Present distribution, population status, and conservation of Western Hoolock Gibbons *Hoolock hoolock* (Primates: Hylobatidae) in Namdapha National Park, India

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Abstract: A survey on the present distribution, population status and conservation of Western Hoolock Gibbon (*Hoolock hoolock*) was conducted from September 2006 to April 2007 in Namdapha National Park, Arunachal Pradesh, northeastern India. The data were recorded from 12 localities in the Park: Gibbon land, Baghnallah, Deban, 15th Mile, 16th Mile, Hawaghar, 19th Mile, Haldibari, Hornbill camp, Baranallah, Firmbase camp, and Embyong. A total of 50 individuals in 20 groups were recorded during the census by using direct and indirect methods. Out of 20 groups, nine groups were observed through direct visual observation. The remaining 11 groups were estimated by using indirect observation methods such as songs, calls, and branch shaking. The composition of the population was 19 adult males (38%), 19 adult females (38%), and 12 immatures (24%). The group size was estimated as 2.5 individuals per group. Anthropogenic disturbances observed in the gibbon habitat were habitat loss, hunting and poaching, canopy gaps, livelihood issues for local people, and livestock grazing.

Keywords: Canopy gaps, conservation, distribution, Hoolock Gibbon, Namdapha National Park, population status.

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Introduction

India has 32 taxa of primates in the wild (Molur et al. 2003). Of these, the Western Hoolock Gibbon *Hoolock hoolock* and Eastern Hoolock Gibbon *Hoolock leuconedys* are two species of lesser apes found in India (Das et al. 2006). The Hoolock Gibbon was formerly associated with genera *Hylobates* (Prouty et al. 1983a, 1983b) and *Bunopithecus* (Brandon-Jones et al. 2004; Groves 2005). Today it is classified in the genus *Hoolock* (Mootnick & Groves 2005) with two species: Western Hoolock Gibbon *Hoolock hoolock* from northeastern India south of the Brahmaputra River (Mukherjee 1982; Alfred & Sati 1986; Choudhury 1987), Bangladesh (Anderson 1878; Siddiqi 1986; Das et al. 2003a) and western Myanmar (Tickell 1864), and Eastern Hoolock Gibbon *H. leuconedys* from Lohit District of Arunachal Pradesh, India (Das et al. 2006), Myanmar and China (Groves 1971; Anderson 1978; Lan 1994). The Debang-Bramhaputra river system in the west (Tilson 1979) and Chindwin in the east act as physical barriers for the distribution of species (Parsons 1941; Groves 1967, 1972; Choudhury 1987). In India and Bangladesh, the *Hoolock* range is strongly associated with the occurrence of contiguous canopy, broad-leaved, tropical wet evergreen and semi-evergreen forests.

The population of *H. hoolock* in the wild has declined by more than 90% over the past three decades due to numerous anthropogenic threats (Walker et al. 2007). The debilitating threats include habitat destruction and fragmentation as a result of agricultural expansion, shifting cultivation, establishment of tea gardens, coffee estates, logging, developmental projects, and hunting and poaching for food, traditional medicine, body parts, pet collection, and illegal trade (Choudhury 1990, 1991, 1996a; Mukherjee et al. 1992; Srivastava 1999; Ahmed 2001; Malone et al. 2002; Solanki & Chutia 2004; Das et al. 2006; Walker et al. 2007). These threats occur in Arunachal Pradesh as well as in other areas of its distribution (Srivastava et al. 2001a, 2001b) and may have a direct impact on the population growth and distribution pattern of *Hoolock hoolock* due to its dependency on forest canopy for habitat, its being frugivorous, a brachiator and its territorial behaviors. Owing to its being frugivorous, the species plays a vital role as a seed disperser and pollinator (Howe 1986; Terborgh 1990) in lowland tropical rain forest ecosystems. Because of the evidence of widespread and rapid population decline, *H. hoolock* is listed by the IUCN Red List of Threatened Species as Endangered (Brockelman et al. 2008). In Bangladesh it is categorised as Critically Endangered, while in India it is Endangered as per the IUCN Regional Red List (Molur et al. 2003). In India the species is listed in Schedule I of the Indian Wildlife (Protection) Act 1972, and also in Appendix I of CITES. Against such a backdrop and the importance of the species for conserving the forest ecosystem, we realized that there still are various gaps with respect to the conservation of *H. hoolock* in Arunachal Pradesh. These gaps in our knowledge require immediate attention to save this species from its current threat status and were the impetus of this study.

