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VEGETATION FEATURES AND RESTORATION INITIATIVES IN THE INDIAN GREY HORNBILL HABITATS IN SATHYAMANGALAM WILDLIFE SANCTUARY, EASTERN GHATS, INDIA

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***ABSTRACT.* –** Vegetation features are described with particular reference to the distribution of food plants in the habitat of Indian Grey Hornbill (*Ocyceros birostris*) in southern Eastern Ghats, India, highlighting the urgent need for restoration of habitats. The species is reported to occur in dry forest tracts along the foothills of the Himalayas, Western and Eastern Ghats and in rural cultivation. In Sathyamangalam Wildlife Sanctuary, this species use two habitats, namely tropical dry deciduous forest for foraging, and riverine forests for foraging and nesting. Vegetation assessment showed 30 tree species and 43% of Indian Grey hornbill's food plant species in dry deciduous forests, and 64 species and 38% of food plant species in the riverine habitat. All the nest trees were in riverine habitat which appears to be crucial for the survival of Indian Grey Hornbill. Due to anthropogenic activities, the hornbill habitats have become degraded. A comparison of vegetation features of the undisturbed dry deciduous forest with that of the degraded forest site revealed the loss of 53% of tree species and 65% of food plant species in the degraded site. Hence, habitat restoration efforts have been initiated with the collaboration of the state forest department. As an initial phase, 16 hornbill-dispersed tree species were raised in a nursery. As the hornbill-dispersed tree species are not popular among the foresters, efforts are made to popularize these species, so that these species could be raised and planted in large numbers as part of the ongoing afforestation programme.

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***KEY WORDS.* –** Indian Grey Hornbill, reforestation, habitat use, conservation.

INTRODUCTION

The Indian Grey Hornbill (*Ocyceros birostris*) also known as Common Grey Hornbill is distributed in India, Pakistan and Nepal (Ali & Ripley 1987). Birds from Northern India are reported to be less brown and greyer than those from southern peninsula and have been recognized as *Ocyceros birostris peregriseus*. The Indian Grey Hornbill is known to occur in deciduous biotopes and open thorn forests and many rural areas of cultivation (Kemp, 1995). According to Balasubramanian et al. (2007), this species is common in the Eastern Ghats, and occasional in the Western Ghats. In the Eastern Ghats, it inhabits the dry deciduous forests, usually up to an elevation of 900 m asl. The dry deciduous forests are subjected to maximum anthropogenic disturbances and habitat destruction has been recorded as a major cause of disturbance in the hornbill habitats. According to Kemp (1995), this species has been reported locally extinct from Kathiawar region, including Gir Forest, India, and it is likely to go extinct in several other regions due to habitat destruction and other human interferences. As hornbills require huge trees with large girth for nesting, they are mostly confined to primary forests. The old growth forests in peninsular India have been subjected to various human disturbances which directly affect the survival of frugivorous birds such as hornbills and other vertebrate frugivores (Kannan, 1994). As information on population status and ecological requirements of hornbills are essential in conserving them, an

ecological investigation was made on Indian Grey Hornbill in Sathyamangalam Wildlife Sanctuary, southern Eastern Ghats, India, where a reasonable population was observed. In this paper, we discuss the hornbill habitat features, distribution of Indian Grey hornbill's food and nest trees and habitat restoration initiatives.

STUDY AREA

The Sathyamangalam Wildlife Sanctuary earlier known as Sathyamangalam Forest Division (10°29'15" to 11°43'11" N latitude and 76°50'46" to 77°27'22"E longitude) has been declared as Wildlife Sanctuary only recently, on 3rd December 2008. This sanctuary located in a strategically important region, connecting the two major biogeographical units, the Western and Eastern Ghats of India. Topography of the sanctuary is highly variable with plains, slopes, hills, streams and rivers. The slopes and plains are subjected to hot and dry climate. The average annual rainfall is 800 mm. The sanctuary is very rich in flora and fauna, known for sandal wood, Santalum album and Asian elephants, Elephas maximus. Vegetation of the sanctuary primarily composed of dry deciduous forests in addition to semi-evergreen forests that are confined to higher reaches of the hills and rivers/stream beds in lowlands. There are a number of tribal settlements inside the sanctuary that depend on forests and forest products for livelihoods. They also practice agriculture alongside the streams/rivers and plains.

