J. Sci. Trans. Environ. Technov. 2023, 16 (3) : 1 - 25

Special Issue: Biodiversity Conservation of Andaman and Nicobar Island

BREEDING ECOLOGY OF NARCONDAM HORNBILL *RHYTICEROS NARCONDAMI* HUME, 1873

Sivaperuman C[1], Gokulakrishnan S[2] and Thiyagesan K[3]

1,2 Zoological Survey of India, Andaman and Nicobar Regional Centre, Ministry of Environment, Forests and Climate Change, Government of Inia, Port Blair.

3 AVC College (Autonomous), Mannampandal, Mayiladuthurai.

Article History

Received: 09.01.2023

Revised and Accepted: 08.02.2023

Published: 13.03.2023

https://doi.org/10.56343/STET.116.016.003.001

www.stetjournals.com

ABSTRACT

Hornbills (Bucerotidae and Bucorvidae) are among the largest and most conspicuous bird species in the tropical forests of Asia and Africa. The Narcondam Hornbill *Aceros narcondami* is endemic to the Narcondam Island (6.82 km²) in Andaman and Nicobar Islands. It was first described as *Rhytidoceros narcondami* by Hume (1873) and Baker (1927). This study was carried out in Narcondam Island Wildlife Sanctuary (Fig. 1) situated in the oceanic island of volcanic origin (13°45′N and 94°27′E), Northeast of the main Andaman group of Islands in the Bay of Bengal, about 180 km west of the Burmese mainland, a small Island rises abruptly from the sea. The extent of the areas is about 6.8 km²and located about 240 km northeast of Port Blair in the South Andaman Islands, and about 125 km east of North Andaman. The nearest Island is North Andaman, while Coco Island of Myanmar is about 96 km (Raman *et al.,* 2013). The Island is part of the Indo-Myanmar Biodiversity Hotspot (Myers *et al.,* 2000). This species is found only on this Island which was declared an Important Bird Area (Islam and Rahmani, 2004). Narcondam Hornbill were surveyed in the Narcondam Island using modified line-transect method, based on the distance sampling (Buckland *et al.*, 1993). Data on feeding, breeding and roosting behaviour were collected using focal animal sampling method (Altman, 1974) during February 2020 - May 2020. The estimated density of Nacondam Hornbill is 798.78 individuals / km². Totally 83 nests from twenty-two species of nesting trees were identified during the period of study. Of these, *Tetrameles Nudiflora*(24.1 %) showed highest percentage of nest, followed by *Casearia andamanica*(8.4 %), *Ficus nervosa* (7.2 %),*Flacourtia jangomas, Gyrocarpus americanus* and *Planchonella longipetiolatum*(6.0 %). Nesting frequencies were higher at a GBH range of 200-300 cm, followed by 100-200 cm range and were least at 500-600 cm. During the study period a greater number of nests were observed in west. Overall, 58.8% of nests were found on branches, while 42.2 percent were found in the main trunks. Nesting frequencies were highest at a level of 0-100 m elevation (height), while decreased frequencies were found at 200-300m. A total of 83 nests were observed from 22 tree species. Out of 83, 23 nests (24%) were observed from *Tetrameles nudiflora*, followed by *Casearia andamanica* (7 nests; 8.4%). The Narcondam hornbill feed both fruits and animals, however the quantity of animals ingested is higher during the post-breeding phase, which is thought to be used as a nutrient supplement for the young ones' growth. During the nesting period (February-May), male Narcondam hornbills were observed for feeding activity at the 6 identified and verified nest sites. The feeding observation during the nesting season showed that male Narcondam Hornbills brings food to his mate or his family at (0445 – 1740). After sealing the female hornbill within the nest, the male hornbill visited the nest frequently ±(28.337.51 SD visits per day) to forage with his partner and brood. When comparing hourly foraging, foraging was higher during the hours of 8 AM to 3 PM and then gradually declined.

P-ISSN 0973-9157

E-ISSN 2393-9249

INTRODUCTION

Hornbills (Bucerotidae and Bucorvidae) are among the largest and most conspicuous bird species in the tropical forests of Asia and Africa. They are brightly coloured, have loud calls, and characteristically large bills and casques. Due to their predominantly frugivorous diet, the hornbills have always been considered important agents of seed dispersal in the tropical forests. They are known to be among the most easily surveyed forest organisms, allowing both visible and audible means of identification (Kemp and Kemp, 1974; Poonswad*et al*., 1987; Johns 1987, 1988). The remarkable nesting habit is that the female seals herself in a large cavity of a living tree leaving only a narrow opening for her mate to pass food to her and later chicks. They are omnivores feeding on a great variety of fruits and animals. Thus, they are important for seed dissemination and keep balance of some animal groups in the forest (Poonsward*et al*., 1987; Kemp, 1995).

There are 61 species of Hornbill species recorded in the world (Kemp, 1988; Gonzales, 2013). Of which 32 species are present within Asian continent (Poonswad*et al*., 2013). India is home to nine species of hornbills, of which two are endemic (Ali and Ripley 1987; Praveen *et al*., 2016). Hornbills are useful indicators of forest ecosystem and human disturbance because they require large forest tracts of unfragmented forest with large fruiting trees for feeding and nesting. Hornbills are secondary cavity nesters and these forest dwelling species are predominantly frugivorous. Their breeding cycles are synchronous with feed productivity of forest (Kannan, 1994), but they are also dependent on keystone resources like *Ficus* for their survival in times of low food availability. They exhibit wide-ranging movements to meet their specialized food requirements (Poonswad and Tsuji, 1994). Functionally, they have been described as keystone mutualists (Gilbert, 1980) as they play an important role in dispersal of many rare rain forest tree species (Whiteny*et al*., 1998; Mudappa, 2000).

The Narcondam Hornbill *Aceros narcondami* is endemic to the Narcondam Island (6.82 km^2) in Andaman and Nicobar Islands. It was first described as *Rhytidoceros narcondami* by Hume (1873) and Baker (1927). Later, Ripley (1961) and Ali and Ripley (1970) treated it as a subspecies *Rhyticerous* (*Plicatus*) *narcondami*. However, Grimmet*et al.* (1998), Kazmierczak and Van Perlo (2000) and Rasmussum and Anderson (2005) treated it as a separate species and named it *Aceros narcondami.* It is an interesting species from the ecological and evolutionary point of view, and is also Red listed (King, 1981). It has been declared endangered due to its restricted range (Stattersfield *et al*., 1998). The island was recently declared an Important Bird Area (IBA) under the IBA programme launched by Birdlife International.

Several studies have been conducted on the aspects of ecology and breeding biology of Hornbills in other countries. Some important works are reviewed here. Ecology and behaviour of the Black-and-white Casqued Hornbill (*Bycanistes subcylindicus subquadratus*) in Kibale forest, Uganda was reported by Kalina (1988). Status of nest cavities of Hornbills in Khao Yai National Park, Thailand has been reported by Chuailua *et al*. (1998). Chong (1998) surveyed hornbills in the rain forest habitats of Peninsular Malaysia. Anggraini *et al*. (2000) studied the effects of fruit availability and habitat disturbance on an assemblage of Sumatran Hornbills. Chaisuriyanane *et al*. (1998 and 2005) made a detailed comparative study of fruit diets of Great Hornbill (*Buceros bicornis*) and Rhinoceros Hornbill (*Buceros rhinoceros*) during the breeding season in Budo Sungai-Padi National Park, Southern Thailand. Gale and Thongaree (2006) reported the density of nine hornbill species (*Buceros rhinoceros*, *Buceros bicornis*, *Buceros vigil*, *Anthracoceros malayanus*, *Anorrhinus galeritus*, *Aceros comatus*, *Aceros corrugatus*, *Aceros undulatus* and *Aceros subruficollis*) in the Hala-Bala Wildlife Sanctuary on the Thai-Malaysia border using variable-width line transect surveys, one of the few remaining areas of lowland forests in Thailand. Hadiprakarsa and Kinnaird (2004) studied the foraging characteristics of an assemblage of four Sumatran hornbill species. Ecology and breeding biology of hornbills of Thailand was provided by several workers (Poonswad, 1993; Kanwatanakid-Savini and Poonswad, 2007; Poonswad*et al*., 1983, 1987 and 1998).

