

Threatened Rodent Species of Arunachal Pradesh

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Abstract

The rodents are important animals in food chain and play an important role in the ecosystem. They also serve as prey for many important and endangered carnivorous and make up almost 40% of the mammalian species. They are essential part in the regeneration of forests. In Arunachal Pradesh, there are three types of forest *i.e.* tropical, subtropical and alpine experienced with different climate. Such type of environment is favourable for multiplication of rats, squirrels and porcupines, even though, their population is decreasing day by day due to indiscriminate hunting. Most of the squirrels and porcupines are hunted for meat, furs, skin, teeth and quills. Field surveys were conducted in different districts of Arunachal Pradesh for the present review. The presence of squirrels and porcupines were observed by direct sighting with the help of binocular or by hearing calls. Information was also collected through interaction of local people and forest staffs. The major threats for rodents are consequences due to hunting for meat, shifting agriculture (*Jhum*), deforestation, human settlements and infrastructure development in forest areas. Many of the rodents have come under endangered species and some gone extinct in recent years. Keeping this view, the present review has been made to document the diversity of rodents in Arunachal Pradesh and to review their habitat and conservation. The article reports 10 threatened rodent species under 9 genera belonging to 3 families.

Highlights

- The present study has been carried out in East Siang, West Siang, Upper Siang, Lower Subansiri, Lower Dibang valley and Lohit districts of Arunachal Pradesh.
- At present 10 threatened wild rodent species existing in the study area.
- The major threats for wild rodents are hunting for meat, habitat loss and deforestation.

Keywords: Threatened species, rats, squirrels, porcupines, conservation, habitat, behavior, Arunachal Pradesh.

Rodents are important link in food chain between plants and the carnivorous predators, hence, it play an important role in different ecosystems. Certain rodent can be used as indicator monitoring the distribution as well as the density to indicate the health of biotic system (William and Lidicker 1989; Koprowski and Nandini, 2008). Rodents are important sources of prey for a vast array of predators, of

which few species are threatened or endangered. For rare species such as snow leopards and northern spotted owls, rodents are essential part of their diet. Squirrels are also essential in the regeneration of forests around the world through their seed dispersal activities. This is not only because seeds are left in the feces of these animals but also because of the caching habits of many squirrels (Kanoje,

2008). Rodents are also important in dispersing the spores of fungi that they eat, including ecologically important underground endorhizal fungi. Sciurids are a typical meal for many opportunistic domestic animals, wild predators and birds. Many of the vulnerable, endangered and threatened bird species including eagles, vulture, hawks, falcons, kite and owls prey upon rodents (Singh *et al.*, 2013). Since their diets consist of mainly fruits and seeds, squirrels become very useful in seed dispersal. Squirrels that eat flowers or drink nectar may also aid in pollination. Squirrels are used in medical and scientific research. Squirrels are also hunted for food and fur by human being. Of the 279 species of Sciuridae, 2 are listed as critically endangered, 15 are listed as endangered and 16 are listed

as vulnerable (Thorington and Ferrell, 2006). The critically endangered sciurid is the Vancouver Marmot (*Marmota vancouverensis*), consisting of only an estimated 35 individuals in the wild as of 2004 (IUCN 2013). Common factors leading to these marmots being listed as endangered include destruction of habitat and human encroachment. Lack of accurate information on populations and threats is another important factor in rodent conservation. The indiscriminate hunting of rodents is one of the factors for decreasing population. The local tribes of Arunachal Pradesh use to hunt the wild animals and rodents as a hobby. The *Adi* tribe of Siang belt also celebrates hunting festival in first week of March known as ‘*Aran*’. When the celebration of festival is fixed, the male members of the



Fig. 1: Rodents hunting during ‘*Aran*’ festival



Fig. 2: Rat traps commonly used in hunting



Fig. 3: *H. alboniger* immediately after hunting



Fig. 4: Different Species of rodents hunted for meat



Fig. 5: Collection of hunted rodents before smoke drying



Fig. 6: Skin burning of rodents



Fig. 7: Smoke drying of rodents



Fig. 8: Sale of smoke dried rodents in local market

Plate 1: Activities related to hunting, value addition and marketing of different species of rodents in Arunachal Pradesh (fig. 1 to 8)



village go to the forest for hunting and catch rodents (Fig.1). The rodent hunters used to set the traps in the forest hills. They place the traps on the rodent route and on some artificial bridges which are made for running of rodents across water stream or in a narrow gap between the trees (Figure2). They used to stay in the forest for 5-6 days and hunt many wild rodents indiscriminately (Figures 3, 4 and 5). Meat of hunted rodents are consumed either in fresh condition or value added by skin burning (Figure 6) and smoke drying (Figure 7) for selling the same in local market (Figure 8).

Diversity of rodents in India

Rodents make up almost 40% of the mammals species and represent the largest order of the mammals comprising some 1700 species in 35 families that include 389 genera in the world. Further 12 families and 300 genera are known only from fossils (MacDonald and Fenn 1994). Out of these, four families namely Sciuridae, Muridae, Dipodidae and Hystricidae occur in India. Family Muridae, which is the largest family, represents 28 genera and 68 species; family Sciuridae represents 12 genera and 29 species; family Dipodidae represents one genus and one species while family Hystricidae represents 2 genera and 3 species (Agrawal, 2000; Pradhan and Talmale, 2011). Zoological Survey of India published faunal document including rodents from Arunachal Pradesh (De *et al.* 2006). Their principal nonflying feature is the possession of one pair of incisors, which are used for gnawing. The name of the order rodentia is derived from the Latin '*rodere*' meaning to gnaw. The rodents' incisors are remarkable in their length, the open roots of the lower pair reaching back to the articulation of the jaw and their front surface is coated with enamel. This enamel enables the dentine for producing a self-sharpening blade.

