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Source: Primate Conservation, 23(1) : 65-73

Published By: Conservation International

URL: <https://doi.org/10.1896/052.023.0107>

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Primates of Bhutan and Observations of Hybrid Langurs

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Abstract: Six, possibly seven, species of non-human primates occur in Bhutan: slow loris (*Nycticebus bengalensis*), Assamese macaque (*Macaca assamensis*), Rhesus macaque (*Macaca mulatta*), Hanuman langur (*Semnopithecus entellus*), golden langur (*Trachypithecus geei*), and capped langur (*Trachypithecus pileatus*). A variant of the Assamese macaque, named *Macaca munzala*, has also been recorded there. Natural hybrids between golden and capped langur occur in an area in south-central Bhutan. The Assamese macaque is the most abundant and widespread primate, while slow loris is the least abundant, with a small range in Bhutan. Primates are not hunted for food in Bhutan, there are large areas of contiguous habitats for primates, and there is, besides, a good network of protected areas in the country. Overall, it would appear that primates have a secure future in Bhutan. The main conservation issues come from development, such as the construction of road networks and hydroelectric projects, grazing by domestic stock in some areas at high elevations, and people living in protected areas.

Key Words: Primates, conservation, *Nycticebus*, *Macaca*, *Semnopithecus*, *Trachypithecus*, *Macaca munzala*, Bhutan

Introduction

The kingdom of Bhutan in the Himalayan region of the Indian subcontinent is a poorly studied area for non-human primates. Bounded by India on three sides and China (Tibet) along the north and north-west, this mountainous country is known for its conservation of wildlife, strongly influenced by religious beliefs and codes. To date, six, possibly seven, species of non-human primates have been recorded there: the slow loris *Nycticebus bengalensis* (Lacépède, 1800) (formerly *coucang*); Assamese macaque *Macaca assamensis* McClelland, 1840; Rhesus macaque *Macaca mulatta* (Zimmermann, 1780); Hanuman langur *Semnopithecus entellus* (Dufresne, 1797); golden langur *Trachypithecus geei* (Khajuria, 1956); and capped langur *Trachypithecus pileatus* (Blyth, 1843). *Macaca munzala* Sinha *et al.*, 2005, a variant of the Assamese macaque and described as a new species, also occurs in Bhutan.

The first report on the primates of Bhutan was published by Choudhury (1990), and further information is available in Choudhury (1992a, 1992b), Wangchuk (1996), Wangchuk *et al.* (2001, 2003, 2004), and Kawamoto *et al.* (2006). There are also a number of synoptic works on primates or wildlife in general covering the sub-continent, which include or mention

Bhutan, for example, Pocock (1939, 1941), Prater (1948), Choudhury (1988, 1989, 1997), Corbet and Hill (1992), and Groves (2001, 2005). Here I discuss the distribution, habitat status, and conservation of the primates in Bhutan.

Study Area

The Himalayan kingdom of Bhutan (26°42'–28°20'N 88°45'–92°08'E; 46,500 km² in area) (Fig. 1) is hilly and mountainous. There are small montane valleys in north and middle Bhutan, such as Paro, Thimphu, and Phobjikha, and narrow strips of plains in the south along its border with India. Elevations vary from 100–7,500 m above sea level. Towards the north is the Great Himalayan range. Mt. Kula Kangri (7,554 m above sea level) is the highest peak in Bhutan. The ranges of Lesser Himalaya cover the middle part of the country. The lowest areas are in the south, along India-Bhutan border, especially along the rivers (100 m above sea level.). The main rivers (= *chu*) are the Manas (Dangme *Chu*), Sankosh, Mangde *Chu*, Khulong *Chu*, Kuri *Chu*, Torsa *Chu* and Wang *Chu*. All these ultimately drain into the Brahmaputra River. The Manas (Dangme *Chu*) and one of its tributaries, the Kuri *Chu* are trans-Himalayan rivers, having originated in Tibet (China).

The natural vegetation ranges from tropical wet evergreen and semi-evergreen in the southern foothills to subtropical and temperate forests in the north. Farther north there is the subalpine and alpine vegetation with snow on the high peaks. The climate is tropical monsoon in the south, and montane with a hot and wet summer and a cool and drier winter. The annual rainfall is 2,300–3,800 mm. The temperature ranges from below freezing to 35°C (occasionally to 37°C). The peaks of the Great Himalayan range remain snow-capped for the greater part of the year, while some of the high areas of the Lesser Himalaya, such as the Black Mountains, also experience snowfall in winter. The country is divided into 20 *dzongkhags* or districts.

