MAMMALIAN WEALTH OF SIKKIM

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ABSTRACT

The mammalian fauna of Sikkim comprises of 125 species and sub-species under 24 families and 10 orders of which about 18% are threatened. The faunal variety is so high as the state acts as a transitional zone between Palaearctic and Oriental fauna. The mammalian fauna comprising of little more than 2.5% of the total faunal wealth of the state. In relation to the Indian vertebrate species the percent species diversity of Sikkim mammal is 2.57% and that in relation to mammalian species of the country is 31.5% which is very high in relation to the geographical area, probably due to its geographical position. There is no mammal in the state which could be treated as true endemic. There are a number of threatened species distributed in the state which needs proper conservation and study.

KEY WORDS: *Sikkim, mammal, Eastern Himalaya*

Red Panda in temperate forest

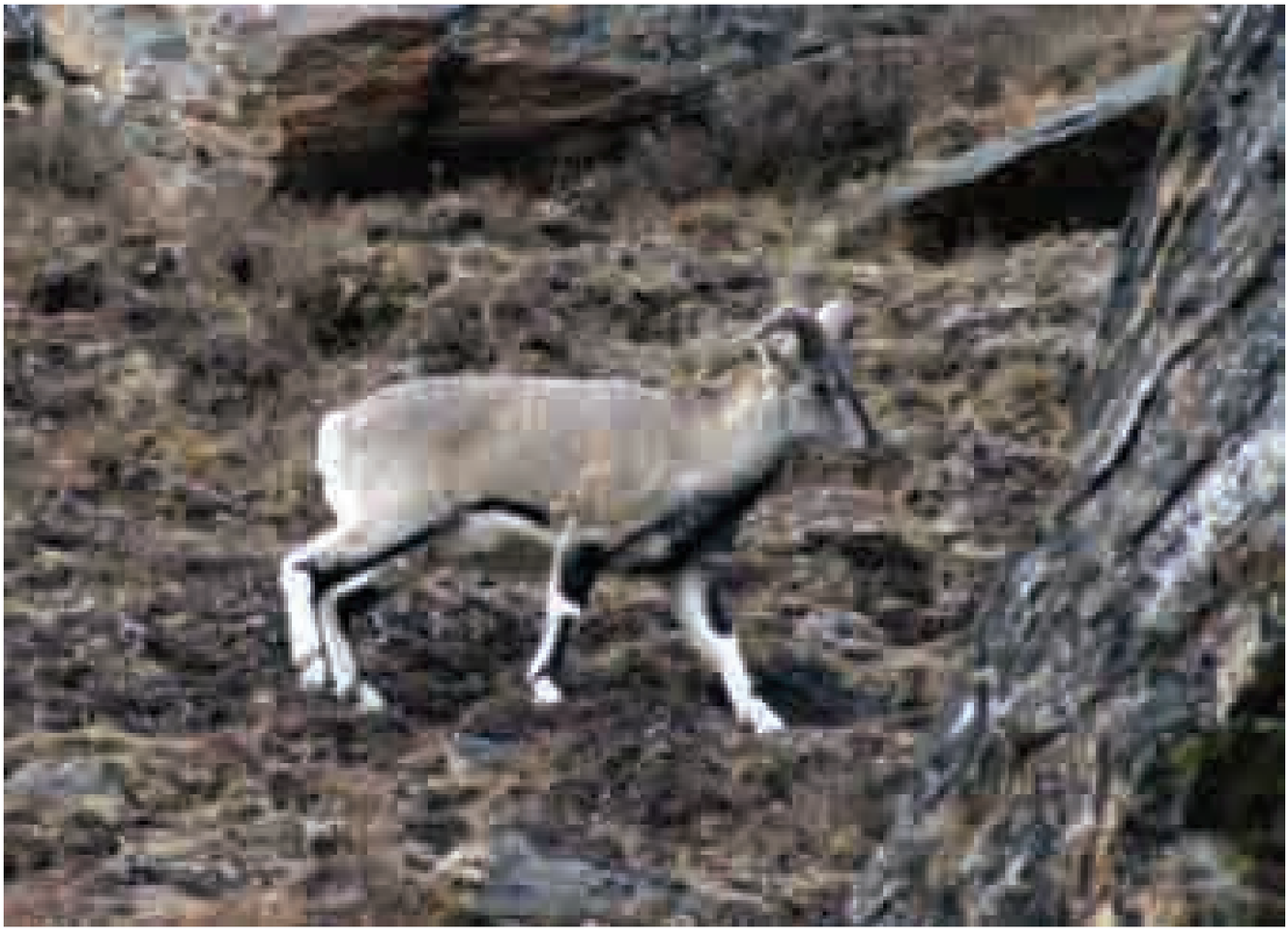
Barking Deer, a cute cervid in lower Sikkim