In India, most of the studies focused on breeding and nesting ecology of selected species of Hornbills *e.g.,* Malabar Pied Hornbill (*Anthracocero scoronatus*), Great Pied Hornbill (*Buceros bicornis)*, Wreathed Hornbill (*Aceros undulates)* and Malabar Grey Hornbill (*Ocycerus griseus)*. Maheswaran and Balasubramanian (2003); Balasubramanian *et al.* (2004) have studied the fruit preferences of Malabar Pied Hornbill and their habitat conservation in the Western Ghats. Datta (1998 and 2001) and Datta and Rawat (2003 and 2004) made detailed ecological studies on three species of hornbills *viz*. Great Hornbill (*Buceros bicornis)*, Wreathed Hornbill (*Aceros undulates)* and Oriental Pied Hornbill (*Anthracoceros albirostris)* in the tropical forest of Arunachal Pradesh. Ecology and conservation of the Great Pied Hornbill (*Buceros bicornis*) in the Western Ghats of Southern India has been reported by Kannan (1994 and 2007) and Kannan and James, (1997, 1998 and 1998). Detailed account of nesting and breeding biology of Malabar Grey Hornbill in the Anamalai hills of Southern Western Ghats is given by Mudappa (1998 and 2005), Mudappa and Kannan (1997) and Raman and Mudappa (2003). Very little information is available on the population and breeding ecology of Narcondam Hornbill due to remoteness of this Island, even though few week-long surveys were conducted (Hume, 1873; Prain 1892; St. John 1898; Cory, 1902). Hussain (1984 and 1993) and Yahya and Zarri (2003) made an attempt to study this species through a month-long survey. In this chapter, we made an attempt to describe the breeding biology and nesting behaviour of Narcondam Hornbill.

This study was carried out in Narcondam Island Wildlife Sanctuary (Fig. 1) situated in the oceanic island of volcanic origin (13°45′N and 94°27′E), Northeast of the main Andaman group of Islands in the Bay of Bengal, about 180 km west of the Burmese mainland, a small Island rises abruptly from the sea. The extent of the areas is about 6.8 km²and located about 240 km northeast of Port Blair in the South Andaman Islands, and about 125 km east of North Andaman. The nearest Island is North Andaman, while Coco Island of Myanmar is about 96 km (Raman *et al.,* 2013). The Island is part of the Indo-Myanmar Biodiversity Hotspot (Myers *et al.,* 2000). This species is found only on this Island which was declared an Important Bird Area (Islam and Rahmani, 2004).

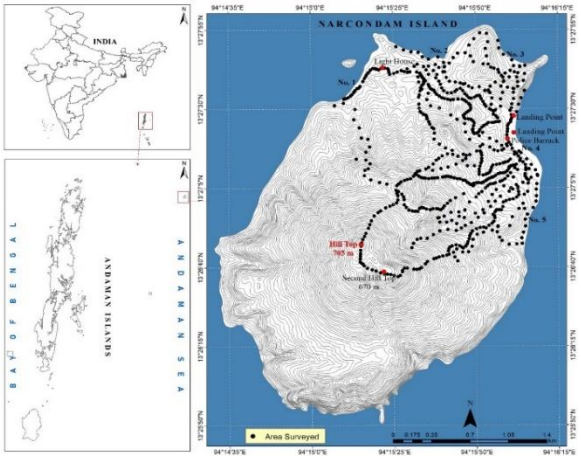

Fig. 1. Map of the Narcondam Island with details of transect surveyed

Narcondam lies about 135 kilometres north of Barren Island, a volcano that has erupted four times since 1991, the most recent in 2008-2009, following previous eruptions between 1787 and 1832. (Venkatachala*et al*., 1992).Narcondam Island is an island with two highest peaks, the first peak (756 m height) and the truncated top rising to 710 m above sea level (Pal *et al*., 2007). Rains had been falling on the island for around nine months (first May to first January). Except for a few sandy sections on the island's west and east coasts, the majority of the island's beach is rocky. We investigated the interior of the island, focusing on the north-easternpart of the island, in order to observe and document the species.

METHODS

Population estimation

Narcondam Hornbill were surveyed in the Narcondam Island using modified line-transect method, based on the distance sampling (Buckland *et al.*, 1993). Transects were repeatedly surveyed on foot for estimation of hornbill numbers. The following details were collected during the 'census': the group size, distance from observer and group, time, angular distance and tree species. The density of hornbill was estimated from the transect data using the computer programme Distance (Lake *et al.*, 1993).

Behavioural observation (Feeding, Breeding, and Roosting)

Data on feeding, breeding and roosting behaviour were collected using focal animal sampling method (Altman, 1974) during February 2020 - May 2020. Active nests of Narcondam Hornbill were located by following the breeding males and by checking signs of the previous year faecal remains at the base of the nest trees. Begging calls

Scientific name	:	*Rhyticeros narcondami*
Species author	:	Hume, 1873
Synonyms/Protonym	:	*Rhyticeros narcondami* A.O. Hume, 1873
Order		Bucerotiformes
Family	:	Bucerotidae
Common name	:	Narcondam Hornbill
Other names	:	Narcondam Wreathed Hornbill
Distribution	:	Endemic to Narcondam Island
Diet and feeding habits	:	Fruits, Berries, Figs
IUCN status	:	Endangered (EN)

of the young hornbills being fed by the males also used to identify the nest. Observations were made at close quarters from selected vantage points in the study area using binoculars and telescope. Information on time activity budget and foraging behaviour were collected. Four nests were observed throughout the study period (04:45hrs - 17:45hrs) for continuous monitoring.

Quantification and determination of vegetation and its phenological patterns

Specimens of various parts of the trees were preserved as herbarium for identification of species. Floristic composition, density of plant species, extent of canopy cover and vertical stratification were studied in detail. To assess the density of trees, 10 X 10m quadrats were laid at every 100 meters interval along transect lines (Ravindranath and Premnath, 1997). Tree species identified based on the available literature (Sinha, 1999; Hajra, Rao and Mudgal, 1999). Food plants were estimated by visual encounter method (Vivek and Vijayan, 2003).

All the trees more than 30 cm GBH were identified and its GBH and height were measured. A total of 20 plots 50 m X 50 m size were measured in different forest habitat. In each plot all nesting trees and fruiting plants (climber, shrub, tree,) were enumerated, for climber girth was measured (GBH ≥ 1 cm) at breast height, for shrub girth was measured (GBH ≥ 10 cm) at breast height and for tree girth measured (GBH ≥ 30 cm) 1.3 m above ground level. In case of multi-stems, basal area was measured separately. The collected data were analyzed for species structure like, relative density, relative frequency, relative dominance, Importance Value Index (IVI), using the formula by Cottom and Curtis (1956). The Importance Value Index (IVI) was used to understand the relative importance of species present in the community.

Narcondam Hornbill an Overview

The Narcondam Hornbill (*Rhyticeros narcondami*) is closely related to Blyth's Hornbill (*Rhyticeros plicatus*) and Wreathed Hornbill (*Rhyticeros undulatus*).

Appearance, physical description and identification

The Narcondam Hornbill (*Rhyticeros Narcondami*) is a small hornbill, measuring 45 to 50 cm in length. They are sexual dimorphic, both in size and plumage. The male is slightly larger and weighs 700 to 750g and the female weighs 600 to 750g. The overall plumage is blackish. The male hornbill's upper parts are black with green gloss. The male has rufous head, neck and upper breast. The rest of the underparts are black. The male has orange red irises. The female is totally black. In female, the irises are olive brown. There is a pale blue gular pouch and short white tail in both the sexes. The bare skin around the eyes is bluish. The juveniles look similar to males and have dull-looking bills without folds. The base of the bill is pinkish. The upper mandible has folds near the base. The furrows of the casque are brownish. The legs are blackish and the soles are yellow.

Origin, geographical range and distribution

This hornbill species is distributed in Narcondam Island, a small dormant volcanic island in the Andaman Sea, which is part of Andaman Islands. The extent of area is 6.8 km². The Islands is one of the Important Bird and Biodiversity Areas (IBA) of in India and it is a Wildlife Sanctuary.

Ecosystem and habitat

The Narcondam Hornbill species are highly forest dependent. These species occur in altitudes from 0 to 700 meters. The natural ecosystems of these species include tropical and subtropical moist lowland forests, open mixed forests and tropical and subtropical moist shrublands.

Diet and feeding behavior

The diet of Narcondam Hornbill species is mostly fruits, berries, figs, invertebrates and small reptiles as their primary food.