I have made occasional visits to parts of southern Bhutan since October 1985, and took part in a trip to north-western Bhutan in January 2001, from September 2004 to June 2007. I was able to make frequent visits as part of my official obligations as Deputy Commissioner of Baksa district in Assam, on the border with Bhutan. During these visits, I had many opportunities to observe the primates, along existing paths and roads but also while traveling by boat on the Manas River.

The Primates in Bhutan

Slow loris *Nycticebus bengalensis* (formerly *coucang*)

The slow loris has been recorded in four of the 20 *dzongkhags* of Bhutan (Fig. 2), not to date by direct sightings in the wild, but by more than 11 live animals (the number in each *dzongkhag* shown in parenthesis) obtained by woodcutters and hunters from Pema Gatshel (4), Samdrup Jongkar (3), Sarpang (3) and Zhemgang (1) since 1990. I have seen three of these live animals. All were released back to the wild or escaped back into the wild. In 2001, a hunter/woodcutter told me that he saw a loris in the forest towards the south-west of Nganglam in Pema Gatshel *dzongkhag*. During heavy monsoon showers, lorises are occasionally washed down on logs to the plains of Assam. One such was rescued in Tamulpur area of Baksa district on 14 June 2001. From these records it is possible to presume that lorises are present in the Royal Manas National Park, Phibsoo Wildlife Sanctuary and Khaling Wildlife Sanctuary. All the capture sites reported were below 300 m above sea level. The first record for the country was a loris seen near Mathanguri in the 1980s (H. P. Phukan, pers. comm.). Wangchuk *et al.* (2004) wrote that lorises also occur in Chukha and Samchi districts, but did not say on what evidence. To date, we have no records of lorises from the Indian side of these two districts in northern West Bengal (Choudhury 2001). The existing records indicate that the Sankosh River is the western limit for the species in Bhutan as well as Assam. Loris habitat in Bhutan is mostly tropical evergreen and semi-evergreen forests in the foothills. The approximate known 'area of occupancy' (as defined by IUCN 2001) in the country is about 2,500 km².

Assamese macaque *Macaca assamensis*, including *munzala*

The Assamese macaque is the most abundant primate in Bhutan. It occurs from 100 to above 2,900 m above sea level and is the only primate that has been recorded in all the 20 *dzongkhags* (Fig. 3). I have seen it in the *dzongkhags* of Bumthang, Chukha, Mongar, Pema Gatshel, Punakha, Samdrup Jongkar, Sarpang, Thimphu, Trashigang, Trashi Yangshi, Trongsa, Tsirang, Wangdue Phodrang and Zhemgang, and in the Royal Manas National Park, Thrumshingla National Park, Bumdeling Wildlife Sanctuary, Phibsoo Wildlife Sanctuary and Khaling Wildlife Sanctuary. They occur in all of Bhutan's protected areas (Sherub and Sharap pers. comm.). Groups that I have seen (20 of them) ranged in size from two and 40, but they can be as large as 50. Lone individuals were also seen.

The Arunachal macaque, *Macaca munzala*, which I consider to be a variant of *M. assamensis*, was observed only in the *dzongkhags* of Trashi Yangshi and Trashigang (northern parts). In January 2006, I saw two groups, of >10 and >15 macaques, near the Gomukora Monastery and between the Gomukora Monastery and the town of Trashigang, at elevations of 900–1,000 m; much lower than mentioned by Sinha *et al.* (2005). Sinha *et al.* (2005) informed that the highest elevation for these macaques in Arunachal Pradesh, India was 3,500 m. I saw them at 3,100 m near Geshela, Tawang district in Arunachal Pradesh in 2001, and believed them to be merely a 'dark variant of *assamensis*' (for details on variation in pelage color in *assamensis*, see discussion and Choudhury [2004]).

The habitat of *assamensis* is mostly tropical wet evergreen and semi-evergreen forests in the foothills, subtropical and temperate broadleaf forests in the higher hills and mountains, as well as rocky cliffs with sparse vegetation. Occasionally, they may be seen in subtropical and temperate conifer forests, and rarely in the sub-alpine zone (in the summer). The known 'area of occupancy' in the country is about 20,000 km². *Macaca munzala* occurs in mostly subtropical and temperate broadleaf forests (occasionally coniferous forests) in the higher hills and mountains, as well as rocky cliffs with thin vegetation. The known 'area of occupancy' in the country is about 3,000 km².

