

The Hoolocks of the Mishmi Hills and the Northern Limit of the Hoolock Gibbons

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Abstract: In India, the hoolock gibbon, *Hoolock hoolock*, is found only in a small part in the northeast, south of the Brahmaputra River and east of the Dibang River. The subspecies *mishmiensis* occurs in a small area north of the Lohit River and east of the Dibang River in Arunachal Pradesh and Assam. In this article, I describe the distribution and conservation of *mishmiensis* and attempt to fix the northern limit of its range, the northernmost of any of the hoolock gibbons. I also discuss the recent findings of a phylogenetic study on hoolocks. The Mishmi Hills hoolocks occur over a relatively small area and in depleted numbers. They have been recorded from elevations of less than 120 m to around 2,000 m. They are becoming increasingly rare due to habitat loss. In the plains of part of their range, they are now found only in scattered groups, and may not survive for long. The construction of several large and medium-sized hydroelectric dams is a recent threat and is likely to severely impact the *mishmiensis* populations. The Mehao Wildlife Sanctuary is the only protected area in the range of *mishmiensis* and is the core of a fairly sizeable habitat. I recommend the creation of further protected areas, adequate protection of the sanctuary, control of *jhum* cultivation and occasional poaching, a review of some of the dam proposals to avoid submerging the hoolocks' habitat, minimization of severe disturbance to the hoolocks during construction, and addressing awareness and involvement of churches, traditional institutions and village headmen in regard to the conservation of the forests and wildlife of the area.

Key words: *Hoolock hoolock mishmiensis*, Mishmi Hills hoolock, Northeast India, Lower Dibang Valley, Lohit, Sadiya

Introduction

The hoolock gibbon, *Hoolock hoolock*, is the only ape in South Asia and the Indian subcontinent. Adult males and juveniles of both sexes are black with white eyebrows. When subadult, the pelage of the females changes to grayish and then to a tan colour, which they retain as adults. The range of *Hoolock hoolock* is between the Brahmaputra and Chindwin rivers, covering parts of Northeast India, eastern Bangladesh, and west and northwest Myanmar (Burma) (Groves 1972; Choudhury 1987, 2016). In India, it is confined to the northeast, where it is restricted to the south of the Brahmaputra River and east of the Dibang River (Parsons 1941; Choudhury 1987, 2013a). The hoolocks occurring north of the Lohit River and east of the Dibang River were described as a new subspecies, *mishmiensis* Choudhury, 2013, owing to noticeable morphological differences and their geographic isolation (Table 1) (Choudhury 2013b).

These hoolocks, north of the Lohit River and north of the Noa-Dihing River, were mistakenly treated as eastern hoolocks, *H. leuconedys* (Groves, 1967) (see Das *et al.* 2006;

Chetry *et al.* 2008, 2010, 2012, 2021; Chetry and Chetry 2010, 2011; Kumar *et al.* 2013; Sarma *et al.* 2014). In these studies, the basis for this was the morphological characteristics but the key features such as colour and length of tail tuft and the gap between the eyebrows were not illustrated through proper evidence such as photography or examined specimens. Trivedi *et al.* (2021) carried out a phylogenetic analysis on the hoolocks found in India (details in the discussion). Different publications describe different ranges, and another issue to resolve is the northernmost limits to the range of the hoolock gibbons.

In this article, I describe the distribution, status, and conservation of the Mishmi Hills hoolock in Arunachal Pradesh and Assam, discuss the findings of Trivedi *et al.* (2021), and also fix the northernmost range limits, which are the northernmost for *H. hoolock* and for the genus.