Most of the studies on the Western Hoolock Gibbon's population and distribution status have been conducted in northeastern India including Assam (Choudhury 1990; 1996a, 1996b, 2000, 2001; Das et al. 2003a, 2003b, 2004, 2005, 2006a, 2006b), Meghalaya (Tilson 1979; Alfred & Sati 1986, 1990; Chaudhury 1998, 2006; Gupta & Sharma 2005a), Mizoram (Misra et al, 1994; Gupta & Sharma 2005b; Chaudhury 2006), Tripura (Das et al. 2005; Gupta & Dasgupta 2005), Nagaland (McCann 1933; Chaudhury 2006) and Manipur (Chaudhury 2006). A few studies were conducted between 1988 and 2003, and these were concerned only with general distribution patterns (Mukherjee et al. 1988, 1991-92; Borang & Thapliyal 1993; Singh 2001; Chaudhury 2003). The sole exception is Chetry et al. (2003) who conducted a quantitative study on the population status of gibbons in Namdapha National Park (NNP), Arunachal Pradesh. Gibbon habitat has been severely affected by anthropogenic causes during the intervening period and no quantitative distribution and population status has been conducted. Therefore, in this article we present quantitative information on the present distribution, population status, and conservation of *H. hoolock* in NNP and compare our results with those of previous studies.

Materials and Methods

Study Area:

Namdapha National Park (27°23'30''-27°39'40''N & 96°15'2''-96°58'33''E) is located in the easternmost part of Arunachal Pradesh in Changlang District. It has an area of 1985km² with a core area of 1808km². The park is bordered on the north by the Kamlang Wildlife Sanctuary and to the west by the Noa-dihing River. To the south and southeast lie high mountain ranges and the international border with Myanmar. It is contiguous with reserve forests and sanctuaries to the south and west, which act as buffer zones. Due to altitudinal variation (200-4571m), the climatic conditions are heterogeneous across the park. The temperature varies from 35°C to 0°C at lower altitudes and ranges to below freezing at higher elevations. The annual precipitation ranges from a minimum of 1400mm to a maximum of 2500mm, 75% of which falls between April and October. Relative humidity remains high except during the winter months, and annually it varies from a minimum of 47% to a maximum of 93%.

There are three major forest types – tropical, temperate and alpine forest (Champion & Seth 1968) in NNP. The highly diverse flora of NNP includes 73 species of lichens, 59 species of Hepaticae (Bryophytes), 112 species of Pteridophytes, five species of gymnosperms, and 870 species of angiosperms (Hajra 1996). A total of 200 plant species belonging to 73 families was recorded by Nath et al. (2005) in three stands of NNP. The predominant vegetation at lower elevations is the tropical wet evergreen forest dominated by *Dipterocarpus macrocarpus*, *Shorea assamica*, *Mesua ferrea*, *Altingia excelsa*, *Elaecocarpus aristantus*, *and Terminalia myriocarpa* and reaching a height of 50m.

Faunal diversity is also high in Namdapha. Ninety-six species of mammals, 233 species of birds, 76 species of fish and 25 species of amphibians have been reported here (Ghosh 1987). Besides these, invertebrates included 188 species of beetles, 102 butterflies, 35 moths, 24 Hemiptera, and 115 Mantodea (Ghosh 1987). Similar to other protected areas in the region, NNP has 27 villages, made up of 1420 households and a tribal population of 9618 people, in and around the park (Arunachalam et al. 2004). The Chakma (3951 individuals), a Tibeto-Burman tribe, dominate the local population followed by Nepali, Lisu, Lama, and Mishmi (Table 1).

