PRIMATES OF BANGLADESH: A PRELIMINARY SURVEY OF POPULATION AND HABITAT

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ABSTRACT

The distribution and abundance of non-human primates in Bangladesh is presented. Roadside and forest surveys were conducted throughout the alluvial floodplains and hill regions of Sylhet, Chittagong, and Cox's Bazar. In forests, walking and vehicle transects were used to census primates. The ecology and status of major habitat types are discussed. Forest primate populations are evaluated according to habitat classification. I estimate a minimum of 140,000 *non-human primates in Bangladesh. Factors contributing to this low population are discussed.*

INTRODUCTION

This paper presents preliminary information on the status of primate populations in Bangladesh. Information pertaining to the primate distribution and taxonomy is meagre (Blanford, 1888; Finn, 1929; Pocock, 1939; Ellerman & Morrison-Scott, 1951; Prater, 1965; Mountford, 1968; Husain, 1974; Roonwal & Mohnot, 1977). Non-human primates found in Bangladesh are listed in Table 1. With the exception of *Macaca mulatta*, the rhesus macaque, these animals are primarily forest dwellers. Although there is no record of *M. arctoides* nor *M. nemestrina* from Bangladesh, these two species are found in bordering regions of Burma and India (Fooden, 1975, 1976). It is likely that both of these species occur in the Chittagong Hill Tracts (Fig. 1).

South Asia is a major source of rhesus monkeys for the biomedical and research

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institutions in the United States and Europe. However, recent political changes have resulted in a significant decrease of rhesus monkey exports from India, acting as a catalyst for exploration of an alternate source of supply.

TABLE 1
NON-HUMAN PRIMATES OF BANGLADESH

Family	*Genus and species*	*Common English name*	*Common local names*
Lorisidae	*Nycticebus coucang*	Slow loris	
Cercopithecidae	*Macaca mulatta*	Rhesus macaque	banar, bondur, bandur
	Macaca assamensis	Assamese macaque	
	Macaca nemestrina	Pigtail macaque	
	Macaca arctoides	Stumptail macaque	
	Presbytis pileatus	Capped langur	Hanuman-lal, black face, long tail
	Presbytis phayrei	Phayre's leaf monkey	Hanuman-kala
Hylobatidae	*Hylobates hoolock*	Hoolock gibbon	Uluck, bonmanas

Bangladesh, formerly East Pakistan, had officially prohibited export of endemic primate species, including the rhesus, under provisions of the Bangladesh Wild Life Preservation Order of 1973 (Anon., 1973*b*). However, a recent 1975 amendment to this legislation permits a quota for *M. mulatta*, under supervision of the Ministry of Forest, Fisheries and Livestock. Official US Department of Commerce statistics indicate, nonetheless, that Bangladesh has supplied the following numbers of primates to the US: 1972, 50; 1973, 515; 1974, 340; 1975, 53; and 1976, 1071.

Forest destruction and alteration by land clearing is a serious problem in Bangladesh, which is one of the most crowded and densely populated nations in the world (Johnson, 1975). There is at present little, if any, indication of a reduction in its high rate of population growth. At the 1961 census, Bangladesh (E. Pakistan) had a population of 50·8 million, compared with 42·1 million in 1951. The 1974 census population estimate is 76 million people, representing an annual growth rate of slightly more than 3%.

Social, cultural, and religious attitudes influencing primate populations in India (Southwick *et al.*, 1961*a*, 1961*b*, 1964; Southwick & Siddiqi, 1968; Singh, 1969) are applicable to Bangladesh. Both the rhesus and langur have a special reverence among the Hindus as a sacred image of Hanuman, the monkey-god warrior in tales of the Ramayana, but Bangladesh, unlike India, is primarily an Islamic nation and Muslims have no religious sanctity for monkeys. At partition in 1947, it was estimated that the population of East Bengal included 29% Hindus, which has gradually declined to approximately 15%. Hence, any measure of protection accorded to the rhesus, as well as langur, as a result of Hindu religious attitudes has probably declined significantly. The rhesus macaque, particularly, is a serious agricultural pest, but no data are available determining amounts of rice damaged.