Study Area

The study area includes the districts of Lower Dibang Valley, Dibang Valley, Lohit, Anjaw, Namsai and Changlang

in Arunachal Pradesh, and the Sadiya sub-division of Tinsukia district in Assam (26°53'–29°23'N, 95°20'–97°24'E) (Fig. 1). In Arunachal Pradesh, the area is mostly hilly and mountainous, taking in the Mishmi Hills and the Dapha Bum ridge. However, part of the districts of Lower Dibang Valley, Lohit, and Changlang, and a large part of Namsai are flat or slightly undulating plains. Its range in Assam is entirely a lowland plain. The plains were formed by the Dibang, Lohit, Digaru and Noa-Dihing rivers and their larger tributaries. The highest elevations of the Mishmi Hills are more than 5,000 m above sea level. The climate is tropical, with hot and wet summers (May to September) and cool and generally dry winters (December to February). The higher areas of the Mishmi Hills and the Dapha Bum ridge have montane climates. Annual rainfall ranges from less than 500 mm in the very high elevations to more than 4,000 mm. At places such as Dambuk, Lower Dibang Valley, there was a record of more than 10,000 mm in a year (Choudhury 2003). The bulk of the rain falls during the summer monsoon (May to September). Snow falls in the higher hills and mountains. The temperature ranges from below freezing in higher areas in winter to more than 35°C in summer (often reaching 37°C in the plains).

Surveys

From July 1989 to October 2020, I carried out field surveys in the areas mentioned above to look for hoolocks and find their range limits, part of a broader survey of the wildlife of Northeast India. The presence of hoolocks was ascertained by direct sightings or by hearing their calls, as well as through finding preserved skulls in the tribal villages and by interviewing local forest staff, villagers, and hunters (using visual aids such as photos and drawings). Direct observations were made along trails (mostly during foot-transsects), roads (by car), and rivers (by boat). The data were obtained during numerous field surveys carried out since July 1989, and particularly between July 1992 and July 1994, when I was posted as Project Director of Rural Development at Tinsukia, March 2003, November–December 2008 (when I camped at several sites in the study area), and in October–November 2013 (camped at Sadiya), April–May 2019 (camped at Pasighat) (the last two as an Election Observer), and in January 2020. I made sporadic visits at other times as well.

Distribution and Northern Limits

Probably the first published information on the occurrence of hoolocks in the Mishmi Hills was by Hinton and Lindsay (1926), when H. W. Wells, their collector, mentioned the apes' presence in Denning in the present Lohit district and a male collected at Chikorpani. The variant hoolocks are distributed in the Lower Dibang Valley and Lohit districts of Arunachal Pradesh. In Assam, they occur only in the Sadiya sub-division of Tinsukia district. Hoolocks were

found to be absent from the Dibang Valley district, while in Anjaw, they occur south of the Lohit River. The variant hoolocks, north of the Lohit river were described as a subspecies, the Mishmi Hills hoolock, *H. hoolock mishmiensis* Choudhury 2013(b). In Arunachal Pradesh, the range of the Mishmi Hills hoolock includes the Mehao Wildlife Sanctuary, the Deopani and Kerim reserved forests, the unclassified forest north and west of Mehao, and south up to the inter-state border with Assam (all in the Lower Dibang Valley district), and the Paya, Denning, Tebang (probably extirpated) and Digaru reserved forests, and the unclassified forest up to Tidding River (all in the Lohit district). In Assam, *mishmiensis* used to occur almost throughout the Sadiya sub-division. It has now vanished from most of its range there and is struggling to survive in just three forest patches, the reserved forests of Kundil Kaliya, Hollogaon and Kukuramara. The largest contiguous range now extends from the confluence of the Ithun and Dibang rivers through Mehao Wildlife Sanctuary to the Tidding River. The unclassified forest between Mehao and the inter-state border with Assam in the south has been lost, and the hoolocks are surviving in small forest fragments and scattered trees. The Kerim Reserved Forest and major areas of the Deopani Reserved Forest have also been cleared.

Towards the north, *mishmiensis* might have occurred at least up to Anini (1,968 m above sea level) with the Dri River, a left bank tributary of the Dibang, as the barrier, as