Reproduction and breeding habits

The breeding season of these Narcondam Hornbill species is from February to April. The nesting sites are located in mature, undisturbed forests with large trees. These hornbill species nest in holes and hollows in trunks and broken branches in large trees.

	Estimate	Percent CV	95% Confidence Interval	
DS	374.02	550.88	9.7852	14296.
D	798.78	2.33	2.0404	2.2354
Average Cluster	2.1937	5.27	1.9782	2.4328

Table 1. Estimated density of Narcondam Hornbill

RESULTS

Population estimation

The estimated density of Nacondam Hornbill is 798.78 individuals / km². (Table 1)

Nesting trees preference by Narcondam Hornbill

Totally 83 nests from twenty-two species of nesting trees were identified during the period of study. Of these, *Tetrameles Nudiflora*(24.1 %) showed highest percentage of nest, followed by *Casearia andamanica*(8.4 %), *Ficus nervosa* (7.2 %),*Flacourtia jangomas, Gyrocarpus americanus* and *Planchonella longipetiolatum*(6.0 %) (Fig.2.).

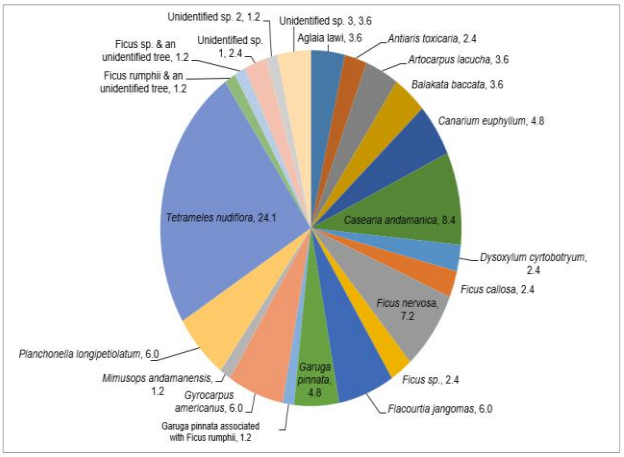

Fig.2.Utilization of different tree species by Narcondam Hornbill for nesting

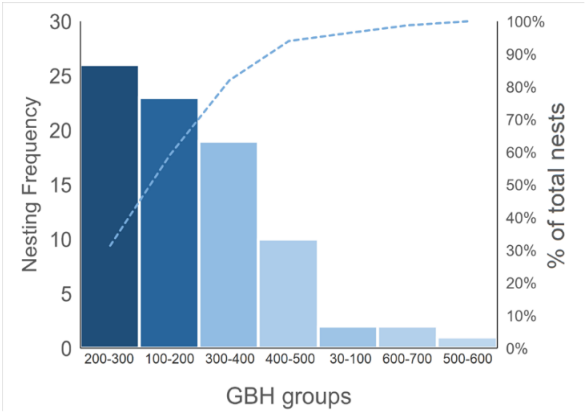

Fig.3.Nesting frequency Vs. GBH for Narcondam Hornbill

Nesting frequency Vs. GBH

Nesting frequencies were higher at a GBH range of 200-300 cm, followed by 100-200 cm range and were least at 500-600 cm. (Fig.3).

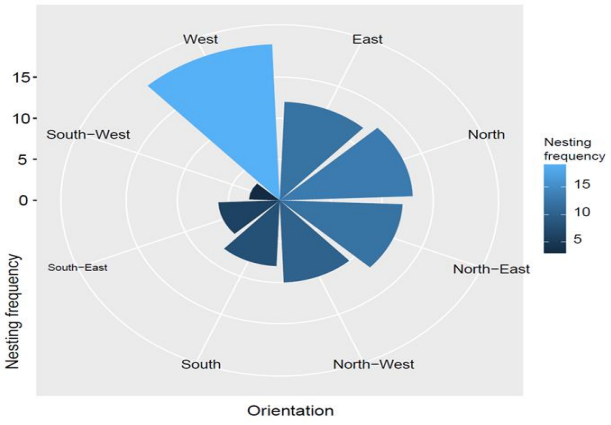

Fig.4.Cavities in different cardinal directions

Cavities in different cardinal directions

During the study period a greater number of nests were observed in west.(Fig.4)

Frequency of nesting vs. nesting characteristics

Overall, 58.8% of nests were found on branches, while 42.2 percent were found in the main trunks.(Fig,5).

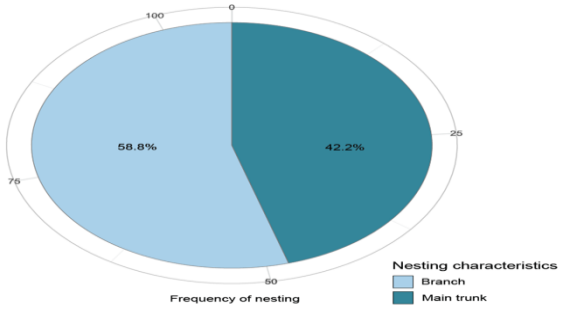

Fig.5.Frequency of nesting vs. nesting characteristics for Narcondam Hornbill

Table 2. Nest tree and habitat characteristics of Narcondam Hornbill

Tree species	GBH (cm)		Nest height (m)		Tree height (m)		No. of trees	Hatching Success
	Mean ± SE	Range	Mean ± SE	Range	Mean ± SE	Range		
Aglaia lawi	219.66 ± 7.44	209-234	12.33 ± 2.33	10-17	15.66 ± 2.72	12-21	3	4
Antiaris toxicaria	366.5 ± 118.5	248-485	15.0 ± 9.0	6-24	19.0 ± 5.0	14-24	2	3
Artocarpus lacucha	262.33 ± 29.67	215-317	8.0 ± 2.08	5-12	18.33 ± 1.76	15-21	3	5
Balakata baccata	176.33 ± 31.29	125-233	6.16 ± 2.42	3.5-11	15.33 ± 1.76	12-18	3	3
Canarium euphyllum	407.25 ± 63.67	329-596	14.5± 2.59	11-22	31.0 ± 2.41	27-38	4	2
Casearia andamanica	243.85 ± 22.54	148-340	9.57 ± 2.95	3-26	17.4 ± 2.49	8-28	7	7
Dysoxylum cyrtobotryum	236.0 ± 32.0	204-268	9.50 ± 0.5	9-10	19.0± 4.0	15-23	2	1
Ficus callosa	268.0 ± 4.0	264-272	10.0 ± 2.0	8-12	19.0	19	1	1
Ficus nervosa	221.83 ± 20.33	160-278	16.66 ± 4.03	7-30	26.5 ± 2.15	16-30	2	1

Ficus sp.	215.50 ± 3.50	212-219	11.50 ± 1.50	10-13	22.5 ± 3.50	19-26	6	6
Flacourtia jangomas	210.8 ± 18.41	178-274	11.6 ± 2.20	5-17	24.6 ± 3.17	15-34	5	6
Garuga pinnata	206.25 ± 14.60	179-238	8.0 ± 2.27	4-14	17.0 ± 1.35	13-19	4	5
Garuga pinnata & F. rumphii	315	-	14	-	19	-	1	1
Gyrocipus americanus	248.6 ± 22.83	203-314	14.0 ± 2.21	8-21	19.4 ± 1.28	15-22	5	1
Mimusops andamanensis	248		11		18		1	0
Planchonella longipetiolatum	252.2 ± 43.48	149-373	15.2 ± 3.29	11-28	29.0 ± 5.63	17-49	5	4
Tetrameles nudiflora	432.9 ± 17.31	314-658	18.65 ± 1.62	9-30	28.15 ± 1.90	14-42	20	13
Ficus rumphii& an unidentified tree	367	-	11	-	22	-	1	1
Ficus sp.*& an unidentified tree*	224	-	3	-	16	-	1	1
Unidentified sp. 1	275.0 ± 26.0	249-301	6.75 ± 1.25	5.5-8	16.5 ± 1.5	15-18	2	2
Unidentified sp. 2	240	-	17	-	23	-	1	1
Unidentified sp. 3	159.33 ± 22.21	115-184	9.66 ± 1.76	7-13	15.0 ± 2.0	12-19	3	2

No. of Nests vs elevation group (levels)

Nesting frequencies were highest at a level of 0-100 m elevation (height), while decreased frequencies were found at 200-300m.This demonstrates the species predilection for nesting in trees with a height of less than 200 meters or in the 0-100 m range (Fig.6.).

