 doi:10.20944/preprints202109.0473.v1

Squirrels and tribes – A cultural analysis from Indian Eastern Himalayas

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Abstract

Based on an ethnozoological study carried out from December 2018 to November 2019, this paper attempts to document the usage of squirrel species for various purposes by the Adi, Idu Mishmi, Miju Mishmi, Tangsa, Chakma and Monpa tribe living near the villages adjoining the protected areas located in the districts of East Siang, Lower Dibang Valley, Dibang Valley, Lohit, Changlang and West Kameng of Arunachal Pradesh, India. The paper also describes the use of certain squirrel species as a part of their traditional culture and lists their names in English, Vernacular and Latin names. The study has led to an understanding that eight squirrel species are used by the tribes for cultural, food and medicinal purposes. This work contributes to ethnozoological research by describing a knowledge system of squirrel species use and the association of squirrel species with the cultural believes of the tribes.

Key words: Cultural use, squirrel, gliding squirrels, tribes, Arunachal Pradesh

Introduction

Traditional Ecological Knowledge (TEK) can be defined as ““a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, and about the relationship of living beings (including humans) with one another and with their environment” (Berkes 1999). Gadgil, Berkes, and

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TEK is defined as abstract, qualitative, inclusive, intuitive, diachronic, and is formed from communal knowledge gained over time through practice and application and it is traditionally shared through oral accounts, is highly synonymous to adaptive management, and provides a holistic view of managing for multiple resources (Gadgil, Berkes and Folke 1993; Berkes, Colding, and Folke 2000; Mason et al. 2012). Some authors consider it as "cumulative and long-term, dynamic, historical, local, holistic, embedded, moral, and spiritual" (Menzies and Butler 2006). An example of a traditional ecological knowledge moral attribute is preventing any waste and avoiding greedy use of environmental resources (Menzies 2006).

The traditional medical knowledge of indigenous peoples around the world has played an important role in identifying species that are endowed with essential medicinal values for the treatment of human and livestock health problems (Lev 2003). Human societies have accumulated tremendous knowledge about animals over the centuries, that is closely linked to many other cultural aspects, and this zoological knowledge is an important part of our human cultural heritage (Alves and Suoto 2015). The value of traditional ecological knowledge has only recently been recognized and in combination with western scientific approaches show great promise in natural resource management (Hoagland 2017). Zootherapy, the curing of human ailments using animals as therapeutics (Costa-Neto 2005), plays an important role in healing, magic rituals and religious practices in all around the world (Anageletti et al. 1992; Kendie et al. 2018). As most of the human communities are losing their socio-economic, cultural and local ecological knowledge, there is an urgent need to document it (Aswani et al. 2018; Hill et al. 2020). Animals and products obtained from their body parts are part of the inventory of medicinal substances, and such practices persist in traditional medicine (Alves and Rosa 2005). Zootherapy is an important alternative to many other well-known therapeutic approaches. Wild and domestic animals, as well as their by-products, such as

 doi:10.20944/preprints202109.0473.v1

hooves, skins, bones, and tusks, are key elements in the manufacture of therapeutic, protective, and preventive remedies (Anageletti 1992; Adeola 1992; Kang 2003). In addition, animals' cultural importance is reflected in art, literature, symbolism, music, mythology and religion (Senior 2009; Alves 2018). Understanding the potential values of wildlife species is important to document but also help us appreciate conservation and management opportunities.

With a mere 2.2% of the world's land area, India is gifted with a high faunal diversity of 101,167 faunal species, which accounts for 6.45% of the Earth's total faunal species (Venkatraman et al. 2020). Arunachal Pradesh in the Northeastern India lies between the coordinates of 26° 28' to 29° 30' N latitude and 91° 20' E to 97° 30' E longitude and has an area of 83,743 km^2. It is the largest state of the northeastern region and is part of the Eastern Himalayan biodiversity hotspot. Uneven topography and a vegetational range from tropical to alpine are the characteristic features of the state. Arunachal Pradesh also is a hotspot of biocultural diversity. With over 26 major human tribes and 105 subtribes (Solanki and Chutia 2004) with distinctive dialects, social organisation, food tradition, and habituation, the state represents a great deal of cultural diversity. The presence of such rich ethnic diversity and biological resources has lead to the evolution of numerous ethnozoological knowledge systems (Kato and Gopi 2008) including food traditions, ethnomedicinal traditions, and ritual purposes. The tribal people depend on the forest for their livelihood livelihood and their very survival depends on their ability to efficiently and accurately track and manage their biological resources.

Squirrels (Family Sciuridae) are important components of an ecosystem, which play important ecological roles to include prey-predator relationships, seed dispersal, and pollination. There are 58 genera of squirrels which can be further divided into tree squirrels,

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ground squirrels and gliding squirrels on the basis of morphology, social structure and behaviour (Thorington et al. 2012). Southeast Asia is a hotspot of squirrel diversity with 97 species of squirrels (Thorington et al. 2012) and in Arunachal Pradesh, about 21 species of squirrels can be categorised into 14 gliding squirrel species (Krishna et al. 2016) and 7 tree squirrel species (Datta and Nandini 2014).

Different tribes of Arunachal Pradesh hunt squirrels for food, ethnomedicinal or ritual reasons. Squirrel like the Orange-bellied Himalayan Squirrel (*Dremomys lokariah*) are used for disease treatment and social ceremonies by Apatani community; Malayan giant squirrels (*Ratufa bicolor*) are used for ethnomedicinal, social, and traditional purpose by the Adi community (Dollo et al. 2010; Singh et al. 2014). Species like Orange-bellied Himalayan Squirrels, Grey-headed Gliding Squirrels (*Petaurista caniceps*) and Particolored Gliding Squirrels (*Hylopetes alboniger*) are hunted for wild meat by the Idu Mishmi community (Aiyadurai 2014). The richness of the ethnozoological knowledge of the tribal communities of Arunachal Pradesh encouraged us to explore and document the use patterns of squirrels in traditional foods, ritual ceremonies and medicine systems.