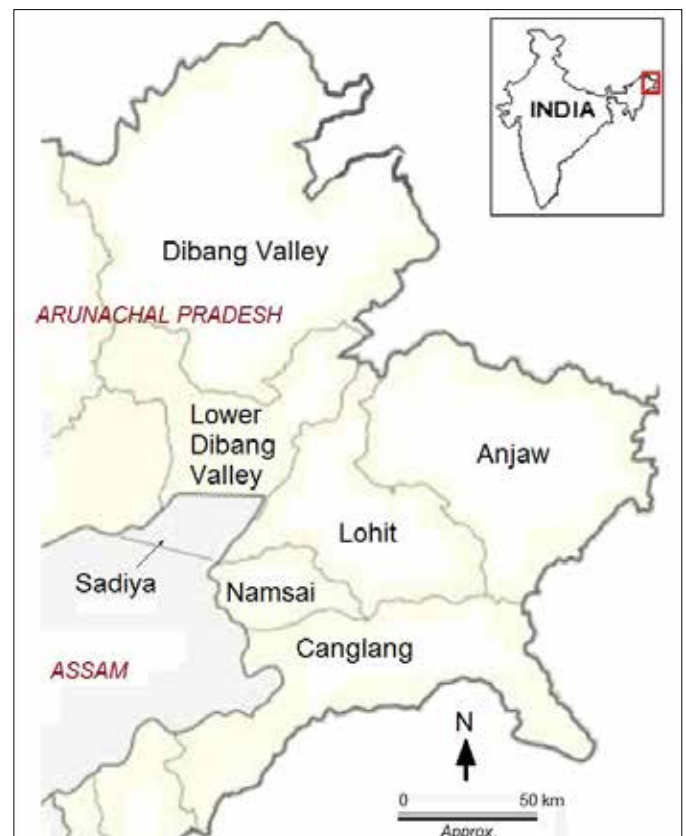


Figure 1. The study area in northeastern India.

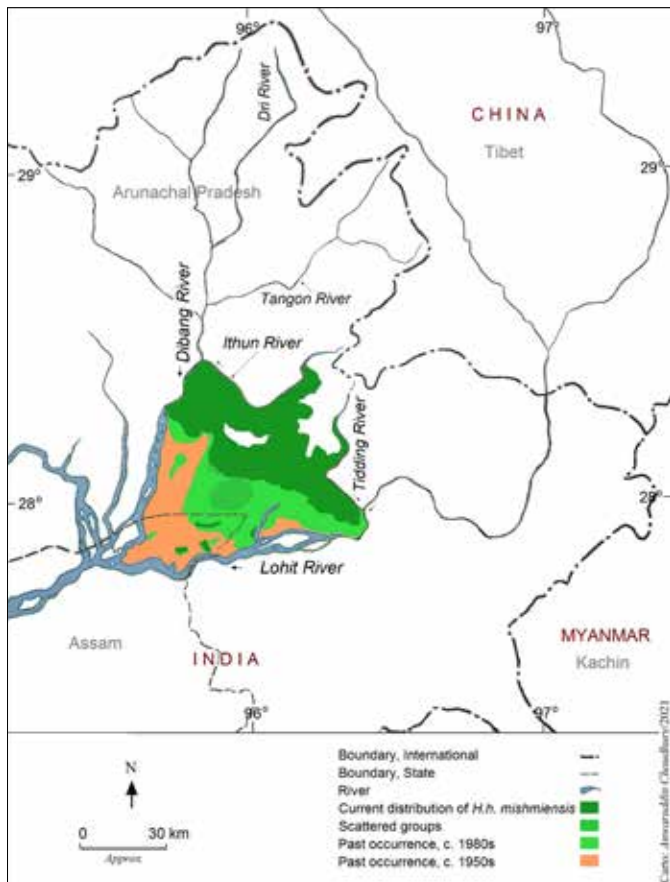


Figure 2. The geographic distribution of *Hoolock hoolock mishmiensis*. Map by Anwaruddin Choudhury, 2021.

I surmised before going to the field and considering the habitat type. The villagers on both sides of the river never heard any call nor have seen the ape, except a few who visited Lower Dibang Valley. The next major tributary was Tangon, where the local communities' response was similar. The third major tributary was Ithun where I heard hoolocks calling from the left bank but not from right. The villagers confirmed that they had never heard calls from the right bank. Thus, I consider the Ithun River to be the northern limit. The northernmost point is just before its confluence with the Dibang River ($28^{\circ}26'N$, $95^{\circ}50'E$).