Family Sciuridae

The family Sciuridae has five sub-families and includes tree squirrels, ground squirrels and flying squirrels which are a diverse group consisting of approximately 51 genera and 279 species. Tree squirrels have long, bushy tails, sharp claws and large ears. Some have well-developed ear tufts. Flying squirrels have a furred membrane '*patagium*' extending between the wrist and ankle that allows them to glide between trees. Ground squirrels are generally more robust than tree squirrels and often have short, sturdy forelimbs those are used for digging. Their tails, while fully furred, generally are not as bushy as those of tree squirrels

(Gurnell, 1987; Steppan and Hamm, 2006). Squirrels are especially diverse in African and southeast Asian forests. They are found in a vast array of habitats, including rainforests, arid grasslands, arctic tundras, alpine regions, suburban areas and cities (Saiful and Nordin, 2004; Thorington and Ferrell, 2006).

Family Hystricidae

The family Hystricidae includes 11 species of porcupines found in Africa and Asia. These Old World rodents are large, weighing up to 25 kg. Members of this family are nocturnal and fossorial possess specialized pelage or hairs those are modified into sharp spikes or quills. These quills act as a deterrent defense against larger predators. Three species of porcupines are found in India (Agrawal and Prakash, 1992) out of which two are threatened (IUCN, 2013).

Family Cricetidae

Cricetidae is an extremely diverse family of muroid rodents. This is one of the largest families of mammals, with 6 subfamilies, 130 genera and 681 species (Musser and Carleton, 2005). About 21% of the species in this family are included on the IUCN's Red List of Threatened Species. Of these, 58 are of lower risk, 2 are near threatened, 27 are vulnerable, 27 are endangered, 11 are critically endangered and 10 are lacking sufficient data. Another 6 have gone extinct in recent years. Many cricetids have restricted geographic ranges, making them even more vulnerable to extinction. Few actions, other than basic research, are underway to conserve these and other rodent species, as most attention is directed toward saving larger, more charismatic fauna (IUCN, 2013). As research animals, cricetids have contributed greatly to the fields of ecology, physiology, and genetics. Some species are used for food or for their valuable fur. Also, cricetids play an important role in controlling populations of insect pests (Nowak, 1999). Cricetids have a large impact on forest succession by preying on tree seedlings, and are sometimes considered keystone species when they play such roles (Manson *et al.*, 2001). Cricetids represents five species in India of which two species are threatened (including *Alticola roylei* from Arunachal Pradesh) and one is vulnerable (Srinivasulu and Srinivasulu, 2012).

Need for study: The purpose of the present study has been to introduce something of the diversity of rodents in Arunachal Pradesh and to managing the tiny mammals which are wild in nature. It is also important to understand

their ecology and behavior. Considering the huge impact on ecosystem by some rodent species, it is astounding that so little effort has been directed at studying their natural behavior and conservation in India.

Materials and Methods

Arunachal Pradesh is the largest state among all the North eastern states of India with an area of 83, 743 sq. km. located in the Eastern Himalaya. The state also has various topographical zones experienced different climates in the different parts with tropical, subtropical and alpine forests. The present study has been carried out in East Siang, West Siang, Upper Siang, Lower subansiri, Lower Dibang valley and Lohit districts of Arunachal Pradesh. Field surveys were carried out in the above mentioned districts to trap the rats. The presence of squirrels and porcupines were ascertained by direct sighting, by hearing calls, as well as through finding preserved furs and skin used by the tribal people as decorative materials in the villages. The information was also collected through interviews and discussions with local people, forest staff, village heads and hunters showing them visual aids like photo and movie. The arboreal species of rodents were observed with the help of binoculars and noticed its diagnostic characters as described by Menon (2003).

Threatened species in Arunachal Pradesh: The review on threatened species of rodents has been done including taxonomy, IUCN red list category, habitat, economic importance and major threats. The present article reports 10 threatened rodent species of Arunachal Pradesh under 9 genera of 3 families.

Family Sciuridae

Red billed Squirrel [*Callosciurus erythraeus* (Pallas, 1779)] (Figure 9)



Fig. 9: Red billed Squirrel

Source: www.animaldiversity.ummz.umich.edu

Taxonomy: A major structured program for collection of red billed squirrel and their morphological study is required to clarify the complex taxonomy of this species (Evans *et al.*, 2000). It is often found in reports as *C. flavimanus*.

IUCN Red List: Least Concern (Duckworth *et al.* 2008)

Distribution: This species is widely distributed in northeastern South Asia, much of central and southern China including Taiwan, Myanmar, Thailand, Lao PDR, Vietnam, eastern Cambodia and Peninsular Malaysia (Duff and Lawson, 2004; Smith and Xie, 2008). In South Asia, the species is known to occur in Bangladesh and northeastern India (Molur *et al.* 2005; Wilson and Reeder 2005).

Habitat: Red billed squirrel is diurnal and arboreal species typically occurring in subtropical montane evergreen and broadleaved forests (Hori *et al.*, 2006). In Arunachal Pradesh and China, it is also present in sub-alpine coniferous forests or in a mix of conifers and broadleaf trees at altitudes up to 3,000 m MSL (Hegde 2003; Smith and Xie, 2008). It has been found to occupy tree hollows in mid high canopy. *C. erythraeus* was considered to be a “good invader” due to its ability to colonize in new environments (Novillo and Ojeda, 2008). It is also considered to have a good ability to spread efficiently in urban areas also, using small fragmented forest sites (Miyamoto *et al.*, 2004), individual trees and cables as stepping-stones (Guichon *et al.*, 2005).

