OCHOTONA ROYLEI: A Flagship Species from India Himalaya

Written by

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Horizon Research Publishing, USA

OCHOTONA ROYLEI

(ORDER: LAGOMORPHA)

A Flagship Species from India Himalaya

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1.1. Garhwal Himalaya: *A Snowfed and Steppe Mountains*

Central Himalaya is recognized as a rich biodiversity center due to its different climatic conditions and provides variety of ecosystems with floral as well as faunal diversity. Himalayan mountain system includes about 18,500 plant species, 241 mammals, 528 birds, 149 reptiles and 74 amphibian species (Ghosh, 1996). The diversity index of both plant and animal appears to be very significant including many of the primitive, new evolving wild species. Few of them are also categorized as threatened due to rise in human population and anthropogenic activities. About the medicinal plant wealth, the said region is enriched with a huge variety of medicinal and aromatic plant species and few of them are only restricted to this region. The present study area is a sub-alpine region at Garhwal Himalaya, Uttarakhand (30° 01' N to 30° 58' N **latitude**, 78° 27' E to 78° 32' E **longitude** and 2500 to 5500 m asl), is one of the finest examples of exceedingly diverse and productive sub-alpine ecosystem (figure 1 and 2). The adverse climatic condition of this area reveals about maximum 22°C to minimum -4°C air temperature, intensive solar intensity recorded 2500 lux in September to 79200 lux in May, high wind velocity, heavy frost, blizzards and low air pressure throughout the year is very common except few months of the summer season. Precipitation is found to be in the form of snow, hail and sometime heavy rain. The soil type of the study area is loam or sandy loam, light gray to brown in colour at low altitude and sandy with large debris above the 3500 m. Surface soil pH ranges between 4-8 and 5-7 (acidic). The maximum areas of Garhwal Himalaya are covered with herbal and valuable medicinal plant species (Bahuguna and Upadhyay, 2008). Garhwal Himalaya is characterized by dry summers and cold winters, vegetation consisting of grasses, medicinal and aromatic herbs, low dwarf-shrubs and tree (Gaur, 1999; Bahuguna and Upadhyay, 2008). Plants in mountain environments are tolerant to a wider range of temperature and moisture conditions than typical desert or forest species (Lavrenko, *et al.,* 1993). This region is consists about 171 species of different grasses, sedges, monocots, short forbs, medium forbs, tall forbs and shrubs (Nautiyal, *et al.,* 2001). Among them most of the species belongs to medicinal and aromatic properties. In case of medicinal and aromatic plants they generally feeds plant species like - *Picrorhiza kurroa, Saussurea costus, Nardostachys jatamansi, Rheum australe, Arnebia benthamii, Allium humile, Dactylorhiza hatagirea, Polygonatum verticillatum, Aconitum heterophyllum, Angelica gluaca* etc (Joshi, 2009).

CHAPTER - 2: Field Survey and Distribution

2.1. Introduction

India, being one of the 12 "Mega diversity" nations of the world, is home to approximately 45,000 plant species and 75,000 species of animals including 1,200 species of birds and 410 species of mammals (Anonymous, 1994; Venkataraman, 2009). The mammalian diversity in Uttarakhand is the richest in the country, exceeding 75 species; about 50% of these are threatened. The mammals of Uttarakhand not only hold great ecological value but they are also part and parcel of cultural ethos and heritage of this Himalayan state. Himalayan mouse hare (Royle's pika, *Ochotona roylei*) is small non-hibernating, diurnal lagomorphs (rabbits and relatives; order Lagomorphs) belong to the family Ochotonidae. Mouse hares are endemic to the modern Holarctic Region (Corbet, 1978; Hoffmann, 1993). There are approximately 30 species throughout the world (Myers *et al.* 2008), most of them are restricted to Asia with only three pika species that presently live outside of Asia. (Hall, 1981; Feng and Zheng, 1985; Smith et al. 1990; Grayson, 2005).