INTRODUCTION

Sikkim, a state of India is situated in the Eastern Himalaya and encompasses hill ranges from 300m to 8598m. The state is bounded by Nepal in the west, Bhutan and Chumbi valley of Tibet in the east, Tibetan plateau in the north and north-east and Darjeeling district of West Bengal along its southern boundary. The geographical coordinates are 27^{o} 04' 46" to 28^{o} 07' 48" N latitudes and 88^{o} 00' 58" and 88^{o} 55' 25" E longitudes, covering an area of 7096 km^{2}. The state is having diversified forest types like Tropical Moist Deciduous to Evergreen forests (Alt. 300-900m), Sub-tropical Moist to Semi Evergreen forests (Alt. 900-1800m), Sub-temperate to temperate to Sub-alpine forests (Alt. 1800-2700m), Temperate to Sub-alpine forests (Alt. 2700-3000m), Sub-alpine forests (Alt. 3000-3700m), Alpine Moorland forests (Alt. 3700-4500m) (Ramakrishna and Alfred, 2006). Altogether 125 mammalian species are distributed in varied terrain of the state (Table 3).

MATERIALS

The faunal exploration in Eastern Himalaya including Sikkim started long back in the 18^{th} century. The main contributors were Hardwicke (1778-1823), Blyth (1832), Oakes (1842), Hodgson (1845-58), Theobald (1861), Gunther (1868), Blanford (1870), Milman (1870), Stoliczka (1871), King (1872), Godwin-Austin (1874-75), Grammie (1877),



Blue Sheep or Bharal is highly gregarious; lives in higher mountain steppe in the Himalayas

Day (1878), Mandelli (1879), Brooks (1880), Bingham (1894), Baily and Stevans (1823-27), McClelland (1944), Hora (1951) and Ali (1962) (Table 1). The Zoological Survey of India has contributed a lot in the knowledge of Sikkim fauna and surveyed the state from 1953 to 1998. The present article is based on these published reports.

Table 1. Faunal Exploration in Eastern Himalaya (After Ramakrishna & Alfred, 2007)

Name of the explorers	Period	Areas
T. Hardwicke	1778-1823	Himalayas
E. Blyth	1832	Eastern Himalayas
Mrs. Oakes	1842	Eastern Himalayas
B. Hodgson	1845-58	Eastern Himalayas
W. Theobald	1861	Eastern Himalayas
Gunther	1868	Eastern Himalayas
W. T. Blanford	1870	Eastern Himalayas
Mr. Milman	1870	Eastern Himalayas
Dr. F. Stoliczka	1871	Eastern Himalayas
G. King	1872	Eastern Himalayas
Lt. Col. Godwin-Austin	1874-1875	Eastern Himalayas
J. A. Gramme	1877	Eastern Himalayas
F. Day	1878	Eastern Himalayas
L. Mandelli	1879	Eastern Himalayas
E. W. Brooks	1880	Eastern Himalayas
Col. C.T. Bingham	1894	Eastern Himalayas
Col. F.M. Baily & H. Stevans	1923-1927	Eastern Himalayas
J. McClelland	1944	Eastern Himalayas
S.L. Hora	1951	Eastern Himalayas
S. Ali	1962	Eastern Himalayas
Zoological Survey of India	1953-1998	Eastern Himalayas

FAUNAL RESOURCES

At a glance, so far known animal species of the Sikkim state is 4976 (Ramakrishna and Alfred, 2007) under 2407 genera and 471 families (Table 2) of which mammalian species and sub-species comprises of 125 only (Table 3).

