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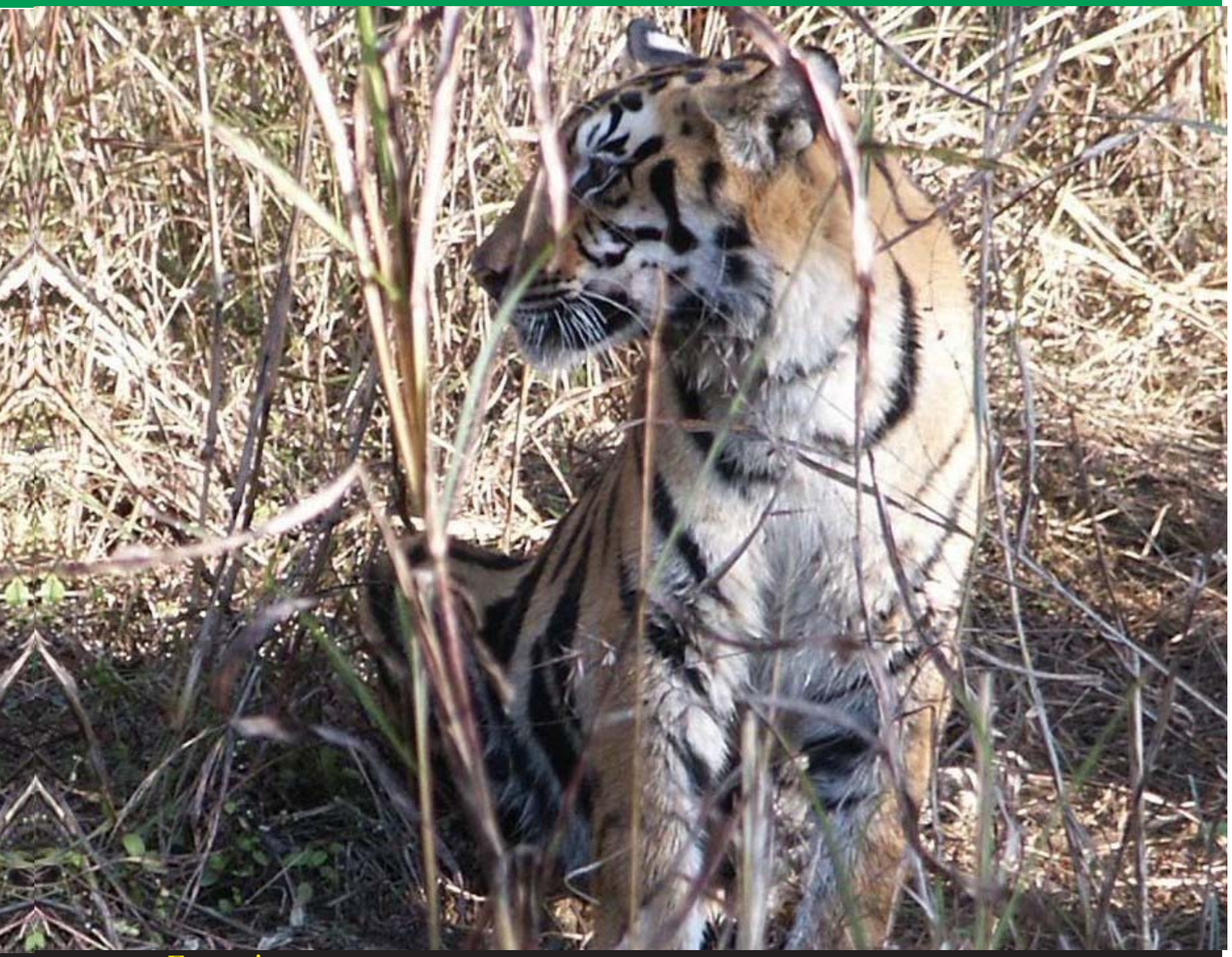

Featuring

FOREST NEWS

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FOREST NEWS

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Cover: Growing tiger cub
Photo: Debabrata Swain

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A REVIEW OF THREATS TO RAMSAR SITES AND ASSOCIATED BIODIVERSITY OF NEPAL

by Gandhiv Kafle, Mohan K. Balla and Bimal K. Paudyal

Introduction

Asia is a vast continent stretching almost half-way around the world. It is estimated that there are at least 120 million hectares of wetlands of international importance in South and East Asia. Asia comprises less than 14% of the world's land surface but supports 56% of its population, thus the population density is eight times higher than the rest of the world and is increasing at a rate of 55 million per annum (Hussain, 1994). The high population density of this region had led to a long historical dependence of people on wetland resources. Thus, wetlands in the region are characterized by their close interaction with local human communities (Parish, 1996). Inland waters and freshwater biodiversity constitute a valuable natural resource, in economic, cultural, aesthetic, scientific and educational terms. Their conservation and management are critical to the interests of all humans, nations and governments (Dudgeon *et al*., 2005). Despite the protection afforded to some wetland sites in certain Asian countries, the great majority of the natural wetland ecosystems in Asia are under threat. Wetlands in South Asia (93%) and South East Asia (94%) are considerably more threatened than those in East Asia (66%). Most of these threats are a direct consequence of immense population pressure (Hussain, 1994). Threats to the wetlands are quite variable between sub-regions and between sites, but taking the region as a whole, the threat most frequently reported from sites is hunting and associated disturbance, closely followed by general disturbance from human settlement/ encroachment and drainage for agriculture (Parish, 1996). A major portion of the wetland area in settled areas has been converted from its natural state to support alternative land uses including agriculture, urbanization, industry, and recreational pursuits. Wetlands have also been degraded by land use practices that have resulted in vegetation destruction, nutrient and toxin loading, sedimentation, turbidity, and altered low regimes. Dredging, intensive aquaculture, logging and acid rain have also affected the natural balance of wetlands (Ramsar Convention Secretariat, 2006). In many parts of the world, fresh water is subject to severe competition among multiple human stakeholders. Fresh waters are experiencing

declines in biodiversity far greater than those in the most affected terrestrial ecosystems (Dudgeon *et al.*, 2005).

Wetlands cover roughly five percent of Nepal's land area (DOAD, 1992). Nepal has approximately 6,000 rivers and rivulets, including permanent and seasonal rivers, streams and creeks (WECS, 2002). IUCN has identified 163 wetlands in 19 Terai districts covering 724,257 hectares in these districts (Bhandari, 1998a). An inventory carried out by ICIMOD (International Centre for Integrated Mountain Development) and UNEP (United Nations Environment Programme) listed 2,323 glacial lakes (75.70 km^2) above 3,500 m. in Nepal. These include 182 lakes of 8 hectares or more, and 2,141 with areas less than 8 hectares (ICIMOD, 2002). As in the rest of the world, wetlands in Nepal have significant human use values. The wetlands of Nepal also provide important habitats of biodiversity including several globally threatened and migratory species. However, the wetlands of Nepal are threatened by natural and anthropogenic causes. Major threats to wetlands and associated biodiversity in Nepal are habitat destruction and degradation, loss of ecosystem integrity and depletion of species abundance and diversity.

Biodiversity value of wetlands in Nepal

Nepal's wetlands support significant species diversity and populations of globally threatened flora. Of the 862 bird species found in Nepal (pers. com. with Dr. Hem S. Baral), 193 or 22.5 % are known to be dependent on wetlands (IUCN Nepal, 2004a). Seventeen out of twenty endemic vertebrates found in Nepal – including eight fish and nine herpetofauna species – are wetland-dependent. The vulnerable relict Himalayan Dragonfly *(Epiophlebia laidlawi)* is the only globally threatened wetland-dependent species known to occur in Nepal (IUCN Nepal, 2004a). A total of 182 fish species have been recorded in Nepal, including eight endemic species (Shrestha, 2001). Wetland-dependent flora includes the plants that flourish well in wetland habitats such as marshes, swamps, floodlands, in rivers or river banks (Chaudhary, 1998). Nepal's wetlands are equally important to flora. About 25% of Nepal's estimated 7,000 vascular plant species are wholly or partly wetland dependent. Twenty-six of the 246 angiosperm species are wetland dependent (Shrestha and Joshi, 1996). Of the 91 nationally threatened plants found in Nepal, ten are dependent on wetlands. Nepal's wetlands hold several species of wild cultivators and wild relatives of cultivated crops. At least 318 wetland-dependent plant species have been recorded in Terai wetlands alone. At least 254 amphibious/emergent species are found exclusively in aquatic habitats (IUCN Nepal, 2004a). Selected threatened plant species that are found in wetland habitats include *Saccharum williamsii, Eulaliopsis sykesii, Cyperus trisulcus, Carex rufulistolon, Eriocaulon kathmanduense, Spiranthes sinensis, Cyathea spinulosa, Sphagnum nepalensis* and *Pandanus nepalensis* (Shrestha, 1998).

Ramsar sites of Nepal

Nepal became a signatory to the Ramsar Convention on Wetlands on 17 April 1988. Nepal presently has 4 sites that have been designated as Wetlands of International Importance, with a surface area of 23,488 hectares. The basic details of these Ramsar Sites are presented in Table 1.

Table 1: Ramsar Sites of Nepal

Name	Designation Date	Area (ha)	Location
Beeshazar and Associated Lakes	Aug.13, 2003	3,200	Chitwan, 286m elevation, 27° 37'N, 084° 26'E
Ghodaghodi Lake Area	Aug.13, 2003	2,563	Kailali, 205m elevation, 28° 41'N, 080° 57'E
Jagadishpur Reservoir	Aug.13, 2003	225	Kapilvastu, 197m elevation, 27° 35'N, 083° 05'E
Koshi Tappu Wetland	Dec.17, 1987	17,500	Koshi, 75-81m elevation, 26° 39'N, 086° 59'E
Total		**23,488 ha**	

Beeshazar and Associated Lakes

Beeshazar and Associated Lakes lies in Bharatpur and Ratnagar Municipalities, 15 km south of Narayangadh town, Chitawan District, in the zone of Narayani, central Nepal. It falls inside the buffer zone of Royal Chitwan National Park, a world heritage site. It is an extensive, typical oxbow lake system situated between the Mahabharat mountain range to the north and the Siwalik range to the south. It is a forested wetland. It provides excellent habitat as a water hole and corridor for endangered wildlife species, including the critically endangered White-rumped vulture (*Gyps bengalensis*), endangered tiger (*Panthera tigris*), one-horned rhinoceros (*Rhinoceros unicornis*), Gharial (*Gavialis gangeticus*), vulnerable Smooth-coated otter (*Lutra perpiscillata*), Sloth bear (*Melaurus ursinus*), Marsh crocodile *(Crocodylus palustris),* Lesser adjutant stork (*Leptoptilos javanicus*), Ferruginous duck (*Aythya nyroca*) and Band-tailed fish eagle (*Haileetus leucoryphus*).

