills are compared between Namdapha (a protected area) and the RF/USF areas (unprotected). On sighting one of the target species, the flock size, flock composition, canopy level, activity, if feeding, the food species, locality, and habitat type were recorded.

Fig. 1. Map showing survey areas in Namdapha National Park (green line depicts park boundary) and Jairampur, Deomali, Lohit FD. Villages/towns visited during the survey are marked as circles, while other locations/camps inside Namdapha are marked with squares. The yellow line depicts the international boundary with Myanmar.

A total of 74 days were spent (walks, active searches) in Namdapha NP, over several years (April 1996, November 1997, November 1998, March 1999, October 1999, December 2002–January 2003, October 2003, and April–May 2004). Short surveys were also carried out in RFs towards the south-western part of the park in Miao Reserve Forest (RF), Pangsu and Rima RFs, Jairampur FD in April–May 2002 and, November 2002. Forests near Kamlang Wildlife Sanctuary (WS) and adjoining RFs in Lohit district and, Deomali in Tirap district were also visited in April–May 2002 (Table 1). Additional information from Khonsa FD in Tirap district, visited in 1997, is also provided. Information about Rufous-necked Hornbill distribution is also presented from Eagle Nest WS, Doimara RF, Papum RF, and community forests in East, and West Kameng districts in western Arunachal Pradesh. Fig. 1 depicts the forest areas, and some of the villages visited during the field surveys in eastern Arunachal.

Results

Distribution and sighting records

Rufous-necked Hornbill: The species is vulnerable, although not critically endangered, but faces high risk of extinction in the wild in the medium-term future (IUCN 2009). It is rare in most parts of its global range, though in Bhutan it is more common. In India, populations are mainly found in Arunachal Pradesh, although it is also reported from Sikkim, and northern Bengal, in the eastern Himalaya.

It is rare in most parts of north-eastern India due to hunting and habitat loss—its status being better only in some protected areas of Arunachal Pradesh. In eastern Arunachal Pradesh, its status is better in Namdapha NP and in forests above 800 m elevation, and in western Arunachal Pradesh in East, and West Kameng districts around Eagle Nest WS and in higher areas of Papum and Doimara RF in Khellong Forest Division. It also occurs in Mehao WS (Dibang Valley district), and Tale WS (Lower Subansiri district), although it is relatively uncommon. In Namdapha NP, it is commonly sighted even at lower elevations (200–900 m). It is heavily hunted by several tribes (*Nishi*, *Wancho*, *Tangsa*, *Mishmi*, *Adi*, and *Apatani*), especially in higher elevation sub-tropical evergreen forests, where the Great and Wreathed Hornbills are less commonly seen. Forest loss is possibly a lesser threat for this species, because the condition and extent of forests at higher elevations are relatively better than in the foothills; hunting may be a more serious proximate threat to this species.

I had 101 sightings of Rufous-necked Hornbills between 1996 and 2004 (Table 1). Most were sighted in Namdapha NP (91 sightings), while seven sightings were in RFs (Rima RF, Pangsu RF in Jairampur Forest Division in eastern Arunachal, and Doimara and Papum RF, Khellong Forest Division, western Arunachal), and three in community forests (also designated as USFs in Arunachal) in the Vijaynagar area, Changlang district.

Austen's Brown Hornbill: Its global range is north-eastern India, Myanmar, Thailand, Laos, Vietnam, and southern China. Its distribution in India is restricted to eastern Arunachal Pradesh and Assam. According to Ali & Ripley (1987) it may occur or have occurred in Manipur and Nagaland; more recently, Chowdhury (2000) has reported its occurrence in these two states. It has been sighted from areas in Upper Assam in Joypur RF (Kashmira Kakati, *pers. comm.*), Tinsukia district, in the Cachar Hills (Pawar & Birand 2001), and from several other RFs in upper Assam (Chowdhury 2000).

