



Conservation status and threats of lesser known Sciuridae species in Dibang Valley District of Arunachal Pradesh, India

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Abstract

Pristine forests of northeast India harbor different species belonging to Sciuridae family. Dibang Valley District of Arunachal Pradesh state has a wide range of forest types, elevation and environmental conditions that provide an ideal habitat for gliders and arboreals. However, the existing knowledge about these lesser-known species in this region is very limited, and therefore this study aims to understand the current conservation status of six squirrels' species, viz. *Callosciurus pygerythrus*, *Dremomys lokriah*, *Callosciurus erythraeus*, *Tamiops maccllellandi*, *Hylopetes alboniger*, and *Petaurista mishmiensis*. We approached the indigenous Idu Community who predominantly resides at the Dibang Valley District and conducted a semi-structured questionnaire survey to evaluate their Traditional Ecological Knowledge (TEK) about these species. The outcome of the survey highlights serious concern of anthropogenic factors for the diminishing population of the gliders and arboreals in the region. Wild hunting, accelerated developmental activities, fragmented habitat, over-harvesting of non-timber forest products (NTFP) and timber logging are the major threats for the population decline. Possible conservation programs in this area should include long-term activities such as community-based conservation-friendly initiatives, sensitization through awareness programs, alternative livelihood options, and sustainable developmental programs.

Keywords: Idu Mishmi, Mishmi hills, Squirrel, Taboos, Traditional knowledge.

Introduction

The Sciuridae family of Order Rodentia holds a speciose lineage of 285 species (58 genera) throughout the world except on Madagascar, Australia and Antarctica and with varying niche preference, majorly classified as arboreal, ground dweller and gliders^{1,2}. Forest ecosystem of Southeast Asia harbors high squirrel diversity and endemism as being a part of global biodiversity hotspot^{1,2}. Northeast India, too is home to a large number of rodents, including fourteen Sciuridae species^{1,3} found only in the magnificent forests of Arunachal Pradesh which falls in the transition zone of Himalaya and Indo-Burma region⁴. Though these forests function as an epicenter of squirrel diversity, very limited publications are found focusing on conservation and management plans². Squirrels play a vital role in the ecosystem services as seed disperser, fungal spore disperser, and act as a significant prey base for a multitude of species in temperate and tropical forests. Their role in the regeneration of forests is huge². They are highly forest dependent animals, adaptable only to a certain degree of habitat degradation⁵. Squirrels have evolved as cryptic and elusive in nature. In addition, the gliding squirrels are nocturnal, hence their habit and habitat has created more difficulty for researchers to study in a detailed way. To date there have been very few studies on these species and, as a result, there is a paucity of information on several aspects of their ecology⁶.

This study focuses mainly on documentation of occurrence, conservation status, and threats of four arboreal squirrels, *Callosciurus pygerythrus* (Hoary-bellied squirrel), *Dremomys lokriah* (Orange-bellied Himalayan squirrel), *Callosciurus erythraeus* (Pallas's squirrel) and *Tamiops maccllellandi* (Himalayan striped squirrel) as well as two gliders, *Hylopetes alboniger* (Parti-coloured flying squirrel) and *Petaurista mishmiensis* (Mishmi giant flying squirrel), all of which are well abundant in the forest patches of Dibang Wildlife Sanctuary (DWLS) and its adjoining landscape of community-forests of Arunachal Pradesh. *Callosciurus pygerythrus*, *Dremomys lokriah*, *Callosciurus erythraeus*, and *Tamiops maccllellandi* are native to Bhutan, India, Bangladesh, Nepal, China, Myanmar, Thailand, western Cambodia, northern Vietnam, western Lao PDR and northern Peninsular Malaysia, Taiwan⁴⁻¹². These four species share a similar kind of distribution pattern in the Northeastern South Asia, Southern China, and much of Mainland Southeast Asia^{8,10-12}. In India, the glider, parti-coloured flying squirrel is widely distributed in Eastern Himalaya including Arunachal Pradesh, Sikkim, Assam, Nagaland, Manipur, and northern West Bengal^{13,14}, at an elevation of 1500m to 4500m above mean sea level (AMSL). Recently discovered giant flying squirrel in the Mishmi hill is endemic only to specific parts of Arunachal Pradesh in northeast India, distributed only at Dibang valley and Anjaw districts. At Dibang valley, its presence has been recorded particularly in

villages of Alinye, Arzoo, and Etalin¹⁵. Despite its significant ecological system of wildlife, the Dibang valley was surveyed little and studied below par, due to its rugged terrain and inaccessible geographic location. Given the limited understanding of the species ecology, the hunting and other anthropogenic effects on their populations can, at best, be hypothesized. In this manuscript, we discuss the conservation status of all six Sciuridae species found in and around DWLS of Dibang Valley District, Arunachal Pradesh, India.