Ghodaghodi Lake Area

The site falls in the Village Development Committees of Darakh, Ramshikharjhala and Sandepani within Kailali District, in the Zone of Seti, western Nepal. It is a large and shallow oxbow lake with associated marshes and meadows. It is surrounded by tropical deciduous forest on the lower slopes of Siwalik. There are around 13 associated lakes and ponds in the area. Some streams are separated by hillocks situated on the site's periphery. The forest and wetlands serve as a wildlife corridor between the lowland and the Siwalik. They support critically endangered Red-crowned roofed turtle (*Kachuga kachuga*), the Tiger (*Panthera tigris*), Leopard (*Panthera pardus*), Three-striped roof turtle (*Kachuga dhongka*), Smooth-coated otter (*Lutra perpiscillata*), Common otter (*Lutra lutra*), Swamp deer (*Cervus duvaucelli*), Lesser adjutant stork (*Leptotilos javanicus*) and Marsh crocodile (*Crocodylus palustris*). Threatened plant species include the endangered Orchid (*Aerides odorata*), religiously important and threatened Lotus (*Nelumbo nucifera*), and rare wild rice (*Hygrohiza aristata*). They support six threatened bird species, including Critical: White-rumped vulture *(Gyps bengalensis)* and Slender-billed vulture *(Gyps tenuirostris);* Vulnerable: Lesser adjutant *(Leptoptilos javanicus)* and Indian-spotted eagle *(Aquila hastate);* and Near-threatened: Oriental darter *(Anhigna melanogaster)* and Ferruginous pochard *(Aythya nyroca)*. The resident population of *Nettapus coromandelianus* comprises nearly 1% of the total Asian population.

Jagadishpur Reservoir

The site lies 10 km north of Taulihawa city, in Kapilvastu District and Lumbini Zone, central Nepal. It is a reservoir that was constructed in the early 1970s over Jakhira lake and agricultural lands for irrigation purposes. The water is fed from Banganga lake in the Churia hills catchment. The reservoir is surrounded by cultivated land and a few smaller lakes. These serve as a buffer zone for bird movements. The site provides shelter for an assemblage of some rare, endangered species of conservation importance. These include plants such as endangered Serpentine (*Rauvolfia serpentine*), rare Pondweed *(Potamogeton lucens),* threatened and religiously important Lotus (*Nelumbo nucifera*), rare Wild rice (*Hygrorhiza aristata*), as well as the **IUCN Red Book**-listed and tallest flying bird species – the Indian Sarus Crane (*Grus antigone antigone*).

Koshi Tappu Wetland

The site is located about 8 km northeast of the town of Hanumannagar, on the border with the Indian state of Bihar, in southeast Nepal. It is the first Ramsar site that was declared in Nepal. It lies within the Koshi Tappu Wildlife Reserve and is a section of the Sapta Koshi River and its floodplain. It offers an important habitat for a large variety of wildlife. The threatened crocodile *Gavialis gangeticus*, bird species such as *Eupodotis bengalensis* and *Pelecanus philippensis*, and leopard *Panthera pardus* occur in the site. Koshi Tappu forms an ideal habitat for resident as well as migratory waterbirds and substantial numbers of waders.

Threats to Ramsar sites of Nepal

The biodiversity value and socio-economic use of Ramsar Sites of Nepal is very high. There is close interaction between local communities and lake ecosystems in these sites. This interaction has caused significant disturbances and threats to the

wetland ecosystem and associated biodiversity. The threats to Ramsar Sites of Nepal are presented in Table 2.

Table 1: Major Threats to Ramsar Sites of Nepal

Wetlands	Major Threats
Ghodaghodi lake	High dependency of local people on forest and wetland resources, encroachment of lake shores, overgrazing, poaching, eutrophication, haphazard infrastructure development, erosion on upstream areas, sedimentation, aquatic invasion, drainage, vegetation succession, traditional fishing, immigration from adjacent hills, smuggling of Sal (*Shorea robusta*) and Khair (*Acacia catechu*) timber, illegal tree felling, unplanned infrastructure development, highway traffic at the southern edge, use of agricultural chemicals, fish poisoning, insufficient environmental education among locals
Beeshazar and Associated Lakes	Unsustainable use of water resources, aquatic invasion, leaching of inorganic fertilizer and pesticide from farmlands, eutrophication, haphazard infrastructure development, water pollution, weak earthen embankment of the reservoir, siltation, illegal collection of forest products, illegal hunting, pollution
Jagadishpur reservoir	Aquatic invasion, exploitation of wetland birds, water pollution from fertilizers and pesticides, drainage, over-fishing
Koshi Tappu	High dependency of local people on forest and wetland resources, excessive extraction of resources, overgrazing, poisoning, poaching, illegal hunting, bird trapping, haphazard development projects, flooding and siltation, aquatic invasion, over-fishing

Threats to Ghodaghodi Lake area

The Ghodaghodi lake area is beset with multiple environmental problems, which are the manifestation of continued unplanned and haphazard human interventions occurring in the area (Gurung, 2003). The growing human and livestock population, immigration from the adjoining hilly areas and easy accessibility has further compounded these problems (IUCN, 1998a). The lake area has a dense population of around 6,700 inhabitants, of whom about 50% are illegal immigrants from adjoining hilly areas. These populations intensively use the lake resources for traditional fishing and agriculture. The local people are highly dependent on forest and wetland resources. Hill migrants use fodder collected from the forests more than Tharus do, but the opposite is true in the case of many non-timber forest products (Sah and Heinen, 2001). Other factors putting pressure on the site's ecology include highway traffic at the southern edge, construction of unplanned new temples, overgrazing, poaching and hunting, as well as illegal tree felling and smuggling of Sal *(Shorea robusta)* and Khair *(Acacia catechu)* timber, and natural eutrophication accelerated by human religious and agricultural activities (Ramsar Convention Secretariat, 2004).

The lake area is severally affected by natural eutrophication, although agricultural run-off is also affecting Nakhrodi Lake. The extensive proliferation of macrophytes causes a shift in the balance of bird species, favoring egrets, storks and jacanas at the expense of those migratory waterfowl that require some open water for feeding. Ultimately, these plants die and contribute to the organic material on the lake bottom, raising it and accelerating seral succession towards dry land. In Nakhrodi Lake, the succession is rapid due to shallow, eutrophic, macrophyte-rich waters, and the lake is changing into marshland where *Ipomoea fistulosa* and *Salix species* are prominent (IUCN Nepal, 2004a). A recent study shows that over 12,600 cattle regularly graze the shoreline forests at Ghodaghodi, where the composition of wetland vegetation is gradually changing into terrestrial communities as a result of over-grazing. Intensive year-round grazing in forests disrupts the regeneration of trees and impoverishes the ground flora (IUCN Nepal,

2004b). Haphazard recreational development initiated by the local government could pose a significant threat to bird and other wildlife in the area (Baral and Inskipp, 2005).

Rapid deforestation, overgrazing and other human disturbances have increased soil erosion and siltation in the lake system, which have gradually led to the subsidence of the lake's bottom. *Ipomoea carnea* sub-species *fistulosa* is the major invasive alien species in the area. The water hyacinth *Eichhornia crassipes* has been introduced in small lakes and marshes. Use of poisons is widespread at Ghodaghodi to catch fish, either indiscriminately or introduced into bait. It reduces the fish population by mass killing, affects the food chain of the ecosystem and causes pollution of water bodies. Exotic fish farming is also prevalent at Ghodaghodi. The main interest of landowners downstream of the lake area is to secure water for irrigation.

OBSERVATIONS ON BATS IN THREE NATIONAL PARKS IN THAILAND

by M.T. Abdullah, Puttipong Jusanit, Prakwat Wo Han Di, Mohammad Zabani Ariffin and L.S. Hall

Introduction

Of the 263 species of mammals recorded from Thailand, Lekagul and McNeely (1977) list 35% from the order chiroptera, 26% rodentia and 13 % carnivora. Biogeographically, Thailand lies in both the Sundaic and Indochinese subregions. The region south of the Isthmus of Kra (latitude 11°40'N) and peninsular Malaysia is considered as the Malayan faunal division, while the northern part is within the Indochinese subregion (Corbet and Hill, 1992). This report presents the results of bat surveys conducted in protected areas in Thailand and also provides additional knowledge on the status of bats in certain areas.

Study areas & methods

Information on the study sites was obtained mainly from Gray *et al.* (1994), Lekagul and McNeely (1977), Lekagul and Round (1991) and unpublished reports from the superintendent's office at Taleban National Park.

Taleban National Park is located in peninsular Thailand in the southern district of Satun (37 km from the city), between latitude 06°42'36"N and longitude 100°10'10"E. The 196 km^2 park was established in 1980 and is covered mostly by rainforest on limestone hills. Altitude ranges between 20 and 756 m a.s.l. The average annual rainfall is between 2,000-3,000 mm, peaking between August to October (Lekagul and McNeely, 1977; Taleban National Park unpublished records). The average annual temperature in the peninsula remains constant between 27° and 28° C.

Two sites were sampled near Ranee Waterfall and Loop A between 26 March to 4 April 1997. The netting station was located in an area with 71% mean canopy cover and undergrowth vegetation cover of between sparse to moderate with seedlings, saplings, poles and large trees. Heavy fruiting of *Ficus* sp. was observed in the park. A 9 m understorey net was hoisted in a *Ficus* tree in a length-wise manner. Some mist nets were set up near flowering *Musa* sp. clumps, fruiting *Ficus* sp. and in palm tree (Palmae) dominated sites. *Durio* were flowering in surrounding areas.

The survey was conducted in Doi Suthep-Pui National Park between 18 to 20 May 1997. The park was established as a protected area in 1981. It is located about 12 km west of the city of Chiang Mai in the northern region of Thailand. The 261

Cynopterus brachyotis (photo by L.S. Hall)

km^2 park is situated at latitude 18^{o}51'N and longitude 098^{o}52'E, and the elevation is 1,020 m a.s.l. The park is covered with hill mixed deciduous forest comprising more than 2,000 species of flowering plants and ferns (Gray *et al.,* 1994). The climate is seasonal with a minimum temperature of 6^{o}C and maximum of 41^{o}C, with an average annual mean temperature of 25^{o}C, and a mean annual rainfall of 1,268 mm. Netting stations were located in tree plantations and disturbed habitats with partially open, sparse to moderate undergrowth, saplings and trees. There was some flowering and fruiting of trees in the park as well as flowering and fruiting of fruit orchards in nearby villages.

Sri Nakarin National Park is located in Kanchanaburi Province in the central region, at 14^{o}38'30"N and longitude 098^{o}57'13"E. The elevation is 220 m a.s.l. The 1,534 km^2 park is near the Myanmar border to the west and is covered with dry dipterocarp forest. The Karen villages practice slash-and-burn agriculture and graze cattle in the park. About 30% of the park is disturbed forest, agriculture land and inundated with water. Netting stations were set up in disturbed habitat and bamboo thickets with canopy cove between 1 to 69%. Mist-netting was conducted only once.

Standard ground level bat mist netting followed the technique of Abdullah and Hall (1997) and Hall *et al.* (2004); mammals were identified according to Lekagul and McNeely (1977) and Medway (1978). Hand-netting was conducted in Tondin Cave and at a bridge under-passageway located about two km from the Taleban National Park headquarters. Bats were tagged for other studies before being released; external morphological measurements and weight were taken following Nagorsen and Peterson (1980). Most of the external measurements were taken from live bats in the field by using Mitutoyo™ digimatic callipers calibrated to 0.01 mm and weighed using a Pesola™ spring scale. The degree of fusion of the epiphyseal plates on the phalanges was used to distinguish bats in different age classes (Kunz, 1988). Before release, a large majority of the bats were tagged with No 4 nickel-plated bead chain necklaces and 2.8 mm serially-numbered metal bands imprinted with the Universiti Malaysia Sarawak, Kuching return address. Geographical co-ordinates were located by using a Magellan GPS NAV 5000 PRO™ and the altitude by Casio Alti-Meter™. A few bats were collected, chloroformed and preserved as voucher specimens in 75% alcohol and deposited at the Taleban National Park in Thailand.