Economic importance: *C. erythraeus* damages trees by gnawing bark in Japan (Hori *et al.* 2006) and Taiwan (Kuo, 1982). Damage to buildings, cables (Hori *et al.*, 2006; Stuyck *et al.* 2009) and irrigation systems (Guichon and Doncaster, 2008) by this species are also reported. Their consumption of oil palm nuts has brought them into conflict with plantation owners who now hunt them as pests. Similar to all tree squirrels, red bellied squirrels rely heavily on a diet consisting of leaves, fruit, seeds, insects, nuts, acorns and cones. These squirrels feed mainly in the trees, but spend some time feeding on the surface. Red bellied squirrels are well adapted to rotate their dietary need based on the seasonal availability of the items. In winter, they consume primarily Camellia tree flowers, which bloom from October to June. Later the diet switches toward the greatest period of leaf consumption from April to May. In June, their palate is suffused with the luscious fruits while in fall, squirrels feed on the nutritious food source of ants (Setoguchi, 1990).

Threat: Hunting for consumption has depleted the species in a great extent in Arunachal Pradesh.



Hoarybellied Himalayan Squirrel [*Callosciurus pygerythrus* (Hilaire, 1832)] (Figure 10)



Fig. 10: Hoarybellied Himalayan Squirrel
Source: www.wildphotons.co.uk

Taxonomy: This species resembles *Callosciurus inornatus* and sometimes confused with this.

IUCN Red List: Least Concern (Shrestha *et al.*, 2008).

Distribution: Hoarybellied Himalayan Squirrel is a widely distributed species at present in northeastern South Asia, southern China and western Southeast Asia. In South Asia, this species is widely distributed in Bangladesh, Bhutan, India and Nepal at elevations up to 1,560 m MSL (Hegde 2003; Molur *et al.*, 2005; Smith and Xie, 2008). It is largely confined to western and central Myanmar.

Habitat: In general, this is a diurnal and arboreal species that occupies mid canopy temperate, tropical and subtropical moist forest with thick to moderate evergreen forest patches (Molur *et al.*, 2005). In Bangladesh and China, the species has been recorded from gardens, plantations (including bananas) and cane shrubs. The species reproduces once each year, with a litter size averaging three to four offspring (Smith and Xie, 2008).

Economic importance: Hoarybellied Himalayan squirrels were observed to prefer a rich and varied habitat consisting predominantly of Bamboo, *Ficus* spp., *Azadirachta indica*, *Bombax ceiba*, *Olea europaea*, *Bambusa* spp., *Dendrocalamus* spp. and various other fruit plants and wild shrubs and trees (Kalita, 2009).

Threat: It is listed in the Schedule II of the Indian Wildlife (Protection) Act, 1972. It is known from the protected areas in India *viz.* Namdapha National Park (27°38'N, 95°55' E, 152m) and Pakhui Wildlife Sanctuary (27°05'N, 92°49' E, 325m) in Arunachal Pradesh, and Gorumara National Park (26°42'N, 88°46' E, 110m) and Mahananda Wildlife Sanctuary (26°54'N, 88°30' E, 571m) in West

Bengal. Further, more survey and monitoring are recommended for this species (Molur *et al.*, 2005).

3. Orange bellied Himayayan Squirrel [*Dremomys lokriah* (Hodgson, 1836)] (Fig. 11)

Taxonomy: Orange bellied Himayayan Squirrel is medium sized forest squirrel with a head to body length of 200 mm and tail length of 220 mm. The dorsal coat is dark rufous brown speckled with yellowish brown, while the ventral side is orange, varying from pale to rusty red. It has three subspecies *i.e.* *D.l. lokriah*, *D. l. macmillani* and *D. l. garonum* (Pradhan and Talmale, 2011).

IUCN Red List: Least Concern (Molur 2008).

Distribution: This species is distributed in northeastern South Asia, southern China and western Southeast Asia including Bangladesh, Bhutan, India and Nepal (Prater 1971; Corbet and Hill, 1992; Hoffmann *et al.*, 1993) with elevations of 900 to 3,000 m MSL (Molur *et al.*, 2005; Smith and Xie 2008). The species was also reported from Cachar district of Assam (Soud *et al.*, 2010).

Habitat: It is diurnal and arboreal species that also forages on the forest floor. It occurs in subtropical montane evergreen and broadleaved forests (including moist semi-deciduous forest). It has been found to occupy tree hollows in mid high canopy of dense oak, bamboo, fir, conifer and pine forest patches (Molur *et al.*, 2005). The species litters of two to five young (Smith and Xie, 2008).

Economic importance: The species is reported to feed on fruits and nuts of *Ficus* spp., *Artocarpus lakoocha*, *Desmodium* sp., *Calamus tenuis*, *Daemonorops jenkinsianus*, *Homalomena aromatic*, *Cromelina* sp., *Combretum* sp., *Melastoma malabathricum*, *Macaranga* sp., *Mikania cordata*, and *Ipomea* sp.



Fig. 11: Orange bellied Himayayan Squirrel
Source: www.flickrriver.com

Threat: Hunting for consumption is a major threat in northeastern India. It is known from the following protected areas of Arunachal Pradesh *viz.* Eagle's Nest Wildlife Sanctuary (26°56'N, 93°01' E, 400m), Kamlang Wildlife Sanctuary (27°44'N, 96°20' E, 479m), Namdapha National Park (27°38'N, 95°55' E, 152m), Pakhui Wildlife Sanctuary and National park (27°05'N, 92°49' E, 325m), Sessa Orchid Sanctuary (27°04'N, 92°31' E, 1368m), Tale Valley Wildlife Sanctuary and National Park (27°34'N, 93°59' E, 2489m). In Nepal and Bangladesh, the species is threatened by deforestation and fragmentation of habitat (Molur *et al.*, 2005). This beautiful species is hunted in Arunachal Pradesh for medicinal and religious purposes although it is protected by the *Apatani* tribe through traditional conservation mechanisms (Dollo *et al.*, 2010).