I had a total of 31 sightings of Austen's Brown Hornbill over several visits between 1996 and 2004 (Table 1). Calls were heard in Mopaya Village Forest Reserve, Deomali Forest Division. Only

two sightings were in Miao RF, while the rest were in Namdapha. The species is also present in Jairampur FD, as was evident from skulls and heads seen with hunters in the villages. Although it was not sighted in Kamlang WS and adjoining reserve forests in Lohit district, reports from local villagers suggest that it may occur there and is possibly the western-most distribution limit of this species. Earlier reports of this hornbill in Arunachal Pradesh were only from Namdapha (Singh 1995).

Relative abundance

Relative abundance of hornbills was obtained from trail walks in the survey areas. In trails walks between 1996 and 1999 (total distance 357 km, pooled over several visits, which includes 112 km walked from Deban to Vijaynagar), we counted 162 and 123 individuals of Rufous-necked and Austen's Brown Hornbills, respectively, with an average encounter rate of 0.32/km (± 0.49) for Rufous-necked, and 0.39/km (± 0.27) for Austen's Brown Hornbill.

In field surveys between 2002 and 2004 (total distance 326 km, which includes 230 km (two walks from Mpen/Deban to Vijaynagar), we counted 55 Rufous-necked, and 29 Austen's Brown Hornbills, with an average encounter rate of 0.28/km (± 0.32) and 0.29/km (± 0.29), respectively.

There appears to be a considerable difference between the breeding and non-breeding season in numbers of both species seen in the low- and mid-elevation forests (200–1000 m) (Fig. 1), with consistently fewer sightings and numbers in the non-breeding season (winter) for both species. However, this could also be due to the fact that most of the survey effort, in the breeding season (all years), was in the Deban–Haldibari–Hornbill–Ranijheel area, while in the non-breeding season, more effort was along the main Noa-dihing valley on the way to Gandhigram–Vijaynagar. On the other hand, the Wreathed Hornbill, which is known to make long-distance movements, is seen in the area in large flocks in the non-breeding season (winter) (Table 1).

Encounter rates of hornbills were considerably lower in reserve and community forests in Jairampur, Deomali, and Lohit FDs (total distance walked, 133 km, in April–May 2002). Three species, Rufous-necked, Austen's Brown, and Oriental Pied Hornbills were sighted; calls of Great, and Austen's Brown Hornbills were heard once. There were three sightings of seven birds [Brown, Rufous-necked and Wreathed hornbill]. The Rufous-necked hornbill was very rare in adjoining reserve and community forests it (0.004 birds/km ± 0.01). However, much of the survey in the reserve and community forests was in low-elevation forest, where Rufous-necked Hornbills generally do not occur. Austen's Brown Hornbill encounter rates were also low (0.2 birds/km ± 0.6).

An additional 116 km (15 days) were walked in Jairampur FD in November 2002 during a survey for the leaf deer (Datta *et al.* 2003), during which all hornbill sightings were noted. Two species—Wreathed and Rufous-necked Hornbills—were sighted, a total of 27 individuals from 10 sightings.

Table 1. Hornbill records in areas surveyed between 1996 and 2004 (effort in terms of days spent and distances walked) in eastern Arunachal Pradesh