Mist netting capture success was used as a relative population index which is associated with the abundance of animals in a sampling site (Abdullah and Hall, 1997). The number of bat species netted in a particular site indicates the species richness. During the survey (March to April 1997), the weather was rather unusual with slight to heavy convectional rainfall in the afternoon on many days.

Results

The species composition from different habitats in Taleban, Doi Suthep-Pui and Sri Nakrin are shown in Table 1. Seventy-six bats were recorded, representing 14 species in four families. The family Pteropodidae was the best represented by six genera and nine species. Mist-netting favors the capture of non-echolocating megachiropterans, and the presence of flowering and fruiting trees near the survey sites also increases the possibility of capturing this group of bats. Nine species were captured in mist nets in Taleban, six species in Doi Suthep-Pui and four in Sri Nakrin. About 84% of the bats were captured in Taleban National Park. *C. brachyotis* and *C. horsfieldi* represented 57% of the bats

recorded from the three habitats. In terms of trophic structure, 57% of the species netted were frugivorous and the remaining were insectivorous. In terms of zoogeography, 64% of the bat species were recorded within the Malayan subregion that is closely related to the Malaysian fauna. Netting efforts were not equal among the three sites, with the highest (22.5 net-nights) being in Taleban and lowest in Sri Nakarin (3 net-nights). The highest netting success was recorded at Taleban (2.4 animals/net-night), and the lowest in Doi Suthep-Pui (0.7 bats/net-night). In terms of species richness, Taleban primary forest has nine species, while Doi Suthep-Pui and Sri Nakarin have six and four species respectively. The bat species diversity was relatively higher at Taleban (H' = 1.158) and lowest at Sri Nakarin (H' = 0.577).

Discussion

In Thailand, the chiroptera are the most diverse mammalian group with 10 families, 33 genera and 92 species (Lekagul and McNeely, 1977). The microchiroptera represent 83% of the bat fauna (Lekagul and McNeely, 1977). However, in continental Asia, north of the Kra Isthmus where most of Thailand is located, there are 127 bat species and 27 are endemic (Koopman, 1989). Thirteen fruit bat species are shared with peninsular Malaysia; on the other hand, only 11 species are shared with Borneo (Koopman, 1989; Lekagul and McNeely, 1977; Medway, 1978; Payne *et al.,* 1985). Comparatively speaking, bat diversity in Thailand is slightly lower than Malaysia (101 species, including 20 megachiropterans).

During the present survey, ecological observations were recorded for 57% of the individuals netted (comprising nine bat species) regarding their breeding status and development. About 28% of the total number of bats from seven species were at various stages of reproduction. At Taleban National Park, the sympatric *C. brachyotis* , *C. sphinx*, and *C. horsfieldi* were pregnant while two female *C. brachyotis* were carrying juveniles. From the present study, it can be suggested that the *Cynopterus* reproduction period in Thailand might begin as early as January and last up until June. Ten other individuals from five species were immatures and 11 bats from four species were subadults. The endemic *Sphaerias blanfordi* was represented by an immature and a subadult.

Wade (1958) suggested that breeding is seasonal among most mammals in the tropical rain forest and the onset is associated with the period of lowest precipitation. According to Lim (1970), in the lowlands of peninsular Malaysia, most pregnancies in *C. brachyotis* occur from March through June and coincide with the peak of fruiting in April and June. Two other small peaks in pregnancies are linked to times of high rainfall. However, during the months of heaviest rainfall in October to November, the pregnancy rate was found to be low. In the mountains of Berinchang, Pahang, the breeding period for *C. brachyotis* was February to April, which coincided with the major local fruiting season from March through June (Lim, 1973). In Negro Island of the Philippines, there were two annual birth peaks among *C. brachyotis*, the first one between February and March and the second in June (Heideman, 1987). In secondary habitat of north Luzon, Heideman (1987) observed that females experienced parturition in July and August. In contrast to the seasonal peaks observed by Lim (1970) and Heideman (1987), Start (1974) noted that *M. minimus*, *E. spelaea, C. horsfieldi* and *R. amplexicaudatus* were found to be breeding throughout the year. The availability of food resources explained the lack of seasonal variation in reproduction. Early pregnancies in the Macroglossinae may be due to a postpartum oestrus which overlapped with lactation. Start (1974) also observed that very few of the lactating females of *M. minimus, M. sobrinus* and *E. spelaea* that were netted carried young. In Brunei, Kofron (1997) observed that *C. brachyotis* experienced two birthing seasons annually, which coincided with the season of less rainfall and abundance of mangoes. The first birthing season was from mid-January to mid-April and the second from mid-June to early October.

In Thailand, the flowering and fruiting season for mangoes, lychee, longan, durian and rambutan is usually from February through September (Ketsa, 1995). In the northern Malaysian state of Perlis bordering Taleban, the annual fruiting season for mango is between April to June, for durian between May to August, for *Artocarpus* species

between May to October and for rambutan between June to August (Anon, 1996). Our observations on the breeding of bats and the reproduction of food plants in Thailand are consistent with most of the observations by previous authors. The postpartum oestrus in *Penthetor lucasi* and presence of juveniles, immatures and pregnant females of other megachiropteran species suggests two birthing seasons similar to the observations by Lim (1970), Kofron (1997) and Sandhu (1984). There is also evidence suggesting that the breeding period of certain species of bats coincided with the flowering of durian (*Durio zibethimus*) and other fruit trees.

The lack of food resources (forest trees bearing flowers and fruits) might also encourage some bats to disperse into resource-rich habitats. Pteropodids are known to migrate seasonally to take advantage of fruiting seasons (Findley, 1993). Specimens of *M. sobrinus* were mainly netted in Taleban in mist nets situated closed to banana (*Musa* spp) clumps. We also suspect that some of the fruit bats around our sampling sites had moved closer to villages to take advantage of the seasonal flowering and fruiting of durian, mangoes, longan and lychee. The abundance of continuously flowering, or aseasonal, *Musa* sp. and *Cocos nucifera* found in the villages in Thailand also provided important food resources for fruit bats. The movement of bats to other areas might affect the rate of capture and netting success. Differential netting effort, equipment, weather and moon phases might also contribute to poor results during this study.

Unlike the more traditional museum work, which is primarily based on preserved specimens, the challenge of capture, mark and release research work is to accurately identify the animal alive *in situ,* as well as to encourage non-destructive species conservation. However, anomalies in morphological measurements, phenotypic and geographic differences create greater difficulties for a field biologist in handling live specimens in relatively short periods of time. For example, there were some difficulties in separating the congeneric, especially between *C. sphinx* and *C. horsfieldi*. According to Lekagul and McNeely (1977) *C. sphinx* has a longer forearm length (65-74 mm) and normal lower cheek teeth, while *C. horsfieldi* has a peg-like central cusp on the 3rd and 4th lower cheek teeth and a forearm length of 70 to 80 mm. The forearm measurements for *C. horsfieldi* (70, 70, and 78 mm) overlapped with *C. sphinx* (65-76 mm) in peninsular Malaysia (Medway, 1978). In Borneo, *C. horsfieldi* is distinguished by the broader and squarer lower cheek teeth (Payne *et al.,* 1985). In Kalimantan Barat, Indonesian Borneo, *C. horsfieldi* had a forearm length of 78.54 to 77.01 mm and weighed between 59.5 to 64.0 g (Abdullah *et al* 1997). However, we observed that for old adults with worn molars on the lower mandible, both species appeared to be morphologically similar and the forearm measurements overlapped. In the case of *C. brachyotis*, the morphological anomaly was due to the fact that there is more than one species in the population (Abdullah, 2003). During this field survey, we also found that *M. sobrinus* can be distinguished from *M. minimus* by the longer forearm length (43.35 to 46.95 mm vs 40 to 43 mm) and head length (30.05 to 30.54 mm vs 26 to 28 mm) and heavier body weight (17 to 23 g vs 13 to19 g) (Medway, 1978).

An adult pregnant and lactating female *P. lucasi* that was captured and released in Doi Suthep-Pui, is a new distributional record for Thailand. The species is distributed from the lowlands up to about 2,000 m altitude in Borneo, peninsular Malaysia, the Riau archipelago and Singapore (Mickleburg *et al.,* 1992; Payne *et al.,* 1985). In Malaysia, the species roosts in caves, rocks, crevices and between boulders (Hall, 1997; Medway, 1978; Payne *et al.,* 1985). The presence of caves in the hilly Chiang Mai area should provide suitable and protected habitat for the species. Further surveys are needed to collect more specimens and to determine the full distribution of the species.

C. brachyotis, *C. sphinx* and *C. horsfieldi* were netted sympatrically within the Taleban National Park study site. To have three sympatric species of *Cynopterus* is an unusual occurrence and may be a result of a lack of resource partitioning, diet overlap, or similar roosting, emergence time and flight behavior of the species. The three species were netted at a site located in vegetation dominated by palms. Palm fronds are known to provide suitable roosting sites for these species of

bats (Medway, 1987; Lekagul and McNeely, 1977).

Despite the relatively short sampling period, the population index from this study is comparable to other studies. The netting success rate in Taleban (2.49 bats per net-night) is higher compared to some protected areas in Malaysia (1.16 bats per net-night) (Abdullah and Hall, 1997) and suggests higher numbers of bats in the Thailand rainforest. Relatively speaking, the species richness in Taleban is comparable to some protected areas in peninsular Malaysia (10 species in Taman Negara), but slightly lower than that in Borneo (Abdullah and Hall, 1997). Although our total netting effort (44.5 net-nights) is lower than Zubaid's (1993) work in Bangi, peninsular Malaysia (185 net-nights), the number of species netted is similar (pooled 14 species vs 13 species in Bangi).

The limestone outcrops around Taleban and the hilly region of Chiang Mai may have greater potential to document more cave-roosting species of bats. Since many of the protected areas in Thailand have not been thoroughly surveyed for the bat fauna there is a high probability that more new distributional records for chiroptera are awaiting to be discovered in the future.