4. Particolored Flying Squirrel [*Hylopetes alboniger* (Hodgson, 1836)] (Fig. 12)

Taxonomy: The synonyms are *Pteromys alboniger*, *Sciuropterus alboniger* and *Hylopetes alboniger alboniger*.

IUCN Red List: Least Concern (Duckworth *et al.* 2008a).

Distribution: This species is present in northeastern South Asia, southern and central China, and mainland Southeast Asia including mountainous regions of Nepal, Bhutan and northeastern India upto 4,000 m MSL (Molur *et al.*, 2005; Smith and Xie, 2008).

Habitat: This is an arboreal and nocturnal species, found in tropical, subtropical montane forests, and in more temperate oak and rhododendron forests (Duckworth *et al.* 2008a). Populations can be found in primary forests as well as secondary, degraded forests and scrubby habitat. Two to three offspring are born in each litter.

Economic importance: It is found to feed on fruits, flowers and leaves of several trees. The species also reported to



Fig. 12: Particolored Flying Squirrel
Source: M.M. Kumawat

feed on the ripened fruit of *Psidium guajava*, *Neolamarckia cadamba*, *Ficus curtipes* and on the flowers of wild mango *Mangifera* sp. (Murali Krishna *et al.*, 2013).

Threat: The population of this species is believed to be declining in South Asia, but the rate of decline is not known. In North east India, the species is threatened by habitat loss due to shifting (Jhum) agriculture, small wood plantations, mining activities, infrastructure development, establishment of human settlements, construction of dams and forest fires (Molur *et al.*, 2005). In Arunachal Pradesh, this species is hunted for food. It is included in the Schedule II (Part II) of the Indian Wildlife (Protection) Act, 1972 and is found at Namdapha National Park (27°38'N, 95°55' E, 152m), Arunachal Pradesh, India.

5. Giant Flying Squirrel [*Petaurista petaurista* (Pallas, 1766)] (Fig. 13)

Taxonomy: It is commonly known as red giant flying squirrel. *Petaurista petaurista* possibly represents a complex of several similar species.

IUCN Red List: Least Concern (Walston *et al.*, 2008).

Distribution: This widely distributed species has been recorded from northern South Asia, southern China and Southeast Asia. Beside these, it has a large distribution in eastern Afghanistan, northern Pakistan, eastern Bangladesh, Bhutan, Nepal and northern India at elevations up to 3,100 m MSL (Hegde, 2003; Molur *et al.*, 2005; Smith and Xie, 2008).

Habitat: It is an arboreal and nocturnal species occurs in moist evergreen broadleaf forest, temperate forest, coniferous forests, scrub forest, rocky areas as inland cliffs, mountain peaks (Molur *et al.*, 2005; Smith and Xie, 2008). These solitary animals are nocturnal and are most active and vocal during the evening hours. Their low, monotonous moan is believed to be a mating call of some kind.



Fig. 13: Giant Flying Squirrel
Source: www.thaivisa.com



Economic importance: The giant flying squirrels' diet primarily consists of pine cones, tree buds, leaves, young branches, various fruits and nuts. In captivity, individuals have been maintained on resins and nuts but refuse shrubs and other leafy substances.

Threat: The cutting and burning of forest regions have significantly decreased the size of their habitats. This species is present in many protected areas *viz.* Namdapha National Park (27°38'N, 95°55' E, 152m) in Arunachal Pradesh, India.

6. Malayan Giant Squirrel [*Ratufa bicolor* (Sparrman, 1778)] (Figure 14)

Taxonomy: *Ratufa bicolor* possibly represents a complex of several similar species. It is also known as black giant squirrel. Based on cranial measurement, *R. b. gigantea* and *R. b. hainana* are all valid subspecies (Li *et al.*, 2008).

IUCN Red List: Near Threatened (Walston *et al.* 2008a).

Distribution: Black giant squirrels are found across much of the Oriental region. Their native range spans from northern Nepal and southern China through Vietnam, Myanmar, Thailand, Lao PDR, Cambodia, Indonesia and Malaysia. They are numerous across the Malaysian Peninsula (Endo *et al.*, 2004). In Indian subcontinent, this species has been recorded widely distributed in Bangladesh, Bhutan, India (Arunachal Pradesh, Assam, Meghalaya, Nagaland and West Bengal), and eastern Nepal at elevations up to 2,500 m MSL (Duckworth *et al.*, 1999; Hegde, 2003; Molur *et al.*, 2005).

Habitat: It is diurnal and arboreal species occasionally feeding on the forest litter. Its presence noticed in tropical and subtropical montane evergreen and dry deciduous forests occupying tree hollows in mid high canopy (Molur

et al., 2005). It is not tolerant of habitat modification, and has a long generation time of eight to nine years, with a litter size of one or two young. Often, they are found nesting in the canopy of tall trees (Abramov *et al.*, 2006; Harrison and Traub, 1950).

Economic importance: Black giant squirrels were, until recently sold in large quantities at fresh food markets in Vientiane, Laos. Black giant squirrels disperse seeds of large-seeded tree species especially Burseraceae seeds, *Canarium euphyllum* (Kitamura *et al.*, 2006).