A taxonomically Himalayan mouse hare (Pika) belongs to Phylum Chordate, Class Mammalian, Order Lagomorpha and Family Ochotonidae (Myers *et al.* 2008). Geographically the present study animal is also reported from Ganesh Himalayan area including northern highland belt of Nepal (Khanal, 2007), Himalayan area of China, Tibet and adjacent areas (Kawamichi, 1971). In Garhwal Himalayan area, they are restricted to snow fed areas where aromatic and medicinal herbs are abundant (Dhyani and Kala, 2005; Khanal, 2007; Bahuguna and Upadhyay, 2008).

Presently in Himalayan region due to extremely rural areas in Garhwal Himalaya, studies on the faunal diversity and animal activity pattern was not much more. Also in the absence of detailed studies and monitoring, it appears too conjectural to assume that the Himalayan animals that are new species present only in this area either they are migratory or resident. The order Lagomorpha comprises of two families, the Leporidae (hares and rabbits) and the Ochotonidae (Mouse hares). Mouse hare (*Ochotona*) is small tail less animal with short, broad, rounded ears and short legs. They are restricted to the Himalayas, the mountains and steppes of central Asia and the mountains of western north America (Yang *et al.* 2008; Bahuguna and Upadhyay, 2008; Khanal, 2007). In past few years some little information related to presence of Himalayan mouse hare (*Ochotona roylei*) in Indian Himalaya (Kawamichi, 1971; Inskipp and Lachungpa, 2003; Tambe and Rawat, 2006; Jha and Avasthe, 2007; Ballabh *et al.* 2007; Khanal, 2007) at different snowfed areas of Garhwal and Kumaon Himalaya at elevation between 3,400 to 5,500 m asl (Sharma, 1998; Uniyal, 2002; Ilyas and Baiju, 2006; Kunwar and Tiwari, 2007; Bahuguna and Upadhyay, 2008). They feed on the valuable medicinal plants and also destroy a sizeable quantity of medicinal plants in high altitude areas (Dhyani and Kala, 2005). Till date no report is available about the distribution of Himalayan mouse hare (Royle's Pika, *Ochotona roylei*) from the different area of Garhwal Himalayan viz. Tungnath, Badrinath, Kedarnath, Yamunotri, Gangotri etc. Hence an attempt has been made to find out their different aspects

CHAPTER - 3: Morphology and General Behaviour

3.1. Introduction

Central Himalaya is distinguished as a rich biodiversity center due to its different climatic conditions and supplies a variety of ecosystems with floral as well as faunal diversity. The present study area is Garhwal Himalaya situated (30°01'N to 30°58' N latitude and 78°27' E to 78°32'E longitude) in Uttarakhand, India. The adverse climatic condition of this area ranges from -4°C to 20°C (Bahuguna and Upadhyay, 2008). High wind velocity, heavy frost, blizzards and low air pressure throughout the year is very common except for few months of the summer season. Precipitation is found to be in the form of snow, hail, and sometimes heavy rain. The study area is also enriched with myriad types of floral as well as faunal diversity. The two most remarkable climatic characteristics of the Garhwal Himalayas are hypoxia and cold. Thermoregulation is very important for animal's survival in cold environment.

Taxonomically a tail-less mouse (Pika) belongs to phylum Chordata, class Mammalia, order Lagomorpha and family Ochotonidae (Myers et al. 2008). Geographically the present study animal is reported from Ganesh Himalaya area including northern highland belt of Nepal (Khanal, 2007), Himalayan area of China and Tibet (Kawamichi, 1971). In Garhwal Himalayan area, they are restricted to snowfed areas where aromatic and medicinal herbs are abundant (Khanal, 2007; Bahuguna and Upadhyay, 2008).