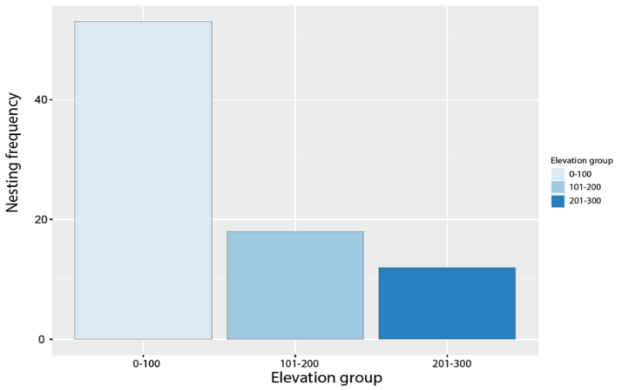

Fig.6.Number of Nests vs elevation group (levels)

Nest tree and habitat characteristics of Narcondam Hornbill

A total of 83 nests were observed from 22 tree species. Out of 83, 23 nests (24%) were observed from *Tetrameles nudiflora*, followed by *Casearia andamanica* (7 nests; 8.4%). Dominant of GBH tree: *Tetrameles nudiflora* 432.9±17.31 (314-658); Smallest GBH *Balakata baccata* 176.33 ± 31.29 (125-233). Dominant of Nest height: *Tetrameles nudiflora* 18.65 ± 1.62 (9-30); Smallest nest height *Balakata baccata* 6.16 ± 2.42 (3.5-11). Dominant of Tree height: *Canarium euphyllum* 31.0 ± 2.41 (27-38); Smallest tree height *Balakata baccata* 15.33 ± 1.76 (12-18). A total of 72 chicks were successfully fledged, Dominant of Hatching Success: *Tetrameles nudiflora* (13) and smallest hatching success *Casearia andamanica* (7) (Table 2.).

Factors influencing hatching success of Narcondam Hornbill

The deviance residual distribution reveals a median deviance residual close to zero, indicating that the model is not skewed in one way. Furthermore, the model predicted a high null deviation (36.27), compared to a low residual deviance (25.59), indicating that the run model's log likelihood is near to the saturated model's log likelihood.

Table 3. Deviance residuals

Min1Q	Median	3Q	Max
0.9548	0.5441	0.324	1.4625

Table 4. GLM model showing factors influencing hatching success of Narcondam Hornbill

Coefficients	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	1.66E+00	5.80E-01	2.86	0.01	**
Altitude	2.12E-03	9.69E-04	2.19	0.03	*
Microhabitat Ridge	-1.09E+00	8.11E-01	-1.35	0.18	
Microhabitat Slope	-7.83E-01	4.64E-01	-1.69	0.05	*
Microhabitat Valley	-4.66E-01	5.47E-01	-0.85	0.40	
GBH (cm)	3.60E-05	7.02E-04	0.05	0.96	
Nest Height (m)	4.11E-03	1.37E-02	0.30	0.76	
Tree Height (m)	-1.77E-02	1.15E-02	-1.54	0.08	*
Nest Opening North	-4.24E-02	2.50E-01	-0.17	0.87	
Nest Opening North-East	5.22E-01	2.54E-01	2.05	0.04	*
Nest Opening North-West	-9.07E-02	2.78E-01	-0.33	0.74	
Nest Opening South	2.89E-01	2.90E-01	0.99	0.32	
Nest Opening South-East	-3.92E-01	3.13E-01	-1.25	0.22	
Nest Opening South-West	2.60E-01	4.03E-01	0.65	0.52	
Nest Opening West	-9.80E-02	2.40E-01	-0.41	0.68	

Table 5. Pseudo R^2 Values from the GLM model

R^2 Parameters	Pseudo R^2
McFadden	0.27
Cox and Snell (ML)	0.49
Nagelkerke (Cragg and Uhler)	0.53

We can observe from the summary output results in (Table 3. and Fig.7). that altitude, microhabitat slope, and North east Nest opening all predict hatching success probability positively and considerably, although tree height does not. Pseudo-R2 was obtained at a rate of 53%. (Nagelkerke-R2). Other variables were either not significant or had a little impact on the response variable (*i.e.*, hatching success) (Tables 4 & 5.).

Table 6. The diversity of food items provisioned at the nests by male Narcondam Hornbill

Food items provisioned	Nest-1	Nest-2	Nest-3	Nest-4
Invertebrate				
Arachnida (Spiders)	15	4	5	16
Orthoptera (Grasshoppers)	13	2	3	16
Phasmatidae (Leaf stick & insects)	15	4	4	-
Chilopoda (Centipedes)	2	-	-	4
Coleoptera (Beetles)	2	3	3	3
Decapoda (Brachyura-crabs)	19	4	2	2
Hemiptera (Cicadas, Bugs)	-	1	-	-
Hymenoptera (Wasps, Ants)	1	-	-	2
Lepidoptera (Butterflies and Moths)	2	-	-	-
Mantodea (Mantids)	16	-	3	7
Scorpiones (Scorpions)	-	2	-	1
Unidentified Insect	55	13	3	11
Vertebrate				
Reptilia (Geckos, Lizards)	2	-	1	3
Plants				
Ficus	9517	1515	3329	4028
Non-Ficus	3343	226	1980	1527

Narcondam Hornbill diet Composition

The Narcondam hornbill feed both fruits and animals, however the quantity of animals ingested is higher during the post-breeding phase, which is thought to be used as a nutrient supplement for the young ones' growth (Table 6.). The food items have been identified based on the direct observations through telescope & video recording. Further the faecal matter which were collected from the nesting sites also analysed.

Fruit diets of Narcondam Hornbill

During the period of study, we have recorded 75 species of fruits eaten by Narcondam Hornbill during breeding and non-breeding season (Table 7). The recorded fruit species belongs to 56 genera and 30 families, dominated by Moraceae (13 species) followed by Rubiaceae (8 species) and Ficus fruiting plants 11 species and non-ficus plants 64 species.

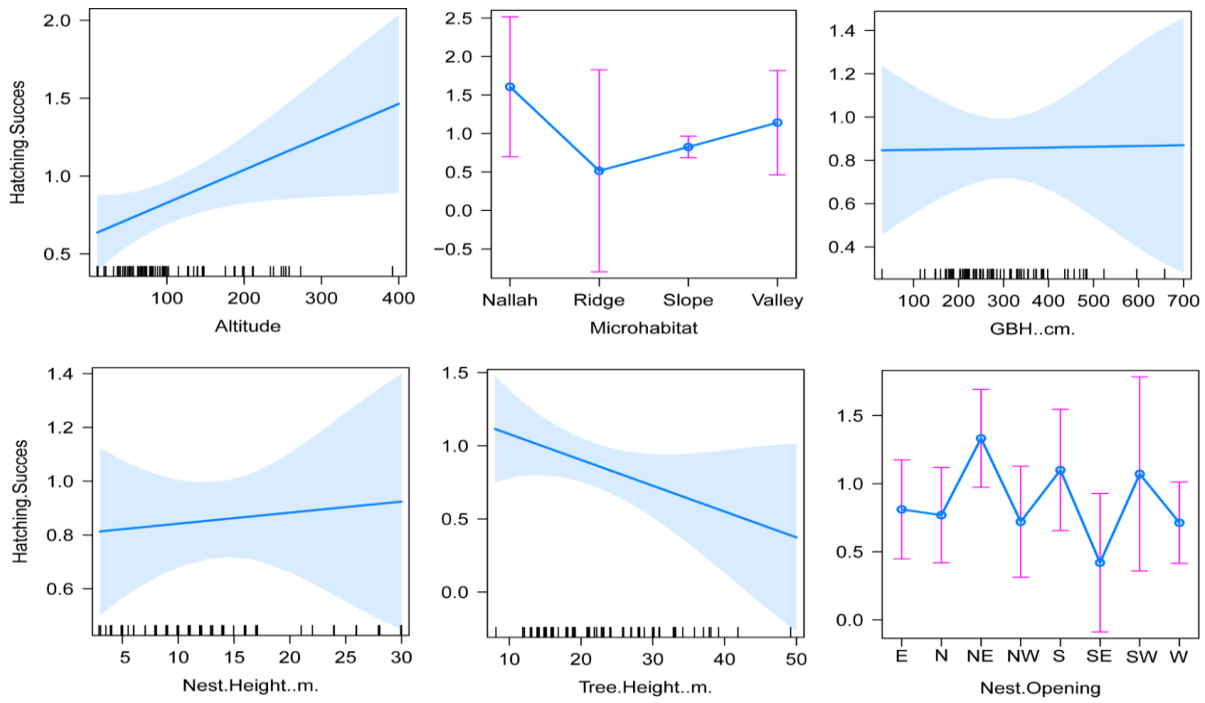

Fig.7.Factors influencing hatching success of Narcondam Hornbill

Table 7. Fruits consumed by Narcondam Hornbill species

Sl. No.	Family	Name of the species
1.	Menispermaceae	*Anamirta cocculus* (L.) Wight &Arn.
2.		*Parabaena sagittata*Miers ex Hook.f. & Thomson
3.		*Pycnarrhena lucida* (Teijsm. &Binn.) Miq.
4.		*Tinospora cordifolia* (Willd.) Hook.f. & Thomson
5.	Capparaceae	*Capparis floribunda* Wight