Study area: The study was carried out at the centre and periphery of DWLS (95°17'-96°38' E and 28°38'-29°27' N) of Dibang Valley District of Arunachal Pradesh. The district has an area of 9,129km², out of which 4,149km² area comes under DWLS (Figure-1). Anini is the district headquarter and it is the least populated district in India having a population density of less than 1 inhabitant per km²¹⁶. Dibang Valley extends over the Mishmi Hills and is surrounded by the Autonomous Region of Tibet at the northern and eastern sides. The altitude ranges from 1,800-5,500m, and the area receives an annual rainfall of 2,866 mm from occasional rains and the southeast and northeast monsoons¹⁷. The forest types are broadly classified as temperate broad-leaved forest, temperate conifer forest to alpine forest⁹⁻¹¹. Conifer forests hold mainly three kinds of species viz., *Pinus roxburgii*, *Pinus wallichiana* and *Pinus merkushii* while the alpine forest consists mainly of dwarf rhododendrons, such as *Rhododendron nivale*, *Rhododendron anthropogony*,

Rhododendron thomsonii, *Sedum* spp., *Fescuta* spp., *Rhodiola* spp., *Saxifraga* spp., *Saussaurea* spp., *Arenaria* spp., and *Rheum* spp. *Rhododendron arboretum*, *Alnus nepalensis*, *Castonopsis indica*, *C. tribuloides*, *Engelhadtia spicata*, *Macaranga denticulate*, *Lithocarpus fenestratus*, *L. pachyphyllus*, *Diploknema butyraceoides*, *Terminalia myocarpa* etc dominate over the region of Temperate broadleaved forest¹⁸⁻²⁰. Among the lush green forests, there lay secondary growths of degraded forest along with bamboo patches and grasslands. Idu Mishmi, the main inhabiting community of Dibang Valley District is a recognized Schedule Tribe (ST) under the Indian Constitution Act. They follow the religion of animism and believe in the presence of spirits living in the natural surroundings.

They have their own culture, dialects, healing practices and perform traditional ritual ceremonies²¹. The majority of households in this community are subsistence farmers, seasonal hunters and very few accounts to government employees, contractors, and businessmen. They mostly indulge in shifting cultivation at different seasons for various crop types. The shifting cultivation is the only practicable way of farming in such kind of rugged terrain in the Dibang Valley District. However, they have a strong traditional ecological knowledge-based management system and taboos to control the overexploitation of wild animals, natural resources and enhance proper regulation among the ecosystem pyramid and ultimately aid in the conservation of species²².