The next issue was the eastern boundary, with the possibility of it being the Lohit River bend above Hawaii where the south-flowing river turns west. I surveyed the area in 2008 but well before reaching Hawaii, when I reached the Tidding river, a right bank tributary of the Lohit, I heard calls from the west bank but none from the east. Discussions and interviews with locals and the laborers working in road maintenance, and who were for years familiar with the hoolocks' calls, confirmed my observations. There was no evidence that hoolock gibbons could be found east of the Tidding River to the town of Hayuliang, Anjaw district, although occasional calls could be heard of the nominate subspecies to the south of the river. No evidence was

found for the occurrence of gibbons on either side of the river between Hayuliang and Hawaii, i.e., while *mishmiensis* stopped at Tidding River, the nominate subspecies of the south likewise did not extend beyond Hayuliang, towards the east. Exploration is necessary farther south, away from the river, to find out the extent of the nominate subspecies' occurrence. Between Hawaii, Walong and Kibithoo (near the India-China international border), the Lohit River flows from north to south and on both sides there was no hoolock habitat, no evidence in the form of calls, and local communities were unfamiliar both with the call and appearance of the hoolock. Moreover, the habitat was dominated by Sumatran pine *Pinus merkusii*. So Tidding River is evidently the easternmost limit of *mishmiensis* (Fig. 2).

Habitat and Status

In the Lower Dibang Valley and Lohit districts, *mishmiensis* occurs from 135 m to about 2,000 m above sea level, and in Sadiya, Assam, between 120 and 160 m above sea level. The highest recorded elevation for *H. hoolock* is 2,700 m above sea level in the Saramati area of Nagaland (Choudhury 2006). At this elevation in the Mishmi Hills, there is high to medium snowfall during winter. The Mishmi Hills hoolock is found in two major types of habitat in its range: tropical evergreen and subtropical broadleaf forest. It is seen in tropical semi-evergreen forests which developed after rain forests were disturbed. In the highest areas of its range, it marginally enters temperate broadleaf forest. In the southern parts of Lower Dibang Valley, most of the lowland has suffered heavy encroachment and hoolock habitat is scattered trees in farmland. The situation in Assam is no better. The once evergreen forest patches have now become considerably degraded and semi-evergreen. The approximate current habitat available for the Mishmi Hills hoolock is about 1,200 km² in Arunachal Pradesh and 30 km² in Assam excluding the encroached and cleared areas.

Although reasonably widespread, *mishmiensis* is now rare in its range. The only secure population seems to be that of the single protected area where it occurs, the Mehao Wildlife Sanctuary. Little is known about the current abundance of hoolocks in Lohit district.

In January–February 2019, Chetry *et al.* (2021) counted a population of 17 in Assam. In my last visit in January 2020, it was less than 16. In a previous survey, Chetry *et al.* (2012) had estimated 33 individuals in Assam and counted at least 157 groups in Mehao (Chetry *et al.* 2010). Sarma *et al.* (2014) found 54 groups and three solitary hoolocks outside Mehao in fragmented habitat in the Lower Dibang Valley district. The current population in unprotected fragments outside the Mehao sanctuary has apparently undergone a significant decline. The Mehao population may be treated as more or less stable. In Lohit, the Paya Reserved Forest has a small surviving population but the status of the hoolock gibbons elsewhere is not known.

Table 1. Key differences between two ssp., of *Hoolock hoolock*. Modified from Choudhury (2013b).

Characters	<i>hoolock</i>	<i>mishmiensis</i>	Figures
Pelage in black animals: dorsum	Black with some brownish overlay.	Black with some brownish overlay.	
Pelage in black animals: ventrum	Black	Black often with grayish or white hairs, especially on chest. Seen in close-up view.	Figs. 3a, 3b
Genital tuft in male	Black or faintly grizzled	Black (mainly at base) with conspicuous buffy or rufescent buff or rusty buff hairs.	Figs. 4a, 4b, 4c
Brow-streaks in male	Separated by narrow gap. Streaks are generally narrower than <i>mishmiensis</i> .	Separated by narrow gap. Streaks are mostly thicker than nominate ssp.	Figs. 5a, 5b
Tuft (beard) on chin in male	Black (in one individual variation with some whitish hairs seen in Mizoram).	Black, sometimes with visible grey or rufescent hairs. Generally longer than nominate ssp. Individual variations with whitish hairs seen in a few individuals.	Figs. 3a, 3b, 3c, 5a, 5b
Pelage in female	Overall darker than <i>mishmiensis</i> . Gray-brown and darker on the chest and throat.	Overall lighter than nominate ssp. Creamy buff, sometimes with an apricot wash to brownish buff with darker at chest and throat.	Figs. 6a, 6b