6.	Salicaceae	*Casearia andamanica King*
7.		*Flacourtia indica (Burm.f.) Merr.*
8.	Rutaceae	*Glycosmis mauritiana*(Lam.) Tanaka
9.		*Zanthoxylum rhetsa*(Roxb.) DC.
10.	Burseraceae	*Canarium euphyllum* Kurz
11.		*Garuga pinnata*Roxb.
12.	Myrsinaceae	*Ardisia oxyphylla*Wall. ex A.DC.
13.		*Ardisia solanacea*(Poir.) Roxb.
14.	Vitaceae	*Ampelocis susbarbata* (Wall.) Planch.
15.		*Cayratia japonica* (Thunb.) Gagnep.
16.		*Cayratiatrifolia* (L.) Domin
17.		*Cissus hastata*Miq.
18.		*Cissus repens* Lam.
19.		*Leea indica* (Burm. f.) Merr.
20.		*Leea asiatica* (L.) Ridsdale
21.	Rubiaceae	*Morinda coreia*Buch.-Ham.
22.		*Morinda citrifolia* L.
23.		*Aidia densiflora* (Wall.) Masam.
24.		*Ixora brunnescens* Kurz
25.		*Ixora barbata* Roxb. ex Sm.
26.		*Ixora javanica* (Blume) DC.
27.		*Discospermum abnorme* (Korth.) S.J.Ali&Robbr.
28.		*Mussaenda macrophylla* Wall.
29.	Melastomataceae	*Meme cylonovatum* Sm.
30.	Opiliaceae	*Cansjer arheedii* Blanco
31.	Anacardiaceae	*Lannea coromandelica* (Houtt.) Merr.
32.	Lamiaceae	*Callicarpa arborea*Roxb.
33.	Arecaceae	*Caryota mitis* Lour.
34.	Meliaceae	*Aglaia lawii* (Wight) C.J.Saldanha
35.		*Aphanamixi spolystachya* (Wall.) R.Parker
36.		*Azadirachta indica*A.Juss.
37.		*Dysoxylum arborescens* (Blume) Miq.
38.	Moraceae	*Artocarpus lacucha*Buch.-Ham.
39.		*Antiaris toxicaria* (J.F.Gmel.) Lesch.
40.		*Ficus benjamina*L.
41.		*Ficus callosa*Willd.
42.		*Ficus chartacea* (Wall. ex Kurz) Wall. ex King

43.		*Ficus glaberrima*Blume
44.		*Ficus microcarpa*L.f.
45.		*Ficus nervosa* B.Heyne ex Roth
46.		*Ficus rumphii*Blume
47.		*Ficus sinuata*Thunb.
48.		*Ficus sundaica*Blume
49.		*Ficus tinctoria* subsp.*gibbosa*(Blume) Corner
50.		*Ficus virens* Aiton
51.	Cannabaceae	*Celtis philippensis*Blanco
52.	Myristicaceae	*Endocomiama crocoma* subsp. *Prainii* (King) W.J.de Wilde
53.	Sapotaceae	*Mimusops andamanensis*King & Gamble
54.		*Planchonella longipetiolata* (King &Prain) H.J.Lam
55.	Oleaceae	*Chionanthus mala-elengi* subsp. *terniflorus* (Wall. &G.Don) P.S.Green
56.	Myrtaceae	*Syzygium claviflorum* (Roxb.) Wall. ex A.M. Cowan & Cowan
57.		*Syzygium cumini* (L.) Skeels
58.	Sapindaceae	*Allophylus dimorphus*Radlk.
59.		*Harpullia cupanioides*Roxb.
60.		*Lepisanthes rubiginosa* (Roxb.) Leenh.
61.	Euphorbiaceae	*Balakata baccata* (Roxb.) Esser
62.		*Macaranga tanarius* (L.) Müll.Arg.
63.	Malvaceae	*Sterculia rubiginosa*Vent.
64.	Ebenaceae	*Diospyros kurzii*Hiern
65.		*Diospyros montana*Roxb.
66.	Araliaceae	*Schefflera elliptica* (Blume) Harms
67.	Convolvulaceae	*Erycibe paniculata*Roxb.
68.	Phyllanthaceae	*Antidesmabunius*(L.) Spreng.
69.		*Breynia vitis-idaea* (Burm. f.) C. E. C. Fisch.
70.		*Flueggea virosa*(Roxb. ex Willd.) Royle
71.		*Margaritaria indica* (Dalzell) Airy Shaw
72.		*Phyllanthus reticulatus* Poir.
73.	Passifloraceae	*Adenia cordifolia* (Blume) Engl.
74.	Boraginaceae	*Ehretia laevis*Roxb.
75.	Putranjivaceae	*Drypetes assamica (Hook.f.) Pax &K.Hoffm.*

Table 8. Difference among food type frequency and nests observed

Food type frequency	Nest-1	Nest-2	Nest-3	Nest-4	k (p) among food type
Arachnida	10	4	3	9	
Arthropoda	4	0	0	0	
Centipede	1	0	0	2	
Cicada	0	0	1	0	
Coleoptera	1	1	0	2	
Decapoda	1	1	3	10	
Gekkonidae	0	0	0	2	
Hymenoptera	3	0	0	1	136(0.043)
Lepidoptera	0	0	0	2	
Mantodea	5	3	0	14	
Orthoptera	13	1	2	13	
Phasmatidea	4	4	3	15	
Scorpionidea	1	0	1	0	
Skink	1	0	0	0	
UN ID Insect	16	4	8	45	
Fig	110	96	63	240	
Non-fig	145	156	19	237	
k (p) among nests		125 (0.871)			

Animal matter diets

On the other hand it is also known that Narcondam Hornbill feeds on both vertebrates and invertebrate animal species that includes a record of 13 animal species such as Invertebrate Arachnida (Spiders), Orthoptera (Grasshoppers), Phasmatidae (Leaf &stick insects), Chilopoda (Centipedes), Coleoptera (Beetles), Decapoda (Brachyura-crabs), Hemiptera (Cicadas, Bugs), Hymenoptera (Wasps, Ants), Lepidoptera (Butterflies and Moths), Mantodea (Mantids), Scorpiones (Scorpions) and Unidentified Insect. In addition, vertebrate Reptilia (Geckos, skinks) were recorded at the nesting sites. Fruit species were consumed throughout the year depending on availability, whereas animal matter feeds were consumed primarily after the hatching period to augment the dietary requirements of the chicks for growth and the mother for health restoration (Table 8).

Feeding observation

During the nesting period (February-May), male Narcondam hornbills were observed for feeding activity at the 6 identified and verified nest sites. After around 30 days of incubation inside the nest, two nests were unsuccessful.

Feeding Bouts

The feeding observation showed that during the nesting season, male Narcondam Hornbills brings food to his mate or his family at (0445 – 1740).

Per Day Feeding

After sealing the female hornbill within the nest, the male hornbill visited the nest frequently (28.33 ± 7.51 SD visits per day) to forage with his partner and brood. Male birds perch on the nest entrance rather than inspecting the nest environment for some time by making sounds, causing the female and her chicks to grumble in response to their father's arrival (Figure 5).At a later stage of the breeding, the frequency of visits increases, and the type of food varies, with fleshier and lipid-rich fruits in addition to food rich in proteins, such as animal matter, as required by the chicks as they grow. Seeds and other meals that were regurgitated and dropped were collected and documented. Narcondam hornbills were spotted feasting on a variety of fruit species of varying sizes, of which we were only able to identify and collect a few. This does not include off-breeding season food, which is only collected by male hornbills.