Methods

Study Area

The study area is comprised of the districts of Lower Dibang Valley (3,900 km^2), Dibang Valley (9,129 km^2), Lohit (11,402 km^2), East Siang (4,005 km^2), Changlang (4,662 km^2) and West Kameng (7422 km^2), located in eastern and western Arunachal Pradesh (Figure 1) that cover about 40,520 km^2. The districts fall under the mountain ranges of Mishmi Hills, Patkai range and Bomdila range. Several Protected Areas that are located in the districts (282 km^2),

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Dibang Wildlife Sanctuary (4,149 km^2), Kamlang Wildlife Sanctuary (783 km^2), Daying Ering Wildlife Sanctuary (190 km^2), Namdapha Tiger Reserve (1,985 km^2) and Thembang Bapu Community Conserved Area (635 km^2) respectively, which tally about 8024 km^2 of protected area. The region has a rich diversity of squirrel species with 13 species of squirrels documented from the region including endemic Mishmi Hills Gliding Squirrels (*Petaurista mishmiensis*), Namdapha Gliding Squirrels (*Biswamoyopterus biswasi*) and Mebo Giant Gliding Squirrels (*Petaurista siangensis*).

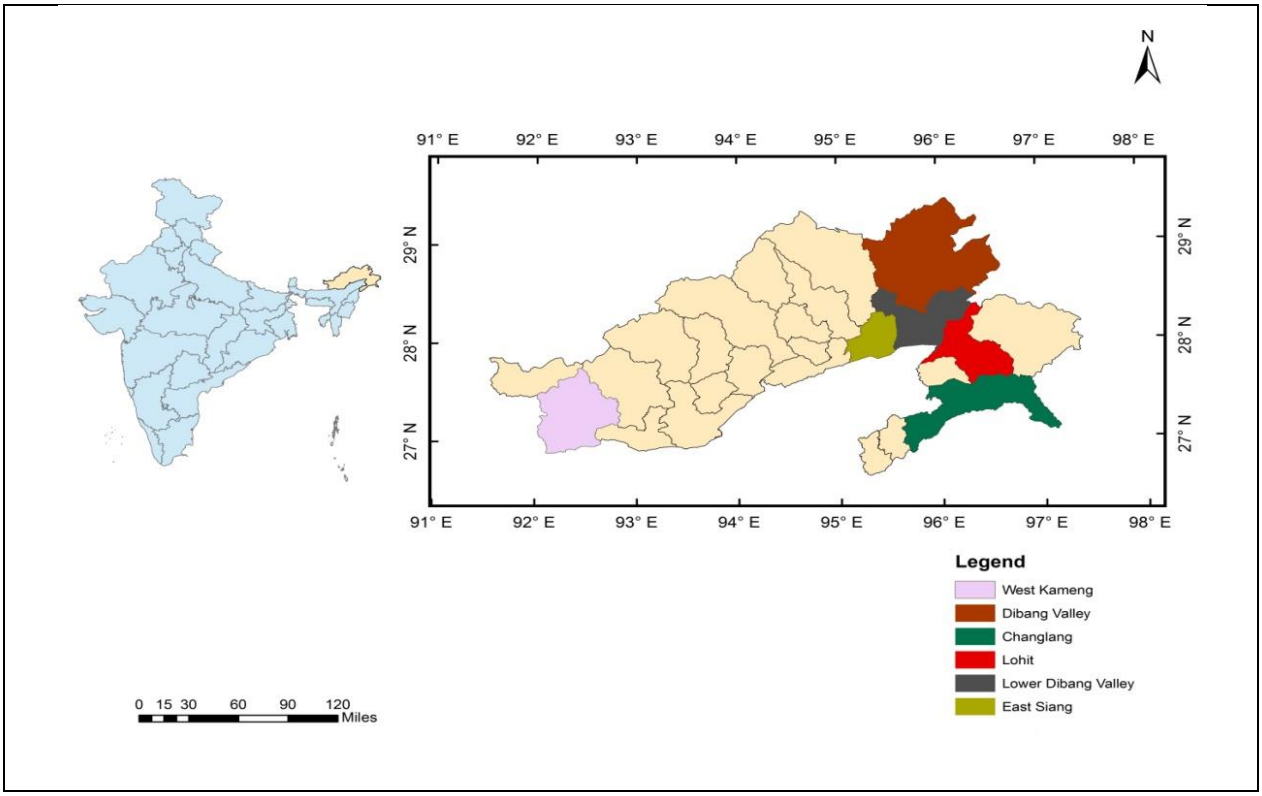

Figure 1. Highlighted districts showing the study locations in the state of Arunachal Pradesh, India.

Tribal Communities

Adi, Idu Mishmi, Miju Mishmi, Tangsa, Chakma and Monpa are the tribes that were interviewed during the study.

 doi:10.20944/preprints202109.0473.v1

Adi

The Adi trace their origin from Pedong Nane, the ancestral mother of Tani-the man. Pedong Nane was the great grand-daughter of Sedi Melo the creator. Adi tribe of Arunachal Pradesh is said to have migrated from Southern China in the 16th century and presently scattered in the eastern Himalayan hills. The Adi primarily inhabits regions within East Siang, West Siang and Lower Dibang Valley. The literal meaning of Adi is considered to be "hill" or "mountain top. (Raj 2010). Family is the smallest unit of administration with a patriarchal structure in. Both nuclear and joint family systems are prevalent nowadays. They have own local customary laws to regulate day to day life ranging from family matters to politics. In order to ensure the smooth functioning of their life, a well organized village council called Kebang, administers village affairs and manages different activities of the village. Kebang is responsible to regulate, formulate laws and issue ordinances for the well-being of the society (Danggen, 2003).