METHODS

***Vegetation assessment.* –** In the Eastern Ghats, two habitats were found to be used by the Indian Grey Hornbill, namely, dry deciduous forest and riverine forest. Vegetation assessment was done in the above-mentioned habitats and also in a disturbed dry deciduous forest site to assess the loss of food plants by anthropogenic interventions. Disturbed habitat includes dry deciduous forest site which is closer to human settlements, where activities such as fuel wood collection, livestock grazing etc are noticed. Three one-hectare plots (100×100m) were laid in each of the above-mentioned three habitats. In each of the habitat, the 1 ha plot was subdivided into 100 sub-plots (10×10m). In each of the 10×10m plots, number of individuals of trees and GBH (Girth at Breast Height) were noted. Data collected were analyzed to obtain quantitative structure and composition of plant communities. Density value was calculated for each species following Curtis & McIntosh (1950). Density is defined as the number of individuals of a species in a unit area. It is an expression of the numerical strength of a species in a community from the sampling data and was calculated as the total number of individuals divided by the total number of quadrat studied. The relative value of density was determined as by Philips (1959). Relative density (RD) is the study of numerical strength of a species in relation to total number of all species and is calculated as the number of individuals of a species divided by number of individuals of all species, and multiplied by 100. Species diversity of the sampling site was calculated by Shannon-Weaver Index (Shannon & Weaver, 1949) as given below:

$$H' = - \sum P_i \ln P_i$$

Where H' is the measure of diversity and P_i is the proportional of the i^{th} species in the landscape element sampled.

***Documentation of food plants.* –** The breeding-season diet was determined by making direct observation at the nest as well as midden analysis. At the nests, male delivering food to the nest inmates was documented through a pair of binoculars. Ten nests were observed for 720 hrs. To determine the non-breeding season diet, feeding observations were made along marked transects by following the foraging hornbills.

***Documentation of nest trees.* –** Active nest cavities were identified by following the breeding pair of hornbills and breeding male carrying fruit to the nest as well as by examining midden deposits under the nest tree. Tree species harboring the nests was identified.

***Hornbill conservation awareness and habitat restoration initiatives.* –** The occurrence of Indian Grey Hornbills, their unique habits and need for restoring their habitats were highlighted to the forest department staff. Lectures, popular articles and Television interviews on hornbills were done to convey the message of hornbill conservation. A nursery of hornbill's food plants was created inside the forest department's field station.

Table 1. Tree community parameters in two hornbill habitats in Sathyamangalam Wildlife Sanctuary.

Parameters	Riverine forest	Dry deciduous
# Families	25	17
# Genera	49	28
# Species	64	30
# individuals	588	322
Shannon's diversity index	3.40	2.64

RESULTS

***Features of prime Indian Grey Hornbill habitats: species richness, diversity of trees.* –** The present study shows that the Indian Grey Hornbill's prime habitats in Eastern Ghats include riverine forests and the dry deciduous forests. While the dry deciduous forest is used for foraging, the riverine forests for foraging and nesting.

Vegetation parameters of two hornbill habitats are provided in Table 1. A total of 64 tree species belonging to 49 genera and 25 families was recorded in the riverine forests. Moraceae (fig family) represented by seven species followed by Mimosaceae (six species) and Fabaceae (five species) were the dominant families. *Terminalia arjuna* (1.7) followed by *Pongamia pinnata* (1.00) and *Mangifera indica* (0.4) were the densest species. Mean girth size of tree species ranged

Table 2. Density of food plants in two hornbill habitats in Sathyamangalam Wildlife Sanctuary.