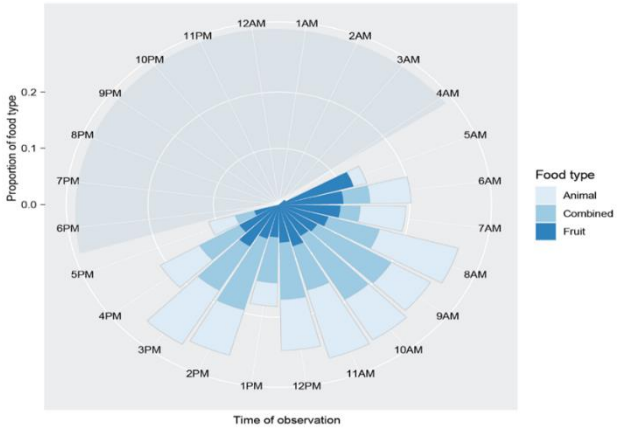

Fig.8. Proportion of food vs Time of observation for overall nests

Proportion of food vs Time of observation for overall nests

When comparing hourly foraging, foraging was higher during the hours of 8 AM to 3 PM and then gradually declined. In comparison to animal and fruit food-type wide groups, the combination food type exhibited a larger share (Fig.8).

Frequency of food intake vs time of observation per nest

Food intake frequency (or food type frequency) was assessed hour by hour among the nests during daylight observations. Nest 3 had a reduced foraging frequency, but nests 1, 2, and 4 had higher foraging frequencies (Fig.9).

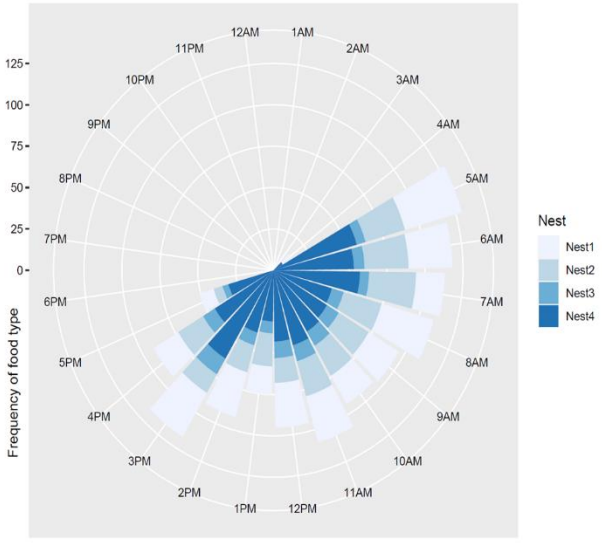

Fig.9.Frequency of food intake vs time of observation per nest

Proportion of food vs Time

Proportion of food type was estimated per nest observed, when compared hour wise, foraging was higher during 9 am–3 pm and later declined gradually. Among the food types, combined food type showed higher in proportion compared to animal and fruit food-type categories in this hour range (Figs. 10-13).

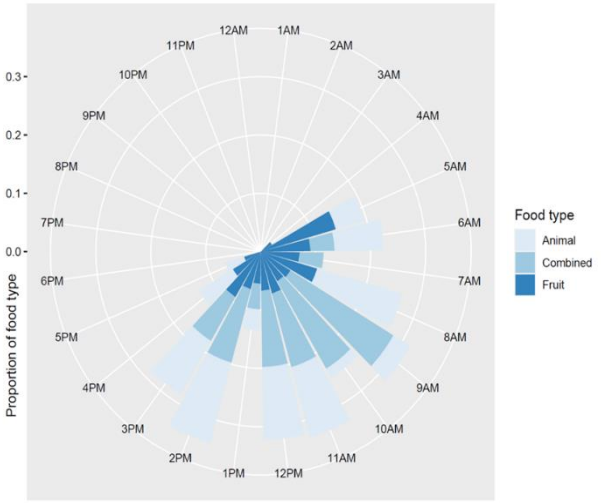

Fig.10.Proportion of food vs Time of observation for Nest 1

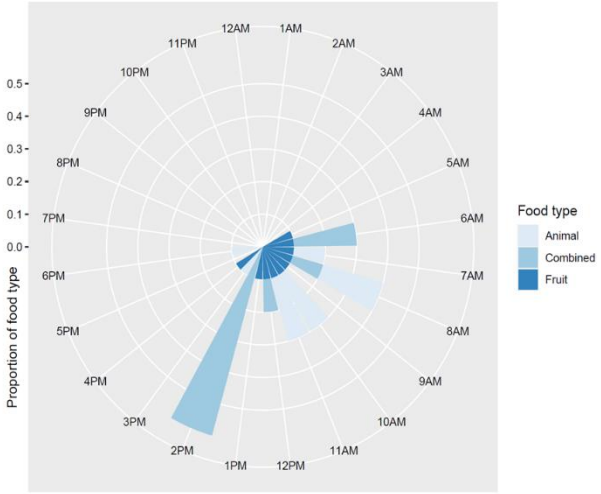

Fig.11.Proportion of food vs Time of observation for Nest 2

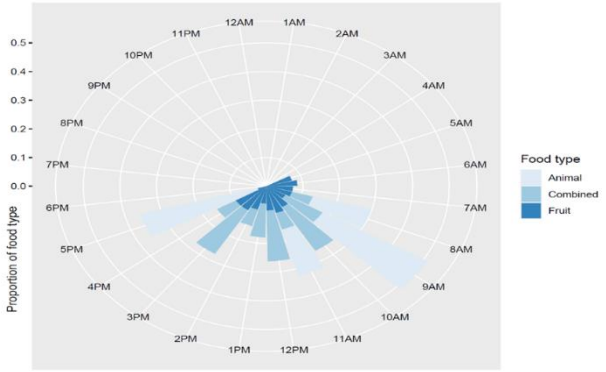

Fig.12.Proportion of food vs Time of observation for Nest

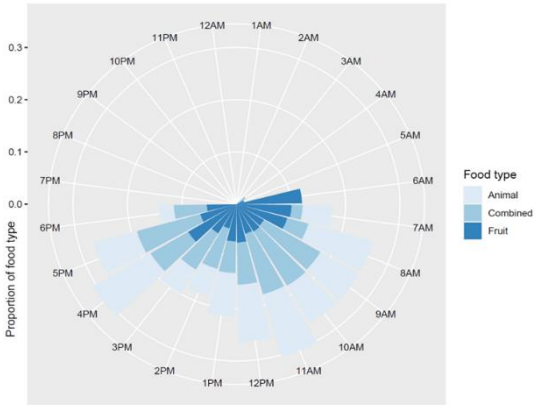

Fig.13.Proportion of food vs Time of observation for Nest 4

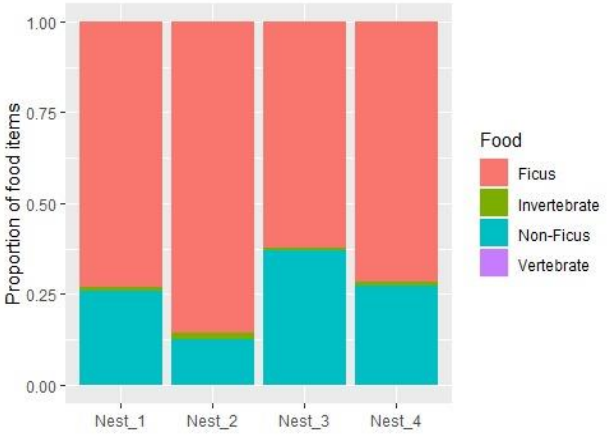

Fig.14. Percentage contribution of figs, non-figs, invertebrate and vertebrate in the breeding season diet of four nests of Narcondam Hornbill

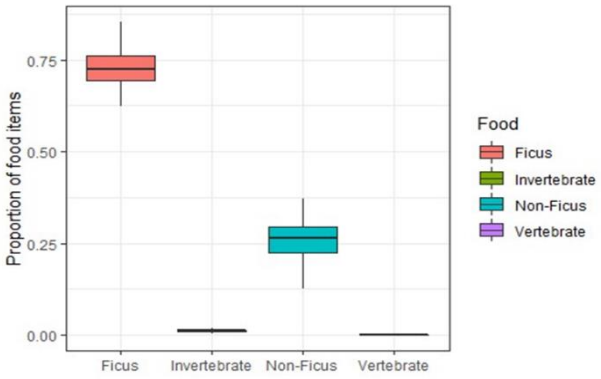

Fig.15. Percentage contribution of figs, non-figs, invertebrate and vertebrate in the breeding season diet of overall nests of Narcondam Hornbill

Structural analysis of various plant, and tree species

Details of structural analysis of fruiting climbers, shrubs and tree species are presented in Table.9 - 11. Among the climbers *Cayratiatrifolia* (6.37) showed high values of IVI, followed by *Pycnarrhena lucida* (4.37), *Pycnarrhena lucida* (3.53), and *Phyllanthus reticulatus* (3.36). With regard to shrubs, *Breynia vitis-idaea* (5.73) was highest in IVI, followed by *Flueggea virosa* (4.23), and *Leea indica* (3.79). In the tree species, *Planchonella longipetiolata* (19.91), had the highest IVI *followed by Canarium euphyllum* (13.00).