Agriculture is the major occupation and mainly practice Jhum cultivation. Besides rice cultivation, they also cultivate bamboos, vegetables and fruits. Like other tribes of Arunachal Pradesh, Adis are also rich in rituals and festivals. Sedi-Melo is regarded as the creator but is neither worshipped nor followed as source of attain spiritual purity and eternity. Rather, they believe in and worship Donyi-Polo, i.e. the Sun-Moon duality. To them, Donyi-Polo is not the physical Sun and Moon but an unseen supreme power, which is omni-present, omniscient and omnipotent. On the other hand, the people also believe in the existence of numbers of spirits, which are both malevolent and benevolent.

Idu Mishimi

The Idu Mishmi are one of the Mishmi tribes that are primarily inhabitants of Dibang Valley and Lower Dibang Valley district of Arunachal Pradesh. The Idus have a rich oral

 doi:10.20944/preprints202109.0473.v1

tradition with no written record. Agriculture is the main occupation of Idu Mishimi people. In high hills, the people practices shifting cultivation and in plains they do wet cultivation. The Idu Mishimi family structure is generally patriarchal. Generally, when the sons attain the age of marriage they are given separate houses to live with the youngest son becomes the owner of his parent's house.

In religion, they believe in indigenous goddess named as Nani Intaya. Though the Idu Mishimi performs and observed a number of rituals and festivals individually as well as collectively yet their major festival is Reh. Handicrafts and Handlooms are integral part of their tradition (Das 2014).

Miju Mishmi

The Miju Mishmi, also known as Kaman or Kammaan, is one of the three Mishmi tribes of Arunachal Pradesh and primarily located in Anjaw and Lohit districts and are believed have come from the Kachin country of Burma (Mills 1952). Agriculture is the main occupation of the tribe and they cultivate rice along with other vegetables and fruits. Similar to other tribes of Arunachal Pradesh, family is main unit of administration which is patriarchal in nature. Customary laws are prevalent which regulates their day-to-day activities. They believe Amik Matai to be their supreme deity. Their main festival is the Tamla-Du, which they celebrate in the month of February.

Tangsa

The Tangsas' common belief is that they originated in a hill called Masai Sinrapum, which is supposed to be in the east beyond Burma. They consider themselves as a migrant population in search of cultivable lands for their livelihood where living at present. Agriculture is their major occupation along with handicrafts and handlooms. Paddy, millet, maize and arums are

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the major crops. They also grow winter and summer vegetables of different categories. Inter-village trade is common among the Tangsas. Families are patriarchal. They have the system of traditional village council to regulate and manage their day to day activities. The village councils also serve as the traditional justice system. Being an agrarian community, festivals related to agriculture plays an important role in the life of the Tangsas. Champang Mol or Chamchengpa is one of the major festivals which is related to the sowing of seeds in the field, celebrated on the month of February and April (Sebastian, 1999).

Chakma

Ethnically the Chakma people belong to the Tibeto-Burman lineage and speak the Chakma language of the Indo-Ayan family which is related to Assamese and Bengali. They were the original inhabitants of the Chittagong Hill Tracts (CHT) region of the southern Bangladesh (Mondal et al. 2017). Chakma people are the followers of Theravada Buddhism. In Arunachal Pradesh they are given the refugee status and are mostly found in the Changlang, Lohit and Papumpare districts. They celebrate many Buddhist festivals, Buddha purnima being the most important one. In the Month of April, a three days festival called Bishu is also celebrated.

Chakmas are divided into clans *(gojas),* which are further subdivided into subclans *(guttis).*

Monpa

The Monpa are believed to be the only nomadic tribe in Northeast India where they are totally dependent on animals like sheep, cow, yak, goats and horses. The Monpa share a very close affinity with the Sharchops of Bhutan. The Monpa are sub-divided into six sub-groups because of variations in their language, namely, Tawang Monpa, Dirang Monpa. Lish Monpa, Bhut Monpa, Kalaktang Monpa and Panchen Monpa. Most of the Monpa have a

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religious adherence to the Gelug sect of Tibetan Buddhism. But some of the Monpa also adhere to the pre-buddhist religion of Bon. Family units are patriarchal.

Trukdri, is the traditional society of the Monpas that is headed by a council of six members and the members are known as *Kenpo*. Lamas also hold honoured position; two monks are are known and *Nyetsangs* and the other two *Dzongpen*.

Methods

For the information related to the ethnozoological and squirrel use, a study was carried out between December 2018 to November 2019 in the villages adjoining the protected areas located in the districts of Lower Dibang Valley, Dibang Valley, Lohit, East Siang, Changlang and West Kameng. Data on the squirrel specie use in the food, culture and medicine was collected through personal interviews and semi-structured questionnaires with the villagers; no personal information or identities of individuals were recorded beyond tribal affiliation and roles. In all the interviews, local names of the squirrel species were used. The local names were known by showing the photographs of the squirrel species to the people of the respective tribes of the respective areas. The photographs were taken during the field surveys in the respective areas. For the information regarding the ethnomedicinal value, mode of preparation of the medicine and its administration, semi-structured questionnaires were used in their local language with the help of a mediator. The mediators that were taken for the study were a person from the tribe that was being studied. Apart from translation, the role of the mediators was to introduce the researcher to the people of the villages where the study was carried out and tell the people about the importance of the study. The local languages that were used for the study are Adi Padam for the Adi Tribe, Idu Mishmi for the Idu Mishmi

 doi:10.20944/preprints202109.0473.v1

tribe, Miju Mishmi for the Miju Mishmi tribe, Mossang for the Tangsa tribe, Chakma for the Chakma tribe and Dirang Monpa for Monpa tribe living in Thembang and Sangti. The selection of the informants was based on the recognition as expert hunters within the locality of the respective tribes, elderly persons of the tribe, and recognised folk/traditional healers of the respective tribes. Different festivals were also attended for the obtaining the information about the cultural use of the squirrels. From the Adi tribe 28 persons were interviewed, which included 7 recognised expert hunters, 13 village elders and 8 folk healers. A total of 26 persons from the Idu Mishmi tribe were asked for the ethnozoological information regarding the squirrel species. Out of which 8 were recognised expert hunters, 12 were village elders and 6 were folk healers. From the Miju Mishmi tribe 18 persons were interviewed, out of which 4 were recognised expert hunters, 7 were village elders, and 7 were folk healers. From the Tangsa tribe 13 persons were interviewed, which included 3 expert hunters and 10 village elders. From the Chakma community, 18 persons were interviewed, which included 5 expert hunters, 8 village elders and 5 persons who practiced *kabiraaji or* traditional medicine (Table 1). From the Monpa tribe 13 persons were interviewed, which included 3 expert hunters, 8 village elders and 2 were folk healers. Prior to the study all the required permissions were taken from the necessary village authorities (Goan Bura – Village headsmen). Our purpose was to document whether species were used and not the frequency of use given the different societal roles of interviewees.