Rhesus macaque *Macaca mulatta*

This species has been recorded in six of the 20 *dzongkhags* of Bhutan (Fig. 3). It is confined largely to the southern region of foothills near the India-Bhutan border, at elevations of 100 to 300 m. I have observed groups in the *dzongkhags* of Samchi, Chukha, Pema Gatshel, Samdrup Jongkar, Sarpang and Zhemgang and in the Royal Manas National Park, Phibsoo Wildlife Sanctuary and the Khaling Wildlife Sanctuary. Group sizes ranged from two to 25, but are known to be larger. Their habitats in Bhutan are mostly tropical wet evergreen and semi-evergreen forests, including degraded forests in the foothills. The known 'area of occupancy' in the country is about 4,000 km².

Hanuman langur *Semnopithecus entellus*

The Hanuman langur occurs in western Bhutan, in 10 of its 20 *dzongkhags* (Fig. 4). I have seen it at elevations ranging from 100 to above 2500 m, and Wangchuk *et al.* (2004) reported it from Dochu-la at 3,600 m. I have seen Hanuman langurs in the *dzongkhags* of Chukha, Punakha, Thimphu and Wangdue Phodrang, and they are reported from Samchi,

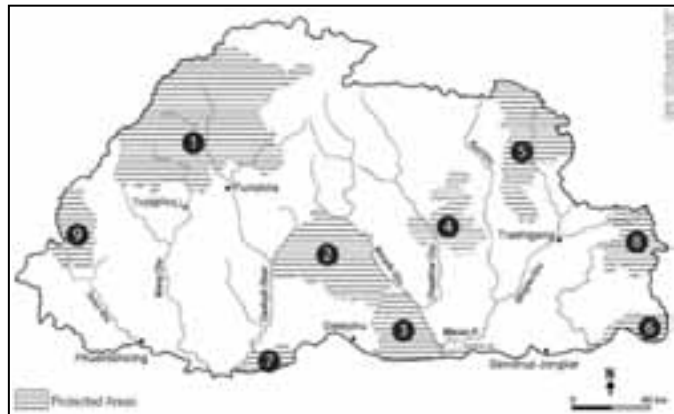


Figure 1. Map of Bhutan showing the general features and the Protected Areas. 1. Jigme Dorji National Park; 2. Jigme Singye Wangchuk National Park; 3. Royal Manas National Park; 4. Thrumshingla National Park; 5. Bumdeling Wildlife Sanctuary; 6. Khaling Wildlife Sanctuary; 7. Phibsoo Wildlife Sanctuary; 8. Sakteng Wildlife Sanctuary; 9. Torsa Strict Nature Reserve. For details, see Table 1. Map by Anwaruddin Choudhury.

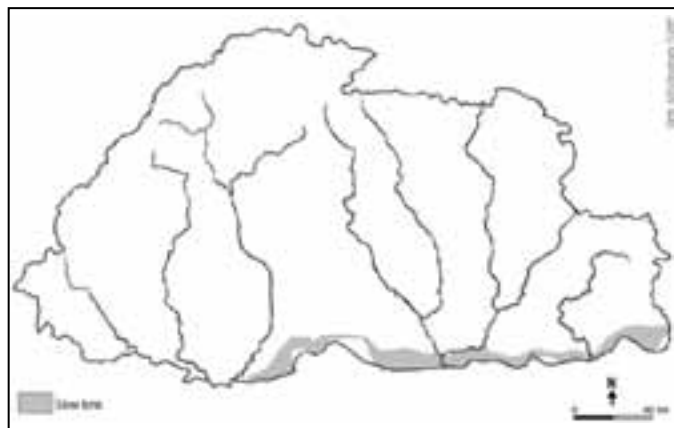


Figure 2. Distribution of slow loris in Bhutan. Map by Anwaruddin Choudhury.