Area	Year	Days spent	Locations	Effort (km walked)	Number (species)	Sightings/calls (total numbers seen)
Namdapha NP	April 1996	3	Deban-Bulbulia, 17-19 mile MV road	37	2 (RNH, BH)	7 (24), 1 call
Namdapha NP	November 1997	3	Deban-Bulbulia, 17-19 mile MV road	37	3 (RNH, BH, WH)	8 (54)
Namdapha NP/ Vijaynagar USF	November 1998	9	Deban-Vijaynagar	112	2 (RNH, WH)	24 (143)
Namdapha NP	March 1999	15	Deban-Firmbase (various trails)	126	4 (RNH, BH, WH, GH)	85 (248), 4 calls
Namdapha NP	October 1999	3	Deban-Hornbill, 17-19 mile MV road, Deban-Mpen	41	3 (BH, WH, GH)	13 (42)
Namdapha NP	December 2002	10	Deban-80 mile	102	1 (WH)	2 (23)
Vijaynagar USF	December 2002	15	80 mile -Gandhigram-Vijaynagar	28	2 (RNH, WH)	8 (32)
Namdapha NP	April 2003	7	Deban-Bulbulia, 17-19 mile MV road	ca. 40	3 (BH, GH, RNH)	14 (23+)
Namdapha NP	October 2003	7	Mpen- Gandhigram	128	1 (RNH)	2 (9)
Namdapha NP	April 2004	7	Deban-Ranijheel, 17-22 mile MV road	ca. 56	3 (BH, GH, RNH)	22 (55)
Jairampur FD	November 1998	1	Hongkap RF	14	None	—
Jairampur FD	April 2002	4	Rima, Pangsu and Miao RF	59	2 (BH, RNH)	2 (5)
Jairampur FD	November 2002	15	Nampong-Rima-Putok-Changlai-Tengpum	116	2 (RNH, WH)	10 (27)
*Kamlang WS & Namsai FD	May 2002	4	Kamlang WS, Turung & Kamlang RF	34	None	—
Deomali FD, Joypur RF	April 2002	5	Mopaya VFR, Joypur RF	40	3 (BH, GH, OPH)	1(2), 3 calls

Poor weather hampered fieldwork and only the edge of the sanctuary was visited (about 7 km along the trail to Glao lake from Wakro). Most time spent in areas near Wakro town and Turung RF.
Abbreviations: BH=Austen's Brown Hornbill; GH=Great Hornbill; OPH=Oriental Pied Hornbill; RNH=Rufous-necked Hornbill; WH=Wreathed Hornbill.

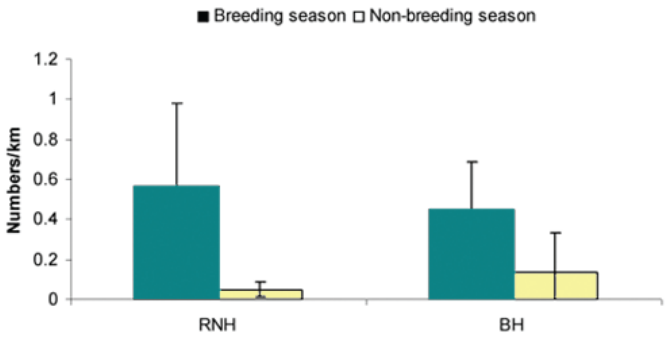

Fig. 2. Mean (± SD) Encounter rates (nos/km) of two hornbill species in breeding (n = 313, effort: 246 km), and non-breeding season (n = 55, effort: 437 km) in the Namdapha National Park.

Flock sizes

Rufous-necked Hornbills were mainly seen in pairs (45% of sightings). Only 3% of sightings were of birds in bigger flocks (> 10 birds), mostly at large fruiting trees. Austen's Brown Hornbill was mostly seen in flocks comprising more than three birds (70% of sightings). The maximum flock size was 15. There were only four sightings each, of single birds, and of pairs.

The mean flock size of the Rufous-necked Hornbill was 2.36 birds in the breeding season, while the modal and median flock size was one (n = 85 sightings). The mean, median, and modal flock size was two in the non-breeding season (n = 15 sightings). The maximum flock size seen was 19 birds in the breeding season, and 7 in the non-breeding season.

The mean flock size of Austen's Brown Hornbill was six birds in both the breeding (n =22), and non-breeding seasons (n = 5). The median and modal flock size was four in the breeding season, while in the non-breeding season median and modal flock size was two and one respectively.