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Table 1: Bat species composition, abundance and richness in Taleban, Doi Suthep-Pui and Sri Nakarin national parks, Thailand

Family Species	Taleban	Doi Suthep-Pui	Sri Nakarin
Pteropodidae			
Cynopterus brachyotis	21	1	0
Cynopterus sphinx	8	6	2
Cynopterus horsfieldi	20	0	2
Penthetor lucasi	0	1	0
Sphaerias blanfordi	0	4	0
Megaerops ecaudatus	1	0	0
Eonycteris spelaea	1	0	0
Macroglossus sobrinus	4	1	0
Megadermatidae			
Megaderma spasma	1	0	0
Rhinolophidae			
Rhinolophus affinis	0	1	0
Rhinolophus pusillus	0	0	1
Rhinolophus coelophyllus	3*	0	0
Rhinolophus yunanensis	0	0	1
Hipposideridae			
Hipposideros bicolor	5*	0	0
No. family : 4	4	2	2
Species richness : 14	9	6	4
Effort (net-night)	22.5	19	3
Capture rate (bat per net-night)	2.49	0.74	2.0

* *Hand netted in Tondin Cave and a bridge underpassageway*

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STUDY OF HUMAN CASUALTIES BY BENGAL TIGERS (*Panthera tigris tigris* L.) IN THE SUNDARBANS FOREST OF BANGLADESH

by Md. Wasiul Islam, Md. Shafiqul Alam an Md. Muktarul Islam

Introduction

Once, the Bengal tiger (*Panthera tigris tigris* Linnaeus 1758) had a wide range of occurrence in the forests of Bangladesh. It was seen in all the major forests of Bangladesh until the late 1940s (Anonymous, 2000). Now, however, there are no authentic reports of the existence of Bengal tiger in the forests of Bangladesh other than in the Sundarbans. The Sundarbans has an age-old history of man-tiger conflict (Corbett, 1946; Khan, 1961; Mountfort, 1969; Chakrabarty, 1992). From the Management Plan (1931) records it is known that the Forest Department killed 452 Bengal tigers from 1912 to 1921 (Curtis, 1933) and 269 tigers were killed between 1947 and 1971, or an average of 11.2 tigers per year (Salter, 1984). Not only were tigers killed by man, but there were many human casualties by tigers in the nearby Sundarbans. It was reported that between 1975 and 1999, tigers killed a total of 544 people – an average of 22 people per year (Reza, 2000). Over the last fifty years, tigers in the Sundarbans have taken a toll of about 1,000 people. These are only the reported cases (official data); the actual number (unofficial data) may be 30% higher than that. The victims are mostly poor villagers viz., Bawalies (i.e., woodcutters), Mualies (i.e., honey collectors) and fishermen (JJS, 2003). Many of the human casualties occured when the tiger was being attacked by the villagers, who would assemble from all directions with sticks and spears, giving the animal no space to escape. So the tiger would jump on the mob, killing and injuring some people (Gani, 2002).

The man-eating propensity of the Sundarbans tigers is a subject of traditional debate amongst naturalists, ecologists and wildlife enthusiasts all over the world. The terrain has an age-old history of man-tiger conflict, which has turned the situation into a survival competition between man and tiger. The Sundarbans tigers are popularly branded as hereditary man-eaters (Chakrabarti, 1992). Certain factors may cause tigers to become man-eaters (Jackson, 1990; Tilson and Ulysses, 1987). Some examples include the following:

- A tiger may be desperate for food because of old age or injury, and humans are relatively easy prey.
- Tigers living in habitats where native prey is scarce may be forced to hunt humans for food. Likewise, a mother tiger with cubs may hunt humans to provide enough food for her young. Consequently, the young tigers learn that human are prey.
- As tiger habitats become smaller and more isolated, tigers and people come in contact with each other more often. Tigers may venture into surrounding agricultural lands to hunt or to find dens for their cubs. A chance attack on a human may become routine behavior for some tigers. Fortunately, not all tigers that attack humans become habitual man-eaters.
- Some tigers may learn to associate humans with food if they have had the opportunity to scavenge human corpses.

The main objectives of the current study were: 1) to assess the present status of human-tiger interaction in the Sundarbans; 2) to assess the time and seasonal variation of tiger attacks on humans in the Sundarbans and its periphery; 3) to identify the critical areas of tiger entry into localities; and 4) to make recommendations to minimize tiger-human conflicts in the Sundarbans.

Materials and methods

The study area covered the entire Sundarbans of Bangladesh and its vicinity. The Sundarbans forest covers about 10,000 km^2 and is located in southwest Bangladesh and in the southeast of the

Indian state of West Bengal. The Bangladesh part of this forest covers about 6,017 km^2 (68.85% land area and 31.15% water body) (Haider, 2004).The Sundarbans is located south of the Tropic of Cancer and at the northern limits of the Bay of Bengal. It is mangrove forest and broadly classified as tropical moist evergreen forest.

The study was based on both literature reviews and field surveys. Data covering 1995-2004 was collected through surveys of villagers in the impact zone, Sundarbans resource users (Bawalies, Mualies and fishermen), from Sundarbans East Forest Division, Sundarbans West Forest Division and Khulna Circle Office, Bangladesh. A survey questionnaire form was prepared to get primary data from villagers and Sundarbans resource extractors. Stratified random sampling was used in this survey.

To begin, the Sundarbans was divided into four areas according to four forest ranges and data was collected from the resource extractors of each range. In the case of the villagers' survey, four villages (one in each range) near the periphery of Sundarbans were selected and eight representative samples (Bawalies, Mualies, Fishermen and village people) were picked at random from each of those villages. Another survey collected data about humans killed by tigers in the Sundarbans from different offices of the Forest Department of Khulna Circle. The data was collected between November 2004 to 31 January 2005. For the analysis of this study it was targeted to collect 15 years of data, but in some cases the data was not available up to the target limit and in other cases more data was collected according to its availability.

Results and discussion

A total of 582 people were killed or injured by tigers in the Sundarbans during the 25 years from 1980 to 2004. Of this number, 553 (96%) people were killed and 29 (4%) were injured in tiger attacks. The highest number of human casualties (52) killed by tigers occurred in 1988 and the lowest number of casualties (1 person killed) was recorded in 1997. According to the Forest Department and the local people, there is no discernible reason for the difference in the number of casualties occurring in those specific years. The number of human casualties gradually dropped after 1994, increased again in 2000, and dropped again after 2000, thereafter staying steady in the following years.

A large number of people utilize the forest for their livelihoods and some of them fall victim to tiger attacks. It is a repeated occurrence in the Sundarbans, but why the number of attacks fluctuates from year to year is unknown. Differences in the number of people entering the forest each year may be one of the reasons. Deficient data may also affect the results. From the statistics it seems that people seldom survive tiger attacks, which indicates the ferociousness and accuracy of the tigers. According to the Forest Department, on an average, 22 people are killed by tigers each year in the Sundarbans, but this figure may be 30% higher according to the people who reside around and work in the forest. Chakrabarti (1992) claimed that the salinity of the water is probably the most important factor for as much as 25% of tigers turning man-eater.

The maximum number of casualties by tiger attack were recorded in Satkhira Range. Between 2000-2004, out of a total 110 people attacked by tigers, 87 persons (79.09%) were killed in Satkhira Range. The total number of casualties at Khulna, Chandpai and Sarankhola Ranges within the same period of time are 21 (19.09%), 0 and 2 (1.82%) respectively. One of the reasons that more people are killed in Satkhira Range is that more people work in this range for collection of forest products, especially honey and fish. That there were no casualties in Chandpai Range within the time frame may be due to the fact that it is the smallest sized range among the four and so the least number of people work there. Data deficiency may also be another reason for the result. The most critical areas on the borders of the Sundarbans which are used by tigers as corridors to enter into the villages are at Satkhira Range - Kaikhali Forest Station to Burigoalini Range Office; at Khulna Range - Shekbaria to Koyra Forest Patrol Post; at Chandpai Range - Chandpai Range Headquarter to Baiydamari Forest Patrol Post and at Sarankhola Range - Bogi Forest Station to Sarankhola Range Headquarter and Nangli to Gulisakhali Forest Patrol Post. Compartments nos. 47, 48, 49, 46, 55, 40, 36 and

38 (there are 55 compartments) of Satkhira Range are the most tiger infested areas in the Sundarbans. From 2000-2004, the total human casualties recorded were 23, 21 and 14 in compartments no. 47, 48 and 49 respectively More people work in these regions for fishing and to collect honey, goran and other non-timber forest products. These regions have a higher salinity, which has been speculated to make tigers more ferocious.

From 1990-2004, 334 people of different occupations were killed by tigers in the Sundarbans, with fishermen comprising the highest number of casualties (168 or 50.3% of the total casualties). The other occupations of casualties are: goran collectors (54 or 16.2%), honey collectors (38 or 11.4%), nipa collectors (32 or 9.6%), fuelwood collectors (8 or 2.4%), phoenix collectors (2 or 0.6%) and other types of labor (32 or 9.6%). It is seen that almost half of the number of casualties are fishermen; therefore, the question is why this number is so high. There are higher numbers of fishermen than any other profession in the Sundarbans and they enter the forest more frequently to collect fuelwood and other forest products. There may be other reasons for their higher casualty rate, so it requires further research. The second highest casualties by profession is goran collectors (16.2%), which are close to honey collectors and nipa harvesters. These are more risky jobs than fishing but the casualties are less in number because there are fewer people of these professions in comparison to fishermen engaged in the Sundarbans. Most of the casualties took place in 1990 (14.7% of total), followed by 1993 (13.8%), 1991 (12.6%), 1994 (10.8%), etc. No definite cause has been identified for the difference in the number of accidents in different years. No tourists have been killed by tigers in the Sundarbans since 1990. The reason may be increased awareness of the tourists and that they do not enter into the deep forest.

From 2000 to 2004, 45% of the total tiger attacks on humans took place between 3-6 pm; 30% took place between 10 am-3 pm and 21% took place between 6-10 am. The tiger is a nocturnal animal; during the first half of the day it rests and during the second half they come out to seek prey. This may be one of the reasons for more people being attacked in the afternoon, but more research is needed to confirm this. Most tiger attacks take place during the day and very few at night. This may be because few people work at night in the Sundarbans.

Tiger attacks on resource extractors in the Sundarbans take place all year round. The monthly trend of tiger attacks shows that during the rainy season in July to October attacks are low (24.6%). The frequency of attacks increases during the summer months March to June (35%) and during the winter months November to February (40.2%). This is because in the wet season only fishermen work in the forest; in the dry and winter seasons various non-wood products are harvested, which brings more people into the forest area. More casualties are recorded during December to April because during that period more people work in the forest. Less people work in the forest during June to August due to the rains and difficult conditions in the river and sea.

From the study it was evident that afternoon is the most critical time for tiger attacks. The percentage of tiger attacks on humans in the afternoon is 59%, in the morning 22% and at noon 19%. It was also found that about 89% of the attacks occurred during high tide when the water current is static, which helps tigers cross the river more easily. Tigers also avoid muddy areas so they choose the high tide to cross the river or canals to patrol the periphery or to catch the prey species.

According to the villagers, tigers generally enter the villages at night, especially during the high tide period, with 55.56% of the forays occurring at between 10 pm-3 am, 29.63% between 3-6 am and 14.81% between 6-10 pm.

In the Sundarbans mangrove forest, high and low tides are continuous phenomena occurring alternately every 6 hours, twice a day. Tigers can swim and that is why at the high tide they can easily avoid the muddy banks of the water bodies which are seen clearly at low tide. The Sundarbans is separated from the surrounding locality by narrow canals; some are filled with silt which makes it easier for the tigers to leave the forest.

Tigers may become confused about the location of the periphery of forest at night and enter into the villages. During the day, the forest boundary is clear and that may be the reason why no tigers leave the forest area during the day.

To overcome the problem of human-tiger interaction in the Sundarbans, proper action should be taken immediately. There are short- and long-term remedies that can be followed to improve the human-tiger conflict in the Sundarbans. If these are properly implemented, there is a greater chance of successfully reducing negative human-tiger interaction in the Sundarbans.

Short-term recommendations include:

- Fencing of critical areas in the vicinity of villages;
- Establishment of water-harvesting ponds to ensure the supply of fresh water for the wild animals;
- Seeking the cooperation of the local administration;
- Strengthening existing rules and regulations;
- Excavation of canals along the boundary adjacent to the locality; and
- Wearing of masks on the backs of the heads of resource extractors to discourage the tigers from attacking from behind.