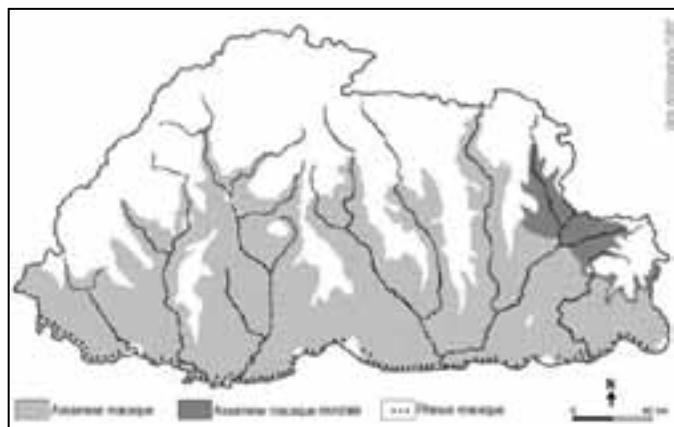


Figure 3. Distribution of macaques in Bhutan. Map by Anwaruddin Choudhury.

Ha, Paro, Gasa, Daga and the western part of Sarpang. I have never seen them in any protected areas, but they are reported from the Jigme Dorji National Park and Torsa Strict Nature Reserve (Sherub and Sharap, pers. comm.). I did see groups outside protected areas between Dochu-la and Punakha in the *dzongkhag* of Thimphu and south of the township of Wangdue Phodrang in the *dzongkhag* of Wangdue Phodrang in December 2005. In the *dzongkhags* of Sarpang and Daga, these langurs are confined to the west of the River Sankosh; but in Wangdue Phodrang it also occurs east of the river up to Pele-la. The sizes of the Hanuman langur groups that have been seen ranged from 8 to 11. Their habitat is mostly tropical wet evergreen and semi-evergreen forests in the foothills, and subtropical and temperate broadleaf in the higher hills and mountains. They also frequent subtropical and temperate conifer forests and can occasionally be found in the sub-alpine zone in the summer. The known 'area of occupancy' in the country is about 6,000 km².

Golden langur *Trachypithecus geei*

The golden langur has been recorded in five of the 20 *dzongkhags* of Bhutan (Fig. 4). One of the more abundant primates of south-central Bhutan, it occurs from 100 to above 2,600 m above sea level, between the Sankosh River and a high mountain ridge (running across Pele-la) in the west, and Manas River, Mangde *Chu* and the high mountain ridge west of Chamkhar *Chu* in the east. I have seen golden langurs in the *dzongkhags* of Mongar, Sarpang, Trongsa, Tsirang, and Zhemgang, and in the Royal Manas National Park, Jigme Singye Wangchuk (Black Mountains) National Park and Phibsoo Wildlife Sanctuary. Group size ranges from 7 to 12, and lone langurs can also be seen.

I saw hybrids of *T. geei* and *Trachypithecus pileatus* in the *dzongkhag* of Zhemgang. These hybrids have features resembling more *geei* than *pileatus* (see also the discussion). Four groups were observed around the town of Zhemgang and between Zhemgang and Buli in April 2005. The group size of these hybrid langurs ranged from 9 to 12, and three lone individuals were also seen.

The habitat of golden langur is mostly tropical wet evergreen and semi-evergreen forests in the foothills, and

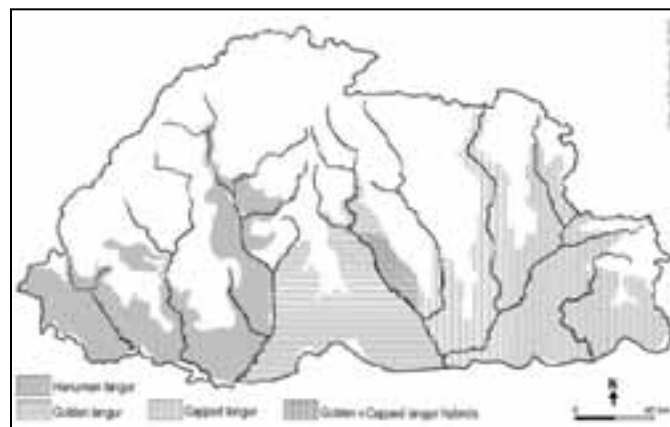


Figure 4. Distribution of langurs in Bhutan. Map by Anwaruddin Choudhury.

Table 1. Protected areas in Bhutan with known primate populations.