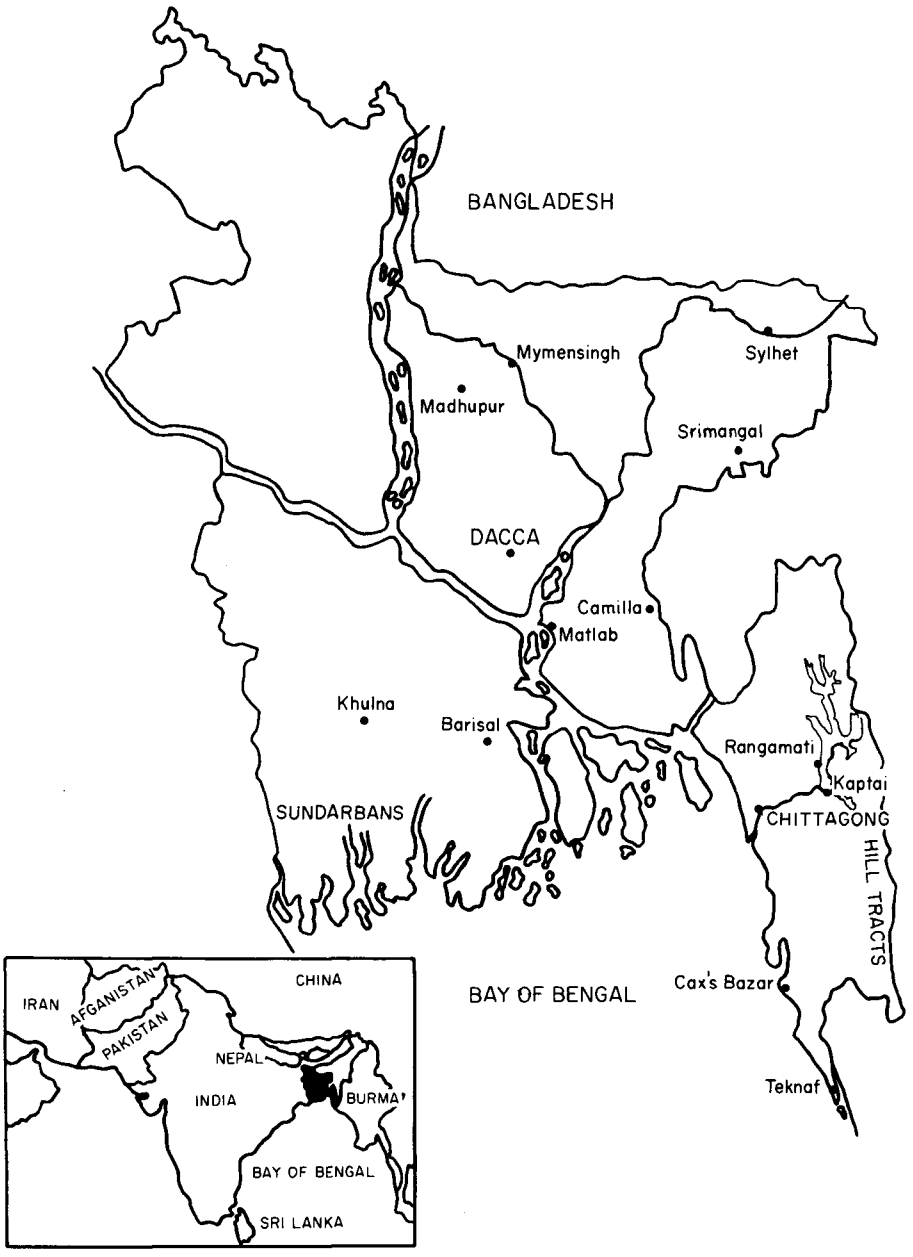

Fig. 1. Map of Bangladesh.

STUDY AREAS

Bangladesh stretches over 88,698 km^2 extending from 20° to 26° north latitude and 88° to 92° east longitude (Fig. 1). The maximum length is 648 km from north to the southern tip of the Teknaf peninsula; the maximum width is 480 km.

The climate is tropical monsoon, having moderately high temperatures for about eight months of the year, April to November. The mean annual rainfall has a range extending from under 1500 mm in the west to over 3000 mm in Sylhet and southern Chittagong. There is a significant demarcation of rainfall between the dry season months (November–March) and the monsoon months of May through September. The yearly daylight temperature ranges from 32–35 °C to 20 °C in the cooler months of December and January.

The country may be divided into two main topographic divisions, (1) the vast alluvial plain, and (2) the marginal hills in the east and southwest. More than 90 % of the total area of Bangladesh is lowland alluvial deposits of the Ganges, Brahmaputra, and the Meghna Rivers, which traverse the country primarily in a southerly direction to reach the Bay of Bengal.

In the districts of Chittagong, the Chittagong Hill Tracts, and to a minor extent in Sylhet, the plains rise to steeper hill country. These hill formations are mainly sandstones, sandy clays, shales, and siltstones, which form a north–south chain of parallel ridges. These sedimentary deposits range in age from the Miocene to the Pleistocene. Several rivers traverse the ridges, most notably the Karnuphuli, which originates further east in the Indian state of Assam. The gradient of the hill country rivers is slight, with surrounding slopes rising sharply to steep ridge crests of 300 m. The highest peak of Bangladesh is 1003 m and lies in the Hill Tracts on the Burma border. These Hill Tracts extend northwards into Tripura State (India) from which the range projects into the Sylhet plains where ridges are of lower relief.

Forest areas

Most sources quote the forest area of Bangladesh to be about 21,756 km or 16 % of the country (Ahmed, 1968; Anon., 1976), but the actual amount of forest is considerably less. Forest Department statistics and reports (Chowdhury, 1968, 1973; Anon., 1969, 1970, 1973*a*, 1974, 1976; Baten, 1969; Chaudhury, 1969) are included in Table 2.

Because of the great land demand for agricultural production, most of the original reed swamp vegetation in the fertile alluvial plain, which has been long ago removed, today yields to endless paddy fields, dotted with thousands of human settlements. Evidence indicates that forest never existed throughout most of these flood-plains (UNDP-FAO, 1971). Today forest areas are restricted to the lowland mangrove forests in the southwest and higher land areas (Fig. 2).

The Sundarban mangrove forest extends into West Bengal (India) with an

estimated 6063 km^2 in Bangladesh. This forest was declared a reserve in 1875 and, at the advent of British rule, the forests were reported to be double their present extent (Ahmed, 1968). The net land area of the forest comprises 4071 km^2 and is a vast deltic swamp, not more than 2 m above sea level. It is intersected by a network of numerous rivers and channels. The soil is of recent formation, consisting of alluvial sand and clay deposits. Alternate flooding at high tide and drainage during the ebb continuously flushes the area with saline or slightly brackish water. Towards the south the forest faces the Bay of Bengal.