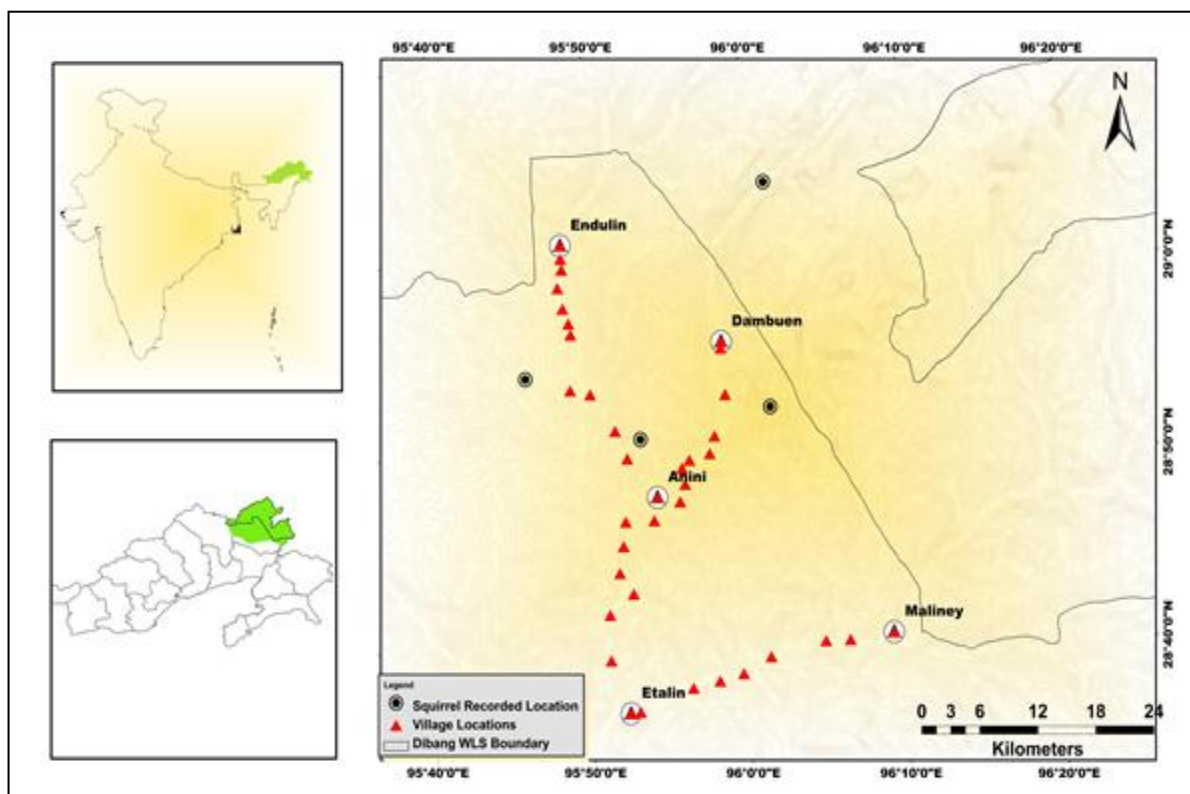


Figure 1: Map showing the photographic record of squirrel species in camera traps and settlement areas around the periphery of Dibang Wildlife Sanctuary, Dibang Valley, Arunachal Pradesh.

Materials and methods

Sighting records were photographed during our opportunistic observations while working in the forests for camera trapping of mammals. We also conducted informal interviews with local people to survey their existing knowledge about squirrels. We spoke to tribal villagers, expert hunters, and traditional experts such as priests from 104 households. While documenting information, the focus was given on indigenous names of squirrel species, the reason for hunting, hunting season, usage of hunting tools and methods for each species, and also whether any taboo is there to hunt rodents or not. Confirmation of animal presence and facts were checked by showing them visual aids photos from field guides on mammals' and high-resolution color photographs.

Results and discussion

The survey was conducted during the years of 2015-2017. A total of 104 households in 28 villages were surveyed in which 12 villages and 16 settlements were covered from the rural area and Anini town of Mipi and Anini circles respectively around the DWLS of Dibang Valley District. The survey revealed that the six species of squirrel viz., hoary-bellied squirrel, orange-bellied squirrel, Pallas's squirrel, Himalayan striped squirrel, particoloured flying squirrel, and Mishmi giant flying squirrel were commonly hunted from the nearby villages, forest, and even inside the protected area, primarily sustenance and leisure^{2,23}. Though, the presence of hoary-bellied and the particoloured flying squirrels are firmly recognized and

identified by Idu hunters, we were not able to collect the photographs of parti-coloured flying squirrel during the survey period. However, tail representation of a hoary-bellied squirrel was collected from a secondary source.

Discussion: Luxuriant vegetation types of Arunachal Pradesh support wide-ranging habitats for arboreal rodents at varied altitudinal gradients from lower to a higher elevation^{8,10-12}. Dibang Valley District also has a wide range of forest types, elevation and environmental conditions that provide ideal habitat for these arboreal species. However, these squirrel species face a serious threat due to emerging anthropogenic activities. Major threats assessed by IUCN to large extent are intense hunting pressure, forest fire, encroachments, fragmentation, *jhum* (slash and burn agriculture), residential and commercial development, unsustainable extraction of annual and perennial non-timber forest products, logging and wood harvesting, etc.⁹. The tribal communities of northeast India are specialized hunters; their traditional cultural systems fundamentally rely on natural resources. The vast majority of them regularly consume meat. The Adi tribe celebrates 'Aran' in the first week of March, where they trap rodents, including squirrels²⁴. Orange-bellied Himalayan squirrel is hunted for medicinal and medico religious purposes and is protected by the Apatani tribe through their traditional conservation practice called Dapo²⁵. Remoteness and deficiency of protein-rich food have led these indigenous tribes to practice hunting for ages, previously used to be a way of maintaining higher social status too^{26,27}.



Figure-2: Photographic images of (a) Himalayan striped squirrel, (b) Orange-bellied Himalayan squirrel, and (c) Pallas's squirrel at different vegetation patches in the Dibang valley (left to right).



Figure-3: (a) Skin of Mishmi giant flying squirrel, (b) dead Orange-bellied Himalayan squirrel, (c) Mishmi giant flying squirrel and Hoary bellied-squirrel (encircle) from the Dibang Valley (left to right). Photos credit to Anonymous.