Name	Dzongkhag	Area (ha)	Primate species found
Jigme Dorji National Park	Gasa, Punakha, Thimphu and Paro	434,900	Assamese macaque, Hanuman langur
Jigme Singye Wangchuk (Black Mountains) National Park	Zhemgang, Trongsa, Sarpang, Wangdue Phodrang and Chirang	173,000	Assamese macaque, Golden langur
Royal Manas National Park	Zhemgang and Sarpang	102,300	Slow loris, Assamese macaque, Rhesus macaque, Golden langur
Thrumshingla National Park	Bumthang, Lhuentse and Mongar	88,900	Assamese macaque, Capped langur
Bumdeling Wildlife Sanctuary	Trashigang, Lhuentse and Mongar	148,600	Assamese macaque, Assamese macaque (<i>munzala</i>), Capped langur
Khaling Wildlife Sanctuary	Samdrup Jongkar	33,400	Slow loris, Assamese macaque, Rhesus macaque, Capped langur
Phibsoo Wildlife Sanctuary	Sarpang	26,600	Slow loris, Assamese macaque, Rhesus macaque, Golden langur
Sakteng Wildlife Sanctuary	Trashigang	75,500	Assamese macaque, Assamese macaque (<i>munzala</i>), Capped langur
Torsa Strict Nature Reserve	Ha and Samchi	65,100	Assamese macaque, Hanuman langur

subtropical and temperate broadleaf in the higher hills and mountains. Occasionally, they can be seen in subtropical and temperate conifer forests. Contiguity with the forests in India was partially lost due to the construction of Sarpang-Gelephu road and the subsequent development of human settlements along it (Choudhury 2002). The known 'area of occupancy' in the country is about 3,000 km². The hybrid langurs occur in subtropical and temperate broadleaf forests between 800 and 2,600 m. Their known 'area of occupancy' in the country is about 600 km².

Capped langur *Trachypitecus pileatus*

The capped langur has been recorded in eight of the 20 *dzongkhags* of Bhutan (Fig. 4). A common primate of eastern Bhutan, I recorded it between 100 and a little more than 2,600 m above sea level. Its western limit is the Manas River, Mangde *Chu* and the high mountain ridge west of Chamkhar *Chu*. Groups were observed in the *dzongkhags* of Bumthang, Mongar, Pema Gatshel, Samdrup Jongkar, Trashigang, Trashigang and Zhemgang. It also occurs widely in Lhuentse, almost up to the Bhutan-China border along the Kuri *Chu*. I have seen capped langurs in the Royal Manas National Park, Thrumshingla National Park, Bumdeling Wildlife Sanctuary and Khaling Wildlife Sanctuary. Group size ranged from 9 to 13, and individuals can sometimes be seen alone. The habitat of capped langur is mostly tropical wet evergreen and semi-evergreen forests in the foothills, and subtropical and temperate broadleaf forests in the higher hills and mountains, as well as rocky cliffs with sparse vegetation. It can occasionally be found in subtropical and temperate conifer forests. The known 'area of occupancy' in the country is about 7,000 km².

Conservation Issues

Habitat destruction and fragmentation

Forest destruction through tree felling and human encroachment is not a serious problem in Bhutan as a whole. In the border areas, in the *dzongkhags* of Samchi, Chukha, Sarpang, Pema Gatshel and Samdrup Jonkar, for example, illegal immigrant loggers are a matter of concern. This, along with road development and expanding settlements could put the slow loris in some trouble through the fragmentation of its habitat. For the other species of primates, the existing level of

harvesting of forest resources is unlikely to be of any serious concern, although Wangchuk *et al.* (2004) reported that commercial logging in eastern Bhutan is a threat to capped langur habitat.

Grazing of domestic stock, with seasonal movements of large herds from summer hill pastures and back to the lowlands in the winter (transhumance), are a serious concern for protected areas at the higher elevations. The pastures for yaks (*Bos grunniens*), cross breeds between yak and cattle, and between mithun (the domesticated gayal, *Bos frontalis*) and cattle, are increasing in the area at the cost of natural habitats. In winter, forest fires, mostly set by accident, also damage forests, especially conifers.

Poaching and trade

There is no organized poaching or trade of any primate inside Bhutan. The illegal woodcutters and loggers from across the border occasionally take slow loris or young golden langur when they catch them opportunistically. These are either kept as pets or eventually released. The hunters from India are occasional visitors, unlike woodcutters who are regulars. These occasional hunters do not do much damage to wildlife as a whole; they hunt otters (the skin is in high demand in Tibet), and sometimes small game (deer, wild pig) but not primates.