In order Lagomorpha, the Himalayan mouse hare occupy a distinguished position due to their behaviour different from rabbits and hares (Kawamichi, 1968). In last few years some valuable works related to Lagomorpha is done by various authors (Ellerman, and Morrison-Scott, 1951; Kosaka et al.1985; IUCN, 1990; Yang, 1990; Niu et al.2004; Yang et al. 2008). Some information is also available related to reproductive behaviour of *Ochotona species* under predation risk (Yang et al. 2007), body temperature regulation at higher elevation (Kosaka et al. 1985), foraging behaviour (Barash, 1973), seasonal changes in activity pattern and adaptive value in relation to plant haying behaviour (Conner, 1983). In last few years, from India as well as abroad very little information is available specially from the different part of the mouse hare about geographical distribution (Bahuguna and upadhyay, 2008), winter behaviour (Kawamichi, 1968) and symbiotic relation with some other species (Khanal, 2007) while a short note is available from Indian Garhwal Himalaya, where Dhyani and Kala, (2005) reported that *Ochotona roylei* is a major distructive animal of the medicinal plants in high altitude areas. So, an effort has been made to find out the external morphology, daily activity pattern and general behaviour of the Himalayan mouse hare (*Ochotona roylei*; Lagomorpha)

3.2. Methodology

An extensive field survey has been carried out in different localities of Garhwal Himalaya. For morphological study the mouse hare has been captured from the three

CHAPTER - 4: Foraging Behaviour

4.1. Introduction

All animals confront the problem of finding enough food for growth, maintenance, and reproduction while faced with needs to perform other demands and confront with hazard, from other animals (Perry and Pianka, 1997). Foraging behaviours can also be affected by other factors such as anatomical and physiological limitations (Stephens and Krebs, 1986; Grier and Burk, 1992). According to Perry and Pianka, (1997), foraging behaviours reflect both intrinsic and extrinsic constraints on what and where to feed. The behaviour of foraging has some modifications as per habit and ecological habitat of the animal. As in Lagomorpha foraging behaviours are influenced by intrinsic and extrinsic factors such as age, sex, breeding status, individual variation, and spatial and temporal variation in foods (Perry and Pianka, 1997; Bolnick et al. 2003). Formozov, (1968) described non-hibernating burrowers types of strategies for the *Ochotona spp*. Burrow system provides protection from environmental extremes, lesser predation risk, allows access to hoarding of food (Kinlaw, 1999) and is an adaptation to avoid food shortage in environments where food availability fluctuates greatly (Smith and Reichman, 1984; Vander Wall, 1990). Food hoarding may also provide a supplementary diet for growing young's and to reduce the time spent in foraging when other behaviours are more important (Smith and Reichman, 1984; Vander Wall, 1990). Food is a major source of energy, all the living things required food for three main purposes; for physical movement, for growth and for energy supply and maintenance. Thus food may be defines as any substance that when taken in to the body, will furnish energy and materials for the structure and repair of tissue. In case of heterotrophic animals, all the food requirements are satisfied by the intake of organic materials of plants or animals. The common classification of food includes carbohydrates, proteins, fats, water, minerals, salts and vitamins. The first three are required for energy and building of materials, the latter three for building and regulating different functions. Although the needs of all animals for these substances are almost similar, they have different ways and means of getting them. Some animals are exclusively herbivorous (rabbit and relatives), others are exclusively carnivorous (tiger) and still others are omnivorous (man). These are also difference in the amount and kind of food required.

In last few years some valuable works related to foraging behaviour of Lagomorpha were done by Barash, (1973); Charls, (1980); Conner, (1983); Grayson, (2005); Bahuguna and Upadhyay, (2009); while a short notes is available from Indian Garhwal Himalaya, by Dhyani and Kala, (2005) as per their report this Himalayan mouse hare is a major destructive animal for medicinal plants from the High Altitudes areas. Studies on the faunal diversity and animal activity pattern is not much more have been reported from the Garhwal Himalaya region, also in the absence of detailed studies and monitoring, it appears too conjectural to assume that the Himalayan animals that are new species present only in this Garhwal high altitude region are either migratory or resident. So an effort has been made to find out the foraging, hoarding behaviour