TABLE 2
FOREST RESERVE AREAS AND EQUIVALENT FOREST

Location[a]		*Total area*[b] (km^2)	*Actual forest* (km^2)	*Reduction factor*	*Equivalent forest*
Dacca-Tangail		699	337[c]	50%	168
Sylhet	RF	389	777[d]	50%	389
	AF	114			
	USF	319			
Chittagong	RF	847	847[e]	50%	414
	PF	272	272		272
Sangoo	RF	332	332		332
Cox's Bazar	RF	1075	1075[f]	50%	660
	PF	124	124		
Chittagong HT North	RF	1652	1401[g]		1401
	USF	1730	1730	50%	865
Chittagong HT South	RF	821	821[h]		821
	USF	8793	8793	50%	4395
Sundarbans		5771	4071[i]		4071
				Total equivalent forest	13788

[a] Code: (RF) = Reserve forest, (AF) = Acquired forest, (USF) = Unclassed estate forest, (PF) = Protected forest.
[b] Anon. (1976).
[c] Chowdhury (1973).
[d] Anon. (1970).
[e] Baten (1969).
[f] Chaudhury (1969).
[g] Anon. (1974).
[h] Anon. (1973*a*).
[i] Chowdhury (1968).

The vegetation is primarily a mangrove forest community, with other semi-tidal, saline, adapted species. The predominant tree species is 'sundri' (*Heritiera minor*) which forms mixed stands with varying quantities of 'gewa' (*Excoecaria agallocha*). Other important tree species are: goran (*Ceriops roxburghiana*), baca (*Aricennia officianalis*), amur (*Amoora cuculata*), keora (*Sonneratia apetala*), kankra (*Bruguiera gynohiza*), dhundal (*Carpa abouata*), and the palm, golpata (*Nipa fruticans*).

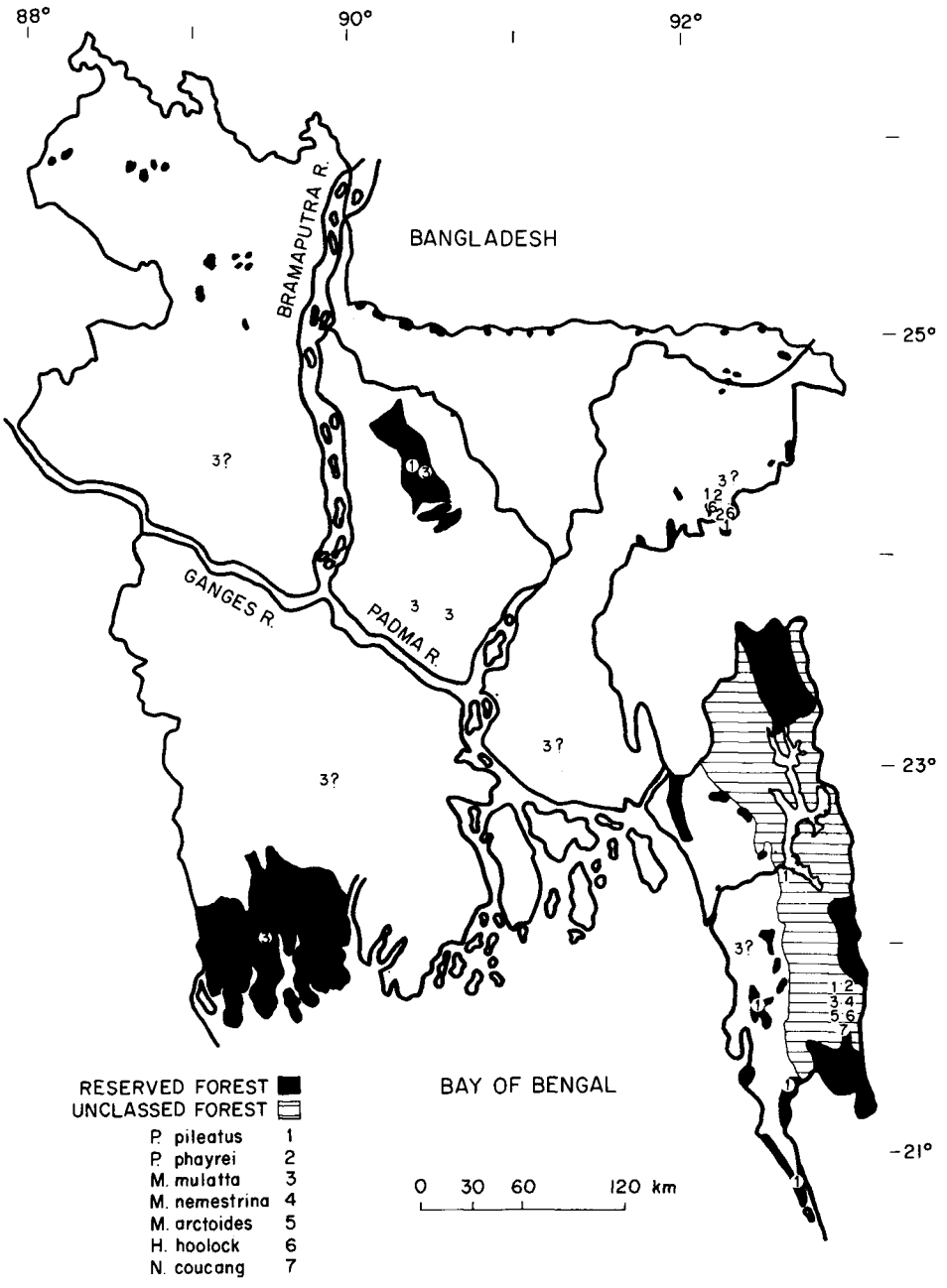

Fig. 2. The distribution of primate species and forests in Bangladesh.