Methods

The present distribution and population status of *H. hoolock* was carried out at 12 specific localities in NNP from September 2006 to May 2007 based on information gathered from the literature, forest department, and local inhabitants. The population was estimated by a modified line transect method (Burnham et al. 1980; NRC 1981) and direct count method in different forest types. The line transects were laid in a stratified random manner to cover all selected areas in the park. Three observers walked slowly covering a distance of between 10 and 15 km per day between 0600hr and 1730hr or until sunset. While sighting the presence of gibbon by direct or indirect methods, such as calls, branch shaking, and sounds associated with locomotion and feeding, observers recorded the exact count of each group size, composition, and sex in addition to vegetation type and evidence of anthropogenic disturbances in its habitat. Age and sex compositions of *H. hoolock* were classified into two major age categories, adult and immature; these were further subdivided into four subcategories, adult, sub-adult, juvenile and infant, based on morphological differences as described by Gupta et al. (2005).

Results

Population distribution

The population survey was mostly concentrated in the buffer zone areas of NNP except for a few areas of the core zone. The core zone of the park is completely inaccessible due to dense vegetation and hilly terrain. Nine populations of *H. hoolock* were found throughout the entire tropical evergreen forest of NNP and three populations were recorded from sub-tropical moist-deciduous and bamboo thick forest. They occur in all the different tree associations and were observed at altitudes from 150 to 800m. The majority of the groups were sighted at an elevation of 500m. They were found to be sympatric with the Capped Langur (*Trachypithecus pileatus*).

Ninety-five km of transects were laid and surveyed for the presence of *H. hoolock* in 12 different localities of NNP (Table 2). In these 12 localities we recorded a total of 20 groups. Eleven groups (55%) were recorded by indirect observations, with nine groups (45%) observed directly. The majority of the NNP gibbon population (17 groups) was recorded in tropical evergreen forest. Of the 20 groups, 12 groups (60%) were recorded from four localities namely Gibbon land, Hawaghar, Hornbill camp, and Firmbase camp.

Group composition and size

A total of 50 individuals were recorded in the 20 groups during population estimation. The group size and composition of the population surveyed in different localities are presented in Table 2. The smallest group contained a single sub-adult solitary male. Of the 50 individuals, 19 (38%) were adults males, 19 (38%) were adults females, 2 (4%) were sub-adults, 2 (4%) were juveniles, and 8 (16%) were infants (Fig. 1). The sub-adults, juveniles, and infants formed the immature class comprising 24% of the total population. The average group size was estimated

Table 1. Human profile of dependent villages in and around Namdapha National Park (Arunachalam et al. 2004)

Periphery of Park and total villages	Name of community	No. of village of particular community	Migrated from	Total no.of households	Total human population	Population/ household
Northwestern periphery (12)	Lama	01	Bhutan	23	122	5.30
	Chakma	09	Bangladesh	658	3951	6.00
	Mishmi	01	Lohit district	11	50	4.54
	Singpho	01	Patkai range	12	68	5.67
Southeastern periphery (13)	Lisu	04	Myanmar	385	2742	7.12
	Nepali	09	Assam rifle ex-service man	288	2405	8.35
Inside the Park (02)	Lisu	02	Myanmar	43	280	6.51
Total	**06**	**27**		**1464**	**9618**	**Av. 6.22**

Table 2. Total number of groups and individuals with age-sex composition recorded from twelve surveyed areas in Namdapha National Park