Threat: The species is included in the Schedule II (Part II) of the Indian Wildlife (Protection) Act, 1972. Human induced habitat degradation due to shifting agriculture (*jhum*), small-scale logging, clear-cutting, forest fires, expansion of human settlement, harvesting for local consumption have been observed to be major threats for this species in South Asia (Molur *et al.*, 2005). It is also threatened by hunting and habitat loss in China, Lao PDR, Viet Nam and Thailand (Wang *et al.* 1989; Evans *et al.*, 2000). This reduction in number is strongly correlated to the reduction in canopy cover and tree density in Arunachal Pradesh because black giant squirrels nest in the high canopy layer of tall trees (Datta and Goyal, 2008). This species is one of the most commonly sold mammals in the food market in Pasighat, Arunachal Pradesh and other local markets nearby.

7. Three-striped Palm Squirrel [*Funambulus palmarum* (Linnaeus, 1766)] (Figure 15)

Taxonomy: It is known as common Palm Squirrel, Indian Palm Squirrel and Three-striped Palm Squirrel. The synonyms of this species are *Sciurus brodei* Blyth, *Sciurus indicus* Lesson, *Sciurus kelaarti* Layard, *Sciurus palmarum* Linnaeus, and *Sciurus pencillatus* Leach.



Fig. 14: Malayan Giant Squirrel
Source: <http://envirosea.photoshelter.com>



Fig. 15: Three-striped Palm Squirrel
Source: <http://fr.wikipedia.org>



IUCN Red List: Least Concern (Nameer and Molur, 2008).

Distribution: This species is endemic to southern India and Sri Lanka (Molur *et al.*, 2005; Thorington and Hoffmann, 2005). It is widely distributed found at elevations from sea level up to 2,000 m MSL (Molur *et al.*, 2005).

Habitat: This is a very adaptable species. It is a diurnal and semi-arboreal. This species occurs in tropical and subtropical dry deciduous forest, mangrove forest, grasslands, scrublands, plantations, rural gardens and urban areas. In Sri Lanka, this species is found throughout the island except in deep jungles (Molur *et al.*, 2005).

Economic importance: These squirrels eat mainly nuts and fruits. They are fairly vocal, with a cry that sounds like “chip chip chip” when they are in danger. Naturally active, their activity reaches levels of frenzy during the mating season. They tend to be very protective of their food sources, often guarding and defending them from birds and other squirrels.

Threat: The species is rare in Arunachal Pradesh and not protected by any legislation. It is however, known from the many protected areas in North India (Molur *et al.*, 2005).

Family Cricetidae

8. Royle’s Mountain Vole [*Alticola roylei* Gray, 1842] (Figure 16)

Taxonomy: It belongs to the subfamily Arvicolinae under family Cricetidae. The synonyms are *Arvicola roylei* and *Alticola roylei cautus*.

IUCN Red List: Near Threatened (Molur and Nameer, 2008)

Distribution: This species is endemic to northern India, where it is distributed in the western Himalayas from Kullu Valley in Himachal Pradesh to Kumaon in Uttarakhand



Fig. 16: Royle’s Mountain Vole
Source: www.arkive.org

(Agrawal 2000; Molur *et al.*, 2005). Its existence has been recorded from 1,800 to 4,300 m MSL (Hegde, 2003; Molur *et al.*, 2005)

Habitat: This species is diurnal, colonial and herbivorous. It lives in subtropical and temperate montane rocky areas (including cliffs and peaks), extending from the coniferous treeline to the snowline (Molur *et al.*, 2005).

Economic importance: It is used as prey for snow leopard (Bagchi and Mishra, 2006). Its presence is the indicator of well-being ecosystem and considered a key stone species in ecosystem succession.

Threat: Major threats are from overgrazing by livestock of the species habitat, human settlement and general disturbance (Molur *et al.*, 2005). It is listed as Near Threatened with significant decline because of widespread habitat loss through much of its range, thus making the species close to qualifying for Vulnerable under criterion A2c. It has been recorded from Nanda Devi National Park (30°39’N, 79°33’ E, 3707m), Chamoli, Uttarakhand. General field surveys and monitoring of populations are recommended for this species (Molur *et al.*, 2005).

Family Hystricidae

9. Bush-tailed Porcupine [*Atherurus macrourus* (Linnaeus, 1758)] (Figure 17)

Taxonomy: It belongs to the family Hystricidae. The synonyms of this species are *Atherurus assamensis*, *Atherurus macrourus assamensis*, *Hystrix macroura* and *Hystrix macrourus*.

IUCN Red List: Least Concern (Lunde and Molur, 2008).

Distribution: They are found in Cambodia, Indonesia, Laos, Malaysian Peninsula, Malacca, North East India, China, Sumatra, Myanmar, Thailand, Vietnam and adjacent Indo-chinese islands (Corbet and Hill, 1991; Wilson and Reeder,



Fig. 17: Bush-tailed Porcupine
Source: www.zooinstitutes.com



1993; Grzimek *et al.*, 2003). It has been reported to found upto an elevation of 2,500 m MSL (Hegde, 2003; Molur *et al.*, 2005).

Habitat: It is a nocturnal and fossorial species occurring in subtropical and tropical montane forests. It is found on the forest floor, often in areas with profuse undergrowth interspersed with cane and bamboo brakes and palms (Molur *et al.*, 2005). It constructs burrows, which may be occupied by up to three animals. Two litters of a single young are born after a gestation period of 100 to 110 days (Smith and Xie, 2008).

Economic importance: These animals strictly forage during the night. They are herbivorous and usually feed on vegetation. They enjoy tree bark, roots, tubers, leaves, bulbs, and fallen fruits. However, they sometimes also feed on cultivated crops, insects and carrion (Gould *et al.*, 1998; Grzimek *et al.*, 2003).