Long-term recommendations include:

- Starting a community awareness program;
- Introducing a participatory wildlife management approach;
- Patroling the most critical borders of the Sundarbans;
- Introducing a compensation program for the villagers;
- Undertaking a wildlife rescue, treatment and relief program;
- Management of grassland/vacant areas for wildlife; and
- Training and human resource development.

Conclusion

The Sundarbans is abundant with valuable resources. People going to the Sundarbans to extract major and minor forest products sometimes fall under tiger attacks. The records show that 22 people are killed by tigers in each year, but according to the local people the actual number may be around 50-75 per year. The tiger-human interaction is still in an alarming state, so the Forest Department should adopt and implement an effective work plan to deal with the problem.

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Table 1. Humans killed/injured by tigers in the Sundarbans of Bangladesh from 1980 to 2004

Year	No. killed	No. injured	No. of total casualties	% of deaths
1980	7	0	7	100
1981	8	0	8	100
1982	26	0	26	100
1983	17	0	17	100
1984	6	0	6	100
1985	15	0	15	100
1986	16	0	16	100
1987	33	3	36	91.7
1988	52	3	55	94.5
1990	39	4	43	90.7
1990	49	5	54	90.7
1991	42	0	42	100
1992	15	1	16	93.8
1993	46	2	48	95.8
1994	36	2	38	94.7
1995	18	0	18	100
1996	11	0	11	100
1997	1	0	1	100
1998	3	0	3	100
1999	12	0	12	100
2000	35	1	36	97.2
2001	19	5	24	79.2
2002	10	1	11	90.9
2003	19	2	21	90.5
2004	18	0	18	100
Total	**553**	**29**	**582**	**96**

Source: Forest Department, 2004

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SMALL MAMMALS IN THE NORTHERN REGION OF PAPUA, INDONESIA

by Freddy Pattiselanno

Introduction

A number of activities have been launched to foster biodiversity research in Irian Jaya by conducting training in collaboration with research institutes to strengthen the research capacity of local institutions (NGOs, government and young lecturers from universities) (Conservation International, 1999). Yongsu, in the northern site of Cyclops Mountains, and the Mamberamo River have been selected to represent the coastal and marshland areas in the northern part of Papua as locations for such training sessions by the Conservation International Irian Jaya program.

McPhee (1988) reported that habitat modification by human activity has radically affected the diversity and relative abundance of rodent species, although it is difficult to discern any relationship between diet and habitat. Research conducted by Dwyer from 1979 to 1980 in Papua New Guinea indicated that altitudinal effects and long term modification of forest at the latter locality might have contributed to the differences in the mammals' diversity.

From previous studies in Papua, several factors have been identified that may have contributed to the low capture rate of small mammals, such as the fact that they occur in low densities, have uneven (patchy) distribution, the local abundance of food resources in the forest (where traps were set), that perhaps the baits used were not appropriate, and/or other unknown factors. Therefore, further study is important to compare the capture results in different habitat types/ conditions in the northern region of Papua Province.

Study area

Cyclops Mountain is one of the mountain sites officially protected in the Cyclops Mountains Nature Reserve in close proximity to Jayapura, a capital city of Papua Province. Due to its location near Jayapura, the reserve has been exposed to severe pressure from other land use purposes (e.g., road construction, conversion to agriculture, settlements and logging concessions).

In the northern part of Cyclops Mountain near Yongsu (02°26S; 140°29E) is a village, reachable from Jayapura by boat, where the study was carried out in the primary rainforest with small areas of secondary forest along the coastal site. In Yongsu, the driest month is September (with an average rainfall of 260 mm) and the wettest month is April (mean rainfall: 1,075 mm). Temperatures range between 17.2°C – 35.6°C with a mean annual temperature of 21.7°C. Humidity is between 81.8%-85%.

The Mamberamo River watershed, one of the wetland sites in West Papua, covers 7,711,602 hectares and includes part of the central mountains of New Guinea, as well as forests, coastal forests, and tropical marshlands. This potential marshland area in West Papua is currently classified as production forest (31.6%), conversion forest (29.6%), protected forest (29.6%) and other categories (1.4%). The Department of Research and Technology has decided to develop the area by building a dam for the center of the industrial and agricultural program in West Papua. The value of this system in terms of biological conservation is obvious, and if the proposed dam proceeds to fruition at its point of passage through the Foja/ Van Rees Mountains, it will be an ecological catastrophe for Papua's biodiversity (Polhemus and Richards, 2002).

The study site near the town of Dabra (03° 16.220'S & 138° 36.938'E), an hour's trip by airplane from Sentani Jayapura, was described as lowland swamp surrounded by primary rain forest and close to the small stream that leads to the

(continued on p.17)

(continued from p.16)

Mamberamo River Basin, which is the major river in this area. The vegetation found in this area is much more varied, ranging from tall, mixed species forest near rivers through low, open forest of mixed pandanus species, to herbaceous swamp dominated by sedges, reeds and floating grasses. The dry season (May-September) is slightly drier than the rainy season. Year-round temperatures reach into the high 80s (°F) during the day. The survey was conducted during the dry season when water levels in the main river channel and small streams that branch from the main channel were relatively low.

Methodology

The survey was conducted during August 2000 in Yongsu and continued during September at the Dabra sites. In Yongsu, small mammals were sampled using locally made wire mesh live traps (10x20x10cm). This trap is like a small cage with a spiral spring door and is commonly used to catch house rats. Twenty-four traps were randomly set in 2 trap stations per habitat (garden and forest). Trap stations were 10m apart in each habitat. Each trap station had three traps with 3 kinds of bait (roasted coconut, ripe banana and smoked fish), with each trap set 5m apart, roughly in a circle. The general habitat features were noted. All traps were located at ground level, and were baited and put in position just before sunset (16:00-17:00 pm). They were checked and collected the following morning (08:00-09:00 am). Rodent captures were extremely rare in the afternoon; nevertheless, trap rounds were necessary to replace bait which was often consumed by ants. When an animal was captured, it was removed and the trap was washed and replaced. Trapping took place on four consecutive nights during the survey dates.

In Dabra, Mamberamo, thirty-six Elliot traps were installed in a 50x 50 m grid, and 35 were set at 2 m intervals along a 70 m transect. A variety of baits were used, including bananas, fish and biscuits. Traps were opened in the evening (4:00-5:00 p.m.) and were checked and closed the next morning between 8:00-9:00 a.m.

Captured bats were identified according to Flannery (1995), and Menzies and Dennis (1979). Each specimen was weighed and measurements were recorded for ear length (EL), body length (BL), tail length (TL), hind foot (HF) and forearm (FA). After identification and measurement, several species were collected as representatives and the rest were released at the point of capture.

Results and discussions

The morphometrics of some species captured during the survey are presented in Table 1.

Table 1. Species captured and some morphometric measurements

Species	Bait	W (g)	HB (cm)	TL (cm)	HF (cm)	Sex
Murexia longicaudata	SF	229.5	20.0	19.0	3.5	M
Pogonomelomys mayeri	RC	139.5	14.9	10.1	3.2	M
P. mayeri	RC	100.0	15.5	12.0	2.7	M
Melomys lutillus	RC	95	12.0	12.7	2.5	F
M. platyops	RB	119.5	13.8	1.2	2.7	M
M. leucogaster	RC	112	130mm	120mm	35mm	M
Parahydromis asper	RC	390	270	222	53	M
Distoechurus pennatus	LC	42	115	135	17	F

Note: W: weight, HB: body length, TL: tail length, HF: hind foot, M: male, F: female, RC: roasted coconut, RB: ripe banana, SF: smoked fish, A: caught by local hunter

The survey team recorded at least 8 visits (traps were closed) during the trapping period in Yongsu site. Two traps baited with smoke fish that were set up in the garden's ground adjacent the secondary forest (under the tree) were broken and thus the animals could not be identified.

Only one mammal, the Short-furred dasyure (*Murexia longicaudata*), was captured at this particular site which was baited with smoked fish. This area was described as dense habitat with some *Pandanus* sp., moderate leaf litter and no ground cover. In the rainy season, this area is flooded. As cited by Flannery (1995), the Short-furred dasyure appears to be more abundant at lower elevations throughout the island of New Guinea.

The other four mammals (all rodents) were captured in the center of the garden, three of which were baited with roasted coconut and one with ripe banana. Shaw Mayer's *Pogonomelomys mayeri* was recorded in new localities from the mainland of New Guinea Island. Grassland Melomys *(Melomys lutillus*) has a very patchy distribution in the southern New Guinea (Flannery, 1995). This species was always reported in grassland areas, but the site it was captured at in Yongsu (garden plot) supported the fact that it also invaded old garden plots (Flannery, 1995).

Flannery (1995) noted that lowland *Melomys platyops* was primarily a terrestrial species, assumed to be present in the disturbed habitats. Our trapping results supported this when it was found in a garden described as "disturbed habitat." The garden in this study supported a variety of native and exotic crops, including *Ipomoea batatas*, *Manihot utilisima* and *Saccharum edule* and some fruit trees such as *Musa* sp. and *Papaya* sp.

At the Mamberamo site, two rodent species – the Waterside rat (*Parahydromis asper*) and the White-bellied Melomys (*Melomys leucogaster*) – were captured in the secondary forest relatively close to the stream, using roasted coconut as bait. The Waterside rat has a wide distribution across New Guinea from elevations ranging from 530m to 1,450m (Flannery, 1995) and usually inhabits stream banks, but it has also been found in forests in streamside vegetation (Menzies and Dennis, 1979). It has been categorized as an aquatic insectivore due its being constantly found in the vicinity of water.

The White-bellied Melomys was previously known only from southern New Guinea (Flannery, 1995). Therefore, our finding in Mamberamo suggests that this species also occurs in the northern part of New Guinea, and it was evident that the White-bellied Melomys has a wide distribution throughout the New Guinea Island.

One marsupial species, *Distoechurus pennatus*, captured by a local hunter using a traditional trap, was carrying embryos in her pouch. The collection of the Feathered-tailed possum (*Distoechurus pennatus*) in Mamberamo is important as it fills a wide gap in its known distribution in New Guinea and is one of few records for this species in Papua, particularly from the Indonesian part (Flannery, 1995).

This site was characterized by the presence of pioneer species such as *Macaranga mappa, Nauclea orientalis, Endospermum peltatum, Cananga odorata* and *Duabanga mollucana*. The area is used by the Dabra community for hunting and gathering activities (e.g., collecting forest products). The situation gave evidence that the forest at the study site has suffered from low to medium levels of disturbance. The riverbank is dominated by *Mitragyna speciosa, Planchonia cf. vallida, Leucosyke capitelata, Dracontomelon da'o, Homalium foetidum*, and *Croton* spp. (de Fretes *et al*., 2002).

Conclusions in relation to the catch results in both study sites, and the diversity of small mammals were as follows:

- Habitat modification had an effect, because the study sites had been converted to a garden location (Yongsu) and were utilized by local people for hunting and other extraction activities from the forest (Mamberamo).
- The animals' activities were limited because of the rainy season during our survey in Yongsu, and the smell of the baits did not carry well to the whole part of the study area.
- The territory and home ranges of small mammals were diverse among the species, particularly in the disturbed areas.

It was suggested to use a greater number and more suitable traps and longer trapping periods, as well as using more diversified baits (e.g. easily portable and longer lasting) in future studies. The studies should also be designed for different

seasons in order to see whether or not the capture rate is also influenced by the seasons.

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DISTRIBUTION, STATUS AND CONSERVATION OF BLACKBUCK (Antelope cervicapra) IN THE THAR DESERT OF RAJASTHAN (INDIA)

by Hemsingh Gehlot and Jakher G.R.