	Locations	Type of vegetation	Adults		Immature			Total individuals	Mode of sighting of groups		Total group	Average group size
			M	F	SAD	JUV	INF		Direct (Visual)	Indirect (Song)		
1.	Gibbon land	Tropical evergreen forest	03	03	-	-	02	08	01	02	03	2.66
2.	Baghnallah	Tropical evergreen forest	01	01	01	-	-	03	01	-	01	3.00
3.	Deban	Sub-tropical moist-deciduous	01	01	-	-	01	03	01	-	01	3.00
4.	Fifteenth mile	Tropical evergreen forest	01	01	-	01	01	04	01	-	01	4.00
5.	Sixteenth mile	Tropical evergreen forest	01	01	-	-	01	03	01	-	01	3.00
6.	Hawaghar	Tropical evergreen forest	03	03	-	-	01	07	-	03	03	2.33
7.	Nineteenth mile	Bamboo thickets	01	01	-	-	-	02	01	-	01	2.00
8.	Haldibari	Tropical evergreen forest	-	-	01	-	-	01	01	-	01	1.00
9.	Hornbill camp	Tropical evergreen forest	03	03	-	01	01	08	-	03	03	2.66
10.	Baranallah	Tropical evergreen forest	01	01	-	-	-	02	-	01	01	2.00
11.	Firmbase camp	Tropical evergreen forest	03	03	-	-	01	07	02	01	03	2.33
12.	Embyong	Sub-tropical moist-deciduous	01	01	-	-	-	02	-	01	01	2.00
	Total		**19**	**19**	**02**	**02**	**08**	**50**	**09**	**11**	**20**	**2.50**

M - Male; F - Female; SAD - Sub-adult; JUV - Juvenile; INF - Infants

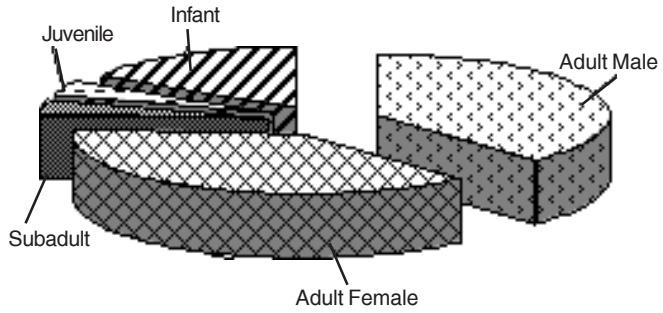

Figure 1. Group composition of Hoolock Gibbon in NNP

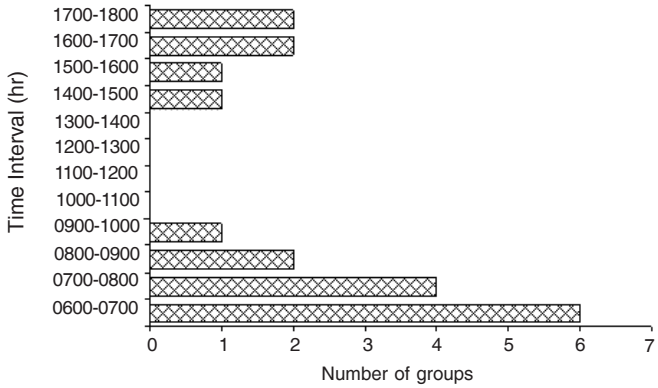

Figure 2. Temporal sighting periods of *Hoolock hoolock* at Namdapha National Park

to be at 2.5 individuals, ranging from 1 to 4 individuals. The estimated adult sex ratio was 1:1.

Temporal sighting period of Hoolock Gibbon in Namdapha National Park

Gibbon sightings at NNP were recorded from 0600hr until the end of sunset. The highest number of groups (30%) were sighted just after sunrise between 0600hr and 0700hr followed by the second highest number of groups (20%) between 0700hr and 0800hr (Fig. 2). No gibbon sightings were recorded between 1000hr and 1400hr.

Anthropogenic disturbance and conservation:

Table 3 expresses the presence of anthropogenic pressure on NNP. While evidence of hunting and poaching was recorded in all 12 surveyed areas, timber logging and agricultural activities were absent from the surveyed areas. Hunting, illegal fishing, and trapping of wild fauna like Tiger, Barking Deer, Leaf Deer, Sambar, bear, wild cat, and a variety of birds by local inhabitants, particularly the Lisu, Chakma and Mishmi tribes for bushmeat and their body parts, was a very common phenomenon. Livestock grazing and human settlement were recorded only in the Deban area and in the periphery of the park. Collection of non-timber forest produce (fuelwood, medicinal plants, wild vegetable and housing materials) and tourism pressure were recorded in the Gibbon Land, Baghnallah, Deban, Fifteenth Mile, Hawaghar, Haldibari, and Hornbill camp sites. All of these

Image 1. A pair of adult male and female gibbons feeding.