Other problems

Other conservation issues include the rapid development occurring in some parts of the country, and a number of proposed hydroelectric projects. The construction of some bridges has been given as the cause of hybridization of langurs in some places (Wangchuk *et al.* 2004; Brandon-Jones 2005; also see discussion). Power lines passing through forests represent a potential threat to primates due to electrocution (no such cases have been reported from Bhutan, there have been instances of this in nearby Assam). Lastly, there are villages inside the protected areas, which may not be of any immediate conservation concern, but could be major issues in future management.



Figure 5. Subtropical broadleaf forests in eastern Bhutan: a key habitat for capped langur and Assamese macaque. Photo by Anwaruddin Choudhury.



Figure 6. A golden langur at 100 m elevation in Royal Manas National Park. Photo by Anwaruddin Choudhury.



Figure 7. The tropical forests of Royal Manas National Park are major habitat of slow loris and golden langur. Photo by Anwaruddin Choudhury.



Figure 8. A capped langur at 1,100 m elevation above Deothang in eastern Bhutan. Photo by Anwaruddin Choudhury.



Figure 9. The variant Assamese macaque, *munzala* from Trashi Yangshi district at 900 m elevation. Note the small but clear 'hair tuft' and longer muzzle in the above photo and white on buttock area in the photo on the right. Photo by Anwaruddin Choudhury.



Figure 10. The variant Assamese macaque, *munzala* from Trashi Yangshi district at 900 m elevation. Note the white on buttock area in the above photo and the small but clear 'hair tuft' and longer muzzle in the photo on the left. Photo by Anwaruddin Choudhury.



Figure 11. A male hybrid langur in Zhemgang. Note its almost golden langur-like coat except for two blackish 'horn' like tufts. Photo by Anwaruddin Choudhury.



Figure 12. Another male hybrid langur in Zhemgang. Note its grey fore-arms, thighs and tail and two blackish 'horn' like tufts. Photo by Anwaruddin Choudhury.



Figure 13. Another adult hybrid langur in Zhemgang. Note its entirely grey arms, thighs and tail. Photo by Anwaruddin Choudhury.



Figure 14. A sub-adult of the same group looking like a light-colored capped langur with a lighter grey cap. Photo by Anwaruddin Choudhury.



Figure 15. A group of young *Lamas* at a monastery in eastern Bhutan. The influence of Buddhism has played the key role in successful wildlife preservation including those of the primates in Bhutan. Photo by Anwaruddin Choudhury.

Conservation Measures

The golden langur is protected under Schedule 1 of the Forest and Nature Conservation Act 1995. There are nine protected areas (four national parks, four wildlife sanctuaries and a strict nature reserve) in Bhutan, but only five of them are operational (Bhutan, Ministry of Agriculture 2002). Some of the protected areas are fairly large and contain significant primate habitat (see Table 1). IUCN (2007) lists the golden and capped langurs as 'Endangered', the Assamese macaque as 'Vulnerable', the Rhesus macaque and Hanuman langur as 'Lower Risk', and the slow loris as 'Data Deficient' (see also Molur *et al.* 2003).

Discussion

Bhutan offers a rare opportunity for long-term conservation of these different species of primates, as well as other wildlife, because 72.5% of its land area is under forest cover (Bhutan, Ministry of Agriculture 2002). An added advantage is its predominantly Buddhist population, most of which do not hunt animals. There are nine protected areas in Bhutan covering a significant 26.23% of the country's geographical area (Bhutan, Ministry of Agriculture 2002). There would appear to be no threat from poaching for any of the primates, but with the country undergoing rapid development in a number of regions, there could be some threat from habitat loss, alteration and fragmentation in the years to come. Except for some specialized species, such as the nocturnal slow loris in a limited part of the southern low hills, however, other primates are unlikely to be significantly affected.

The Assamese macaque in Bhutan is sympatric with all the other five primates, except perhaps for the form *munzala*, in the east. The range of the Rhesus macaque, although much smaller than that of the Assamese species, is also shared by all the other species in some part or other. The three langur species on the other hand are strictly allopatric, with major rivers and high mountain ridges being zoogeographic barriers.