All people who interviewed were asked about various folklores and myths associated with their respective tribes and squirrel species. They were also asked about the medicine preparation techniques with the use of squirrels, about the mode of preparation and the parts of the squirrels used in the preparation.

 doi:10.20944/preprints202109.0473.v1

Tribes	Expert hunters	Village elders	Folk healers	Total
Adi	7	13	8	28
Idu Mishmi	8	12	6	26
Miju Mishmi	4	7	7	18
Tangsa	3	10	0	13
Chakma	5	8	5	18
Monpa	3	8	2	13

Table 1. Number, tribal affiliation and social role of people interviewed.

Results

Our interviews of 116 people who were experienced hunters, folk healers, village elders from the five tribes, the results reveal the different usage of squirrel across species and among tribes. The specific usage of each species by each tribe is listed as food, culture and ethnomedicinal purposes as below

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Sl No.	Species	Local Names	Purpose of Use	Use Pattern					
				Adi	Idu Mishmi	Miju Mishmi	Tangsa	Chakma	Monpa
1	Himalayan Striped Squirrel (*Tamiops macclellandi*)	Ko'sung (A), Adaka (IM), Khrenjong (MM), Retseo (Ta),Sogoda (Ch), Grongthang Sherbu (M)	Food (A, IM, MM, Ta, Ch)	Consumed as wildmeat	Consumed as wildmeat	Consumed as wildmeat	Consumed as wildmeat	Consumed as wildmeat	
2	Hoary-bellied Squirrel (*Callosciurus pygerythrus*)	Kekkah/Kebek (A), Adango (IM), Da'oo (MM),Retseo (Ta),Sogoda (Ch), Choshagrongthang (M)	Food/ Decoration/Cultural (A), Food (IM,MM,Ta,Ch)	Consumed as wild meat. The tail is used as decorating item in the Dao (machete) sheath and keyrings and used as dowry item.	Consumed as wildmeat	Consumed as wildmeat	Consumed as wildmeat	Consumed as wildmeat	
3	Orange-bellied Himalayan Squirrel (*Dremomys lokriah*)	Leiboh/Leipoh (A), Adango (IM), Da'oo (MM),Retseo (Ta), Sogoda (Ch)	Cultural (A), Food(IM, MM, Ta, Ch)	Used as food and *Réying* (dowry item) in marriage. The animal (with tail intact) is given by the groom as bride price along with Mithuns (*Bos frontalis*).	Consumed as wildmeat	Consumed as wildmeat	Consumed as wildmeat	Consumed as wildmeat	
4	Malayan Giant Squirrel (*Ratufa bicolor*)	Sikat/Hikat (A), Aakey (IM), Lankhai (MM), Khijion (Ta),Gudungmosogoda (Ch)	Food/Decoration/Cultural (A), Food (IM,MM, Ta,Ch)	Consumed as wild meat .The tail is used as decorating item in the Dao (machete) sheath and Keyrings. Used as dowry item.	Consumed as wildmeat	Consumed as wildmeat	Consumed as wildmeat	Consumed as wildmeat	
5	Particolored Gliding Squirrel (*Hylopetes alboniger*)	Sikeng/Hikeng (A), Aagripra (IM),Haapie (MM),Loklu (Ta),Sogolok (Ch), Chergen (M)	Food (A,IM, Ta), Medicinal(MM, Ch)	Consumed as wildmeat	Consumed as wildmeat	Intestine is dried, crushed and taken with water to cure dysentery and malaria.	Consumed as wildmeat	Consumed as wildmeat	Believed to bring bad luck if encountered during the day.
6	Red Giant Gliding Squirrel (*Petaurista petaurista*)	Sibyong/Hibyong (A), Glangso (MM), Loklu (Ta), Choulok (Ch)	Medicinal (A, MM, Ta, Ch)	The alimentary canal is dried and taken to cure stomach ailments.		1. Urine bladder is rubbed in the head and belly of women at the time of pregnancy for easy delivery. Boiled stew is also taken. 2. Gall bladder is dried and crushed with rice (koni sawool) and mixed with water. Consumed to cure gall bladder stones.	Consumed as wildmeat	Gall bladder is dried and crushed with rice (koni sawool) and mixed with water. Consumed to cure gall bladder stones	
7	Mishmi Hills Gliding squirrel (*Petaurista mishmiensis*)	Kaamei (IM)	Medicinal (IM)		The Idu Mishmi people believe that by eating the meat of this species, one will be free of illness.				

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8	Grey-headed Gliding Squirrel (*Petaurista caniceps*)	Aalachi (IM)	Medicinal (IM)		The Idu Mishmi people believe that by eating the meat of this species, one will be free of illness.				
9	Hodgson's Giant Gliding Squirrel (*Petaurista magnificus*)	Choga (M)	Bad Omen						Believed to bring bad luck if this nocturnal species is encountered during the day.
10	Bhutan Giant Gliding Squirrel (*Petaurista nobilis*)	Choga (M0							Believed to bring bad luck if this nocturnal species is encountered during the day..