Use of canopy levels

Austen's Brown Hornbill used all canopy layers equally, while Rufous-necked Hornbills were mostly sighted in the upper canopy layer (71% of sightings) (Fig. 3). This difference in the use of canopy levels is probably related to their diet and foraging strategy. While the Rufous-necked Hornbill is largely a resident (possibly territorial) frugivore feeding on canopy fruits, Austen's Brown Hornbill is more omnivorous in its diet (Poonswad *et al.* 1986), feeding much more on animal matter, which probably reflects in its use of all canopy layers.

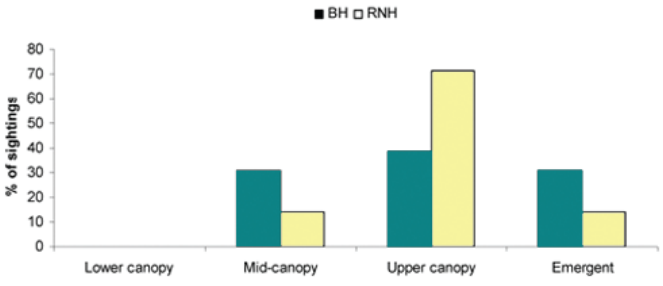

Fig. 3. Use of canopy levels by the two hornbill species in Namdapha National Park, Arunachal Pradesh. n=13 sightings for BH, 59 sightings for RNH.

Diet

Limited observations on the diet of the two species were made during walks. In addition, regurgitated seeds, dropped below two nests each, of both hornbill species, were recorded. Sixteen species were recorded in the diet of the two hornbills, 11 non-fig fruit species, and five fig species (Table 2).

The Rufous-necked Hornbill is largely frugivorous, feeding mainly on berries, drupes, and capsular fruits of primary forest species belonging to Lauraceae, Meliaceae, Myristicaceae, Annonaceae, and figs (Moraceae). No animal matter was recorded in its diet in these limited observations; however more detailed studies in Thailand suggest that it also consumes animal matter, especially crabs (Chimchome *et al.* 1998). Based on 33 feeding observations, the diet of the Rufous-necked Hornbill was made up of figs and non-fig fruits. 51% observations were on fig fruits (four species), and 48% on five species of non-fig fruits. Apart from this, regurgitated seeds of four non-fig fruit species were recorded below fruiting and perch trees visited by Rufous-necked Hornbills. From an old nest, several other species in the diet of these birds—*Horsfieldia kingii*, *Polyalthia simiarum*, and beetle remains—were deciphered. At two active nests in 2004, five non-fig fruit species were recorded.

Austen's Brown Hornbills were recorded feeding on figs and ripe fruits of *Beilshmedia* sp. during six sightings. They were also observed in April 2002, delivering fruits of five species at an active nest. There were regurgitated seeds of *Polyalthia simiarum*, *Dysoxylum binectariferum*, *Aglaia* sp., *Horsfieldia kingii*, and of some Lauraceae species, apart from defecations of fig seeds below the nest. Austen's Brown Hornbill is supposed to have a mixed diet, but is largely insectivorous. Apart from berries, drupes, capsular fruits of primary forest species—Lauraceae, Meliaceae, Annonaceae and figs (Moraceae)—they are reported to consume arthropods, mollusks, and small vertebrates (Poonswad *et al.* 1986, 1998).

Breeding season & nesting records

Rufous-necked Hornbill: The breeding season of the Rufous-necked Hornbill in Namdapha NP commences in late April, much later than that of Great, Wreathed, and Oriental Pied Hornbills further west in Pakke NP, where nesting commences by early- to mid-March in most years (Datta 2001; Datta & Rawat 2004).

In March 1999, I spent 15 days in Namdapha NP, searching for active hornbill nests in the Deban–Haldibari–Hornbill–Bulbulia–Ranijheel–Firmbase area. No active nest trees could be located. It is likely that nesting of Rufous-necked and Austen's Brown Hornbills had not commenced in mid- to late-March, because the former were sighted in pairs till the end of March, and courtship feeding was observed during the second and third weeks of March. An old nest of the Rufous-necked Hornbill, in community forests near Kathang village (10 km from Deban) outside Namdapha NP, was located with the help of a *Miju Mishmi* village headman. The nest had apparently been discovered two years ago and was used the previous year, as evident from old feathers, seeds, and seedlings of the hornbill's regular food plants. The nest was on a *Terminalia myriocarpa* (Hollock) tree, adjacent to a *jhum* field. The village headman also informed that Rufous-necked Hornbills do not start nesting till April. However, there was no nesting on this tree when it was subsequently checked in April and May that year.