Technically, the Sundarban is a reserve area and no permanent settlements are permitted except for forest guards and woodcutters who supply primarily *E. agallocha* to the large Khulna newsprint factory.

The Chittagong Hill Tracts is an extensively hilly region bordered on the north by Tripura State (India), on the south by Akhyab (Burma), on the east by the Lushai hills (India) and on the west by Chittagong district. Hills, ravines, and cliffs running north and south cover the region. Soil of the area is composed primarily of rich loam and clays. The soil base, when void of vegetative cover, and exposed to repeated clearance, burning and rains, is highly vulnerable to rapid erosion. The Chakmas and Moghs are the predominant ethnic hill tribes. These people practise shifting or slash and burn agriculture, locally referred to as 'jhuming'.

These forests may be broadly classified as (1) tropical evergreen, (2) tropical semi-evergreen, and (3) deciduous (Champion & Seth, 1968; Puri, 1960). The forest consists of numerous tree species, with the crowns of the taller trees, in excess of 40 m, forming a closed canopy blocking sunlight from a major portion of the undergrowth of shrubs, small palms, and numerous seedlings. Climbers and epiphytes are also present in large numbers. The most widely distributed genus is *Dipterocarpus*, which is found throughout Southeast Asia.

The important taller tree species are garjan (*Dipterocarpus* spp.), chaplish (*Artocarpus chaplasa*), telsur (*Hopea odorata*), civit (*Swintonia floribunda*), pitraj (*Appanamixis polystachya*), buddha narikal (*Sterygota alata*), gutgutia (*Bursera serrata*), toon (*Cedrela toona*), and jam (*Syzygium* spp.). Numerous second story and understory species are present with the canes (*Calamus* spp.) and bamboos prevalent. Areas of predominantly bamboo brakes are common, consisting of the following species: mulibas (*Bambusa tulila*), dolu bas (*Teinostachyum dulloa*), orah bas (*Dendrocalamus longispathus*) and kalicheri bas (*Oxytenanthera* spp.).

Silviculture was initiated in the Hill Tracts as well as several other forest areas during the latter part of the 19th century. Teak (*Tectonia grandis*) is the major plantation species, as well as mahogany (*Swietenia macrophylla* and *S. mahogoni*), and garjan (*Dipterocarpus turbinatus*). It is reported that significant sectors of reserve forest areas containing relatively undisturbed primary forest are being cleared to plant teak.

The Hill Tracts also contain the only sites for hydroelectric development in Bangladesh. The Karnuphuli Power Station was built on the Karnuphuli River in 1956–58 creating a lake 658 km^2 which flooded the valley lands of approximately 90,000 tribal people. This project, unfortunately, eliminated some of the most fertile and productive valley lands in the region. As a result many of these people migrated and cultivated previously undisturbed forest in the Hill Tracts. Furthermore, a large paper mill at Chandragona, 16 km south of the Kaptai dam, utilises large quantities of lumber, primarily bamboo from the Hill Tracts.

To the north, east, and south of Chittagong city, lie several ranges of hills. Jhuming has reduced the virgin forests to secondary re-growth and in many areas

because of over-cutting, dry scrub or grass remains as the only vegetative cover on the slopes. A most dramatic illustration of the result of such consequences can be observed at the Sitakund range near Chittagong University where the absence of good vegetative cover results in serious erosion problems. The majority of these hill regions were found to exhibit similar features.

The Teknaf range south of Cox's Bazar, with cliff faces 50–100 m high that abruptly meet the beach, has continuous forest. Much of the larger, valuable timber trees have been selectively logged in several areas and bamboos form impermeable thickets. There appears to be a strong floral affinity to the Hill Tracts, with primarily mixed evergreen and deciduous trees.

The district of Sylhet is a broad and level valley bounded on the east, south and north by hills. To the north, in Indian territory, lies the Khasi and Jainta Hills. In southern Sylhet, the lower slopes and valleys grow most of Bangladesh's tea crop. Tea planting was introduced into Bangladesh in the 1870s by the British, and today about 43,000 ha of tea (*Camelia sinensis*) are cultivated in 147 gardens.

Forest reserves are distributed throughout the region with an aggregate area of approximately 777 km^2. Previous to declaration of the reserves in 1914, much forest was jhumed and sugarcane (*Saccharum officinarum*) was cultivated.

Most of the tea plantations surveyed had certain portions of land under rice cultivation, with patches of sun grass (*Imperata* spp.) and forest (Fig. 3). The status of these forests varies from low-stature bamboo to moderately disturbed tall semi-deciduous forest. For example, the Finley Tea Holding, consisting of several divisions in Sylhet, near Srimangel, has 9280 ha of tea and 1320 ha of forest reserve. Large deciduous species prevalent in the Sylhet region include garjan (*Dipterocarpus turbinatus*), tula (*Tetrameles nudiflora*), hargoja (*Dillenia penagyna*), simul (*Salmalia malabarica* and *S. insignii*), and koroi (*Albizzia* spp.). Associated evergreen species are cham (*Artocarpus chaplasha*), jam (*Eugenia* spp.), sutrong (*Loptopetalum fimbriatum*) and ramdala (*Duabanga sonneratoides*).