Table 2: Usage of each squirrel species by each human tribe is listed with specific purpose like food, culture and ethnomedicinal purposes. A for Adi, IM for Idu Mishmi, MM for Miju Mishmi, Ta for Tangsa, Ch for Chakma and M for Monpa.

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Of the six species of squirrels that were recorded from the East Siang districts, five species (Himalayan Striped Squirrel, Hoary-bellied Squirrel, Orange-bellied Himalayan Squirrel, Malayan Giant Squirrel, Particolored Gliding Squirrel) are taken as wild meat by the Adi people. Orange-bellied Himalayan Squirrels are used as bride price at the time of marriage by the groom. The groom must give four hunted Orange-bellied Himalayan Squirrel to the bride's family along with mithuns (cattle). Hoary-bellied Squirrel and Malayan Giant Squirrel are given to all the clan members of the bride as dowry items. One species, the Red Giant Gliding Squirrel is used in traditional medicine; the alimentary canal of the species is dried, mixed with water and taken to cure stomach ailments.

Unying/Aaran is a festival related to hunting to herald the season of shifting cultivation. It is customary that in this festival all male members of the Adi tribe to go on a hunting spree and should stay in the jungle for one week with return to the village on 7 March to display their hunts. The hunt is offered as gift to family and relatives (Figure 2a-2d).

Figure. 2a

Figure. 2b

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Figure. 2c

Figure. 2d

Figure. 2a. An Orange-Bellied Himalayan Squirrel trapped using a *etku* (traditional spring trap)
Figure. 2b. Squirrels that are brought to village after the hunting trip during Aaran festival
Figure 2c. Different species of rodents that are hunted during Aaran festival carried in a *Tali* (traditional Bag)
Figure 2d. A hunted Malayan Giant Squirrel

Out of the seven species of squirrels found in the areas where the Idu mishmi people lives, five species (Himalayan Striped Squirrel, Hoary-bellied Squirrel, Orange-bellied Himalayan Squirrel, Malayan Giant Squirrel, Particolored Gliding Squirrel) are taken as wild meat. The endemic species of the Mishmi Hills, Mishmi Hills Gliding squirrel and Grey-headed Gliding Squirrel are taken because the Idu people believe that the meat of these species have some medicinal properties. These two species are not hunted for the treatment of a specific ailment but are hunted and eaten for the belief that by eating the meat of these two species, one will remain free of illness. Species such as Hoary-bellied Squirrel and Orange-bellied Himalayan Squirrel are used in the preparation of a traditional cuisine called the Aku-Ekkari, where the meat of the squirrels is cooked with buckwheat (*Fagopyrum esculentum*).

In the Wakro circle of Lohit district, the Miju Mishmi people take four four of six available squirrel species as wild meat (Himalayan Striped Squirrel, Hoary-bellied Squirrel, Orange-bellied Himalayan Squirrel, Malayan Giant Squirrel). Two species of gliding squirrels

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Particolored Gliding Squirrel and Red Giant Gliding Squirrel are used for medicinal purposes. The intestine of the Particolored Gliding Squirrel is dried, crushed and taken with water to cure dysentery and malaria whereas urinary bladder and gall bladder of Red Giant Gliding Squirrel is used to ease labor pain during childbirth and gall bladder stones respectively.

The Tangsa people use all six species of squirrels (Himalayan Striped Squirrel, Hoary-bellied Squirrel, Orange-bellied Himalayan Squirrel, Malayan Giant Squirrel, Particolored Gliding Squirrel, Red Giant Gliding Squirrel) that are found in their homeland as wild meat.

They do not use any species as medicine, though some people claimed that they now use the gall bladder of the Red Giant Gliding Squirrel to cure gall bladder stones which they have learnt from the neighbouring Chakma tribe.

The Chakma people use five species (Himalayan Striped Squirrel, Hoary-bellied Squirrel, Orange-bellied Himalayan Squirrel, Malayan Giant Squirrel, Particolored Gliding Squirrel) as wild meat. The species of Red Giant Gliding Squirrel is used extensively for medicinal purposes where the gall bladder of the species is used to cure gall bladder stones.

In the West Kameng district, five squirrel species were recorded. Himalayan Striped Squirrel, Hoary-bellied Squirrel, Particolored Gliding Squirrel, Hodgson's Giant Gliding Squirrel and Bhutan Giant Gliding Squirrel. The Monpa people believe that the gliding squirrel species are bad omen and are thought to bring bad luck if encountered during the day. They also rarely hunt diurnal squirrel species as they believe it to be wastage of ammunition and energy.

Traditional use of squirrels was reported for all six tribes of Arunachal Pradesh. In the study it was documented that except the Monpa, all the studied tribes consumed some squirrels as bushmeat, the number of species used by a tribe varied between tree squirrels and gliding

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squirrels. Species of gliding squirrels were found to be associated with the preparation of medicines within all the tribes except the Monpa, who relate it with taboo. The Orange-bellied Himalayan Squirrel is associated with the culture of the Adi tribe.

Discussion

The remote and rural existence of many people in Arunachal Pradesh means that many are largely dependent on wild animal meat for their protein requirement (Niraj et al. 2019). During winter, the temperature of the region dips considerably, when agriculture is not possible and animal protein is an important and staple food for the local inhabitants (Velho et al. 2012; Velho and Laurance 2013). Hunting of small animals like squirrels are comparatively easy to catch relative to large mammals in these remote landscapes. Rodent hunting by tribes is documented from around the world including Brazil, central Africa, Benin and India primarily for bushmeat, food and cultural purposes (Carpanteo and Germi 1992; Dollo et al., 2010; Mouzoun 2018; da Silva Santos et al. 2019).

Our study recorded ten species (six species of gliding squirrels and four species of tree squirrels) that are used by the tribes in Arunachal Pradesh. Among all the tribes, there is a belief that the gliding squirrels of the genus *Petaurista* have some medicinal properties and are used primarily for the treatment of ailments. In Dibang, Lower Dibang Valley, Lohit and Changlang districts, we observed hunters working at night exclusively for gliding squirrels and children entered the jungle with slingshots to hunt diurnal tree squirrels.