I was also shown an old nest of a Rufous-necked Hornbill in community forests near Pakke-ke-Sangh village, by a *Nishi* hunter, at 1,500 m (East Kameng district) on an *Altingia excelsa* (Jutuli) tree in January 2000. Pakke-ke-Sangh village was accessed on foot from Seijusa (Pakke WS), over a two-day trek (*ca.* 83 km).

Table 2. Food species of Rufous-necked Hornbill and Austen's Brown hornbill in eastern Arunachal Pradesh.

Tree species	Family	*Peak fruiting period	Fruit type & color of ripe fruit	Observation method & season
Polyalthia simiarum (Kari)	Annonaceae	May to June & Dec-Feb (both seasons)	Lipid-rich drupaceous carpel, black	Regurgitated seeds below nest tree
Dysoxylum binectariferum (Banderdima)	Meliaceae	March-April (breeding)	Multi-seeded arillate capsular fruit, aril black	Nest trees and trail walk
Chisocheton paniculatus (Banderdima)	Meliaceae	May-June (breeding)	Multi-seeded arillate capsular fruit, aril orange-white	Nest trees and trail walk
Horsfieldia kingii (Ramtamul)	Myristicaceae	Feb-March (breeding)	Single-seeded capsular fruit	Regurgitated seeds below nest tree
Aglaia sp.	Meliaceae	Feb-April (breeding)	Multi-seeded arillate capsular fruit, orange-red	Regurgitated seeds below nest tree
Beilshmedia sp.	Lauraceae	Oct-Nov (non-breeding)	Lipid-rich fleshy drupe, black	Trail walk, regurgitated seeds below fruit and perch trees
Cryptocarya sp.	Lauraceae	May-July (breeding)	Lipid-rich fleshy drupe, black	At nest
Canarium resiniferum (Kaladhuna)	Burseraceae	Nov-Dec (non-breeding)	Lipid-rich fleshy drupe, black	Trail walk
Cinnamommum cecidodaphne (Gonsorai)	Lauraceae	Nov-Dec (non-breeding)	Lipid-rich fleshy drupe, black	Trail walk
Hovenia acerba (Chetiabola)	Rhamnaceae	March? (breeding)	Drupe	Trail walk
Unidentified species	Meliaceae	March (breeding)	Multi-seeded arillate capsular fruit	Perch tree
**Platea latifolia*	Icacinaceae	Nov-Dec (non-breeding)	Lipid-rich fleshy drupe, black	—
Ficus macclellandi	Moraceae	Available in both seasons	Fig (syconia), bright yellow	Trail walk (April)
Ficus altissima	Moraceae	Available in both seasons	Fig (syconia), red	Trail walk
Ficus hookeri	Moraceae	Available in both seasons	Fig (syconia), reddish-black	Trail walk (November)
Ficus sp.1	Moraceae	Not known	Fig (syconia)	Trail walk
Ficus sp.2	Moraceae	Not known	Fig (syconia)	Trail walk

* Not recorded as food species in Namdapha but fruit characteristics indicate it is a hornbill food species. Recorded in Wreathed hornbills' diet in non-breeding season in western Arunachal.

Intensive searches for nests were carried out again in Namdapha in March–April 2004. However, during this period, most sightings were of birds in pairs, indicating that most birds had still not commenced nesting. Despite the abundance of suitable cavities, most birds had not started nesting even by the last week of April. Two active nests were located in the third week of April, in Namdapha. One was located on a *Terminalia myriocarpa* tree near Hornbill camp on 26 April 2004. It had probably been active since a week. Another was found on a steep slope, downhill from the 19th mile (of the Miao–Vijaynagar road), on 24 April 2004. It was located on a tall, emergent *A. excelsa*.