A sector of land, the Madhupur Tract, elevated 18–30 m above the alluvial plains, measuring 112 km long, north to south, and 8–21 km wide east to west, is situated north of Dacca. This tract is composed of red soil and low-lateral laterites, conditions that support the growth of sal (*Shorea robusta*) forests. These tracts are composed of many interconnected forest blocks and strips, interspersed with numerous depressions called 'baids' and higher land supporting human dwellings and other agricultural plots. These baids are easily flooded during the rainy season and produce rice during October and November (Fig. 4). Some of the higher deforested land produces jute (*Corchorus olitorius*), mustard (*Brassica* spp.), pineapple (*Ananas sativa*) and cassava (*Manihot* spp.). An ethnic tribal people, the Garos, reside in this region.

The forest consists of deciduous tree species that are leafless, although some only briefly, during the drier months. The predominant species is sal (*S. robusta*)

associated with ajuli (*Dillenia pentagyma*), gadila (*Careya arborea*), bahera (*Terminalia belerica*), jiga (*Lannea grandis*), sidha (*Lagerstoemia paruiflora*), kaika (*Andina cordifolia*), cham (*Artocarpus chaplasha*), siris (*Albizzia* spp.), sonalu (*Cassia fistula*) and nankijanka (*Bauhinia* spp.).

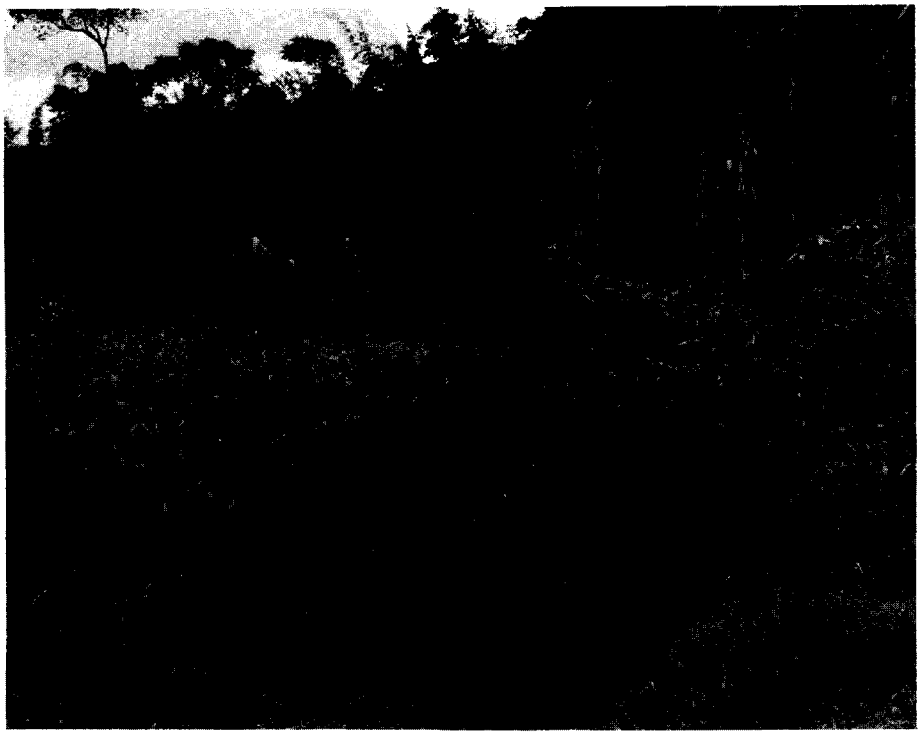

Fig. 3. View of disturbed forest habitat in Sylhet. In the foreground is *Imperata* grass. On the slope several remnant primary tree species are visible with the predominant bamboo growth.

The undergrowth is formed of sothi (*Curcuma zedoaria*) and fulkuri (*Eupatorium odoratum*). Bamboo is conspicuously absent. The canopy, ranging between 20–25 m, is broken with shorter second story trees, permitting good visibility into the upper tree levels. The flat terrain is easily transversed with little impediment from the undergrowth (Fig. 5).

Official records state that 30% of the forest area is occupied by squatters (Chowdhury, 1973). My observations in the Madhupur forest indicate that this is a conservative figure. Homesteads, agricultural plots, and forest are closely associated and it appears that the forest areas are progressively declining in stature and size.

Fig. 4. A baid lying between strips of sal (*Shorea*) forest in the Madhupur Tract.

METHODS

Survey data reported here were collected over a five-month period, from July to November 1976. Several modes of transportation were utilised varying with the habitat, which consisted of three ecological types: rural cultivation, tea plantation, and forest.

Rural cultivation supports crops of rice (*Oryza sativa*), jute (*Cochorous capsularis* and *C. olotorius*), and various pulses and vegetable crops. Dispersed throughout these areas are bamboo and adobe homes, clustered among mango (*Mangifera indica*) and jackfruit (*Artocarpus involucrata*) trees, coconut (*Cocos nucifera*), and several palms, such as the country date (*Phoenix sylvestris*), tal (*Borassus flabellifer*) and betal-nut (*Areca catech*).