Table 2. Animal Species at a glance

Groups	Species	Genera	Families
Insecta	3656	1578	142
Other Invertebrate	566	329	191
Chordata	629	437	117
Mammalia	125	63	24

Mammalian Fauna

The knowledge of mammalian fauna of Sikkim is mainly based on the Mammal Survey of India conducted by the Bombay Natural History Society from 1911 to 1930. The collections made by C. A. Crump during the period 1914-15 had enriched the National Zoological Collections of India. Subsequently, more collections were added to the National collection treasure by the scientists of Zoological Survey of India *viz.*, B. Biswas (1953), A. G. K. Menon (1959), T. D. Soota (1977), S. M. Ali (1978), H. C. Ghosh (1979), R.K. Ghose (1979-82), V. C. Agarwal (1988), S. S. Saha (1989), S. Chattopadhyay (1990), S. Chakraborty (1994) etc. Wroughton (1916) described five new species of rodents and 41 species and sub-species of mammals from Sikkim based on the collections of Crump. Information on Sikkim mammals are also available in Blanford (1888-1891), Pocock (1939, 1941), Ellerman and Morrison-Scott (1951) and Ellerman (1961). Sighting records of many more mammals were reported by Biswas and Ghose (1982) and Biswas *et. al.* (1985)

Clouded leopard lives in dense forests and is largely arboreal

from North and West Sikkim. Mistry (1991) reported occurrence of bats from Sikkim and a report on mammalian fauna of the state mentioning measurements etc. was compiled by Chattopadhyay *et. al.* (2006). Additional knowledge on Sikkim mammals were also provided by Alfred (2002).

Table 3. Mammals Species of Sikkim

Sl. No.	Order/Family/Species	Common Name (English)
	Order: **SCANDENTIA**	
	Family: **TUPAIIDAE**	
1.	*Tupaia belangeri* (Wagner)	Common Tree Shrew
	Order: **INSECTIVORA**	
	Family: **TALPIDAE**	
2.	*Euroscaptor micrura* (Hodgson)	Eastern Mole
	Family: **SORICIDAE**	
3.	*Crocidura attenuata* Milne-Edwards	Gray Shrew
4.	*Soriculus nigrescens* (Gray)	Sikkim Large -Clawed Shrew
5.	*S. leucops* (Horsfield)	Indian Long -tailed Shrew
6.	*S. caudatus* (Horsfield)	Hodgson's Brown -toothed Shrew
7..	*S. macrurus* Blanford	Indian Long -toothed Shrew
8.	*Suncus murinus soccatus*	House Shrew
9.	*Chimarrogale himalayica* (Gray)	Himalayan Water Shrew
10.	*Nectogale elegans* Milne-Edwards	Szechuan Water Shrew
	Order: **CHIROPTERA**	
	Sub-Order: **MEGACHIROPTERA**	
	Family: **PTEROPODIDAE**	
11.	*Rousettus leschenaulti* (Desmarest)	Indian Fulvous Fruit Bat
12.	*Sphaerias blanfordi* (Thomas)	Blanford's Fruit Bat
13.	*Eonycteris spelaea* (Dobson)	Dobson's Long -tongued Fruit Bat