Subsequently, in May 2004, another nest was located in Miao RF (Akhi Nathany, *pers. comm.*). The Rufous-necked Hornbill appears to be resident and territorial (mostly sighted in pairs in particular localities), and the breeding season is between April and July / August. Unfortunately, these nests could not be monitored throughout the breeding cycle, as it coincides with the period of heavy rains in the area and both these nests were difficult to access in the monsoon. Thus, there is neither any information on the exact exit dates from the nest nor whether the nests were even successful.

Austen's Brown Hornbill: During intensive nest searches inside Namdapha in March 1999, no nests of this species could be located. The birds were mostly sighted in flocks. During the survey in Jairampur FD in 2002, a flock was sighted visiting and feeding at an active nest in Miao RF. A nest of Austen's Brown Hornbill was shown to me by a *Wancho* youth on 21 April 2002 in Miao RF. The nest cavity was located on an *Ailanthus grandis* (Borpat) tree, approximately 1 km from Miao township, on a steep hillside, near a perennial stream (about 60 m uphill from the stream). The youth had noticed a flock of noisy birds, and subsequently discovered the nest, while cutting and burning his *jhum* field in 2001. According to him, they had nested successfully in 2001. The cavity was at about 23 m, while the height of the nest tree was about 30 m. The shape of the cavity was oval-elongated and the cavity was located on a primary branch. The hole was south-facing. The nest had a flock of four birds, which were making feeding visits. One was possibly the adult male, and the other three were

helpers. The local youth who showed me the nest had not seen Austen's Brown Hornbills before, though he was familiar with other hornbill species in the area. On a subsequent nest watch of two hours on 28 April 2002, I again observed four birds, each taking turns in feeding 2–3 food items, several times during a visit. In a second visit, about an hour later, different individuals fed the female, and chicks 8–9 times. The chicks (possibly three) had already hatched, as they could be heard calling from inside. This is the first recent recorded instance and evidence of Austen's Brown Hornbill breeding in the wild in India.

This nest tree was also active in 2003; however in the breeding season of 2004, the birds did not nest on this tree, possibly due to increased human activity and disturbance in the vicinity of the nest. One additional nest of this species was located in Miao RF (305 m) in May 2004, which was again found to be active in 2006, 2007, and in 2008. Despite intensive searches within the Haldibari–Bulbulia area, no active nest could be found. Austen's Brown Hornbill is reported to be a monogamous, territorial, and co-operative breeder. In Thailand, its breeding season is from February to April (Poonswad *et al.* 1987). From our limited observations, it appears that its breeding season in north-eastern India commences in mid-April, and is over by June–July.

Table 3. Structural characteristics of nest sites of two hornbill species in Arunachal Pradesh

Parameters	Austen's Brown Hornbill N = 1	Rufous-necked Hornbill N = 2
Tree density (per ha) (trees ≥ 25 cm GBH)	NR	410 ± 56.56
Nest tree height (m)	30	34 ± 6
Nest tree GBH (cm)	> 400	708.5 ± 27.5
Emergence (m)	20	22.5 ± 7.5
Height of cavity from ground (m)	23	19 ± 3
Height of first branch (m)	NR	18 ± 8
Girth at cavity (cm)	NR	NR
Cavity length (cm)	NR	NR
Cavity width (cm)	NR	NR
Distance to habitation (m)	500	1500 ± 0.0
Distance to road (m)	700	6000 ± 4000
Distance to river (m)	1000	2500 ± 500
Altitude (m)	200	1100 ± 300

Nest tree species

The nest tree species used by these two hornbill species were all large emergent trees such as *Terminalia myriocarpa*, *Ailanthus grandis* and *Altingia excelsa*. Other potential nest tree species (all

Photo: *Aparajita Datta*

A male Rufous-necked Hornbill (about 2-years old) in Namdapha National Park.