In the East Siang district, Orange-bellied Himalayan Squirrels are exclusively hunted as it is associated with the tradition of the Adi people. The Adi tribe has a folklore on why the Orange-bellied Himalayan Squirrel is used as bride price. The Myth goes like, **"***In the beginning of time, Doying Bote (King of Knowledge) fell in love with Kine Nane (Queen of Abundance). But Doying Bote felt it impossible to convince the family of Kine Nane. He sent*

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all life forms to convince the family of Kine Nane. But none of them succeeded. At last, the time was for Leibo/Leipoh (Orange-bellied Himalayan Squirrel) to go and convince the family of Kine Nane and the offer succeded."

Not surprising, local tribes have noted declines and need to conserve species through their own actions towards sustainable harvest. As the excessive hunting of the squirrel has posed a great threat for the species, the "*Kebang"* (the local governing body of the Adi people), has instructed that there will be a sharing of the animal for marriage. When the groom provides four individual Orange-bellied Himalayan Squirrels as a dowry to the bride's family, the bride's family must give the squirrels to other groom. Thus, by rotating, there will be a decrease in the hunting of the species.

Similarly, in the Dibang and Lower Dibang Valley districts, because of the hunting of the endemic Mishmi Hills Gliding Squirrel, locals report considerable population declines of the species. Tribal members stated that earlier it was easy to find the species but in the recent times they have to travel very far to hunt the species. Efforts of locals to conserve the species are underway.

During the study, interesting myths associated with the gliding squirrels were shared from the Miju Mishmi and the Chakma tribe. Both the tribes share a belief that the urine of gliding squirrels (*Petaurista*) can melt steel and break rocks.

The Monpa people of West Kameng do not indulge in active hunting as they are adherents of the Gelug sect of Tibetan Buddhism. But the people who also incorporate their animist "bon" religion with Buddhism sometimes practice hunting before the advent of traditional ceremonies and occasionally hunt large mammals like deer (*Muntiacus muntjak*) and takin (*Budorcas taxicolor*: Velho and Laurance 2013). We found no records of the harvest of

 doi:10.20944/preprints202109.0473.v1

squirrel species. As for the gliding squirrel species, Monpa people beleive they bring bad luck if encountered during the daytime and are therefore never hunted.

Although studies on ethnozoology had been extensively carried out in the states of Arunachal Pradesh, Nagaland and Mizoram (the northeastern states of India) by various researchers (e.g. Niraj et al. 2019). Most of the research focused on large animals so that the available data are scanty on the use of squirrels, specially by the indigenous tribes. Fragmented records agree with our findings with use of Particolored Gliding Squirrel, Malayan Giant Squirrel, Pallas's Squirrel (*Callosciurus erythraeus*), Hoary-bellied Squirrel, Himalayan Striped Squirrel and Hairy-footed Gliding Squirrel (*Belomys pearsonii pearsonii*) for food and dowries by the Adi tribe of Arunachal Pradesh (Chinlampianga et al. 2013; Singh et al. 2020). The use of the meat and soup of Hoary-bellied Squirrel for the treatment of spasms, swelling and sprain is also recorded from Mizoram (Chinlampianga et al. 2013). Studies from Nagaland also confirm the use of gliding squirrels by several tribes (Ao, Angami, Khiamniungan, Sema , Lotha, Rengma, Pochury, Zeliang and Konyak), where the species are both consumed as food and as medicine for the treatment of poisoning (Jamir and Pal 2005). Adi tribe of Mirem village of Arunachal Pradesh consume Orange-bellied Himalayan Squirrel and Northern Palm Squirrel (*Funambulus pennanti*) as bushmeat (Nimachow et al. 2010). The consumption of Orange-bellied Himalayan Squirrel and gliding squirrel species by the Idu Mishmi tribe is also documented by Aiyadurai (2014). Records from the markets of Tuensang area of Nagaland also confirm the consumption of Himalayan Striped Squirrel, Gliding squirrel species (*Petaurista*) and Orange-bellied Himalayan Squirrel (Bhupathy et al. 2013). Malayan Giant Squirrel is used for the preparation of eththnomedicines and socio-cultural practices by the Adi tribe (Singh et al. 2014). The use of Orange-bellied Himalayan Squirrel for the treatment of diseases and in social ceremonies is also recorded from the Apatani tribe of Arunachal Pradesh (Dollo et al. 2010) (Table 3).

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S. No	Common Name	Scientific Name	Tribe(s)	Location	Reference
1	Particolored Gliding Squirrel	*Hylopetes alboniger*	Adi	Arunachal Pradesh	1. Chinlampianga et al. 2013 2. Singh et al. 2020 3. Singh et al. 2014
2	Malayan Giant Squirrel	*Ratufa bicolor*	Adi	Arunachal Pradesh	
3	Pallas's Squirrel	*Callosciurus erythraeus*	Adi	Arunachal Pradesh	
4	Hoary- bellied Squirrel	*Callosciurus pygerythrus*	Adi, Mizo	Arunachal Pradesh, Mizoram	
5	Himalayan Striped Squirrel	*Tamiops macclellandi*	Adi, Naga	Arunachal Pradesh, Nagaland	1. Chinlampianga et al. 2013 2. Bhupathy et al. 2013
6	Hairy-footed Gliding Squirrel	*Belomys pearsonii pearsonii*	Adi	Arunachal Pradesh	Chinlampianga et al. 2013
7	Northern Palm Squirrel	*Funambulus pennanti*	Adi	Arunachal Pradesh	Nimachow et al. 2010
8	Orange-bellied Himalayan Squirrel	*Dremomys lokriah*	Adi, Idu Mishmi, Naga	Arunachal Pradesh, Nagaland	1. Nimachow et al. 2010 2. Aiyadurai 2014 3. Bhupathy et al. 2013 4. Dollo et al. 2010
9	Gliding squirrel species	*Petaurista sp*	Idu Mishmi, Ao, Angami, Khiamniungan, Sema , Lotha, Rengma, Pochury, Zeliang, Konyak	Arunchal Pradesh, Nagaland	1. Aiyadurai 2014 2. Jamir and Pal (2005) 3. Bhupathy et al. 2013