The roadside survey, employing a technique described in Southwick *et al.* (1964) was used in all habitats. The distance covered between 0700 h and 1800 h was tabulated. The procedure was to drive between 10 and 50 mph, depending upon road and habitat conditions. In forest and tea gardens, a slower rate of progress was maintained, ranging between 10 and 25 mph. Often I had to drive as well as maintain vigilance, thereby reducing observation acuity, but on most occasions I employed another person to drive the vehicle. In forest regions, the car sun roof

facilitated observation into the upper canopy tree levels. Roadside visibility in the extensive, non-forested rural cultivated flood-plains is excellent, in tea plantations and the sal forests of Madhupur it is considered good, but in other regions it is much poorer. Throughout the survey local residents and officials were questioned in Bengali and English concerning the presence of monkeys.

Fig. 5. Sal forest of the Madhupur Tract. Note the absence of bamboo, sothi (*C. zedoaria*) ground cover, and the sparse vegetation permitting good visibility.

Forest areas were also surveyed on foot as well as by car. The procedure for conducting a census was to walk slowly, with minimal noise, and wait five minutes every several hundred metres. This 'transect' method was accomplished both alone or accompanied by one guide. Existing trails and creek beds were used to transverse the forest. Visual indication of the presence of animals included recent signs of feeding and fresh faeces. Auditory cues consisted of vocalisations, and foliage displacements caused by primate activity. Using 9 × 30 binoculars, notation was made of time, location, species, and total number of individuals present. When possible, individuals were categorised as adult male, adult female, juvenile and

infant. Additional information included initial cue, categorised as auditory or visual. Auditory cues were either vocalisations or branch movements. If the animal was sighted, a notation indicated whether it was locomoting or stationary. Horizontal distance was estimated from the first sighted individual to the observer as well as the height of the monkey above the forest floor. Both measures were estimated to the nearest metre. It was determined by measuring trials that I had between 5–15% margin of error in estimating distance.

With the exception of *M. mulatta* and *Hylobates hoolock*, no attempt was made to pursue individuals that took flight. For most sightings, I would remain with the individual or group for a minimum of ten minutes and often longer.

Censusing was conducted during all hours of the day, from dawn to dusk. In addition, although visibility was poor and auditory acuity reduced, census work was conducted during rains. Supplementary information included identification of food items when possible, forest transects to measure and identify tree species, and primate activity profiles. A Nikkormat FT-2, 35mm camera with micro and 200mm telephoto lenses was used with both colour and black and white film. Super-8mm colour photography was also made with a Canon 310 XL.

RESULTS

Primate groups were sighted on 54 instances during the 223 hours of field work. Table 3 presents the data according to mode of travel, hours of field work, kilometres travelled, and primate groups observed in the different habitats. This included 92 hours of transversing forest, 15 hours in tea plantations, and 116 hours

TABLE 3
HOURS OF OBSERVATION, DISTANCE TRAVELLED AND NUMBER OF PRIMATE GROUPS SIGHTED BY MODE OF TRAVEL AND HABITAT TYPE

	Mode of travel	*Habitat type*			*Total*
		Forest	*Tea plantation*	*Rural cultivation*	
Hours of observation	Vehicle	26	12	96	
	Boat	6	0	20	
	Foot	60	3	0	
	Total	92	15	116	223
Kilometres travelled	Vehicle	196	214	3187	
	Boat	16	0	370	
	Foot	105	8	0	
	Total	317	222	3557	4096
Primate groups sighted		54	0	0	54

censusing cultivated rural areas. Approximately 40% of the census hours were conducted in forest habitat, although this represented less than 10% of the distance travelled. All sightings of primates were restricted to forest areas. The primate distribution by species in Bangladesh based on personal sightings, information in the literature and probable, although unconfirmed, localities, are presented in Fig. 2.

The number of primate groups seen in different forests and mean group size for each species is contained in Table 4. The sample mean group size should not be

TABLE 4
PRIMATE SPECIES SIGHTED BY FOREST TYPE

Species	*Forest type*	*No. of sightings*	*No. of individuals*	*Mean*
Presbytis pileatus	Sal	34	258	7·6
	Secondary	1	5	
	Primary	5	34	6·8
Presbytis phayrei	Sal	0	0	
	Secondary	4	23	5·7
	Primary	2	12	6·0
Macaca mulatta	Sal	6	56	9·3
	Secondary	0	0	
	Primary	0	0	
Hylobates hoolock	Sal	0	0	
	Secondary	0	0	
	Primary	2	9	4·5

considered as representative of actual mean group size per species encountered in each habitat. Mean group size is an index of sub-grouping or measure of clumping tendency (Green, in press). As determined from a separate behavioural study, the actual average group size of non-censused capped langur groups in the Madhupur sal forest is 8·7 (details to be published later). The present census data indicated a mean group size of 7·6 individuals for *Presbytis pileatus* in the same location (Table 4). Similar comparative data are lacking for the other censused species, but illustrate the possible variables when calculating primate densities from census data.

P. pileatus was observed most frequently during this survey primarily as a result of its abundance in the Madhupur forest tract. This species was also observed in the primary forests of Sylhet, Chittagong, and Cox's Bazar.

P. phayrei was sighted several hundred metres from a group of *P. pileatus*, in primary forest at the Kalinga Reserve, Sylhet. Previously, these two species of langurs had not been recorded as being sympatric (Fooden, 1975). Primary forest observations of *P. phayrei* were also recorded at a Finley Tea Estate bordering India. In the secondary forests of the Mertinga Tea Estate, predominant with bamboo thickets, only *P. phayrei* was observed. This suggests that *P. phayrei* exhibits greater ecological flexibility than *P. pileatus*. In fact, in the bamboo forests, *P. phayrei* was observed feeding on bamboo shoots and stems.