Image 2. Adult male and female gibbons in copulation.

Image 3. Pregnant female gibbon.

Image 4. Female carrying newly born infant.

Image 5. Juvenile male in bamboo forest.

Table 3. Extraction of forest products in select villages in and around Namdapha National Park (from Arunachalam et al. 2004).

	Demography			Extraction of forest products(tons village^{-1} yr^{-1})				Average seasonal fuelwood consumption (tons village^{-1} season^{-1})	
Name of villages	Community	Total household	Human population	Bamboos and posts (dry wt.)	Roofing material (dry wt.)	Fire wood (dry wt.)	Wild vegetable & medicinal plant(fresh wt.)	Summer (April-Sept.)	Winter (Oct.-March)
Lama basti	Lama	23	122	57.5	3.0	100.2	0.2	46.05	54.72
Budhisatta	Chakma	56	293	140.0	7.4	320.8	5.5	132.50	186.48
Anandapur-I	Chakma	55	315	137.5	7.3	287.4	5.6	115.02	171.11
Anandapur-II	Chakma	38	216	95.0	5.0	236.5	7.0	96.82	139.08
M'pen-I	Chakma	95	585	237.5	12.5	480.4	13.0	214.40	269.38
M'pen-II	Chakma	78	457	195.0	10.3	417.0	9.0	170.35	242.66
38th mile	Lisu	25	165	62.5	2.6	165.6	2.6	74.98	91.50
52nd mile	Lisu	20	130	50.0	3.3	142.3	2.6	58.24	84.18
Total		**390**	**2283**	**975.0**	**51.4**	**2150.2**	**45.5**	**908.36**	**1239.11**

Table 4. Comparison of group composition and group size of *Hoolock hoolock* in Namdapha National Park

	No. of Groups	Total Population	Adult	Sub adult	Juveniles	Infants	Group Size
Present study	20	50	76%	4%	4%	16%	2.5
Chetry *et al.* 2003	10	33	61%	-	30.%	09.%	3.3

areas are located inside the buffer zone of NNP.

Discussion

Hoolock hoolock survive primarily in tropical evergreen forests, tropical wet evergreen forests, tropical semi-evergreen, tropical moist deciduous, and subtropical hill forests in India (Srivastava 1999; Molur et al. 2005). This study clearly shows 75% of the gibbons we observed in tropical evergreen forest, ranging from 150 to 800m in elevation. As this species is largely frugivorous, food availability may be a limiting factor for its distribution versus for a folivorous primate species (Joseph & Ramachandran 2003). The status of gibbons in the state is not conclusively known. There are only mentions of their presence or absence from protected and non-protected areas. There is hardly any quantitative information on the population estimation of *H. hoolock* based on systematic studies in NNP with the lone exception of Chetry et al. (2003) (Table 4). They reported 10 groups of *H. hoolock* comprising 33 individuals in NNP during the 2002 survey. Choudhury (1990) reported 168 *H. hoolock* in seven populations for the state. In comparison, in other northeastern states Das et al. (2005) reported the occurrence of *H. hoolock* populations in Assam (1994) and Tripura (2003) comprising 1985 and 97 individuals, respectively. *H. hoolock* are monogamous, maintain a social network within a group and social proximity with neighboring groups of the same species (Alfred & Sati 1990). Alfred & Sati (1990) also reported that a typical family group consists of a mated pair and one to three immature offspring. We compared our group composition and group size with Chetry et al. (2003) for NNP and these data are presented in Table 4. Our group size of 2.5 individuals for 20 groups is closely comparable to other studies conducted in different part of *H. hoolock* distribution range: 3.2 individuals for 24 groups and 3.4 for seven groups (Tilson 1979), 3.1 for eight groups and 3.0 for 14 groups (Chaudhury 1990, 1991) in Assam, 3-3.2 for six to 10 groups (Mukherjee 1982), 2.1 for 34 groups (Gupta 1994) in Tripura, 3.0 individual for 42 groups (Alfred & Sati 1990) in Meghalaya, 3.5 for six groups (Gittins 1984), 2.3 for five groups and 2.9 for 15 groups (Ahsan 1984, 1994), and 2.9 for 13 groups (Feeroz & Islam 1992) in Bangladesh.