Introduction

The increasing trend of human population has been affecting the antelope numbers and distribution, principally through the gradual contraction of their grazing and foraging areas. Indian blackbucks were once dispersed locally throughout India wherever conditions were favorable (Jerdon, 1874), and their numbers may have once approximated four million (Groves, 1974). The Thar Desert is a zoologist's paradise with respect to the types of animal habitats and in the nature and man-animal relationship. The Thar Desert is the best potential habitat for Indian blackbuck (*Antelope cervicapra*) in Rajasthan. In the 1920s blackbucks were so abundant in the Thar region that if a gun was fired, one could joyfully watch

the fleeing blackbucks for an hour across the road (Prakash, 1977).

As a result of almost continuous hunting and poaching, and due to the gradual degradation of its preferred natural habitats, the present population of the Indian antelope may not be more than 4.6% of its earlier strength (Mukherjee, 1976). During the late 19th century, the Thar Desert, in the northwestern part of India, supported excellent mammalian faunal diversity (Blanford, 1888-91; Jerdon, 1874) due to low human density. The blackbuck is one of the most endangered mammals in the Indian subcontinent. Compared with the situation even a few decades ago, the present distribution of blackbuck in India is drastically reduced and the surviving populations are fragmented and usually very small. The blackbuck thrived in isolated pockets in western Rajasthan in or around closed areas or sanctuaries where *Bishnois* are populated, (Hall, 1936). Great changes have taken place in the landscape of the Thar in the last century. There has been a fast decline in the population of blackbuck around Jodhpur due to indiscriminate poaching and habitat loss.

Study area

The Thar Desert is situated in the west of the Aravali range and lies between 24° and 35°5' N and 70°7' and 76°2' E. The present human population of this arid region is 22.57 million and the density is 133 people/per km^2, making the Thar one of the most densely populated deserts in the world. Along with the human population increase, there has also been a steady increase in the presence of livestock and the present density is 145 animals/km^2.

The climate conditions of the intensive study areas of Jodhpur and Nagaur districts are typically hot and arid, characterized by extreme high and low temperatures during summer and winter, respectively. The other characteristics are high wind velocity (markedly in summer), low relative humidity and high evapo-transpiration exceeding the precipitation. January is the coldest month and the dry hot summer sets in after mid-March, continuing up to June, with the onset of the monsoon. Variation in rainfall from year to year is wide and failure of the monsoon is quite frequent. The study area falls under the arid zone where the annual rainfall varies between 200 to 400 mm and mainly occurs during the months of July to September. Rainfall is mainly restricted to the monsoon season.

The population of the cultivated land is low in the arid districts of Rajasthan. The intensity of cropping is low in the districts of Bikaner, Jaisalmer, Barmer and Jodhpur, which form the major part of the Indian Thar desert in Rajasthan. The cropping patterns of this region reveal the predominance of millets (such as *Bajra* and *Jowar)* and pulses. The Thar Desert supports good numbers of trees and shrub species. The thorny type of vegetation is the most dominant and consists of three series, namely: i) *Calligonum polygonoides-Clerodendrum phlomidis*; ii) *Prosopis-Capparis-Ziziphus*; and iii) *Acacia-Capparis*. Over 60 species of mammals have been recorded from this region of desert. Apart from ungulates like Indian gazelle (*Gazella bennetti*), Blackbuck (*Antelope cervicapra*) and nilgai or Bluebull (*Boselaphaus tragocamelus*), other wild animals in the are include wolf (*Canis lupus*), Indian Fox (*Vulpes bengalensis*), Desert fox (*Vulpes vulpes*) and Indian porcupine (*Hystirx indica*). Among the bird species Indian peafowl (*Pavo cristatus*) are found in this region.

Three sites, all supporting good blackbuck populations, were identified for detailed study of blackbuck. Out of the three, two sites, namely Guda Bishnoi II (in the closed area) and Surpura village (outside the closed area) near Mandore are in Jodhpur district, whereas the third one at Ren village in Jaroda was in the closed area of Nagaur district.

Material and methods

A 10x30x50 mm prismatic field binocular was used throughout the study for direct observations of the animals in the field. Scan and focal sampling methods were followed for recording various activities of the animals.

Line transect

The line transect method, as suggested by Anderson *et al* (1979) was followed for evaluation

of the population density of study animals inside and outside the study areas. Three line transects, of one km each, were randomly placed in each study site. The number of individuals and perpendicular sightings of the animals at a distance from the point were recorded.

Road transect

Road transects were marked 5 km to 20 km in length and observed from 2-or 4-wheel vehicles. Density was estimated according to Sale, Berkmullar (1988), and Rodgers (1991); in the behavioral study data was collected on *Ad Libitum* as per Altmann (1974), as well as by Scan and Focal sampling methods (Simpson and Simpson, 1977).

Results and discussion

The blackbuck in Western Rajasthan are restricted to limited pockets in Jodhpur, Nagaur, Bikaner and Churu districts; however, small numbers were also sighted in the adjoining areas of Pali and Barmer districts in the south and western parts of Jodhpur district. To discover the present distribution and abundance of blackbuck in 12 districts of western Rajasthan in the Thar Desert region and in selected study sites, several visits were made. Since the distribution of blackbuck is limited to some specific areas, the district-wise population density was not estimated in present study. However, the population density of blackbuck was estimated from only specific areas where they are present in good numbers.

During the study, the highest population density of 3.07 individuals/km^2 was found in Jodhpur district, followed by Nagaur district (2.33 individuals/km^2), which may be due to the availability of good habitat and protection from the local people. Furthermore, the population density of each intensive site was also estimated. The selected intensive study site of Ren village was supported with the highest numbers (11.71 individuals/km^2, whereas at the Guda bishnoi and Surpura sites it was comparatively low (9.6 and 5.15 individuals/km^2). Data obtained from the Wildlife Department of different closed areas of Jodhpur showed a higher density than the noted closed areas of Nagaur. The population of blackbucks in three closed areas during 1999 was 3,165 individuals, whereas in 2005 it fell to 2,186 as per census data obtained from the Forest Department. However, earlier, the population of blackbuck of Jodhpur district was estimated at 6,550 animals by Sharma (1982), whereas Ghosh and Goyal (1981) reported 12,000 animals in Jodhpur district. During 1981 in Gajner Sanctuary, the number of blackbuck recorded was 575, which dropped to only 82 in 1991 according to the Forest Department of Bikaner. Ojha and Ajay Kumar (1993) reported 100 individuals in Gajner Sanctuary. In Talchhapar Sanctuary of Churu district, the total number of blackbuck was 1,800 in 1986, but after four years they had decreased to 1,305 in 1990.

Some workers have conducted studies on the behavior, ecology and distribution of blackbuck in this region (Ajay Kumar, 1993; Rahamani, 1990; Goyal *et. al*., 1986; Ghosh *et. al.,* 1988; Krishnan, 1972; Kunhunu, 1989; Sharma, 1981; Groves, 1972). The decrease in populations of blackbuck may be due to the destruction of natural habitats such as scrub land areas, increases in human populations and livestock numbers, and increased hunting and poaching. On the other hand, some protected closed areas or sanctuaries are too small to meet the entire needs of the wildlife, and animals wandering outside in search of food come under increased hunting pressure (Seshadri, 1969). In addition, sanctuaries are often open to grass gathering, tree cutting and over-grazing by livestock.

Conservation

In Rajasthan, the blackbuck population density was once very high in comparison to the present day. This animal has been restricted to only sanctuaries and closed areas with very low population densities. The population of blackbucks declined in Jodhpur, Nagaur, Bikaner and Churu, where earlier they were plentiful. The blackbucks are now restricted to Bishnoi-dominant villages. An alarming increase of feral dogs in habitats of blackbuck has also caused heavy death tolls on this animal.

The following recommendations are made:

1. The favoured grassland habitats of the blackbuck must be conserved or protected

by State Government agencies with the cooperation of the local people.

2. The provisions of the Wildlife (Protection) Act should be strictly imposed against illegal hunting of these animals. The trials of wildlife poachers can be speeded up by creating separate fast track courts for these cases only.
3. Presently, these ungulates have hardly any natural predators of significance but feral/ pariah dogs probably account for more deaths of blackbuck and chinkara than any other creature after man. So, a proper action plan is needed to control the increasing numbers of feral dogs near habitats of the ungulates.
4. The rapid increase of the exotic *Prosopis juliflora* would convert the habitat to one with tree shrub cover which is less suitable for the blackbuck because it reduces the total productivity of the grass. Therefore, the spread of this exotic plant should be controlled because a high density of this plant helps feral dogs and other predators.

If appropriate steps for conservation are not immediately taken, then the blackbuck is likely to soon become extinct from Great Indian Thar Desert.

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PRIMATE SURVEY IN DRI RIVER VALLEY IN DEBANG WILDLIFE SANCTUARY, ARUNACHAL PRADESH, INDIA

by Dilip Chetry, Rekha Chetry, Kumud Ghosh, Druba Chetry

Introduction

The state of Arunachal Pradesh in northeast India occupies a unique place in the eastern Himalayas as a biodiversity hot spot because of its rich biodiversity. Different species of the taxon Primates form a major component of this biodiversity. Out of 15 primate species found in India, 7 species viz. Slow loris, Rhesus macaque, Assamese macaque, Stump-tailed macaque, Pigtail macaque, Capped langur and Western Hoolock gibbon are found in Arunachal Pradesh (Borang and Thapliyal, 1993; Chetry, 2002; Chetry *et al*., 2003a). Choudhury (2002) tentatively reported the occurrence of Pere David's macaque from this region. There is a report of another group of macaques from the state which is yet to be identified properly (Choudhury, 2002; Chetry, 2002; Chetry *et al*., 2003b). Mishra *et al*. (2004) and Sinha *et al*., (2005) reported a species of macaque from Tawang district of Arunachal Pradesh and have named it Tawang macaque/ Arunachal Macaque (*Macaca munzala*), which is new to science. Moreover, Das *et al.* (2006) reported the Eastern Hoolock gibbon (*Hoolock leuconedys)* in Lohit District. Including *Macaca munzala* and *Hoolock leuconedys,* the total number of primate species in Arunachal Pradesh rises up to 9. However, the taxon Primates still remains one of the least documented groups in various parts of the state. The primate diversity of the Debang Wildlife Sanctuary in the state is still unknown, as no scientific studies on primates have so far been conducted in this area, which is biogeographically linked with China and Myanmar. Therefore, a survey of primates was conducted in the sanctuary during 2005-2006. This report summarizes the observations made on the status of primates and the threats affecting the primate community and other wildlife of the area.

Study site

Debang Wildlife Sanctuary (4,149 km^2) is located in the Upper Debang Valley in the district of Arunachal Pradesh, India. The area is located in the Himalayan range at the junction of the eastern end of Arunachal Pradesh between 95°25'18" to 96°36'12" E longitude and 28°35'35" to 29°29'07"N latitude. The vegetation in the area is a mosaic of sub-tropical broad leaf forest,

Himalayan moist temperate forest, sub-alpine forest and alpine moist scrub forest.