The tail feathers of the Great Hornbill are highly valued for use in traditional headdresses by the *Wancho* in eastern Arunachal; in 1997, a single tail feather cost Rs 600/- and were hard to obtain as the Great Hornbill appears to be locally extinct or very rare in parts of Tirap district. The tail feathers are kept carefully wrapped in banana leaves, Konnu village, Upper Wancho area, November 1997.

emergents) in the area are *Dipterocarpus macrocarpus* (Hollong) and *Shorea assamica* (Mekai). *Tetrameles nudiflora* (Bhelu) is the most common nesting tree (emergent softwood species) used by hornbills in the foothill forests in western Arunachal. However, the species does not seem to occur in eastern Arunachal (some were seen in lowland forests in Assam). *T. nudiflora* was not observed in the Mehao WS (Dibang Valley district) or in Namdapha NP, even in relatively lower elevation foothill forests. In Namdapha NP, *A. excelsa*, *T. myriocarpa*, *A. grandis* and two dipterocarp species, *S. assamica* and *D. assamicu*s are the common emergent species, and may be more important nest tree species for hornbills.

In all, four nests of Rufous-necked Hornbill have been recorded, two each on *T. myriocarpa* and *A. excelsa*. Overlap in nesting habitat between the Rufous-necked Hornbill and the other hornbill species is largely precluded, since it generally occurs in higher elevation forests, from 800 m to above 1500 m, though in Namdapha NP, they are also sighted at similar elevations as Great, Wreathed and Austen's Brown Hornbills. Great Hornbills are reported up to 1,200 m and though Wreathed Hornbills do occur up to 2,000 m, they are more common at lower elevations and are often seasonal visitors at higher elevation forests of Namdapha NP, Tale WS, and other community forest areas in Lower Subansiri and East Kameng districts (A. Datta, *unpubl. data*).

Photos: *Aparajita Datta*

Heads/beaks of three species of hornbills (RNH, WH, GH) displayed in household in a Tangsa village, eastern Arunachal.

Table 3 lists the parameter values of some nest trees found, of the two species.

Height and size of trees as well as commonness in the habitat are important factors in nest tree selection (Datta & Rawat 2004). Studies on Asian hornbills, across many sites, have revealed that generally hornbills chose large emergent trees with cavities high up on the tree compared to randomly located trees (Kinnaird & O'Brien 2007). While in some areas, hornbill species choose a few particular softwood species, in others the main nest tree species were hardwoods (Thailand and some areas in SE Asia), and Poonswad (1995) contends that this is probably because such trees last longer and can be used by nesting hornbills for a long time, given their durability, once cavities form on them. On the other hand, it is also likely that softwood species like *T. nudiflora* that rot easily, are likely to form cavities. In southern India, hornbills did not show a preference for any particular species (Mudappa & Kannan 1997).

Proximate structural characteristics (tallness, emergence, softwood, easy cavity formation due to woodpecker / barbet activity or breakage of branch) of some tree species determine whether they are used or not. However, hornbills will ultimately select trees based on availability or commonness of a particular species that meets the structural characteristics (Datta & Rawat 2004).

My observations indicate that hornbills do nest in logged and degraded forest, though these attempts are often unsuccessful, mainly due to anthropogenic disturbances. Hornbills may be able to nest successfully even in such marginal habitats, if further degradation of, or disturbance at, the nest site (especially in the breeding season) is prevented. Given the limited availability of suitable nesting trees and the fact that hornbills nest in such marginal habitats, it is necessary to widen the scope of conservation plans for hornbills to include forests outside the existing protected area network, which forms more than 70% of the forest area of Arunachal Pradesh (Datta & Rawat 2004; Kinnaird & O'Brien 2007).