Threat: In its limited South Asian range, it is threatened by habitat loss due to shifting agriculture (*jhum*), small-scale logging, subsistence harvesting for food, and accidental mortality (Molur *et al.*, 2005). The species is protected under Schedule II of the Indian Wildlife (Protection) Act, 1972. It has been recorded from Namdapha National Park (27°38'N, 95°55' E, 152m) in Arunachal Pradesh, India (Molur *et al.*, 2005). It is present in a number of protected areas in Southeast Asia. Asiatic brush-tailed porcupines are hunted for their meat (Grzimek *et al.*, 2003). It is declining fast enough to qualify for listing in a more threatened category.

10. Chinese Porcupine [*Hystrix brachyura* Linnaeus, 1758] (Figure 18)

Taxonomy: Chinese Porcupine belongs to the family Hystricidae and commonly known as Malayan Porcupine and Himalayan Crestless Porcupine. It is synonymous to



Fig. 18: Chinese Porcupine
Source: www.biolib.cz

Hystrix hodgsoni. Five sub-species of *H. brachyura* are recorded as *H. brachyura hodgsoni*, *H. b. bengalensis*, *H. b. brachyuran*, *H. b. subcristata* and *H. b. yunnanensis*.

IUCN Red List: Least Concern (Lunde *et al.*, 2008).

Distribution: This species found in Nepal, through northeastern India (Arunachal Pradesh, Sikkim, West Bengal, Manipur, Mizoram, Meghalaya and Nagaland) (Molur *et al.*, 2005), central and southern China (Smith and Xie, 2008), throughout Myanmar, Thailand, Lao PDR, Cambodia and Viet Nam, through Peninsular Malaysia, to Singapore, Sumatra (Indonesia) and throughout Borneo. It can be found from sea level to at least 1,300 to 3,500 m MSL (Hegde, 2003).

Habitat: Chinese Porcupine can be found in various forest habitats, and in scrubby, open areas close to forest. It can be found in agricultural areas, but needs to have rocky outcrops or other areas in which it can create a den or dig burrows. Burrows are generally occupied by family groups. Following a gestation period of about 110 days, two or three young are born. Two litters may be produced annually.

Economic importance: The Malayan porcupine has the diet and eating habits of pumpkins, melons, potatoes, roots, corn, tomato, and other cultivated crop.

Threat: In Southeast Asia, it is hunted for food but this not thought to impact populations. In South Asia, it is threatened by habitat loss due to construction of dams, human settlements and other infrastructure development. It is harvested for subsistence food and medicinal purposes (Molur *et al.*, 2005). It is protected by Schedule II of the Indian Wildlife Protection Act. This species is present in many protected areas but still declining enough. It is known from the Namdapha National Park (27°38'N, 95°55' E, 152m) in Arunachal Pradesh in India (Molur *et al.*, 2005).

Conclusion

The rodents are diversified animals found in wide range of habitats including rainforest, grassland, arid grassland, arctic tundra, forests, suburban areas and cities. Their presence shows a healthy and balanced ecosystem. Rodents are essential part of tri-trophic relationship and maintain the food chain. Many endangered birds and other carnivorous are prey upon rodents. The people of Arunachal Pradesh are closely associated with forest. They depend upon forest and forest products for their livelihood. Hence, it is necessary to conserve the forest for their sustainable livelihood for long time. In view of the above, the



conservation of habitats and diversity of threatened wild rodents are very essential in modern era of hi-tech world. Moreover, it seems that their population is decreasing in the wild due to climate change also. Few of them have become extinct in the nature and some are endangered. However, their conservation is needful in present world of increasing human population.