Table 3. Summary table on the use of squirrel species by the different communities of North-East India

 doi:10.20944/preprints202109.0473.v1

The use of squirrels for multiple purposes ranging from cultural to medicinal to food has a potential to exert enormous pressure on the wild populations of squirrels (Singh et al. 2014). Hunters have mentioned the decline of squirrels in local areas (Dollo et al. 2010). Squirrels have high population growth potential due to early maturity, modest litter sizes and multiple litters each year (Thorington et al. 2012), despite this capability, if the declines occur, this shows that species have been over harvested. Assessment of squirrel populations and collaboration with the tribes about sustainable harvest given hypothesized declines could promote the traditional and ecological knowledge (TEK) and continued use by the tribes. Research in this area needs further examination for the benefit of the species to thrive and for the tribes so that the TEK can be preserved.

Conclusion

The study showed that the Adi, Idu Mishmi, Miju Mishmi, Tangsa, Chakma and Monpa tribes have well developed traditional knowledge and culture regarding the use of different squirrel species that urgently needs to be documented. However, two of the squirrel species viz., Malayan Giant Squirrel and Mishmi Hills gliding squirrel that are used by local people are listed in the Near Threatened category of the IUCN Red List (Duckworth and Mouler 2016; Engelbrektsson and Kennerley 2016). Such knowledge reveals a timely need to have a proper understanding of the population density and abundance of heavily used species along with a threat analysis to conserve the species. We hope that the information gathered in this study will inform future research studies in this domain and also help to draw conservation action plans for species that incorporate TEKs of the tribes.

References

Aiyadurai, A. 2014. Traditional Ecological Knowledge of the Idu Mishmis: What do people say about wildlife? Rufford Small Grant for Nature Conservation, Report.

Alves, R. R. N., and I. L. Rosa. 2005. Why study the use of animal products in traditional medicines? *Journal of Ethnobioliogy and Ethnomedicine* 10:1746–4269

Alves, R. R. N., and W. M. S. Souto. 2015. Ethnozoology: a brief introduction. *Ethnobiology and Conservation* 4:1–13.

Alves, R., and R. Barboza. 2018. The Role of Animals in Human Culture. Ethnozoology 277-301pp. Academic press.10.1016/B978-0-12-809913-1.00015-6.

Anageletti, L. R., U. Agrimi, C. Curia, D. French, and R. Mariani-Costantini.1992. Healing rituals and sacred serpents. *Lancet* 340:223–5.

Aswani, S., A. Lemahieu, and W. H. Sauer 2018. Global trends of local ecological knowledge and future implications. *PLoS One* 13: e0195440.

Berkes, F. 1999. *Sacred Ecology: Traditional Ecological Knowledge and Resource Management*. Philadelphia, PA: Taylor and Francis Publishing Company.

Berkes, F., J. Colding, and C. Folke. 2000. "Rediscovery of Traditional Ecological Knowledge as Adaptive Management," *Ecological Applications* 10 (5): 1251-1262.

Bhupathy, S., S. R. Kumar, P. Thirumalainathan, J. Paramanandham, and C. Lemba. 2013. Wildlife exploitation: a market survey in Nagaland, North-eastern India, *Mongabay.com Open Access Journal - Tropical Conservation Science* 6: 241-253.

Carpaneto, G. M., F. P. Germi. 1992. Diversity of mammals and traditional hunting in central African rain forests. *Agriculture, Ecosystems & Environment* 40: 335-354.

Chinlampianga, M., R. K. Singh, and A. C. Shukla. 2013. Ethnozoological Diversity of northeast India: Empirical learning with traditional knowledge holders of Mizoram and Arunachal Pradesh. *Indian Journal of Traditional Knowledge* 12: 18-30.

Costa-Neto, E. M. 2005. Animal-based medicines: biological prospection and the sustainable use of zootherapeutic resources. *Anais da Academia Brasileira de ciências* 77:33–43.

da Silva Santos, S., de Lucena, R. F. P., de Lucena Soares, H. K., dos Santos Soares, V. M., Sales, N. S., L.E.T. Mendonça. 2019. Use of mammals in a semi-arid region of Brazil: an approach to the use value and data analysis for conservation. *Journal of ethnobiology and ethnomedicine* 15: 1-14.

Danggen, B. 2003. The Kebang : A Unique Indegenous Political Institution of Adis,

Himalayan Publishers, New Delhi.

Das, R. R. 2014. Fertility Performance and Health Care Practices among the Idu Mishmi of Lower Dibang Valley District of Arunachal Pradesh, Shodhganga (Thesis).

Datta, A., and R. Nandini. 2014. Sciurids. Chapter 64. In *Mammals of South Asia*, vol. 2, ed. A.J.T. Johnsingh, and N. Manjrekar, 534–535. Hyderabad: University Press.

Dollo, M., G. V. Gopi, K. Teegalapalli, and K. Mazumdar. 2010. Conservation of the orange-bellied Himalayan squirrel *Dremomys lokriah* using a traditional knowledge system: a case study from Arunachal Pradesh, India. *Oryx*, 44(4) 573–576.

Duckworth, J.W. and, Molur, S. 2016. *Ratufa bicolor*. The IUCN Red List of Threatened Species 2016: e.T19377A22261810. https://dx.doi.org/10.2305/IUCN.UK.2016-2.RLTS.T19377A22261810.en. Downloaded on 23 June 2021.

 doi:10.20944/preprints202109.0473.v1

Engelbrektsson, P. and R. Kennerley. 2016. *Petaurista mishmiensis*. The IUCN Red List of Threatened Species 2016: e.T45959040A45973151. https://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T45959040A45973151.en. Downloaded on 23 June 2021.