Behaviourally, *P. phayrei* was shy and would tend to 'hide' in this habitat. One group was observed feeding in the upper canopy of a large 30 m high tree. Upon detecting my presence, each member of the group proceeded to throw itself horizontally several metres out of the canopy and drop 12–15 metres to crash into a clump of bamboo. Contrary to such shy behaviour was the ease of observing *P. phayrei* in the Kalinga Forest. Both species of langur were never observed on the ground.

Rhesus monkeys were seen infrequently in the sal forest of Madhupur and on all occasions during this survey. However, *M. mulatta* was sighted in Dhamrei village, 20 km northeast of Dacca, and urban rhesus monkeys were sighted on several occasions in Dacca city. These sightings were not made during regular census episodes and are therefore excluded from the data.

During interviews of local people, I was informed that rhesus monkeys raided the 'aman', or winter rice crop, particularly during the latter stages of crop maturity. Although I visited many paddy fields during the survey, including the last month of rice maturity, rhesus were never sighted.

In Madhupur, the difficulty of observing *M. mulatta* contrasts with ease of observing *P. pileata.* Rhesus were sighted either on the ground or at low tree level and, immediately upon detecting my presence, most animals on the ground would run off. Those macaques in the trees would drop to the ground and retreat into the dense sothi (*C. zedoaria*) ground cover, prohibiting visibility.

Local people also molested the animals by throwing debris and yelling. Yet, under such circumstances, *P. pileatus* showed little concern and tolerated exceptional abuse. The precise factors contributing to these different behavioural responses between the species are difficult to evaluate. But I suspect that hunting pressure, even though minimal, is important, and that the langurs, totally restricted to the forest, are not 'pest' problems and are persecuted less.

H. hoolock clearly preferred the less disturbed primary forest. The two sightings of gibbons occurred in the Kalacherra and Lawachera Reserve Forests. Both areas contained human settlements and patches of agricultural fields. Adult males, completely black with white eyebrow patches, adult, silver-grey females, and all-black juveniles were sighted. Contrary to expectation, certain individuals remained in close proximity for extended periods, permitting excellent observations. In addition to the group sighted in the Kalacherra reserve, three other groups were heard calling during the same day. These groups, however, are not included in the density estimates.

Density estimates

Linear distances covered by walking and vehicular travel in forest were converted into square kilometre equivalents (Table 5). Transect data presented in this paper are based on both auditory and visual detection which differs according to habitat and mode of survey.

TABLE 5
DISTANCE TRAVELLED AND PRIMATE DENSITY BY FOREST TYPE

		Forest type			
		Sal	*Secondary*	*Primary*	*Total*
Kilometres travelled	Vehicle	105	47	45	197
	Foot	18	45	42	105
Square km equivalent	Vehicle	4·9	1·3	1·8	8·0
	Foot	3·4	2·0	3·9	9·3
	Total	8·3	3·3	5·7	17·3
Total no. of sightings		40	5	9	54
Primate groups/km^2		4·8	1·5	1·6	3·1
Total no. of individuals		314	28	55	397
Primates/km^2		37·8	8·3	9·7	22·8

Because of good visibility in sal forest, the walking observer could cover a transect width of 100 m on either side of the path. Thus, one square kilometre would be equivalent to transversing 5 linear km of a 200 m wide transect. The limited auditory detectability during automobile roadside surveys warrants reduction of the calculated effective transect width in all habitats. Thus when travelling by vehicle through sal forest, I determined that the effective transect width was reduced to 50 m, 25 m on either side of the road. Under such conditions, 20 linear km would be equivalent to one square kilometre.

In primary and sal forests, auditory detectability remained equal and the visual range of detectability was reduced, so that the walking transect covered approximately 50 m on either side of the path. One square kilometre would then be equivalent to 10 linear km. Because of decreased auditory detectability during vehicle surveying, the transect width becomes 20 m on each side of the road. The observer then had to cover 25 linear transect km, for an equivalent square km measure.

Because of dense bamboo thickets and undergrowth in the disturbed secondary forests, visual detection was greatly impeded. The effective transect width was only 50 m with a square km equivalent of 20 linear km.

The highest estimated primate density was seen in the Madhupur sal forest with 37·9 individuals and 5·1 groups/km^2 (Table 6). *P. pileatus* was the most abundant monkey with 31·1 individuals/km^2. The estimated number of groups/km^2 is 4·4. Rhesus macaques constituted about 18% of the primate fauna in this ecosystem, with 6·8 individuals and 0·7 groups/km^2.

The lowest estimated primate density was observed in secondary forests with 8·3 individuals and 1·5 groups/km^2. *P. phayrei* had 6·8 individuals and 1·2 groups/km^2. The conspecific *P. pileatus* had 1·5 individuals and 0·3 groups/km^2.

TABLE 6
PRIMATE DENSITY BY FOREST TYPE

Species	*Sal*		*Secondary*		*Primary*	
	Individuals/ km²	*Groups/ km²*	*Individuals/ km²*	*Groups/ km²*	*Individuals/ km²*	*Groups/ km²*
Presbytis pileatus	31·1	4·4	1·5	0·3	6·0	0·9
Presbytis phayrei	0	0	6·8	1·2	2·1	0·3
Macaca mulatta	6·8	0·7	0	0	0	0
Hylobates hoolock	0	0	0	0	1·6	0·3
Total	37·9	5·1	8·3	1·5	9·7	1·5

DISCUSSION

Travel to the forest reserve areas showed that the total area claimed as forest was often much less than the official records stated. Therefore, I have calculated the 'equivalent forest area' from my own subjective evaluation of the forest areas visited. When portions of reserves were clear-cut, or under cultivation, I extrapolated the general percentage of this amount of land to the entire reserve area. This then yields what I have termed a 'reduction factor' which is applied to produce a more accurate forest area profile (Table 2). From this information and the results of my primate survey, I can estimate the forest primate population of Bangladesh (Table 7).