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14.	*Cynopterus sphinx* (Vahl)	Short-nosed Fruit Bat
15.	*Pteropus giganteus* Brünnich	Indian Flying Fox
16.	*Macroglossus sobrinus* Anderson	Hill Long-tongued Fruit Bat
	Sub-Order: **MICROCHIROPTERA**	
	Family: **EMBALLONURIDAE**	
17.	*Taphozous nudiventris kachhensis* Dobson	Naked-bellied Tomb Bat
	Family: **RHINOLOPHIDAE**	
18.	*Rhinolophus rouxi* Temminck	Rufous Horse-shoe Bat
19.	*R. pearsoni* Horsfield	Pearson's Horse-shoe Bat
20..	*R.ferrumequinum* (Schreber)	Greater Horse-shoe Bat
21.	*R. luctus* Temminck	Wolly Horseshoe Bat
22.	*R.sinicus* (Anderson)	
23.	*Hipposideros armiger* (Hodgson)	Great Himalayan Leaf-nosed Bat
24.	*H. pomona* Anderson	Anderson's Leaf-nosed Bat
	Family: **VESPERTILIONIDAE**	
25.	*Kerivoula picta* (Pallas)	Painted Bat
26.	*Barbastella leucomelas* (Cretzschmar)	Eastern Barbastella
27.	*Harpiocephalus harpia lasyurus* (Hodgson)	Hairy-winged Bat
28.	*Murina cyclotis* Dobson	Round-eared Tube-nosed Bat
29.	*M. aurata* Milne Edwards	Little Tube-nosed Bat
30.	*M. tubinaris* (Scully)	Scully's Tube-nosed Bat
31..	*Myotis siligorensis* (Horsfield)	Himalayan Whiskered Bat
32..	*M. muricola* (Gray)	None
33.	*M. sicarius* Thomas	None
34.	*M. formosus* (Hodgson)	Hodgson's Bat
35.	*Plecotus auritus* (Linnaeus)	Brown Big-eared Bat
36.	*Nyctalus noctula* (Schreber)	Noctula Bat
37.	*Pipistrellus coromandra* (Gray)	Indian Pipistrelle
38.	*P. babu* Thomas	Babu's Pipistrelle
39.	*P. javanicus* Gray	Javan Pipistrelle
40.	*Scotomanes ornatus* (Blyth)	Harlaquin Bat
41.	*Tylonycteris pachypus* (Temminck)	Bamboo Bat
42.	*Areilulus circumdatus* (Temminck)	Large Black Pipistrelle
	Order: **PRIMATES**	
	Family: **CERCOPITHECIDAE**	
43.	*Macaca assamensis pelops* Hodgson	Assamese Macaque
44.	*Semnopithecus entellus schistaceus* (Hodgson)	Hanuman Langur
	Order: **CARNIVORA**	
	Family: **CANIDAE**	
45..	*Canis aureus* Linnaeus	Asiatic Jackal
46.	*C. lupus* Linnaeus	Wolf
47.	*Cuon alpinus primaevus* (hodgson)	Indian Wild Dog
48.	*Vulpes vulpes montana* (Pearson)	Himalayan Red Fox
	Family: **VIVERRIDAE**	
49.	*Arctictis biturong* (Raffles)	Binturong
50.	*Paguma larvata* (Hamilton-Smith)	Himalayan Palm Civet
51..	*Prionodon pardicolor*	Spotted Linnsang
52.	*Viverra zibetha* Linnaeus	Large Indian Civet
	Family: **MUSTELIDAE**	
53.	*Martes flavigula* (Boddaert)	Yellow-throated Marten
54..	*Mustela sibirica* Pallas	Himalayan Weasel
55.	*M. strigidorsa* Gray	Back-striped Weasel
56.	*M. altaica* Pallas	Mountain Weasel
57.	*M. kathia* Hodgson	Yellow-bellied Weasel
58.	*Arctonyx collaris* Cuvier	Hog Badger
59.	*Lutra lutra* (Linnaeus)	Common Ott er

60.	*Amblonyx cinereus* (Illiger)	Small-clawed Otter
	Family: **URSIDAE**	
61.	*Ursus thibetanus* Cuvier	Asiatic Black Bear
62..	*Ailurus fulgens* Cuvier	Red Panda
	Family: **FELIDAE**	
63.	*Felis chaus* Schreber	Jungle Cat
64..	*Prionailurus bengalensis* (Kerr)	Leopard Cat
65.	*Otocolobus manul* (Pallas)	Palla's Cat
66..	*Pardofelis marmorata* (Martin)	Marbled Cat
67..	*Catopuma temminckii* (Vigors & Horsfield)	Golden Cat
68..	*Neofelis nebulosa* (Griffith)	Clouded Leopard
69..	*Uncia uncia* (Schreber)	Snow Leopard
70..	*Panthera pardus* (Linnaeus)	Leopard
	Order: **PERISSODACTYLA**	
	Family: **EQUIDAE**	
71..	*Equus kiang* Moorcroft	Kiang
	Order: **ARTIODACTYLA**	
	Family: **SUIDAE**	
72.	? *Sus salvanius* (Hodgson)	Pygmy Hog
	Family: **MOSCHIDAE**	
73..	*Moschus chrysogaster* Hodgson	Musk Deer
74.	*M. fuscus* Li	Alpine Musk Deer
	Family: **CERVIDAE**	
75.	*Axis axis* (Erxleben)	Spotted Deer
76.	*Muntiacus muntjac* (Zimmerman)	Barking Deer
	Family: **BOVIDAE**	
77..	*Nemorhaedus goral hodgsoni* Pocock	Goral
78.	*N. sumatraensis* (Bechstein)	Serow
79..	*Hemitragus jemlahicus* (Smith)	Himalayan Tahr
80..	*Ovis ammon hodgsoni* Blyth	Nayan or Argali
81..	*Pseudois nayaur nayaur* (Hodgson)	Bharal
82.	*Bos grunniens* Linnaeus	Yak
83..	*Procapra picticaudata* Hodgson	Tibetan Gazelle
	Order: **LAGOMORPHA**	
	Family: **LEPORIDAE**	
84..	*Lepus nigricollis ruficaudatus* Geoffroy	Rufous-tailed Hare
85..	*L. oiostolus* Hodgson	Wolly Hare
	Family: **OCHOTONIDAE**	
86..	*Ochotona curzoniae* (Hodgson)	Black-lipped Pika
87..	*O. nubrica* Thomas	Nubra Pika
88..	*O. roylei* (Ogilby)	Royle's Pika
89..	*O. thibetana sikimaria* Thomas	Moupin Pika
90..	*O. forresti* Thomas	Forrest's Pika
91..	*O. macrotis* (Gunther)	Large-eared Pika
	Order: **RODENTIA**	
	Family: **SCIURIDAE**	
92..	*Belomys pearsoni* (Gray)	Hairy-footed Flying Squirrel
93..	*Hylopetes alboniger alboniger* (Hodgson)	Parti-coloured Flying Squirrel
94..	*Eupetaurus cinereus* Thomas	Woolly Flying Squirrel
95..	*Petaurista elegans* (Muller)	Lesser Giant Flying Squirrel
96..	*P. nobilis nobilis* (Gray)	Gray's Giant Flying Squirrel
97..	*P. magnificus magnificus* (Hodgson)	Hodgson's Giant Flying Squirrel
98..	*Callosciurus caniceps crumpi* Wroughton	Golden backed Squirrel
99..	*C. pygerythrus lokroides* (Hodgson)	Hoary-bellied Himalayan Squirrel
100..	*Tamiops macclellandi* (Horsfield)	Himalayan Stripped Squirrel
101..	*Dremomys lokriah lokriah* (Hodgson)	Orange-bellied Himalayan Squirrel
102..	*Ratufa bicolor gigantea* (M'Clelland)	Malayan Giant Squirrel