Conservation threats

Most of Arunachal Pradesh is hilly with inaccessible terrain and has low human population densities. The foothill lowland habitat, where most hornbills' nesting occurs, is threatened by habitat loss and degradation due to logging and land clearing for settlements and agriculture (Datta & Rawat 2004). Logging also has led to the creation of roads and greater accessibility, which has been followed by creation of settlements and greater incidence of human activities such as hunting and collection of fuelwood and

Head of a young Rufous-necked Hornbill seen with an Apatani hunter in Tale Wildlife Sanctuary, Lower Subansiri district.

forest products that create additional disturbance (Datta 1998). Logging was banned in 1996, though logging has restarted now in several forest divisions. However, although logging does result in reduced abundance of hornbills, several studies have shown that hornbills are able to persist in logged forests (Johns 1987, 1989; Datta 1998).

Hunting of hornbills during the breeding season is taboo in many areas, but is carried out during the winter from November to February (non-breeding season). There is a great demand for hornbill casques, meat, fat and feathers all over Arunachal, particularly among certain tribes, and these are either sold or bartered in exchange for goods (Datta 1998, 2002). Hornbills have become virtually extinct, or very rare, in many areas in eastern and central Arunachal (Datta 2002). Apart from the Rufous-necked Hornbill, which frequents forests above 800 m, all other species are largely restricted to lowland forests, the extent of which is fast declining.

Rufous-necked Hornbill: This species is among the ten globally threatened hornbills. It is believed to be extinct in Nepal and is also near extinction in Vietnam (IUCN 2009). Its current global distribution is north-eastern India (primarily in Arunachal Pradesh), Bhutan, Myanmar, northern and western Thailand, southern China, northern Laos, and Vietnam. Its presence in Cambodia is unconfirmed. The species occurs in hill evergreen forest from 600 m to 2200 m. Hunting is the primary threat to the Rufous-necked Hornbill in Arunachal Pradesh. This is the only hornbill species found at higher altitudes (>1,000–2,000 m), and is targeted extensively by hunters in the survey areas. In western Arunachal, it is hunted by *Nishi, Adi* and *Apatani*, and by the *Wancho*, *Tangsa*, *Miju Mishmi* and *Lisu* in eastern Arunachal—and these tribes have distinct names for the species (Table 4). In 1997, I recorded 32 Rufous-necked Hornbill heads on display (hunted over several years) in a single household in Pongchau, a *Wancho* village in Tirap district. 61% of all hornbill heads seen in 35 households, across 17 villages, were of the Rufous-necked Hornbill (Datta 2002).

Austen's Brown Hornbill: It is probably the most threatened of the hornbills in north-eastern India, in terms of total population in India, because of a naturally restricted and localised range. Its habitat is mostly dense evergreen forest and it is restricted to below 1,000 m. Lowland and foothill forests are the most vulnerable to logging, conversion to tea estates, settlements, and clearing for agriculture. There has been extensive habitat loss/modification (especially in upper Assam and Tirap district). Hunting of this species occurs, by the *Tangsa* and *Wancho*, but much less than that of other hornbill species because of its smaller size and lack of spectacular striking plumage. In eastern Arunachal, local knowledge of Austen's Brown Hornbill is sketchy. While some villages and tribes, *Lisu*, *Tangsa* and some *Wancho*, were aware of this species and knew its habits, in some nearby localities, people were not aware of it. Common names for these species are given by *Tangsa*, *Lisu*, *Khampti* and the *Miju Mishmi*. The species is most commonly sighted in Namdapha NP in low-elevation evergreen forest in the Deban–Haldibari–Bulbulia area and seen further up till the 58th mile on the Miao–Vijaynagar Road. The best place for these two hornbill species is Namdapha NP.

Photo: *Aparajita Datta*

Heads/beaks of three species of hornbills (RNH, WH, BH) displayed in household in a Tangsa village, eastern Arunachal.

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Photo: *Aparajita Datta*

Wreathed Hornbills at a communal roost in Pakke, western Arunachal.