Methods

Direct methods

A modified line transect method (Burnham *et al.,* 1980; NRC 1981, Struhsaker 1997, Indo-US Primate Project, 1995, Chetry *et al*., 2003a) was followed, depending upon the habitat and the forest condition. Transects were laid in a stratified random manner to cover all representative areas of the park (Mueller-Dombois *et al.,* 1974; Kent *et al*., 1994). Three observers walked randomly along existing forest trails and occasionally without forest tracts, covering an average of 10-15 km per day. The walk transect was initiated in the morning and terminated in the evening. The observers would walk slowly through the transect, pausing at regular intervals of 500 m. Upon sighting primates, the group structure and individual details such as age, sex and the number of individuals were recorded. Sightings and signs of other wild animals were also recorded.

Indirect methods

The presence of primates was also recorded from indirect sources such as grunts, branch shaking, sounds associated with locomotion and feeding, etc. All such indications were used to trace the animals. Secondary information was gathered through interviews with the local people from the fringe areas.

Results and discussion

The survey was carried out mainly in the Dri river valley and its adjacent areas. The current study confirms the occurrence of 4 species in the surveyed part of the sanctuary. Rhesus macaque (*Macaca mulatta*), Assamese macaque (*Macaca assamensis*) and another macaque that could not properly identified were sighted directly, while presence of slow loris (*Nycticebus bengalensis*) was confirmed on the basis of indirect information. The sighting rate is very low and animals were found to be very shy. Moreover, they were highly sensitive to the presence of humans, even at a distance, and fled at the slightest pretext. Not a single call of gibbon was heard during the survey period. There was no indication of occurrence of Hoolock gibbon from indirect records. Similarly, for capped langur there were also neither direct sightings nor indirect clues.

Altitudinal records were maintained during the survey for every direct sighting. The study records the distribution of primates from 1,700 m asl to 1,814 m asl.

Besides non-human primates, the area supports a high mammalian diversity and the study confirmed the presence of 27 mammal species. Avifaunal diversity is also high and important bird species include Red breasted hill partridge (*Arborophila mandellii*), Blyth's tragopan (*Tragopan blythii*), Sclater's monal (*Lophophorous sclateri*), Beautiful nuthatch (*Sitta formosa*), Ward's Tragon (*Harpactus wardi*) and Khalij pheasant (*Lophura leucomelana*).

Hunting was identified to be the pre-eminent threat factor to primates and other wildlife in the study site. Animals are hunted mainly for meat, skin, teeth, feathers and beaks, which are used as a part of traditional dress. Bears (*Ursus thibetanus*) are hunted mainly for their gall bladder, teeth and skin. Another major sought after species is Musk deer (*Moschus moschiferus*), which is killed for the musk pods. It has the highest demand in the illegal wildlife market. People from all age groups hunt – teenagers, youths, middle-aged men and women. Hunting is mainly carried out with firearms (guns) but other traditional techniques (traps) are also in use. Recently, the hunters and poachers in this remote corner have established links with the international network of illegal trade in wildlife products. The problem of hunting has become aggravated due to the increase in the human population in the fringe area of the sanctuary. At the same time, the issuing of more gun licenses has emerged as a great threat to the wildlife population. If this trend continues, then the larger mammals will be in more danger in coming years. Indiscriminate and widespread hunting may be a possible explanation for the lower sighting rate of primates in the sanctuary. The condition may be different in other areas of the sanctuary which are yet to be covered. Trans-boundary hunting is another threat to the wildlife of the sanctuary. Every year at least 20-25 hunters cross the China border to the Indian side to hunt musk

deer. This is an alarming situation and needs timely intervention from the concerned authorities. Loop holes in the administrative system also add to the problem of conservation. A distinct boundary demarcation for the sanctuary is still lacking and there is not even a sign board displaying the name and area of the sanctuary. A communication gap between the administration and local communities is also creating problems. People in the fringe areas still feel the sanctuary is land that they have inherited from their ancestors. The majority of the people (96%) at Anini (District Headquarters) do not even know that the area has been declared a sanctuary. The sanctuary does not have a sufficient number of staff to carry out regular patrolling duties and the vast boundary of the sanctuary is yet to be brought under the patrolling network. Jhum cultivation (slash and burn shifting cultivation) in the fringe areas is a major factor in the loss of habitat.

Conclusion

The threat to the habitat and the wildlife in Debang Wildlife Sanctuary needs careful handling as the problems are intricately associated with the tribes and cultural prospectus and their understanding about the wildlife and its habitat. The police and the Forest Department should take care to strictly implement the Wildlife Protection Act, 1972. The setting up of anti-poaching and monitoring camps at strategic sites in each of the fringe areas may be helpful in reducing illegal activities. Recruitment of additional staff is an urgent need. Better infrastructural facilities such as vehicles, motorbikes and modern firearms should be provided to the field staff. Conservation education and public awareness programs should be conducted in all the educational institutions as well as at the community level in the district where the protected area exists. Further surveys for primates and other mammals should be carried out in the near future to collect detailed data on the species and habitats covering all areas of the sanctuary. It is essential to develop a better understanding of the diverse aspects of the sanctuary in order to formulate an effective conservation action plan.

Table 1: Primates of Debang Wildlife Sanctuary

Common name	Species	Sighting	Remarks
Assamese macaque	*Macaca assamensis*	Direct	Very Shy &Rare
???	*Macaca?*	Direct	Very Shy &Rare
Rhesus macaque	*Macaca mulatta*	Direct	Very Shy &Rare
Slow loris	*Nycticebus bengalensis*	Indirect	Yet to be find out
Capped langur	*Trachypithecus pileatus*	No sightings	?
Hoolock gibbon	*Hoolock hoolock*	No sightings/No calls	Absent

Table 2: List of Mammals recorded during the survey:

Sl No.	Common Name	Scientific Name	Sl No	Common Name	Scientific Name
1	Tiger	*Panthera tigris*	15	Sambar	*Cervus unicolor*
2	Leopard	*Panthera pardus*	16	Goral	*Nemorhaedus goral*
3	Clouded leopard	*Neofelis nebulosa*	17	Serow	*Capricornis sumatraensis*
4	Snow leopard	*Panthera uncia*	18	Takin	*Budorcas taxicolor*
5	Leopard cat	*Felis bengalensis*	19	Himalayan tahr	*Hemitragus jemlahicus*
6	Jungle cat	*Felis chaus*	20	Wild boar	*Sus scrofa*
7	Wild dog	*Cuon alpinus*	21	Large Indian civet	*Viverra zibetha*
8	Jackal	*Canis aureus*	22	Small Indian civet	*Viverra indica*
9	Red panda	*Ailurus fulgens*	23	Indian porcupine	*Hystrix indica*
10	Himalayan black bear	*Ursus thibetanus*	24	Pangolin	*Manis crassicaudata*
11	Binturong	*Arctctis binturong*	25	Common mongoose	*Herpestes edwardsi*
12	Gaur	*Bos gaurus*	26	Indian fox	*Vulpes bengalensis*
13	Musk deer	*Moschus moschiferus*	27	Jungle rat	
14	Barking deer	*Muntiacus muntjak*			

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STUDY ON THE PHYSIOGRAPHY AND BIODIVERSITY OF CHURDHAR WILDIFE SANCTUARY OF HIMACHAL HIMALAYAS, INDIA

by Anil K. Choudhary, Punam, Parveen K. Sharma and Suman Chandel

Introduction

Himachal Pradesh is a hill province of India which is situated in the northwestern Himalayas. Churdhar Wildlife Sanctuary is situated in the higher Himalayan region of Sirmour and Shimla Districts of Himachal Pradesh. The area lies between 30º48'37" to 30º54'39" north latitude and 77º23'32" to 77º29'49" east longitude. Churdhar Wildlife Sanctuary is endowed with a rich biodiversity including higher plants, grasses, shrubs, medicinal, aromatic and dye plants, as well as a variety of wildlife. Churdhar and Nauradhar fall within the boundary of Churdhar Wildlife Sanctuary. Nauradhar, the headquarters of Churdhar Wildlife Sanctuary, is situated on the Rajgarh-Haripurdhar motor road in Sirmour district and is covered with dense pine forests. Nauradhar is situated in the lower vicinity of Chur Peak (Churdhar). Chur Peak is the highest point in the Churdhar Wildlife Sanctuary (3,647 m). Churdhar comprises the reserve and demarcated protected forests and other areas of Sirmour and Shimla districts around the Chur Peak presently known as Churdhar Wildlife Sanctuary under the Nohra wildlife range.

Materials and methods

Information about Churdhar Wildlife sanctuary was gathered from the concerned forest officials, revenue officials, local village panchayats, local

inhabitants and personal visits to the study area. Information regarding geographic features, agro-climatic conditions, flora and fauna as well as management issues of this wildlife sanctuary was systematically collected through surveys in the study area.

Significance of Churdhar Wildlife Sanctuary

The focal point of the sanctuary is the famous Chureshwar Mahadev temple, which is located near Chur Peak in the heart of the sanctuary. The residents of Sirmour, Chopal and Jubbal area consider it a main deity. Many people visit Churdhar temple all the year around, except when it is covered with snow from December to April. The altitude of Churdhar Wildlife Sanctuary ranges between 2,000-3,647 m. The area falls in the upper Himalayan region and supports a rich variety of flora in the form of oaks, spruce, fir forests and alpine pastures and a large variety of herbs. This sanctuary is home to a variety of wildlife of the Himalayan region.

Results and discussion

Based on the intensive surveying of the study area as well as secondary information collected from concerned forest officials, revenue officials, village panchayats, local inhabitants and personal visits, the following information has been collected from Churdhar Wildlife Sanctuary:

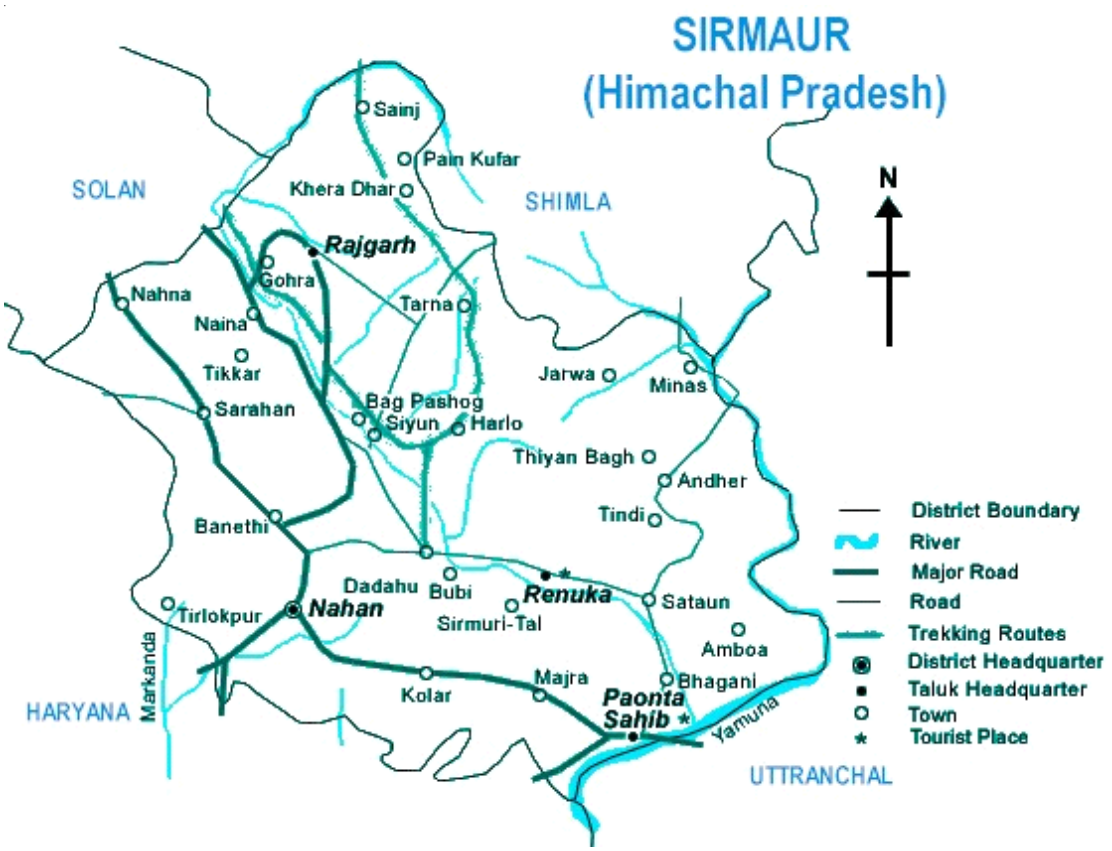

Fig. 1: Map of Sirmour district showing Churdhar Wildlife Sanctuary.