103..	*Marmota himalayana* (Hodgson)	Himalayan Marmot
	Family: **HYSTRICIDAE**	
104..	*Hystrix brachyura* Linnaeus	Himalayan Crestless Porcupine
	Family: **MURIDAE**	
105.	*Alticola stracheyi* (Thomas)	None
106.	*Microtus sikimensis* (Hodgson)	Sikkim Vole
107..	*Pitymys sikimensis* (Hodgson)	Sikkim Vole
108.	*Niviventer niviventer lepcha* (Wroughton)	White-bellied Rat
109.	*N. fulvescens fulvescens* (Gray)	Chestnut Rat
110.	*N. eha eha* (Wroughton)	Little Himalayan Rat
111.	*Rattus rattus brunneusculus* (Hodgson)	Hodgson's House Rat
112.	*R.rattus tistae* Hinton	Hinton's House Rat
113.	*R. nitidus nitidus* (Hodgson)	Himalayan Rat
114.	*R. turkestanicus* (Satunin)	Turkestan Rat
115.	*R. sikkimensis* Hinton	Sikkim Rat
116.	*R. tanezumi* Tem minck	None
117..	*Mus pahari pahari* Thomas	Sikkim Mouse
118.	*M. cervicolor* Hodgson	Fawn-coloured Mouse
119.	*M. musculus castaneus* Waterhouse	House Mouse
120.	*M. musculus homourus* Hodgson	House Mouse
121.	*Bandicota indica nemorivaga* (Hodgson)	Large band icoot Rat
122.	*Leopoldamys edwardsi* (Thomas)	Edward's Rat
123.	*Niviventer eha* (Wroughton)	Little Himalayan Rat
124.	*N. niviventer* (Hodgson)	Himalayan White -bellied Rat
	Order: **PHOLIDOTA**	
	Family: **MANIDAE**	
125.	*Manis pentadactyla* Linnaeus	Chinese Pangolin

Faunal analysis

Altogether the Sikkim state is having 125 species and subspecies of mammals under 84 genera, 24 families and 10 orders. The variety of species is so high because the state acts as a transitional zone between the Palaearctic and the Oriental region. Generally the high altitude forms have an affinity with the Palaearctic forms and the medium and low altitude species are very much allied with the Indo-Chinese and Indo-Malayan forms.

Palaearctic Origin

About 40% of the mammalian fauna of Sikkim are Palaearctic in origin and routed through southern China and Tibet. Those are *viz., Rhinolophus ferrumequinum, Plectus auritus, Nyctalus noctula, Taphozous nudiventris, Barbastella leucomelas, Cuon alpinus, Vulpes vulpes montana, Martes foina, Mustella sibirica, Lutra lutra, Selenarctos thibetanus, Panthera uncia, Moschus chrysogaster, Ovis ammon, Equus kiang, Pseudois nayaur, Procapra picticaudata, Lepus oiostolus, Lepus hypsibius, Ochotona nubrica, Ochotona roylei, Ochotona thibetana, Ochotona forresti, Ochotona macrotis, Marmota himalayica, Eupetaurus cinereus, Rattus turkestanicus, Pitymys sikimensis etc.* (Chattopadhayay *et.al.* 2006).