Table-1: Records of six Sciuridae species with conservation status and purpose of hunting through different methods. IUCN status, IWPA and Indian status through different methods.

Species	Idu's name	Conservation Status			Hunting purpose	Mode of hunting	Hunting season	Records through		
		IUCN	IWPA	Indian Status				CT	DS	QS
Hoary-bellied Squirrel	<i>Anache</i>	LC	Schedule II	Common	Meat Consumption, key chain	Stone trap, bamboo trap, small loop trap, gun etc.	Throughout the year	-	+	+
Himalayan striped squirrel	<i>Adaaka</i>	LC	Schedule II	Common	Meat Consumption	Gun, catapult etc.	Throughout the year	+	+	+
Pallas's squirrel	<i>Adaa</i>	LC	Schedule II	Uncommon	Meat Consumption, trophy ornamentation	Gun, small loop trap etc.	Throughout the year	-	+	+
Orange-bellied Himalayan squirrel	<i>Anache</i>	LC	Schedule II	Common	Meat Consumption, key chain	Stone trap, bamboo trap, small loop trap, gun etc.	Throughout the year	+	+	+
Particolored flying squirrel	<i>Aghrhi</i>	LC	Schedule II	Locally common	Meat consumption	Gun, catapult etc.	Throughout the year	-	-	+
Mishmi giant flying squirrel	<i>Kameyy</i>	NT	Schedule II	Endemic	Meat consumption, trophy board ornamentation, muffler	Gun, stone trap etc.	Sep-Oct to till winter	-	+	+

LC= Least Concern; NT= Near Threatened CT= Camera Trap; DS= Direct Sighting; QS= Questionnaire Survey.

Idu Mishmi is the major tribal inhabitants of Dibang Valley District. They practice traditional hunting not only to fulfill their protein need as meat consumption but also for performing various traditional rituals. Earlier, professional hunters used to keep a tail of Pallas's squirrel *D. lokriah* on the trophy board of their houses as an attractor of good fortune and to keep bad spirits away from the house. For social ceremonies such as "Individual Reh", harvest festival (Keh-meh-ha), and marriage ceremony, they gather a stock of wild meat of rodents, pheasants, and fish species at least one month prior. They consume rodents either by burning skins, smoke-dried, or directly as fresh meat. Among squirrels, hunting of hoary-bellied squirrel (*Anache*), Pallas's squirrel (*Adaa*), orange-bellied squirrel (*Anache*), and parti-coloured flying squirrel (*Aghrhi*) are very common as females can consume that meat without any restrictions or taboos. Though hunting of Himalayan striped squirrel (*Adaaka*) is not common due to its arborealism, preference of living in the primary forest as habitat, and its small body; young people often hunt them more for the purpose of leisure or sports. Mishmi giant flying squirrel (*Kameyy*) is the most hunted species by youngsters, thanks to their shrill vocalization which can be heard from a few hundred meters away even in the densest forest and dark nights. Though

older people do not prefer to kill Mishmi giant flying squirrel, as 'Kameyy' is considered to be one of the priests in animism and animals of 'Golo(n)' in their myth story. According to traditional belief, the spirit of high mountains, 'Golo (n)' will be angry and can bring a curse upon the family if it has been hunted more than a specific number.

Hunting of *P. mishmiensis* reaches its peak during September-October and continues throughout the winter. Other five species are frequently hunted down throughout the year. Among those six species, regular hunt snatches the life more of *P. mishmiensis*, *C. pygerythrus*, and *D. lokriah* as they are found mostly in forest fringes. To trap them up in their traditional hunting procedure *Depaa* (a trap made up of stone and bamboo) or *Adaapu*, they use fruits of locally abundant *Quercus* spp. (Ibishiand Ekashi in Idu) as bait^{27,28}. They get down from the tree to the ground in a hope of foraging on that fruit and get trapped. The Mishmi giant flying squirrel is also commonly hunted by using of guns. Pallas's squirrel too is primarily arboreal and hunting is mostly done by the gun^{27,28}. Himalayan striped squirrel is mainly hunted by catapult or rarely by gun and least preferred among those six species. *Etombra* (small loop trap or twig trap) is another common way to hunt small

sized squirrels in high altitude^{27,28}. Hunting of larger mammals in this area is sustainably maintained by the traditional taboo system in Idu culture²⁷. But in the case of small mammals, especially hunting of Sciuridae species is not restricted in this taboo system. Hence, indiscriminate hunting of all these species can lead to population decline to extirpation from small habitat patches in DWLS and its adjoining landscape.