Geology

Physiologically, the tract forms part of the lesser Himalayan zone, which varies in altitude from 900 m to 3,000 m. The major rock formations include Chur granite and Jutogh formation. Chur granite consists of coarse granite to prophysitic and granetiferous granites and gneiss. It is exposed along the Chur. Soil resulting from granite terrain is clayey loam and it supports fir, spruce forests and alpine pastures. Jutogh formation is exposed around Chur peak and extends to Nohra. The formation consists of carbonaceous schist, phyllitic with hands of carbonaceous limestone. It supports deep mica ions clayey loam soils, which are fertile and support dense oak, fir and spruce forests. The terrain ranges from moderate towards the northern aspect to very steep towards the southern aspect.

The soil is clayey loam to loam, with the depth usually varying with the slope. Well developed soil profiles are found only at the higher reaches under spruce and fir forests. The soil on ridges, spurs, precipitous slopes and southern aspects tends to be shallow and dry. On easier slopes and in sheltered places it is deep, fertile and moist enough to support tree growth. The lower areas devoid of tree cover suffer from intense erosion. In spruce and fir forests, heavy accumulations of raw humus are a characteristic feature and constitute the main inhibiting factor to their natural regeneration.

The tract lies between the sub-tropical and temperate zones. The average annual rainfall is about 1,200 mm, 75% of which is received from south-west monsoons. The south-west monsoons usually begin by the end of June and last until the end of September. The area receives snow during the south-east monsoons in mid-December until March in the higher elevations, decreasing with the elevation. The lower reaches receive only rain. Summers are pleasant with mild temperatures. Winters experience erratic temperature variations, even dropping below freezing point for considerable periods. Some peaks above 3,000 m have an alpine climate. Frost is experienced from November until March and the intensity varies with the altitude.

The tract drains into the Giri and Tons rivers through smaller streams which are snow-fed for most of the year, and by perennial springs coming from vast stretches of forests. The water supply for local habitations in the tract is adequate except in the summer months. Agriculture lands in the tract are mostly rain-fed, except at lower elevations where kuhls have been drawn from adjoining nallahs for irrigation. The water supply for the inhabitants of the region has been arranged through water supply schemes with proper water management so that the irrigation and drinking water requirements of the tract can be fully met.

Wildlife of Churdhar Wildlife Sanctuary

According to the local inhabitants, the area was very rich in wildlife up to the recent past. The spruce, fir and kharsu forests were rich in musk deer, serow, panther, monal pheasant and tragopan. Now, musk deer and tragopan have become almost extinct. The lower areas were rich in black bear, goral, barking deer, koklash, kalij, chakor, partridges and red jungle fowl. However, the population of these animals and birds is much reduced at present. There has been some improvement in the control of illegal hunting and poaching since the area was transferred to the Wildlife Wing in 1987.

The rich variety of flora and wide variation in altitude supports a variety of fauna which is typical of the higher Himalayan region, including Himalayan black bear, Himalayan goat or Goral (*Nemorhaedus goral*), Musk Deer (*Moschus moschiferus*), Barking Deer (*Muntiacus muntjak*), Koklass (*Pucrasia macrolopha*), Red Jungle fowl (Gallus gallus), Hill partridge (Arborophila spp.), Rock partridge (*Alectoris graeca*), Snow partridge (*Lerwa lerwa*), Wedge-tailed pigeon (*Treron sphenura*) and Himalyan pit viper (*Agkistrodon himalayanus*).

Threats to Wildlife

Some of the major threats to the wildlife of Churdhar wildlife sanctuary are described below:

- Frequent wild animal hunting for fur, meat and other economic benefits is causing a major threat of extinction of the target animals and should be stopped with legal enforcement.
- Competition for food by the livestock of migratory and local graziers is a major threat to the wildlife in the area.

- Fires, though common in the area, should be checked and controlled by adopting strict fire protection measures.
- Adequate forest cover for providing shelter to wildlife should be maintained in the area by planting wherever necessary.

Flora of Churdhar Wildlife Sanctuary:

According to revised survey of forest types of India by Champion and Seth, the forests of this sanctuary can be classified into two major groups, i.e., Himalayan moist temperate forests and moist alpine scrub.

Table 1: Forest types and plant biodiversity of Churdhar Wildlife Sanctuary

	Forest type	Height (m)	Plant Biodiversity
1	Moru Oak forests	2000- 2500	*Quercus dilatata, Quercus incana*
2	Moist temperature deciduous forests	1800-2780	*Aesculus indica*, *Cornus capitata*, *Quercus* spp., *Betula alnoides*, *Juglans regia*
3	Kharsu oak Forests	2500-3300	*Abies pindrow*, *Picea smithiana*, *Betula alnoides* and *Taxus baccata*. The undergrowth is moderate comprising of species of *Viburnum*, *Cotoneaster*, *Sarcococca*, *Salix*, *Geranium*, *Viola*, *Anemone*, *Skimmia lanceolata*, ferns and grasses
4	West Himalayan upper oak-Fir Forests	2600-3400	*Abies pindrow*, *Quercus semecarpifolia*, *Betula alnoides*, *Rhododendron* spp., *Salix elegans*, *Skimmia lanceolata*, *Rumex nepalensis*, *Lonicera angustifolia*, ferns and grasses
5	Moist Alpine Scrub	2600-3300	*Rhododendron anthopogon*, *Salix* sp., *Potentilla argyrophylla*, Rosa sericea, *Anemone* sp.
6	Dwarf Rhododendron Scrub Forest	2950-3647	*Rhododendron* sp., *Salix* sp. and *Lonicera* sp.

Plants of traditional importance from Churdhar

Churdhar Wildlife Sanctuary is a rich repository of medicinal and aromatic plants, but many of the species are at the verge of extinction due to unscientific extraction and over-exploitation, both in the past and at present (Chauhan, 1999). Some of the plants of the area having traditional importance are listed below.

Table 2: Plants of traditional importance from Churdhar

Scientific name	Medicinal and aromatic use
Aconitum heterophyllum	Roots are used to treat hysteria, throat infections, dyspepsia and vomiting, abdominal pain and diabetes. The leaves and the extract from roots are used to cure malaria.
Acorus calamus	Juice of leaves used to relieve malarial fever. Rhizomes are often used to check the chest pain caused by severe colds, both in human beings and cattle. The decoction of leaves is also used to cure fever.
Allium govanianum	The whole plant is used as a spice/condiment and flavoring agent. Leaves and the underground part are used in cooking for flavoring and as a substitute for onion.

Angelica glauca	The root powder is used for flavoring dishes. Use as a spice is very common in cooking pulses.
Arisaema flavum	Bulbs of this plant are ground up and applied to raised blisters.
Artemisia vulgaris	The leaves of the plant are crushed and the paste is applied to cuts and wounds to check bleeding. The wound is covered with a cloth and after few minutes the bleeding stops. Healing starts after two to three days.
Bergenia ciliata	People use the herb for the removal of kidney stones. The rhizome of the herb is crushed and mixed with sugar or jaggery and the paste is fed to the person suffering from diarrhea. Also used to cure cough and cold.
Betula utilis	The decoction made of the bark is used to cure jaundice.
Boenninghausenia albiflora	The use of plant as an insect repellent is very common among the people of this area. The entire aerial part is used to kill lice, fleas and other insects.
Cedrus deodara	The wood of the tree is used to extract the cedrus oil. The oil is used as an effective insect repellent in cattle and especially in goats and sheep.
Cotoneaster microphylla	The bright red fruits are eaten. The pulp is used to prepare chutney and jams.
Dactylorhiza hatagirea	The roots are used as a nerve tonic and an aphrodisiac. In the Unani system of medicines, it is used for seminal debility, chronic diarrhoea and general weakness in women after childbirth.
Dioscorea deltoidea	Rhizomes are used as fish poison and to kill lice. Women use it as a shampoo.
Fagopyrum esculentum	The seeds are used to make flour, which is especially used during winters as a staple food. During winters, in intense cold conditions, the roti made of flour is preferred because it provides internal heat. Also used to treat acute diarrhoea in humans as well as cattle.
Juniperus recurva	People regard the plant as a repellent of evil spirits. The twigs are also used as essence and commonly used in Havan.
Jurinea dolomiaea	The aromatic roots are used as incense and form a chief ingredient of the dhoop industry. The roots are considered a stimulant and given for fever after childbirth.
Leucas lanata	Tender shoots are used as a vegetable; also fried and given to treat coughs.
Mentha longifolia	The leaves are used as a cure for vomiting, headache. The leaves are chewed in case of prolonged indigestion. Leaves are also commonly used to make chutney.
Picrorhiza kurroa	The roots of the herb are used to treat influenza and diarrhoea in humans and animals.
Plantago depressa	Seed paste is used to check dysentery.

Pleurospermum brunonis	The plant is a spice and flavoring agent. The shoots are dried and powdered and used in cooking.
Podophyllum hexandrum	Recently it has acquired importance because of its possible use in controlling some forms of cancer. Fruits are edible.
Rheum moorcroftianum	Roots are valued as a purgative. Roots are also used for dying woolen clothes (since it contains tannins).
Rhododendron arboreum	The juice of the flower is used to cure dysentery and diarrhoea and nosebleeds.
Rumex nepalensis	Infusion of leaves is given to treat colic and is also applied to syphilitic ulcers. Leaves are rubbed on the affected parts for the relief from irritation caused by stinging nettles (Urtica dioica).
Selinum vaginatum	Roots are used as a nervine sedative. Roots yield an essential oil having hypotensive, sedative and analgesic properties. Also employed as incense.
Swertia chirata	In Indian medicines, chirata is prescribed in a variety of forms and combinations to treat chronic fevers and anaemia. It has a reputation as a remedy for bronchial asthma and liver disorders.
Swertia purpurascens	The leaf extract is given to persons suffering from malarial fever.
Thymus serpyllum	The flowering tops and the leaves are used to cure stomach ache. Two to three flowering tops are boiled with tea and consumed to relieve pain. Flowers are used to flavor the drinks.
Valeriana jatamansi	The rhizomes and the roots of the herb are used to treat hysteria. Also the plant juice is used against the sting of honeybee and scorpion bites.
Viola serpens	The decoction is given to persons suffering from sore throat, cold, inflamed tonsils and prolonged irritation.

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