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References

- Abramov, A., Rozhnov, V. and Morozov, P. 2006. Notes on Mammals of the Ngoc Linh Nature Reserve (Vietnam, Kon Tum Province). *Russian Journal of Theriology* **5**(2): 85-92.
- Agrawal, V.C. 2000. Taxonomic Studies of Indian Muridae and Hystriidae Mammalia: Rodentia). *Records of the Zoological Survey of India Occasional Paper No.180*: 1-177pp.
- Agrawal, V.C. and Prakash, I. 1992. Ecological distribution of Indian rodents. pp. 1-9. In: Prakash, I. and Ghosh, P.K. (eds), *Rodents in Indian agriculture* Vol. 1. Scientific Publishers, Jodhpur, India.
- Bagchi, S. and Mishra, C. 2006. Living with large carnivores: predation on livestock by the snow leopard (*Uncia uncia*). *Journal of Zoology* **268**: 217-224.
- Corbet, G.B. and Hill, J.E. 1991. *A World List of Mammalian Species, Third edition*. New York: Natural History Museum Publications and Oxford University Press, 243pp.
- Corbet, G.B. and Hill, J.E. 1992. *The Mammals of the Indomalayan Region: A Systematic Review*. Oxford University Press, Oxford, UK, vii + 488pp
- Datta, A., Goyal, S.P. 2008. Responses of Diurnal Tree Squirrels to Selective Logging in Western Arunachal Pradesh. *Current Science* **95** (7): 895-902.
- De, J. K., Mandal, A. K. and Ghosh, M.K. 2006. Mammals, pp. 21 – 68. In: *Fauna of Arunachal Pradesh (Part I) State Fauna Series 13*, Published by Zoological Survey of India, Kolkata.
- Dollo, M., Gopi, G.V., Teegalapalli, K. and Mazumdar, K. 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., Salter, R.E. and Khounblin, K. 1999. Wildlife in Lao PDR: 1999 Status Report. IUCN, Vientiane, Laos.
- Duckworth, J.W., Timmins, R.J. and Molur, S. 2008. *Callosciurus erythraeus*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 01 September 2013.
- Duckworth, J.W., Tizard, R.J. and Molur, S. 2008a. *Hylopetes alboniger*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 01 September 2013.
- Duff, A. and Lawson, A. 2004. *Mammals of the world - a checklist*. A & C Black, London, 312pp.
- Endo, H., Kimura, J., Oshida, T., Stafford, B., Rerkamnuaychoke, W., Nishida, T., Sasaki, M., Hayashida, A. and Hayashi, Y. 2004. Geographical Variation of Skull Size and Shape in Various Populations in the Black Giant Squirrel. *Journal of Veterinary Medical Science* **66** (1): 213-218.
- Evans, T. D., Duckworth, J. W. and Timmins, R. J. 2000. Field observations of larger mammals in Laos, 1994-1995. *Mammalia* **64**(1): 55-100.
- Gould, E., McKay, G. and Kirshner, D. 1998. Rodents, pp. 227. In: *Encyclopedia of Mammals*, 2nd Edition, Vol. 1. Academic Press, A division of Harcourt Brace and Company. San Diego, California.
- Grzimek, B., Schlager, N. and Olendorf, D. 2003. *Atherurus macrourus*, pp. 363. In: M McDade, (ed.). *Grzimek's Animal Life Encyclopedia*, 2nd Edition, Vol. 16. Detroit: Thomson Gale.
- Guichon, M.L. and Doncaster, C.P. 2008. Invasion dynamics of an introduced squirrel in Argentina. *Ecography* **31**: 211-220.
- Guichon, M.L., Bello, M. and Fasola, L. 2005. Expansión poblacional de una especie introducida en la Argentina: La ardilla de vientre rojo *Callosciurus erythraeus*. *Mastozoología Neotropical*, **12** (2): 189-197.
- Gurnell, J. 1987. *The Natural History of Squirrels*. New York: Facts on File Inc, 201pp.
- Harrison, J. and Traub, R. 1950. Rodents and Insectivores from Selangor, Malaya. *Journal of Mammalogy* **31**(3): 337-346.
- Hegde, S.N. 2003. *Arunachal Pradesh State Biodiversity Strategy and Action Plan*. Arunachal Pradesh Forest Research and Development Agency (APFRDA), State Forest Research Institute, Itanagar, India, 199+xxiv pp.
- Hoffmann, R.S., Anderson, C.G., Thorington, R.W. and Heaney, L.R. 1993. Family Sciuridae, pp. 419-465. In: Wilson, D.E. and D.M. Reeder (eds.). *Mammal Species of the World: A Taxonomic and Geographic Reference*. Smithsonian Institution Press, Washington, DC, USA.
- Hori, M., Yamada, M. and Tsunoda, N. 2006. Line census and gnawing damage of introduced Formosan squirrels (*Callosciurus erythraeus taiwanensis*) in urban forests of Kamakura, Kanagawa, Japan, pp. 204-209. In: Koike, F. et al. (eds.). *Assessment and control of biological invasion risks*. Shoukadoh Books Sellers and IUCN, Kyoto, Japan and Gland, Switzerland, 216pp.
- IUCN 2013. IUCN Red List of Threatened Species (ver. 2013.1). <http://www.iucnredlist.org>. Downloaded on 12 June 2013.
- Kalita, G. 2009. Note on breeding and parental care behaviours of albino Hoary-bellied Squirrel *Callosciurus pygerythrus* (Rodentia: Sciuridae) in Sibsagar District of Assam, India. *Journal of Threatened Taxa* **1**(6): 358-360.
- Kanoje, R. S. 2008. Nesting sites of Indian giant squirrels in Sitanadi Wildlife Sanctuary, India. *Current Science* **95**(7): 882-884.
- Kitamura, S., Suzuki, S., Yumoto, T., Poonswad, P., Chuailua, P.,