TABLE 7
ESTIMATED FOREST PRIMATE POPULATION

	Square kilometres
Total equivalent forest	13788
Sundarbans	4071
Total Forest-Sundarbans	9717
Total Forest-Sundarbans-Sal Forests	9549
Sal Forest primate density	Area × Individuals/km²
	168 × 37·8
	6350
Sundarban Forest primate density[a]	40000
Remaining Forest primate density	
	Area × Individuals/km²
	9549 × 9·7
	92625
Total estimated primate population	138975

[a] Hendrichs (1975).

For example, much of the reserve forest lands in the Chittagong division lack actual forest cover. Hence, of 847 km² of forest reserve listed, I estimate that only

50% is actual forest. The primate population in the Sundarbans is calculated from Hendrichs (1975). The estimated Madhupur forest primate density, 37·8 individuals/km^2 is used to estimate the sal forest population in Mymingsingh (Table 7). Population size of the remaining 9549 km^2 of equivalent forest habitat is calculated by using the figure of 9·7 individuals/km^2. Using the estimated primary forest primate density survey data for calculating the Hill Tracts primate density yields only an approximation of real density. Nonetheless, by this method of primate population estimation, I estimate a minimum population of about 140,000 animals for Bangladesh. Further field work, particularly in the Hill Tracts, is required for more accurate primate population estimates.

A major surprise of this survey confirmed by interviews with local people is the low abundance of primates. The paucity of rhesus macaque populations in all habitats is noteworthy. Southwick *et al.* (1964) also found low densities of rhesus macaque populations in central and southern West Bengal, India. This seemed surprising to these investigators since factors attributable to low primate detection were absent. Resources, such as long rows of large well-spaced trees along many roadsides, readily available water in roadside irrigation ditches and ponds, and adjacent agricultural crops, were found throughout the region which Southwick *et al.* (1964) considered important for supporting primate populations.

The same favourable resources and conditions for detecting primates in West Bengal are also found throughout neighbouring Bangladesh. However, East Bengal is a more extensive seasonal flood plain, and has potentially less usable dry land than West Bengal during the wet season.

Hindus, unlike Muslims, provide food for monkeys in many villages, cities, and temple sites throughout the subcontinent. Therefore, during my survey I made special inquiry of Hindu settlements. With several exceptions, I was told that no monkeys at present existed. Upon further questioning it became evident that at some previous time monkeys had inhabited some areas but had disappeared. Attempts to determine the nature of such disappearances proved futile.

Possibly the low density of macaque populations throughout the areas visited in Bangladesh is a result of previous trapping pressures during the last decade. Another explanation which I propose is that the original alluvial flood plain habitat and seasonal flooding conditions never permitted the macaque to colonise this region. The argument that macaques are abundant in the Sundarbans does not preclude this assumption since mangrove forests are known to support extensive primate populations (Southwick & Cadigan, 1972), but treeless reed swamp is not a favourable habitat to support macaques. I suspect, because of the close association between Hindu and monkey, that these macaques were introduced from adjoining forest regions into the flood plains.

My inability to enter the two major forest regions of Bangladesh, the Sundarbans and Chittagong Hill Tracts, reduced the effectiveness of this survey but certain trends and problems are still evident. For all primate species, the status of forest

habitat remains critical. Earlier comments pertaining to both the high human population density and expected continued high population growth rate project a pessimistic outlook. Increasing numbers of people will result in greater demand for fuel and house construction material. With the exception of cow dung, dead leaves, and jute stalks, the primary source of cooking fuel throughout regions adjacent to forest is firewood. In all forest areas visited, poaching of lumber was observed although prohibited. This poaching, due in part to the lack of sufficient forest department manpower and logistical problems in providing adequate protection, is expected to continue and probably increase.

Besides the human pressures operating, for example, on the Madhupur sal forest, forest management practices of converting mature forests into sal or teak plantations is detrimental for primates. Sal does not appear to contribute significantly to primate diets (details to be published later). Teak is reported to be highly non-palatable to numerous wildlife species (Berwick, 1976), and I never observed any primate species feeding in teak. However, *P. pileatus* was seen travelling through a teak plantation to reach an adjacent forest patch.

The tea producing area of Sylhet contains numerous forest refugia varying in size and status. These forest areas are declining because of expanding tea production and lumber poaching. Perhaps more important is that the isolation of forest islands prohibits arboreal primate migration and genetic interchange.

With the exception of rhesus macaques, all primates in Bangladesh require forest habitat for survival. Forest destruction and alteration is projected to continue and possibly accelerate with the high human population growth rate in Bangladesh. Within this context, caution is urged when considering Bangladesh as a primate supply source for the biomedical and research community. If there is no guarantee that such endeavours will concomitantly include long-term scientific evaluation of the effect upon primate population dynamics, this exploitation should not proceed. Furthermore, as indicated in this report, several diverse forest ecosystems are in the process of being altered and steps should be taken by the Bangladesh government actively to preserve such habitats.

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