Oriental Origin

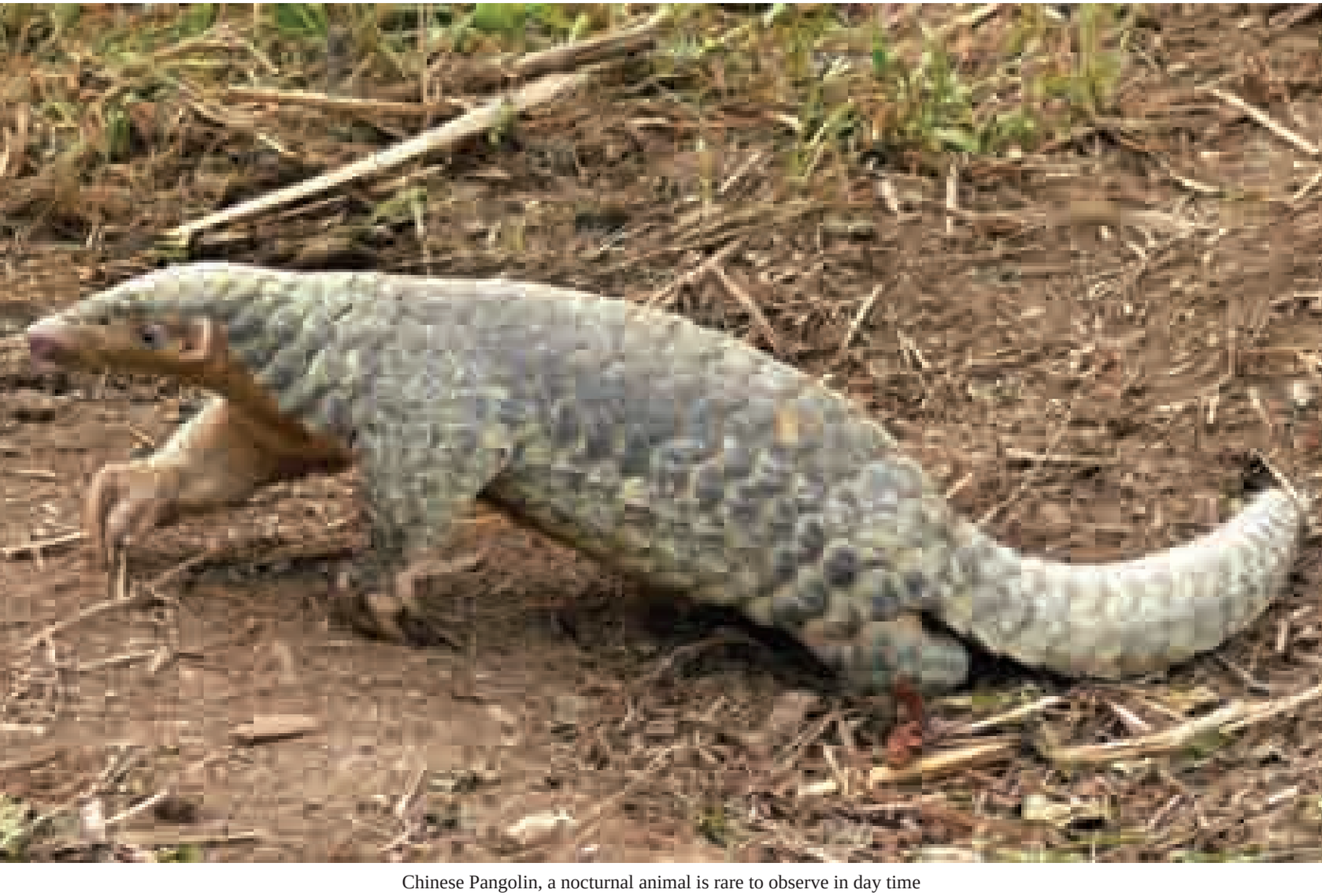
The species percentage of Oriental is little higher than Palaearctic. About 50% mammalian fauna are mostly Indo-Chinese or Indo-Malayan in origin. They are mainly *Chimmarogle himalayica, Talpa macrura, Soriculus nigrescens, Soriculus caudatus, Soriculus leucops, Tupaia glis, Rousettus leschenaulti, Sphaerias blanfordi, Cynopterus sphinx, Eonycteris spelaea, Rhinolophus rouxi, Rhinolophus pearsoni, Hipposideros pomona, Hipposideros armiger, Myotis muricola, Myotis siligorensis, Macaca assamensis, Presbytis entellus, Prionodon pardicolor, Viverra zibetha, Arctictis binturong, Arctonyx collaris, Paguma larvata, Ailurus fulgens, Catopuma temminckii, Prionailurus bengalensis,*