An interesting feature of the primates of Bhutan is the occurrence of 'natural' hybrids between the capped and golden langurs in the *dzongkhag* of Zhemgang. The hybrid langurs observed near the town of Zhemgang resemble golden langurs from a distance (indicating the dominance of the characteristics of this species), but the various shades of grey become evident on closer inspection. There is no uniform pattern. I have seen in the same group, what would seem to be an almost pure golden langur phenotype, one with a gray back, another with gray flanks, and another looking like a capped langur but with lighter gray. Most had gray on their arms, and two blackish 'hornlike' tufts on their heads. I had suspected such hybridization in the zones of overlap (Choudhury 1992b) in the upper reaches of the rivers, where they narrow and often have natural bridges of fallen trees due to landslides or flash floods. The langurs can also cross the streams because of the boulders. However, Wangchuk *et al.* (2004) surmised that the probable cause of such hybrids was the construction of four

bridges over Chamkhar *Chu* in the *dzongkhag* of Zhemgang. The hybrid langurs extend over large parts of the *dzongkhag*, north and east of Mangde *Chu*, and it is possible that such hybridization had been going on well before the construction of the bridges. The capped langur occurs on both banks of the Chamkhar *Chu*.

Wangchuk (2003) and Wangchuk *et al.* (2003, 2004) mentioned a new subspecies of golden langur in Bhutan they named *Trachypithecus geei bhutanensis*. Brandon-Jones (2005) noted that under the stricter criteria of availability introduced in the 4th edition of the *International Code of Zoological Nomenclature* (ICZN 1999), Article 16.1 insists that every new name published after 1999 must explicitly be indicated as intentionally new. Wangchuk *et al.* (2003) failed to satisfy this requirement as they treated the subspecific name as available from an unpublished report (Wangchuk 2003), and *T. g. bhutanensis* is as such a *nomen nudum*. Be that as it may, the validity of this subspecies requires further analysis, as the characters mentioned, such as grey limbs and tail, could have been due to past instances of hybridization. The hybrid langurs are found in the same general area (see also Brandon-Jones 2005).

The presence of the variant Assamese macaque *munzala* is the first confirmed record for Bhutan, although it was expected due to the close proximity with its range in Arunachal Pradesh. The first sighting of this macaque was in 1997 in western Arunachal Pradesh when it was tentatively identified as *Macaca thibetana* (see Choudhury 1998). Groves (2001) felt that the macaque photo in Choudhury (1998) was of *thibetana*. In 1998, at least seven groups were observed in the Tawang district at elevations as high as 2,900 m, which looked different from those reported in 1997, but were treated as a variant of the Assamese macaque. An adult male *munzala* was photographed at Brokser in the eastern part of the district of Tawang in 1998 (by Rupin Dang, a cinematographer; see Choudhury 2004). Whether this is a new species will need further study. Chakraborty *et al.* (2007) made molecular analyses which indicated its distinct identity, but the significant variation that can be found among *assamensis* in Eastern Himalaya needs a detailed review (see Fooden 2003; Choudhury 2004). The *assamensis* found in the high elevation areas of Bhutan and Arunachal Pradesh do look quite different from *M. assamensis pelops* found in the lower hills of Bhutan, adjacent areas of Assam and northern Bengal, and *M. assamensis assamensis* found widely towards the south and east of the Brahmaputra River.

Recommendations

The protected areas that are not operational, should be made so. Those on the international border, such as Khaling, Manas and Phibsoo should have adequate enforcement with increased staff and regular patrolling in view of trans-border tree-felling and poaching. The development projects should have realistic environmental impact assessments so that the damage to natural habitats is minimal. Livestock grazing in

the protected areas may have to be regulated in the future. Awareness campaigns and programs for the regular monitoring of the primate populations are recommended.

Acknowledgments

I thank *dasho* Tshering Wangda, Joint Secretary, Home, Royal Government of Bhutan, Sherub and Sharap Wangchuk of the Nature Conservation Division, the officials of the district (*dzongkhag*) administrations of Sarpang, Zhemgang, Pema Gatsel, Bumthang, Mongar and Samdrup Jongkar, the officials of the sub-divisional administration of Panbang, Nganglam, Bhangtar and Gelephu; the staff of WWF–Bhutan, the late Alauddin Choudhury, S. S. Bist, Dr. Anil Goswami, Dipankar Ghose, Mohabbat Shah Ali, Romu Mazumdar, Sajjad Choudhury, Imran Mazumdar (Babu), C. R. Bhobora, Bhargav Das and Hakim (driver) for their help and support during my visits to Bhutan. Thanks are also due to Sudhir Vyas, India's Ambassador to Bhutan, for sharing his wide knowledge of Bhutan's wilderness.

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Received for publication: July 2007

Revised: September 2007