- Plongmai, K., Maruhashi, T., Noma, N. and Suckasam, C. 2006. Dispersal of *Canarium euphyllum* (Burseraceae), a large-seeded tree species, in a moist evergreen forest in Thailand. *Journal of Tropical Ecology* **22**(2): 137-146.
- Koprowski, J. L. and Nandini, R. 2008. Global hotspot and knowledge gaps for tree and flying squirrels. *Current Science* **95**(7): 851-856.
- Kuo, P.C. 1982. Solving tree squirrel debarking problems in Taiwan - a review. Proceedings of the tenth vertebrate pest conference, University of Nebraska, Lincoln, 87-89 pp.
- Li, S., Yang, J., Jiang, X. and Wang, Y. 2008. Geographic variation in giant squirrels *Ratufa bicolor* (Sciuridae: Ratufinae) from China based on cranial measurable variables. *Acta Theriologica Sinica* **28**(2): 201-206.
- Lunde, D. and Molur, S. 2008. *Atherurus macrourus*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 01 September 2013.
- Lunde, D., Aplin, K. and Molur, S. 2008. *Hystrix brachyura*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 01 September 2013.
- MacDonald, D. W. and Fenn, M.G.P. 1994. The Natural History of Rodents: Preadaptations to Pestilence, pp. 1-21. In: Buckle, A.P. and R.H. Smith (eds.). *Rodents Pests and Their Control*. CAB International Publishing, Wallingford, Oxon, UK, 405pp.
- Manson, R., Ostfeld, R. and Canham, C. 2001. Long-term effects of rodent herbivores on tree invasion dynamics along forest-field edges. *Ecology* **82** (12): 3320-3329.
- Menon, V. 2003. *A field guide to Indian mammals*. Dorling Kindersley (India) Pvt. Limited, Delhi, 200 pp.
- Miyamoto, A., Tamura, N., Sugimura, K. and Yamada, F. 2004. Predicting habitat distribution of the alien formosan squirrel using logistic regression model. *Global Environmental Research* **8**(1): 13-21.
- Molur, S. and Nameer, P.O. 2008. *Alticola roylei*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 01 September 2013.
- Molur, S. 2008. *Dremomys lokriah*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 01 September 2013.
- Molur, S., Srinivasulu, C., Srinivasulu, B., Walker, S., Nameer, P.O. and Ravikumar, L. 2005. Status of non-volant small mammals: Conservation Assessment and Management Plan (C.A.M.P) workshop report. Zoo Outreach Organisation & CBSG-South Asia, Coimbatore, India.
- Musser, G. and Carleton, M. 2005. Superfamily Muroidea, pp. 894-1531. In: Wilson, D.E and D.M. Reeder (eds.). *Mammal Species of the World: A Taxonomic and Geographic Reference*. Washington, DC: Smithsonian Institution Press.
- Murali Krishna, C., Ray, P.C., Sarma, K. and Kumar, A. 2013. Observations on Particolored Flying Squirrel *Hylopetes alboniger* (Hodgson 1836) in Northeast India. *Zoo's Print* **28** (8):18-20.
- Nameer, P.O. and Molur, S. 2008. *Funambulus palmarum*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 01 September 2013.
- Novillo, A. and Ojeda, R.A. 2008. The exotic mammals of Argentina. *Biological Invasions* **10**: 1333-1344.
- Nowak, R. 1999. *Walker's Mammals of the World*, 6th edition, vol. II. Baltimore and London: The Johns Hopkins University Press, 1936pp.
- Pradhan, M. S. and Talmale, S. S. 2011. A Checklist of valid Indian rodent taxa (Mammalia: Rodentia) <[http://www.zsi.gov.in/checklist/Valid Indian Rodents.pdf](http://www.zsi.gov.in/checklist/Valid%20Indian%20Rodents.pdf)>. Downloaded on 01 September 2012.
- Prater, S.H. 1971. *The Book of Indian Animals*. Bombay Natural History Society and Oxford University Press, India. 324pp.
- Saiful, A. A. and Nordin, M. 2004. Diversity and density of diurnal squirrels in a primary hill dipterocarp forest, Malaysia. *Journal of Tropical Ecology* **29**: 45-49.
- Setoguchi, M. 1990. Food habits of red-bellied tree squirrels on a small island in Japan. *Journal of Mammalogy* **71**(4): 570-578.
- Shrestha, N., Sarkar, S.K., Lunde, D., Duckworth, J.W., Lee, B., Tizard, R.J. and Molur, S. 2008. *Callosciurus pygerythrus*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 01 September 2013.
- Singh, K. M., Kumawat, M. M., Phurailatpam, A., Rao, V. V. and Pandey, A. K., 2013. *Birds of Arunachal Pradesh (A compilation)*. College of Horticulture and Forestry, Central Agricultural University, Pasighat, Arunachal Pradesh, India, 206 pp.
- Smith, A. and Xie, Y. 2008. *A Guide to the Mammals of China*. Princeton University Press, Princeton, New Jersey, 576 pp.
- Soud, R., Mazumdar, K. and Gupta, A. 2010. Sighting record of the Orange-bellied Himalayan Squirrel *Dremomys lokriah* Hodgson, 1836 (Rodentia: Sciuridae) in Cachar District, Assam, *NeBio* **1**(3): 14-15.
- Srinivasulu C. and Srinivasulu, B. 2012. *South Asian Mammals: Their Diversity, Distribution, and Status*. Springer Science and Business Media, New York, 478 pp.
- Steppan, S. and Hamm, S. 2006. "Sciuridae. Squirrels. Version 13 May 2006". *The Tree of Life Web Project*. <<http://tolweb.org/Sciuridae/16456/2006.05.13>>. Downloaded on January 28, 2009.
- Stuyck, J., Baert, K., Breyne, P. and Adriaens, T. 2009. Invasion history and control of a Pallas squirrel *Callosciurus erythraeus* population in Dadizele, Belgium. *Proceedings of the Science Facing Aliens Conference*. Brussels, 11th May 2009.
- Thorington, R. and Ferrell, K. 2006. *Squirrels - The Animal Answer Guide*. The Johns Hopkins University Press, Baltimore, Maryland, 208pp.
- Thorington, J.R.W. and Hoffmann, R.S. 2005. Family Sciuridae, pp. 754-818. In: Wilson, D.E. and D.M. Reader (eds.). *Mammal Species of the World: a taxonomic and geographic reference*, 3rd edition. The John Hopkins University Press, Baltimore, MD, USA, 2142pp.
- Walston, J., Duckworth, J.W., Sarker, S.U. and Molur, S. 2008. *Petaurista petaurista*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 01 September 2013.
- Walston, J., Duckworth, J.W. and Molur, S. 2008a. *Ratufa bicolor*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 01 September 2013.



- Wang, S., Zheng, C. and Kobayashi, T. 1989. A tentative list of threatened rodents in China and Japan with notes on their distribution, habitat and status. 42-44pp. In: Lidicker, W.Z.Jr. (ed.). *Rodents: A World Survey of Species of Conservation Concern*. IUCN, Gland, Switzerland.
- William, Z. and Lidicker, J. 1989. Rodents: A world survey of species of conservation concern. IUCN/SSC Rodent Specialist Group. Occasional Paper of the IUCN Species Survival Commission (SSC), No. 4.
- Wilson, D. and Reeder, D.M. 1993. *Mammal Species of the World: A Taxonomic and Geographic Reference*, 2nd Edition. Smithsonian Institution Press, Washington and London, 1206pp.
- Wilson, D.E. and Reeder, D.M. 2005. *Mammal species of the world- a taxonomic and geographic reference, 3rd edition*, Vol. 1 & 2. The Johns Hopkins University Press, Baltimore, pp. i-xxxv + 1-743 & pp. i-xvii + 745- 2142.