Pardofelis marmorata, Neofelis nebulosa, Muntiacus muntjac, Belomys pearsoni, Hylopetes alboniger, Petaurista caniceps, Callosciurus pygerythrus, Tamiops macclellandi, Dremomys lokriah, Ratufa bicolor, Hystrix brachyuran, Niviventer niviventer, Niviventer fulvescens, Niviventer eha, Rattus nitidus, Bandicota indica etc. (Chattopadhayay *et.al.* 2006).

Some species like rats and mice are mainly carried to the place by human agencies which are cosmopolitan in nature. Some others *viz. Semnopithecus entellus, Pteropus giganteus, Pipistrellus coromandra, Lepus nigricollis* etc., are purely Indian in origin.

Percent Species Diversity

The mammalian fauna of Sikkim comprising of little more than 2.5% of the total faunal wealth of the state but among the chordate (630 species) percent species diversity is 19.84.In relation to the vertebrate species (4860) diversity



Chinese Pangolin, a nocturnal animal is rare to observe in day time

and mammalian species (397) diversity of India, the percent species diversity of Sikkim mammal is 2.57 and 31.5 respectively. The maximum and minimum percent species diversity was observed among orders Rodentia and Scandentia/Perrisodactyla/Pholidota respectively (Table 4). Hence the percent species diversity of mammalian fauna is much more in the state in relation to the geographical area in spite of having a large snow covered area in the north.

Table 4. Number and percent species diversity of mammals

Sl. No.	Order	No. of Species	Percentage
1.	Scandentia	1	0.8
2.	Insectivora	9	7.2
3.	Chiroptera	32	25.6
4.	Primates	2	1.6
5.	Carnivora	26	20.8
6.	Perissodactyla	1	0.8
7.	Artiodactyla	12	9.6
8.	Lagomorpha	8	6.4
9.	Rodentia	33	26.4
10.	Pholidota	1	0.8

Among the 13 living orders, species under 10 orders are distributed in the Sikkim state (Table 5). Only the members of the orders Proboscidia, Sirenia and Cetacea are absent from the state.

Table 5. An order wise break up of families, genera, species found in Sikkim as against India and world is given below.

Orders	Families			Genera			Species		
	World	India	Sikkim	World	India	Sikkim	World	India	Sikkim
Insectivora	7	3	2	66	11	6	428	28	9
Scandentia	1	1	1	5	2	1	19	3	1
Chiroptera	17	7	4	177	34	20	925	112	32
Primates	13	3	1	60	6	2	233	15	2
Pholidota	1	1	1	1	1	1	7	2	1
Carnivora	11	7	5	129	35	22	271	60	26
Proboscidea	1	1	0	2	1	0	2	1	0
Sirenia	2	1	0	2	1	0	2	1	0
Perissodactyla	3	2	1	6	2	1	18	3	1
Artiodactyla	10	5	4	81	21	10	220	31	12
Lagomorpha	2	2	2	13	3	2	80	11	8
Rodentia	29	4	3	443	43	19	2021	104	33
Cetacea	10	7	0	41	19	0	78	26	0
Total	**107**	**44**	**24**	**1026**	**179**	**84**	**4304**	**397**	**125**

ENDEMICITY

In the present scenario, there is no mammalian species which could be treated as endemic to the state but 4 species are endemic to eastern Himalaya (Ramakrishna & Alfred, 2007) and species like *Petaurista caniceps, P. Magnificus, P. Nobilis* are localised to Nepal, Sikkim, Bhutan and northern West Bengal (Chattopadhyay *et al.*, 2006). In the eastern Himalaya, the Woolly Flying Squirrel (*Eupetaurus cinereus*) is found only in Sikkim within the Indian boundary.

EXPLOITATION OF MAMMALS

From time immemorial the mammals have been exploited as food, pet, guard, game, amusement, ornament and so on. Their skins are being used as clothes, tents, shoes, carry bags, pots and fancies and for many other purposes. The hairs of mammals are used not only as fur but also in combination with natural and artificial fibres, for the production of cloth (Chakraborty & De, 2010). The skin of large cats is used for making coats, bones are used for making oriental medicine, teeth and claws are used as talisman and faith healing. The skin of small cats is utilized for preparing coats and gloves. The bile of bear is used for the purpose of preparing oriental medicine. The musk gland of musk deer is utilized for Asian medicine as well as fragrance. The dermal plates of pangolin are used as talisman.