Gadgil, M., F. Berkes and C. Folke. 1993. "Indigenous Knowledge for Biodiversity Conservation," *AmBio* 22: 2-3.

Hill, R. et al. 2020. Working with indigenous, local and scientific knowledge in assessments of nature and nature's linkages with people. *Current Opinion in Environmental Sustainability* 43: 8-20.

Hoagland, S. J. 2017. Integrating traditional ecological knowledge with western science for optimal natural resource management. IK: Other Ways of Knowing. 3(1): 1-15.

Jamir, N. S. and P. Lal. 2005. Enthnozoological practices among Naga tribes, *Indian Journal of Traditional Knowledge* 4: 100-104.

Kang, S.P. 2003. Question of attitude: South Korea's traditional medicine practitioners and wildlife conservation. Hong Kong: *TRAFFIC East Asia*

Kato, D. and, G. V. Gopi. 2009. Ethnozoology of Galo tribe with special reference to edible insects in Arunachal Pradesh. *Indian Journal of Traditional Knowledge* 8: 81-83.

Klingender, F. 1971. *Animals in Art and Thought to the End of the Middle Ages*. Routledge.

Krishna, M. C., A. Kumar, O. P. Tripathi, and J. L. Koprowski. 2016. Diversity, distribution and status of gliding squirrels in protected and non-protected areas of Eastern Himalayas in India. *Hystrix* (Available Online). doi:10.4404/hystrix-27.2-11688.

Lev, E. 2003. Traditional healing with animals (zootherapy); medieval to present-day Levantine practice. *Journal of ethnopharmacology* 86:107–18.

Mason, L, G. White, G. Morishima, E. Alvarado and L. Andrew. 2012. "Listening and Learning from Traditional Knowledge and Western Science: A Dialogue on Contemporary Challenges of Forest Health and Wildfire," *Journal of Forestry* 110 (4):187-193.

Menzies, C. 2006. Afterward. *Traditional Ecological Knowledge and Natural Resource Management*, ed. C. Menzies. Lincoln, NE: University of Nebraska.

Menzies, C. and C. Butler. 2006. "Introduction: Understanding Ecological Knowledge," *Traditional Ecological Knowledge and Natural Resource Management*, ed. C. Menzies. Lincoln, NE: University of Nebraska.

Mills, J. P. 1952. *The Mishmis of the Lohit Valley, Assam : presidential address*.

Mondal, N.S., A. R. Khan, J. Chakma and G. Hossain. 2017. Family Structure, Economic Security and Educational Status of Rural Chakma in CHT of Bangladesh. Journal of Social Sciences, 19:3, 219-224, DOI: 10.1080/09718923.2009.11892712

Mouzoun, S. 2018. Écologie et connaissances ethnozoologiques du porc-épic à crête (*Hystrix cristata* Linnaeus, 1758) dans les réserves de biosphère de la Pendjari et du W du Bénin (Doctoral dissertation, Université d'Abomey-Calavi (Bénin)).

Nimachow, G., T. Taga, H. Tag, and O. Dai. 2010. Linkages between Bio-resources and Human-livelihood: A case study of Adi tribes of Mirem village, Arunachal Pradesh (India), *'The Initiation' 2008 issue, an annual publication of Student Forum for Forestry Research and Environment Conservation, (SUFFREC)*, Kathmandu Forestry College, Kathmandu.

Niraj, S. K., S. Sethi, S. P. Goyal, and A. N. Choudhary. 2019. Poaching, illegal wildlife trade, and bushmeat hunting in India and South Asia. In J. L. Koprowski & P. R. Krausman (Eds.), International wildlife management: Conservation challenges in a changing world. Baltimore, MD: Johns Hopkins University Press.

Raj, S. 2010. Traditional Knowledge, Innovation Systems and Democracy for Sustainable Agriculture: A Case Study on Adi Tribes of Eastern Himalayas of North-East India. *ISDA 2010*, Jun 2010, Montpellier, France. (2010) 10 p. ⟨hal-00523309⟩.

Sebastian K.O. 1999. Tangsas of Arunachal Pradesh and socio economic changes since 1947, PhD Thesis, Department of History, Rajiv Gandhi University.

Senior, M. 2009. *A Cultural History of Animals in the Age of Enlightenment*. Berg Publishers.

Singh, R. K., N. R. Alves, and O. Ralen. 2014. Hunting of kebung (*Ratufa bicolor*) and other squirrel species from morang forest by the Adi tribe of Arunachal Pradesh, India: biocultural conservation and livelihood dimensions. *Regional Environmental Change*, 14: 1479–1490.

Singh, R.K., A. Kumar, A. Singh, and P. Singhal. 2020. Evidence that cultural food practices of Adi women in Arunachal Pradesh, India, improve social-ecological resilience: insights for Sustainable Development Goals. *Ecological Processes* 9:29.

Solanki, G. S., and P. Chutia. 2004. Ethno zoological and socio-cultural aspects of Monpas of Arunachal Pradesh. *Journal of Human Ecology*, 15: 251-254.

Thorington Jr, R. W., J. L. Koprowski, M. A. Steele, and J. Whatton. 2012. *Squirrels of the World*. Johns Hopkins University Press.

Velho, N., Karanth, K.K. and Laurance, W.F. 2012. Hunting: A serious and understudied threat in India, a globally significant conservation region. Biological Conservation 148: 210-215.

Velho, N. and Laurance, W.F., 2013. Hunting practices of an Indo-Tibetan Buddhist tribe in Arunachal Pradesh, northeast India. Oryx 47:389-392.

Venkataraman K., G. Sharma, and D. Banerjee. 2020. Faunal Diversity of India. In: Dar G., Khuroo A. (eds) Biodiversity of the Himalaya: Jammu and Kashmir State. Topics in Biodiversity and Conservation, vol 18. Springer, Singapore. https://doi.org/10.1007/978-981-32-9174-4_4.