Discussion

The present study focused on the breeding ecology of Narcondam Hornbill. Most of the studies on breeding ecology of Narcondam Hornbill have been carried out from the month of February onwards (Hussain, 1984; Sankaran, 2000; Yahya and Zarri, 2002; Manchi, 2017) except Vivek and Vijayan, (2003).Active nests of Narcondam Hornbill were found around the third week of January and chicks hatching observed during the 1st week of March, female and young bird flagging last week of April. Hornbill nests were relatively more common in the lower elevations as compared to higher elevations, which is comparable with other studies (Sankaran, 2000; Yahya and Zarri, 2002; Vivek and Vijayan, 2003; Manchi, 2017). This bird has been reported to nest even close to the Narcondam Island peak (Yahya and Zarri, 2002), similar observations were made during the present investigation. Most of the hornbill nest trees are abundant in the 0-100m and the 101-200 zones. The Narcondam Hornbill nested mostly in the trees of *Tetrameles nudiflora* having tall, huge girth and common broad-leaved tree species in the study area. In the nest tree selection of this species is varies from other previous studies (Sankaran, 2000; Yahya and Zarri, 2002; Manchi, 2017).

A total of 83 nests were observed from 22 tree species and more than 24% the same tree species used as nest trees.Twenty three of 83 nests (24 %) were observed from *Tetrameles nudiflora*, followed by *Casearia andamanica* (7 nests; 8.4%). The trees measured 5-22 meters in nest height above the ground level with an average of 100.59 cm GBH correlated the requirements of large sized trees for hornbill nesting. The shape of the nest openings is orbicular while unsealed and vertical oval slit while sealed.

Table 9. Structural analysis of fruiting climber species, for relative density (RD), relative frequency (RF), relative dominance (RDo) and importance value index (IVI)

Sl.No.	Species	Family	Habit	RD (%)	RF (%)	RDo (%)	IVI
1.	*Anamirta cocculus* (L.) Wight &Arn.	Menispermaceae	Climber	2.86	1.49	0.024	**4.37**
2.	*Parabaena sagittata* Miers ex Hook.f. & Thomson		Climber	0.99	0.99	0.002	1.98
3.	*Pycnarrhena lucida* (Teijsm. &Binn.) Miq.		Lianas	1.87	1.65	0.009	**3.53**
4.	*Tinospora cordifolia* (Willd.) Hook.f. & Thomson		Climber	1.06	0.83	0.003	1.89
5.	*Capparis floribunda* Wight	Capparaceae	Scandent shrub	1.43	1.32	0.004	2.75

6.	*Cansjera rheedii* Blanco	Opiliaceae	Climber	1.94	0.99	0.003	**2.94**
7.	*Ampelocis susbarbata* (Wall.) Planch.	Vitaceae	Climber	1.03	1.32	0.001	2.35
8.	*Cayratia japonica* (Thunb.) Gagnep.		Climber	0.81	1.16	0.001	1.96
9.	*Cayratia trifolia* (L.) Domin		Climber	4.88	1.49	0.006	**6.37**
10.	*Cissus hastata*Miq.		Climber	0.77	0.99	0.001	1.76
11.	*Cissus repens* Lam.		Climber	0.84	0.99	0.001	1.83
12.	*Adenia cordifolia* (Blume) Engl.	Passifloraceae	Climber	1.21	1.16	0.002	2.37
13.	*Erycibe paniculata*Roxb.	Convolvulaceae	Lianas	0.40	0.50	0.001	0.90
14.	*Phyllanthus reticulatus* Poir.		Scandent shrub	2.20	1.16	0.004	**3.36**

Table 10. Structural analysis of fruiting shrub species, for relative density (RD), relative frequency (RF), relative dominance (RDo) and importance value

Sl. No.	Species	Family	Habit	RD (%)	RF (%)	RDo (%)	IVI
1.	*Glycosmis mauritiana*(Lam.) Tanaka	Rutaceae	Shrub	0.55	0.99	0.02	1.56
2.	*Leea indica* (Burm. f.) Merr.	Vitaceae	Shrub	1.94	1.82	0.03	**3.79**
3.	*Leea asiatica* (L.) Ridsdale		Shrub	1.80	1.32	0.02	3.13
4.	*Allophylus dimorphus*Radlk.	Sapindaceae	Shrub	1.03	0.99	0.04	2.05
5.	*Schefflera elliptica* (Blume) Harms	Araliaceae	Shrub	0.81	1.32	0.03	2.16
6.	*Ixora barbata*Roxb. ex Sm.	Rubiaceae	Shrub	0.88	1.16	0.03	2.07

7.	*Ixora javanica*(Blume) DC.		Shrub	0.66	0.99	0.02	1.67
8.	*Mussaenda macrophylla* Wall.		Shrub	1.72	1.65	0.07	**3.44**
9.	*Ardisia oxyphylla*Wall. ex A.DC.	Myrsinaceae	Shrub	1.32	0.99	0.03	2.34
10.	*Ardisia solanacea*(Poir.) Roxb.		Shrub	1.91	1.32	0.06	**3.29**
11.	*Breynia vitis-idaea* (Burm. f.) C. E. C. Fisch.	Phyllanthaceae	Shrub	4.44	1.16	0.14	**5.73**
12.	*Flueggea virosa*(Roxb. ex Willd.) Royle		Shrub	3.15	0.99	0.09	**4.23**

Table 11. Structural analysis of nesting and fruiting tree species, for relative density (RD), relative frequency (RF), relative dominance (RDo) and importance value index (IVI)

Sl. No.	Species	Family	Habit	RD (%)	RF (%)	RDo (%)	IVI
1.	*Casearia andamanica*King**^***	Salicaceae	Tree	0.29	0.83	0.75	1.87
2.	*Flacourtia indica* (Burm.f.) Merr.**^***		Tree	0.44	0.99	0.72	2.15
3.	*Sterculia rubiginosa*Vent.**^**	Malvaceae	Tree	0.62	1.49	1.49	3.60
4.	*Zanthoxylum rhetsa*(Roxb.) DC.**^***	Rutaceae	Tree	0.84	1.98	1.95	4.77
5.	*Canarium euphyllum* Kurz**^***	Burseraceae	Tree	1.14	2.64	9.22	**13.00**
6.	*Garuga pinnata*Roxb.**^***		Tree	0.99	1.65	2.52	5.16
7.	*Aglaia lawii* (Wight) C.J.Saldanha**^***	Meliaceae	Tree	1.94	2.48	4.57	8.98
8.	*Aphana mixispolystachya* (Wall.) R.Parker		Tree	1.21	2.15	5.77	9.12
9.	*Azadirachta indica*A.Juss.**^**		Tree	0.22	0.17	0.34	0.73
10.	*Dysoxylum arborescens*(Blume) Miq.**^***		Tree	2.68	2.15	2.87	7.69