Snow Leopard, the magnificent big cat inhabits the Himalaya between the tree line and snow, but rarely comes down to woodlands also

THREATENED SPECIES

Among the 125 species of mammals about 18% are threatened as per IUCN Red list. Those are *viz., Soriculus nigrescens, Canis aureus, Cuon alpinus, Vulpes vulpes montana, Martes flavigula, Lutra lutra, Selenarctos thibetanus, Ailurus fulgens, Pardofelis marmorata, Catopuma temminckii, Otocolobus manul, Neofelis nebulosa, Panthera uncia, Panthera pardus, Equas kiang, Moschus chrysogaster, Nemorhaedus goral,Ovis ammon etc.* Once *Sus sylvanius* was distributed in Sikkim terai region (Alfred *et al.*, 2002) but at present it is probably found in Manas of Assam only (Alfred *et al.* 2006). An extensive survey on this aspect has to be taken up for confirmation.

CONSERVATION

From the above account it is obvious that qualitatively mammalian species diversity is very high in Sikkim. However, except some species of rats, squirrels, bats, shrews and small carnivores, most of the species are represented by small populations. In fact, out of 125 mammalian species of Sikkim, a number of species have already found place in the Red Data Book of Indian Vertebrates (Anon, 1994).

There is no doubt that species are best concerned as a part of the larger ecosystems where they can continue to adapt themselves according to the changing condition. Thus, establishment of Protected Areas has become the keystone of National Wildlife Action Plan. So far the Protected Area is concerned, Sikkim is the best covered State in the country. As against the national average of about 4.76%, nearly 31% of the geographical area of Sikkim has been brought under Protected Area network. However, the desired goal of conservation would not be achieved by this network. In reality, Protected Areas have created some psychological impact among the locals. As the Government has taken the right and care of Protected Areas ignoring the local aspiration and interest, so often they go ahead to abuse the surrounding land and often extending support to the destructive agencies in exploiting even the Protected Areas. Further, most of the natural areas are degrading due to growing human population and domestic stock, over-exploitation of resources, uncontrolled tourism and ill conceived developmental policies. Grazing of domestic livestock increase the chances of genetic degradation as well as transmission of diseases. Military activities also disturb the special movement of wild animals. Lastly, organizations or departments assigned with the responsibility of conservation are far from the actual requirement in respect of man power and financial support.

Tibetan argali is found in the Tso Lhamo region

For the conservation of biodiversity as a whole and mammalian species in particular, recommendations of Mc Neely *et al*. (1978) may be taken into consideration. For some of the threatened species like *Ailurus fulgens*, *Uncia uncia*, *Moschus chrysogaster* etc., species specific or emergency based conservation by way of captive breeding and subsequent release in suitable habitats as per IUCN guide lines is important. Further, may be fruitful in sustainable utilization as well as minimising the rate of poaching. For ecosystem conservation, role of local people and their traditional knowledge should be taken as inclusive and not exclusive. Conflicts between the various activities like agriculture, fisheries, forestry, farming etc., conservation and rehabilitation need to be identified in integrated plans and programmes of the protected areas. The many economic and financial benefits of integrated rural development linked with conservation of biological resources need to be quantified and brought to the attention of policy makers. Restoration of degraded habitats outside the protected areas in a participatory manner will not only provide alternative livelihood to the local people, but also reduce the anthropogenic pressure on protected areas.

Further, this will provide space for spatial movement and local migration of mammalian species. Research and monitoring are important need for scientific management plan. Financial and instrumental support to local research organisation including State Forest Department to be arranged to carry out researches on ecology, wildlife management, wildlife corridors, habitat improvement, ethnic knowledge, population, social science and other related areas. Support of the department like Zoological Survey of India, Wildlife Institute of India may also be asked for monitoring, census and inventorization and to impart training on these aspects. Locals to be included in research activities to incorporate their traditional field knowledge. All the vacant posts of wildlife management authorities to be filled up on a priority basis. For filling up the post in frontier zone, preference to be given to a person having physical fitness and traditional knowledge about field ecology. Lastly, education and awareness programmes to be launched at all the sectors to achieve the ultimate goal of conservation.

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