**Figure 3a.** Whitish hairs on chest of male *mishmiensis* visible when close. Photo by Anwaruddin Choudhury.

Conservation Issues

Forest loss and fragmentation through tree felling, encroachment, *jhum* (slash-and-burn shifting cultivation), and monoculture tree plantations are major threats to the survival of *mishmiensis*. The forest cover in the plains of this part of Arunachal Pradesh has declined alarmingly. In the Dibang Valley district (formerly including the Lower Dibang Valley district), dense forest cover (40 per cent or more canopy cover) was 8,237 km² in a 1999 assessment (FSI 1999) but over a decade was reduced to 6,628 km² (FSI 2019). Unfortunately, a major part of the decline was in the plains that supported a relatively higher density of hoolocks (Fig. 7a). In Sadiya, Assam, the worst affected was Kundil Kaliya Reserved Forest, which has lost nearly four-fifths of its tree cover (Fig. 7b). The small Kukuramara Reserved Forest is cut into two by a metalled road (Fig. 7c).

Poaching of *mishmiensis* was unheard of in the past as Mishmis do not kill them, being sacred to them. In the 1990s, however, I received reports of a few being shot by people of other tribes. Even in 2008 one was killed by somebody in another tribe.

The most serious threat that has emerged recently, however, is the construction of hydroelectric dams on all the rivers that surround *mishmiensis*—Dibang, Lohit, Ithun and Tidding. Of these, the Dibang dam is the largest not only among these but in all of India. At 288 m this dam will be the tallest concrete dam in the world. The submergence area of 40 km² will reduce hoolock habitat in the northwestern part of its range. The construction work of the Dibang

dam is yet to start but a new road is already under construction along the river that cuts across prime hoolock habitat. Three more medium-sized dams have been proposed in the hoolock habitat, Ithun I and II, and Ashupani. The next mega dam in the area of *mishmiensis* is the Lower Demwe dam on the Lohit River. This 124-m-high dam would also submerge some habitat in the southeastern part of the gibbon's range. A few more dams have also been planned farther up in both the Dibang and Lohit rivers. The huge force



Figure 4a. Close up of tail-tuft in *Hoolock hoolock hoolock* male. Photo by Anwaruddin Choudhury.



Figure 3b. An individual *mishmiensis* variant. May be some infection. Photo by Anwaruddin Choudhury.



Figure 4b. Close up of tail-tuft in *Hoolock hoolock mishmiensis* male. Photo by Anwaruddin Choudhury.



Figure 3c. An individual nominate ssp. variant. Photo by Anwaruddin Choudhury.

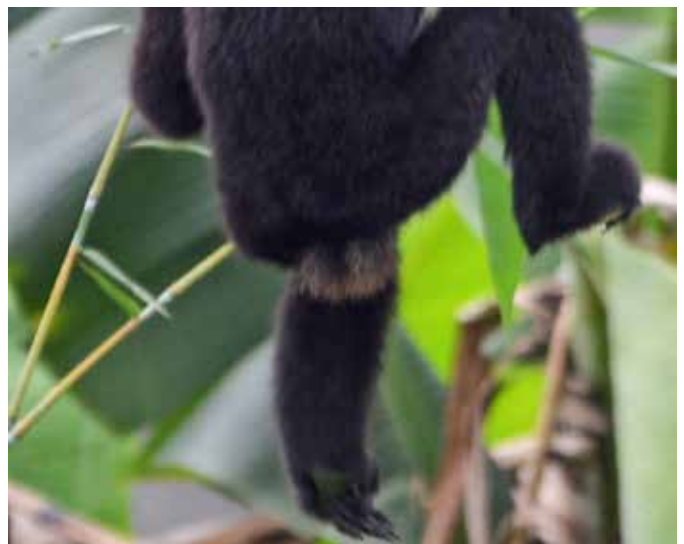


Figure 4c. Close up of tail-tuft in *Hoolock hoolock mishmiensis* male. Photo by Anwaruddin Choudhury.

of several thousands of construction workers would also impact hoolocks and other species as on off days they go hunting as has been observed elsewhere in the region, and anthropic pressure on the habitat would increase manifold.