11.	*Harpullia cupanioides*Roxb.^	Sapindaceae	Tree	0.66	1.32	0.41	2.39
12.	*Lepisanthes rubiginosa* (Roxb.) Leenh.^		Tree	0.40	1.16	0.12	1.68
13.	*Lannea coromandelica* (Houtt.) Merr.^	Anacardiaceae	Tree	0.59	1.16	0.25	1.99
14.	*Syzygium claviflorum* (Roxb.) Wall. ex A.M. Cowan & Cowan^	Myrtaceae	Tree	0.55	0.33	0.29	1.17
15.	*Syzygium cumini* (L.) Skeels^		Tree	0.15	0.17	0.11	0.42
16.	*Memecylon ovatum* Sm.^	Melastomataceae	Tree	2.16	1.82	0.71	4.69
17.	*Tetrameles nudiflora* R.Br.*	Tetramelaceae	Tree	1.06	1.82	8.84	**11.72**
18.	*Aidia densiflora* (Wall.) Masam.^	Rubiaceae	Tree	1.65	1.82	0.93	4.39
19.	*Discospermum abnorme*(Korth.) S.J.Ali&Robbr.^		Tree	1.80	1.32	0.65	3.77
20.	*Ixora brunnescens*Kurz^		Tree	0.26	0.66	0.09	1.00
21.	*Morinda citrifolia* L.^		Tree	0.95	0.83	0.26	2.03
22.	*Morinda coreia*Buch.-Ham.^		Tree	0.33	0.50	0.15	0.97
23.	*Mimusops andamanensis* King & Gamble^*	Sapotaceae	Tree	0.48	0.99	1.44	2.90
24.	*Planchonella longipetiolata* (King &Prain) H.J.Lam^*		Tree	4.22	2.48	13.12	**19.81**
25.	*Diospyros kurzii*Hiern^	Ebenaceae	Tree	1.43	2.15	1.26	4.83
26.	*Diospyros montana*Roxb.^		Tree	0.22	0.33	0.12	0.67
27.	*Chionanthus mala-elengi* subsp. *terniflorus* (Wall. &G.Don) P.S.Green^	Oleaceae	Tree	2.93	2.15	4.40	9.48
28.	*Ehretialaevis* Roxb.^	Boraginaceae	Tree	0.48	0.83	0.16	1.47
29.	*Callicarpa arborea* Roxb.^	Lamiaceae	Tree	1.72	2.31	2.30	6.33
30.	*Endocomiama crocomas* ubsp.*prainii*(King) W.J.de Wilde^	Myristicaceae	Tree	2.27	2.15	3.11	7.52
31.	*Gyrocarpus americanus* Jacq.*	Hernandiaceae	Tree	0.59	1.49	1.77	3.84
32.	*Balakata baccata* (Roxb.) Esser^*	Euphorbiaceae	Tree	0.84	1.65	1.28	3.77
33.	*Macaranga tanarius* (L.) Müll.Arg.^		Tree	1.54	1.16	0.86	3.56
34.	*Drypetes assamica*(Hook.f.) Pax &K.Hoffm.^	Putranjivaceae	Tree	2.42	2.31	2.88	7.61
35.	*Antidesma bunius*(L.) Spreng.^	Phyllanthaceae	Tree	0.18	0.66	0.25	1.09

36.	*Margaritaria indica* (Dalzell) Airy Shaw**^***		Tree	0.48	1.16	1.44	3.07
37.	*Antiaris toxicaria*(J.F.Gmel.) Lesch.**^***	Moraceae	Tree	0.77	1.65	3.26	5.68
38.	*Artocarpus lacucha*Buch.-Ham.**^***		Tree	0.26	0.83	0.86	1.94
39.	*Ficus benjamina*L.**^**		Tree	0.33	1.16	1.03	2.52
40.	*Ficus callosa*Willd.**^***		Tree	0.55	1.16	1.93	3.64
41.	*Ficus chartacea*(Wall. ex Kurz) Wall. ex King**^**		Tree	0.29	0.99	0.15	1.44
42.	*Ficus glaberrima*Blume**^**		Tree	0.22	0.66	0.39	1.27
43.	*Ficus microcarpa*L.f.**^**		Tree	0.70	1.16	1.19	3.04
44.	*Ficus nervosa* B.Heyne ex Roth**^***		Tree	1.21	1.65	2.09	4.95
45.	*Ficus rumphii*Blume**^**		Tree	1.76	2.15	7.20	**11.10**
46.	*Ficus sinuata*Thunb.**^**		Tree	0.44	1.16	0.86	2.46
47.	*Ficus sundaica*Blume**^***		Tree	0.18	0.50	0.40	1.08
48.	*Ficus tinctoria* subsp.*gibbosa*(Blume) Corner**^**		Tree	0.26	0.50	0.30	1.05
49.	*Ficus virens* Aiton**^**		Tree	0.33	1.16	0.78	2.26
50.	*Celtis philippensis*Blanco**^**	Cannabaceae	Tree	0.99	0.99	0.79	2.77
51.	*Caryota mitis*Lour.**^**	Arecaceae	Tree	8.50	2.48	0.73	**11.71**

^ Fruiting tree, * Nesting tree

Nesting success; nest site selection and courtship and nest sealing

Hornbills are generally monogamous due to their breeding habits, pairing for life as "one husband, one wife," which is an exceptional characteristic even among birds (Poonswad, 2012). Nesting success is influenced by a variety of external factors, including the availability of a suitable nest cavity and ideal meteorological conditions, which affect food sources (Kemp, 1973, 1976; Poonswad*et al*., 1987; Poonswad 1998). According to this study, the arrival of spring, together with a new season of plant flowering and adequate food supplies, encourages hornbills to begin nesting.By the end of December to February, the Narcondam hornbill has chosen good nesting sites and begun courtship behaviours (Sankaran, 2000; Manchi, 2017). The passive female hornbill accompanies the male in his hunt for suitable nests, where the duo flies back and forth, inspecting the majority of the empty nests. Hornbills have a limited number of acceptable nest locations due to their incapacity to excavate their own nest chambers, according to a study conducted on Narcondam Island in the Andaman and Nicobar Islands.

The female hornbill closes herself within the nest after copulation and nest preparation, leaving just a small gap and a few orbicular holes. After the wooing customs, the sealing begins a few days or a week later.The distinctive nesting rituals effectively distinguish hornbills from all other bird families anywhere on the world, where the entire process of nest preparation and chick raising takes 14-18 weeks, depending on the species and size of hornbills (Poonswad 2012). When a female hornbill investigates and attempts to locate a good nest, she becomes active and begins cleaning the cavity.

Breeding success

Hornbill breeding is a highly individualized process that involves not only entering the nest, laying eggs, incubating the eggs, and then caring for the chicks after closing the cavity entrance, leaving a narrow oval slit just wide enough for the male to pass food through while squirting faeces and other waste materials (Poonswad*et al*., 2013). From a month of intensive observation of eight nesting sites, the study accounts for 75% of breeding success.During the successful breeding season in a year, one or two chicks fledge out of every 1-2 deposited eggs from successful nests, according to Poonswad*et al*. (2013). The sex ratio of hornbill progenies may be influenced by a variety of biological and physical factors not addressed in the current study, but which may be investigated in the future. We learned through the study that several elements, such as landslides, flash flooding, forest fires, windstorms, and weak conditions of the nest trees, have an impact on breeding success. Otherwise, it would not be a concern because hornbills build their nests in the higher canopy of the forest stand.The breeding period in the study area completed by the last week of May coinciding about 14-15 weeks (140 days).

Hornbill Diet Composition

Ficus flowers are very small and numerous, collected on globose cylindrical or hollow receptacles which often enlarge and bear the fruits with them. Fruits are figs about 1 cm in diameter, sessile, usually in axillary pairs, pinkish or purplish when ripe.The study revealed that the Narcondam hornbill feeds on both fruits and animals but the quantity of animals eaten is more at the post breeding period which is said to be taken as a nutrient supplement for growth of the young ones.

The hornbill are important seed dispersal agents of figs, lipid rich berries, and capsular fruits in tropical forests (Kinnaird, 1998; Whitney *et al*., 1998; Holbrook and Smith, 2000; and Kitamura, 2000). It has been asserted that large hornbills are the sole dispersers of many primary forest species with capsular dehiscent fruits because of their gape size and ability to split open husks (Leighton and Leighton, 1983; Becker and Wong, 1985; Kannan and James, 1999). Hornbills have large gapes, which is associated with specialized frugivory and are able to pry open capsular fruits that other frugivores cannot handle. Hornbills also move other large distances, hence possibly regurgitating and defecating seeds
far away from the parent tree with possible beneficial effects on seed germination and survival (Whiteney*et al*. 1998, Hoolbrook and Smith, 2000). They are also selective feeders and being large-bodied, feed on more fruits per feeding bout than other smaller frugivores. Some hornbill species are wide ranging and show nomadic behaviours during lean fruiting periods, and being specialized frugivores, could help in the regeneration of degraded secondary forests (Whiteney and Smith 1999). Therefore, the hornbills could help in maintaining high species diversity in both undisturbed and managed forests by ensuring the dispersal of several primary forest species.

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