The economic status of local people affects the gibbon population and its habitat directly and indirectly and this has become a major concern for gibbon conservation. Arunachalam et al. (2004) explained the present inherent dependency of the local people on forest resources, particularly those settled in peripheral areas and inside NNP (Table.3). Local people use forest resources and land for extracting fuelwood, housing materials, medicinal plants, wild vegetables, and for agricultural activities. This results in forest fragmentation and degradation in the form of canopy gaps, and food paucity in both quantity and quality. In northeastern India, Bangladesh and Myanmar, most *H. hoolock* habitat is fragmented (Molur et al 2005; Walker et al. 2007). This makes gibbons particularly vulnerable to hunting and predation by domestic and wild dogs while moving on forest floor to forage for food, mate, and find safe shelter (C. Loma, Conservator of Forests, Arunachal Pradesh Forest Department, pers. comm.). Community hunting for their flesh and socio-cultural practices by tribal people is one of the major threats to primate species, including the endangered *H. hoolock* (Biswas 1970; Solanki & Chutia 2004). Further, the songs of gibbons act as a definite guide for hunters, allowing them to locate gibbons easily (Gupta et al. 2005). This has resulted in a sharp decline of gibbon populations in the entire northeast. The majority of gibbon populations in the northeast are very small and declining (Choudhury 1996b; Mukherjee et al. 1991-1992; Molur et al. 2005; Walker et al. 2007) and several fragmented populations face a high probability of extinction (75%) in the near future (Molur et al. 2005) due to isolation, decrease in habitat quality, availability of food and hunting. Gupta et al. (2005) stated that the alarming changes in gibbon habitat that has taken place in the recent years, in the ecology and landscape, have brought about a number of changes in the distribution and population structure of *H. hoolock* in the species' range. *H. hoolock* can be considered a keystone and flagship species, as it helps in the local health of the forest, is a state

animal and is a tourist attraction.

Recommendations

The interdependence of primates and the local people on one common resource for their basic requirements is the main cause for concern. Success in conservation goals would largely depend on the effectiveness with which this interdependence is lessened.

1. The present study recommends that human activities should be controlled in NNP in order to conserve *H. hoolock* populations.

2. The population should be monitored at regular intervals to evaluate the success of the management and conservation actions that have been implemented.

3. Alternative means of survival of local people should be sought by the state government particularly by the park authority in order to provide a lasting solution to the population.

4. The State Forest Department should launch well developed and planned agro-forestry and social forestry program specifically designed as per the requirements of the local people inhabiting in and around the park.

5. Fragmented, degraded forests and canopy gaps that exist in the gibbon's habitats in Namdapha National Park should be restored by planting of preferred and fast growing food plants.

6. The population, which requires immediate protection and conservation due to canopy gaps and lack of food availability, should be located and provided some alternative means for the movement of gibbons from one fragmented patch to another like bamboo bridges or rope way bridges which have been successfully experimented with in the Gibbon Wildlife Sanctuary, Assam to reduce canopy gaps.

7. A community education program for local people and a visitor center should be established. Salient features of gibbons, such as behavior, ecology, and socio-biology, as well as the importance of the species to humans, should be highlighted using banners, posters, and leaflets. These should freely distributed to create awareness of the species.

8. In line with tiger, lion, elephant and crocodile projects, the government should also start a Hoolock Gibbon project for the entire range of the species to determine the present distribution, population status, evaluate threats and conserve the species.

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