Owing to the rapid growth of the human population, the land being farmed, including *jhum*, and the demand for firewood are increasing. The human population in the formerly undivided Dibang Valley, for instance grew from 43,000 in 1991 to 62,000 in 2011, i.e., in just two decades. Since the

bulk of the rural population practice farming as their main occupation, and new villages and hamlets appear constantly, the destruction of the natural habitat seems inevitable. Despite all these constraints, the Lower Dibang Valley and Lohit are the only areas that have two advantages for protecting the Mishmi Hills hoolock: 1) Still large contiguous habitat and a relatively sizeable population for long-term conservation; and 2) the main tribe, the Mishmis, do not hunt it.



Figure 5a. Close up of a *Hoolock hoolock mishmiensis* male. Photo by Anwaruddin Choudhury.



Figure 6a. Close up of a *Hoolock hoolock mishmiensis* female. Photo by Anwaruddin Choudhury.



Figure 5b. Close up of a *Hoolock hoolock hoolock* male. Photo by Anwaruddin Choudhury.



Figure 6b. Close up of a *Hoolock hoolock hoolock* female. Photo by Anwaruddin Choudhury.

Conservation Measures Taken

The hoolock gibbon is protected under Schedule-I of the Wild Life (Protection) Act of India, which prohibits its killing or capture, dead or alive. Enforcement, however, is inadequate even in the single protected area. Most locals are unaware of its legal status. The Mishmi Hills hoolock is categorized as “Endangered” on the IUCN Red List of Threatened Species (Choudhury *et al.* 2020).

Discussion

The northernmost limit of the Mishmi Hills hoolock is also the northernmost for the genus (including *H. leuconedys* and *H. tianxing*) (Fig. 8). Four rivers enclose the distribution of *mishmiensis*—Ithun, Dibang, Lohit and Tid-ding—and only in the northeast does higher elevation limit its range.

Trivedi *et al.*'s (2021) phylogenetic genetic study confirmed that the Mishmi Hills hoolocks are not *leuconedys*, as was supposed by Das *et al.* (2006), Chetry *et al.* (2008, 2010) and Chetry and Chetry, (2010). The sample size in the study of Trivedi *et al.* (2021) was small ($n = 14$), however, and, indicating that the Noa-Dihing River was the southern limit of the Mishmi Hills hoolock, one of their samples was from Wakro in the Lohit district south of the Lohit River. The Noa-Dihing River originates in the extreme northeastern end of the Patkai range in Changlang district, and is not known to be an effective barrier. The Lohit River on the other hand is much bigger, originating in southeast Tibet, China, it cuts across the Mishmi Hills forming gorges and acts as an effective barrier for several mammals (Choudhury 2013a).

Trivedi *et al.*'s (2021) suggestion that *Hoolock hoolock* could be allowed to interbreed in captivity with the Mishmi Hills hoolock is unfortunate, as both have noticeable morphological variations and are unable to interbreed naturally in the wild because they are isolated by the Lohit River. The condition of hoolocks is not yet as precarious as that of, for example, the Javan rhino *Rhinoceros sondaicus* which desperate measures resulted in the recommendation of an attempt to interbreed Javan and Vietnamese animals¹.

Trivedi *et al.* (2021, p.469) stated that the “all Mishmi Hills hoolock samples formed a subclade within the *Hoolock hoolock* samples” (p.469), suggesting that they form a coherent variant. They found the split between *Hoolock hoolock* and *H. leuconedys* to be about 1.49 mya (PP = 0.99) and it would be interesting to know the age of the split between the hoolocks north and south of the Lohit River. In their discussion, they reaffirmed that their “phylogenetic analysis shows that the Mishmi Hills hoolock

1 Which did not happen, however, due to the death of Vietnam's last animal (B. Talukdar, chair of Asian Rhino Specialist Group, pers. comm.).