Apart from this local subsistence hunting pressure, the valley is experiencing accelerated development in recent years. Various upcoming developmental projects, such as linear connectivity construction, infrastructure development, multiple hydroelectric projects, and pipeline laying can lead to forest fragmentation if not managed sustainably. Moreover, people of this valley are highly dependent on forest products such as extraction of NTFP, and medicinal plants like *Paris polyphylla*²⁹. For crop cultivation, they utilize a sustainable process of *jhuming* in and around their native village (or *Aateko*). They utilize the land for 2-3 years' continuous crop cultivation and keep the land barren for a minimum of 7-10 years until bamboo patches grow there. This type of farming has not yet become a major cause for the loss of animals because of the low population of the indigenous tribe. However, dramatic population rise, excessive extraction of forest products and shifting cultivation can lead to the population decline of these species in the near future. Some states of northeast India have already faced such a negative impact of excessive and unsustainable *jhum* cultivation³⁰. Unlike *C. pygerythrus* and *D. lokriah*, rest four species viz. *C. erythraeus*, *T. maccllellandi*, *H. alboniger*, and *P. mishmiensis* are sensitive to anthropogenic pressure. Unsustainable development for the benefit of human civilization put the lives of these animals at risk.

Undisturbed forest structure is crucial for providing ideal habitat to arboreal species³¹. Not only that, the degree of arborealism, canopy cover, tree density, low human disturbances, nesting requirements, and diet plays an important role in squirrel abundance at any forest patch³². Responses of hoary-bellied, Himalayan striped, and Pallas's squirrels to logging were determined by comparing their abundance in Pakke Wildlife Sanctuary³². There, it has been observed that *C. erythraeus* and *T. maccllellandi* prefer unlogged primary forest, particularly *C. erythraeus* prefer habitat with higher tree density and canopy cover. Flying squirrels too prefer continuity between forest patches for smooth locomotion and resource utilization¹⁶. Though detailed study is scanty, by secondary information we can apprise that Mishmi giant flying squirrel seems to be a specialist and choose only a few tree species to make a nest¹⁶. Being a specialist, they are more vulnerable to habitat modification, such as the creation of canopy gaps, loss of food, and nesting sites due to logging. Habitat degradation can reduce the availability of breeding sites and changes in behaviour, especially their foraging pattern³¹. Thus they are facing a risk of extinction with increased shifting cultivation and illegal logging^{6,13,15}. Both hoary-bellied squirrel and orange-bellied squirrel can escape the negative consequences of habitat

fragmentation as they are tolerant of habitat degradation^{11,31}. They can survive well in alternating habitats and fragmented forest zones. The presence of hoary-bellied squirrel is well abundant in logged forest and plantations, with having low canopy cover and reduced tree density^{31,32}.

Conclusion

Though hunting of squirrel species is legally prohibited by the Indian Wildlife (Protection) Act 1972, enforcing protection laws in Dibang Wildlife Sanctuary's adjacent areas is difficult as it is a complex issue for the North-East Indian states. For the tribal community in the state, hunting is part of their existence and it has been passed on to generation after generation. Hunting takes care of their subsistence needs and socio-cultural practices however, nowadays the trend is taking an ugly turn towards commercial hunting. Though selling of hunted squirrel species is not a usual thing yet like other wild meat. The Idu sell at district headquarter: gradual access to markets and opportunities of bulk selling might drive the hunters beyond the subsistence needs for additional income^{25,33}.

Thus, conservation awareness programs are utmost required, not just amongst the local communities and schools, but for the government officials, politicians, bureaucrats, and law enforcement agencies too. Social taboos of Idu Mishmis traditionally provide a safeguard against the over killing of certain species of other wild animals, but not in the case of squirrels in the community. Community-based efforts that provide incentives for eco-friendly and sustainable practices could work in this area. Protection and best practices due to traditional knowledge of local community about natural resources conservation as well as their sustainable utilization should be merged with the conservation management of the Forest Department. With a very limited amount of knowledge available on the current population status and conservation requirements of these species, it is necessary to initiate a conservative program to reduce threats posed by hunting. Keeping the habitat fragmentation in check is necessary for the squirrel population to survive well. Proper protection of natural habitats with fruiting trees and alleviated anthropogenic disturbances can be one of the mitigation procedures. Lack of accurate information on current status is another important factor that impedes rodent conservation. Alternative resources and livelihood options for hunters, environment friendly sustainable development, and awareness about ecological significance of these species are crucial for long-term conservation.

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