S.No	Plant species	Riverine forest			Dry deciduous forest		
		#	Density	Relative density	#	Density	Relative density
1.	*Atalantia monophylla*	1	0.01	0.17	5	0.05	1.55
2.	*Bridelia crenulata*	–	–	–	1	0.01	0.31
3.	*Canthium dicoccum*	3	0.03	0.51	12	0.12	3.73
4.	*Capparis grandis*	35	0.35	5.95	16	0.16	4.97
5.	*Celtis tetrandra*	3	0.03	0.51	–	–	–
6.	*Clausena dentata*	1	0.01	0.17	2	0.02	0.62
7.	*Diospyros montana*	20	0.20	3.40	23	0.23	7.14
8.	*Drypetes roxburghii*	1	0.01	0.17	–	–	–
9.	*Erythroxylum monogynum*	3	0.03	0.51	62	0.62	19.25
10.	*Ficus benghalensis*	11	0.11	1.87	8	0.08	2.48
11.	*Ficus drupacea*	2	0.02	0.34	–	–	–
12.	*Ficus microcarpa*	4	0.04	0.68	–	–	–
13.	*Ficus racemosa*	9	0.09	1.53	–	–	–
14.	*Ixora pavetta*	8	0.08	1.36	5	0.05	1.55
15.	*Mimusops elengi*	–	–	–	2	0.02	0.62
16.	*Naringi crenulata*	1	0.01	0.17	8	0.08	2.48
17.	*Premna tomentosa*	3	0.03	0.51	5	0.05	1.55
18.	*Santalum album*	4	0.04	0.68	–	–	–
19.	*Schelichera oleosa*	6	0.06	1.02	–	–	–
20.	*Syzygium cumini*	15	0.15	2.55	–	–	–
21.	*Vitex altissima*	19	0.19	3.23	69	0.69	21.43
22.	*Zizyphus mauritiana*	18	0.18	3.06	9	0.09	2.80

from 25 cm to 713 cm and the mean girth size of all trees was 203.70 cm. Shannon's species diversity for tree flora was worked out to be 3.40.

A total of 30 plant species belonging to 28 genera and 17 families was recorded in the dry deciduous forests. Family Rutaceae represented by five species followed by Rubiaceae (four species) were the dominant families. *Vitex altissima* (0.69) followed by *Erythroxylum monogynum* (0.62) and *Bambusa arundinacea* (0.34) were the densest species. Mean girth size of tree species ranged from 22 cm to 321 cm and the mean girth size of all trees was 122.95 cm. Shannon's species diversity was worked out to be 2.64.

A comparison of tree community parameters of dry deciduous forest with the riverine forests indicates the presence of higher number of trees, species, genera, and family in the later habitat. Occurrence of just 30 tree species and 17 families in the dry deciduous forests indicates it's relatively less diverse nature.

Features of prime Indian Grey Hornbill habitats: richness and diversity of hornbill's food plants. – The riverine forests harboured 20 food plant species (Table 2). The total density of food plants in riverine forests was 1.67 (Table 3). Most common food plant species were *Capparis grandis* (0.35), *Diospyros montana* (0.20) and *Vitex altissima* (0.19) (Table 2). Although four species of figs namely, *Ficus benghalensis, F. drupacea, F. microcarpa* and *F. racemosa* were recorded here, they were represented by very low density values. Overall fig density was found to be 0.29 (Table 3).

Table 3. Densities (per ha.) of fig, and food trees in hornbill habitats.

Habitat	Fig density	Food plant density
Riverine forest	0.29	1.67
Dry deciduous forest (Undisturbed)	0.08	2.27
Dry deciduous forest (Disturbed)	0.01	0.44

Table 4. Comparison of vegetation parameters in undisturbed and disturbed dry deciduous forest sites.

Parameters	Undisturbed forest	Disturbed forest
# Families	17	11
# Genera	28	13
# Species	30	14
# individuals	322	56
Shannon's diversity index	2.64	2.12

A total of 14 food plant species were distributed in the dry deciduous forests (Table 2). The total density of food

Table 5. Loss rate of hornbill food plants in the dry deciduous forests.

S.No	Family	Plant species	Trees/ha. Undisturbed site	Trees/ha. Disturbed site	Loss/gain (%)
1.	Rutaceae	*Atalantia monophylla*	5	–	–100
2.	Euphorbiaceae	*Bridelia crenulata*	1	–	–100
3.	Rubiaceae	*Canthium dicoccum*	12	15	+25
4.	Capparidaceae	*Capparis grandis*	16	12	–25
5.	Rutaceae	*Clausena dentata*	2	–	–100
6.	Ebenaceae	*Diospyros montana*	23	10	–56.5
7.	Erythroxylaceae	*Erythroxylum monogynum*	62	–	–100
8.	Moraceae	*Ficus benghalensis*	8	1	–87.5
9.	Rubiaceae	*Ixora pavetta*	5	2	–60
10.	Sapotaceae	*Mimusops elengi*	2	–	–100
11.	Rutaceae	*Naringi crenulata*	8	–	–100
12.	Verbenaceae	*Premna tomentosa*	5	–	–100
13.	Santalaceae	*Santalum album*	–	2	+100
14.	Verbenaceae	*Vitex altissima*	69	–	–100
15.	Rhamanceae	*Ziziphus mauritiana*	9	–	–100
16.	Rhamnaceae	*Ziziphus oenoplia*	–	2	+100

plants in the dry deciduous forests was 2.27 (Table 3). *Vitex altissima* (0.69) followed by *Erythroxylum monogynum* (0.62) and *Diospyros montana* (0.23) formed the densest species (Table 2). Only one species of fig, *Ficus benghalensis* was recorded here.