Figure 7a. Hoolock habitat with scattered trees near Abango, Lower Dibang Valley. Photo by Anwaruddin Choudhury.



Figure 7b. Last patch of hoolock habitat in Kundil Kaliya, Sadiya. Photo by Anwaruddin Choudhury.



Figure 7c. Tiny habitat of hoolock gibbons in Kukuramara, Sadiya is cut by a main road. Photo by Anwaruddin Choudhury.

population is a subclade of *Hoolock hoolock*.” Next, however, they stated that “although the pelage coloration suggests that the Mishmi Hills hoolock population belongs to *H. leuconedys*, our genetic analyses do not support that hypothesis”. But pelage coloration had never suggested affiliation with *leuconedys*, except in some females that showed some resemblance. The hoolocks in the Mishmi Hills do not have a silvery or whitish tail tuft nor wide gaps between their eyebrows. In the section on hylobatid phylogenetics, Trivedi *et al.* (2021) suggested that “either the Mishmi Hills hoolock population has isolated very recently, or there might be recent gene flow between Mishmi Hills hoolock and *H. hoolock* populations” (p.473), but they go on to say that “More samples are needed from the high-altitude areas of Mishmi hills to resolve this question”. If the question is not resolved then it is ill-advised to allow for or suggest interbreeding in captivity—a step which, if taken, would be difficult to rectify if they are proved to be distinct lineages.

When discussing my findings concerning the identity of the capped langur *Trachypithecus pileatus* subspecies on the basis of distinct hair patterns in a species which has seasonally variable coat colour (Choudhury, 2014), Colin P. Groves (pers. comm., 2014) suggested that one or two subspecies could be upgraded to full species if their hair pattern is a permanent feature unique to those animals. Trivedi *et al.* (2021) affirm that the Mishmi Hills hoolock is a variant, but at the same time they say that it is not a subspecies. In this case, I argue that their conclusion is premature. The concept of subspecies is under constant debate. There are noticeable and consistent morphological differences between the Mishmi Hills hoolock and the nominate form, and they are geographically separated by a recognised zoogeographic barrier, as detailed in Choudhury (2013b). Subspecies are largely subjective categories. In this regard, Mayr (1959; pp.7–8 in Thomson 1969) stated that “subspecies are ‘geographically defined aggregates of local populations which differ taxonomically from other such subdivisions of a species’”. He also mentioned four features of geographic variation that make it difficult to delimit a subspecies objectively. According to Mayr (1982) and Monroe (1982), subspecies refer to one of two or more populations of a species living in different subdivisions of the species’ range and varying from one another by morphological characteristics. According to ‘Species – Speciation’ (2021) “a common criterion for recognizing two distinct populations as subspecies rather than full species is their ability to interbreed even if some male offspring may be sterile. In the wild, subspecies do not interbreed due to geographic isolation”. Russell *et al.* (2011) argued that “when geographically separate populations of species exhibit recognizable phenotypic differences, biologists may identify these as separate subspecies; a subspecies is a recognised local variant of a species”.

Queiroz (2020) noted that disagreements about whether to recognize certain groups as species versus subspecies have existed for centuries. He referred to Darwin (1859, p.51), for example, and quoted “Certainly no clear line of