Human impacts on vegetation in hornbill habitats: dry deciduous forests. – Comparison of vegetation features of a primary forest patch with that of a disturbed site is shown in Table 4. Thirty five per cent families, 56% genera, 53% of the species and 83% of the trees were lost in the disturbed site. Tree species diversity (2.12) was also found to be lower in the human impacted site, as compared to the undisturbed/ primary forest site (2.64).

Table 5 furnishes the details of loss of hornbill's food plant species due to anthropogenic interventions in the hornbill habitat. Sixty five per cent of the food plant species were not found in the disturbed site. Nine species that were recorded in the primary forest were completely absent in the human impacted site, thus showing 100% loss. Four food plant species namely *Capparis grandis, Diospyros montana, Ficus benghalensis* and *Ixora pavetta* showed lesser values in the human impacted site, indicating moderate loss. Only one species, *Canthium dicoccum* (+25) had slightly higher number of individuals indicating slight gain. Two species *Santalum album* and *Zizyphus oenoplia* were found only in the disturbed site.

Human impacts on vegetation in hornbill habitats: riverine forests. – Thirty two active nests belonging to six tree species were located in the study area. All the nests were located in the riverine forests (Balasubramanian & Santhoshkumar, 2009). The riverine forests are subjected to various sorts of human disturbances. Agricultural practices alongside the rivers by local tribals, livestock grazing and non-timber forest produces collection formed the major disturbances. As a result of these activities, nest and food tree species are lost. Livestock grazing open up the shrub stratum where fast spreading exotic weeds such *Solanum erianthum, Lantana camara,* and *Cassia siamea* colonize. These exotics suppress the emerging native tree saplings which lead to the decline native tree populations whom the hornbill depends upon for nesting and feeding.

Habitat restoration initiatives: hornbill conservation awareness and habitat restoration initiatives. – The occurrence of Indian Grey hornbills, their unique habits and the need for restoring their habitats were highlighted to the forest department staff by delivering lectures, showing various hornbill photographs, reports and arranging field trips to hornbill nesting sites. Popular articles and television interviews on hornbills in regional languages were done to convey the message of conservation.

Habitat restoration initiatives: nursery rising for hornbill-dispersed plants. – A nursery of hornbill's food plants was created inside the forest department field station premises at Hasanur. A total of 16 food plant species belonging to 13 families was raised. Seeds were procured from wild plants, as well as by gathering from hornbill middens. The need for planting bird-attracting tree species was highlighted to the forest staff. A list comprising hornbill's food plants along with vernacular name and notes on phenology etc has been prepared and the same was provided to the forest managers for implementing the recommendations.

DISCUSSION

Johns (1987) observed the greatest diversity and abundance of hornbill species in undisturbed forest. He recorded the loss

of a high proportion of food resources in selectively logged forests. Anggraini et al. (2000) found that the Sumatran hornbills preferring undisturbed forests and avoiding highly disturbed areas. Population declines of Bushy-crested, Rhinoceros and Helmeted hornbills were observed in the fire affected areas of Bukit Barisan Selatan National Park, Sumatra (Anggraini et al., 2000). Datta (1998) related the habitat features with the abundance of various hornbill species in Arunachal Pradesh, India. She observed that hornbill abundance was not correlated with fig tree density. Balasubramanian et al. (2004) mentioned that the lowland riparian forests in Western Ghats, India that harbour Malabar Pied hornbills have higher fig density and tall, large-girthed nest trees than the adjoining vegetation types.

From the present study, it is inferred that the lowland riverine forests that harbour required nest and food trees are very crucial for the survival of Indian Grey Hornbill in the Eastern Ghats. The study indicates the decline of food plant population in the human impacted hornbill habitats and highlights the need for protection of hornbill habitats from human interferences.

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