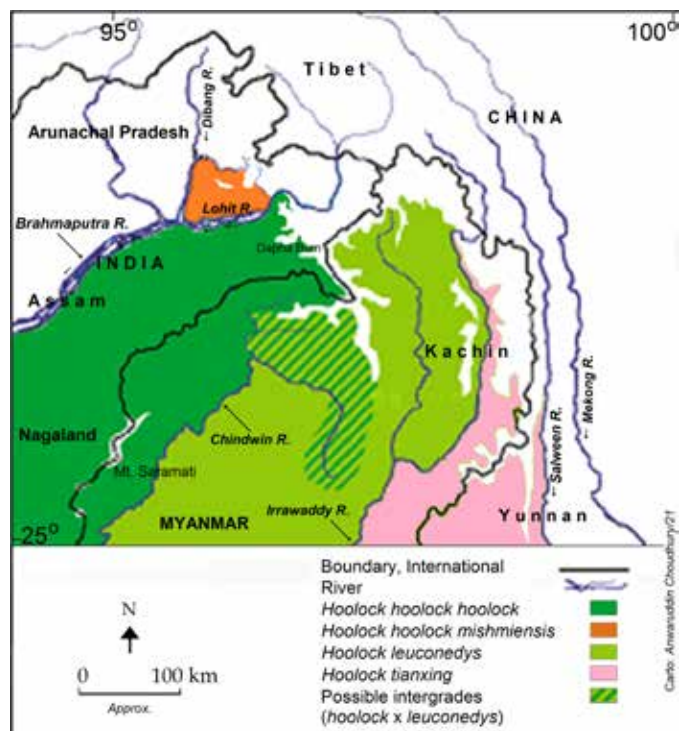


Figure 8. The northern ranges of the hoolock gibbons (modified from Choudhury, 2013b).

demarcation has yet been drawn between species and subspecies” and that (1859, p.47) “cases of great difficulty, which I will not here enumerate, sometimes occur in deciding whether or not to rank one form as a variety of another, even when they are closely connected by intermediate links; nor will the commonly-assumed hybrid nature of the intermediate links always remove the difficulty.” (Note that Darwin commonly used the term “variety” for taxa that later authors would call “subspecies.”) Thomson (1969, p.7) defined a subspecies as “a population of which the members can be morphologically distinguished, if sometimes only on average, from the members of other populations of the species to which all belong.”

Vinarski (2015) noted that the current meaning of subspecies as a morphologically and spatially separated population group or as a synonym for “geographical race” was established by the end of the 19th century. This concept reached its maximum popularity in the 1940s and 1950s and was followed by an evident crisis in subspecies-based systematics that is still unresolved, especially in the systematics of invertebrates. The reasons for the decline in the popularity of the subspecies category include the emergence of new species concepts lacking the subspecies rank (Phylogenetic Species Concept) but the subspecies category is still in demand in the systematics of vertebrates as a means of identifying individuating lineages (see, for example, Tattersall, 2007).

Molecular taxonomy has emerged as a major tool that helped streamline species-level classification and resolved many doubtful issues to a great extent but at a lower rank,

i.e., subspecific level which is also known as a geographic variation, morphology and geographic isolation should always play a major role.

Recommendations

A number of important known habitats of *mishmiensis*, which are outside the protected area network, should be declared as community reserves or wildlife sanctuaries. In Assam, they are the Sadiya Hoolock Sanctuary (in three blocks); in Arunachal Pradesh, the Paya Community Reserve (part of the Paya Reserved Forest where some hoolocks are still surviving), and part of the Denning Reserved Forest, which could be declared a sanctuary and community protected area for isolated hoolocks that at least has linear tree connectivity. These isolated areas have already become centres of eco-tourism—they are accessible by roads or a short trek on flat terrain, and it is relatively easy to see the hoolocks there. The Mehao Wildlife Sanctuary should be better protected, with increased staff and regular patrolling. Measures should be taken to control *jhum* cultivation as well as hunting by non-Mishmi tribes. The plans for the mega dams of Dibang and Demwe need review (if necessary they should even be shelved) for various reasons, they include the seismic sensitivity as they are in a highly earthquake-prone area, social issues, and damage to ecosystems, including avoidance of submergence of hoolock habitat, The medium-sized dams of the Ashu Pani and Ithun rivers also need review. The severe disturbance to the habitat during construction, including roads, buildings, power houses, staff quarters, and the influx of thousands of labourers, needs to be reviewed, modified and monitored. Awareness campaigns should involve the churches, traditional temples and the village headmen to promote conservation measures and programs that should be set up for the regular monitoring of the gibbon populations in select sites in the four states. In the Assam areas, notification of a protected area could involve the reintroduction of some animals from Lower Dibang Valley, or the conservation breeding centre at Itanagar.

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