CHAPTER - 5: Reproduction and Breeding Biology

5.1. Introduction

All animals try to find the good quality of food materials from their surrounding environment, to fulfill and to conduct their various life parameters like breeding, parturition, growth, gestation, weaning, life span, etc. (Ricklefs, 1967; Case, 1978; Roff, 1992; Charnov, 1993; Reale *et al.* 2003). Specially in snowfed alpine areas, where environmental conditions are highly changeable, the animal activity and breeding season in all animals exist at the same time (Rachlow and Bowyer, 1991). All animals face the same tygrapype of environmental condition and may be at the similar time for parturition and for reproduction due to favorable climatic condition such as food availability or density of mates with predation risk (Ims, 1990; Eccard and Ylonen, 2001). There is also considerable evidences show that mammals use changes in photoperiod or some secondary compounds in newly emerging vegetation as predictors of breeding season activity (Bronson, 1985; Goldman, 2001). For territorial species, being born in early snowfed seasons may be critical for finding food materials and securing a territory for survival. The Indian mouse hare (*Ochotona roylei)* is small, diurnal, tail-less snowfed animal belonging to the order Lagomorpha (rabbits and relatives) and family Ochotonidae (Myers et al. 2008). They are territorial and do not hibernate during the winter (IUCN, 1990), but rather forage below the snow and on vegetation that was collected and stored in a hay pile at the end of the summer (Bahuguna and Upadhyay, 2009a). There are approximately 30 species throughout the world (Myers *et al.* 2008), most are restricted to Asia with only three *Ochotona roylei* that presently live outside Asia (Hall, 1981; Feng and Zheng, 1985; Smith *et al.* 1990; Grayson, 2005). Geographically the mouse hare reported from Ganesh Himalayan area including northern highland belt of Nepal (Khanal, 2007), Himalayan area of China, Tibet and adjacent areas (Kawamichi, 1971). In Garhwal Himalayan area, they are restricted to snowfed areas where aromatic and medicinal herbs are abundant (Khanal, 2007; Bahuguna and Upadhyay, 2008).

Within order Lagomorpha, mouse hares occupy distinguished position for their mode of life and behaviour which is quite different from those hares and rabbits. In last few years, some valuable work related to mouse hares were done in many other countries by various authors (Kosaka *et al.* 1985; Smith *et al.* 1990; Yang, 1990; Niu *et al.* 2004; Yang *et al.* 2008). Some information is also available related to body temperature regulation at high altitude areas (Kosaka *et al.* 1985), foraging behaviour (Barash, 1973), seasonal changes in activity pattern and adaptive value in relation to plant haying (plant hoarding) behaviour (Conner, 1983). The study about the growth of the different species of mouse hares in the wild and captive environmental stages was conducted by Millar and Tapper, (1973); Whitworth and Southwick, (1981); Golian and Whitworth, (1985). A few studies have described the growth of the mouse hare and reproductive behaviour under predation risk (Yang *et al.* 2007). Very little information is available specialy from India on mouse hare (*Ochotona roylei*) about geographical

CHAPTER - 6: Chromosomal and Cyto-taxonomy

6.1. Introduction

Himalayan mouse hare (family Ochotonidae) is small; with comparatively short ears, small limbs and a visibly hairy brush like structure in place of origin of tail (Bahuguna and Upadhyay, 2009). The taxonomy of Himalayan mouse hare is poorly understood and on the basis of little evidence, a good number of nominal species and subspecies have been described. The order Lagomorpha comprises of two families, the Leporidae (hares and rabbits) and the Ochotonidae (Mouse-hares). According to different systematic and taxonomical studies, 30 living species of *Ochotona* are known (Argyropulo, 1948; Ellerman and Morrison-Scott, 1951; Gureev, 1964; Sokolov, 1977; Corbet, 1978; IUCN, 1990; Smith et al. 1990; Yu et al. 2000; Hoffmann and Smith, 2005; Erbajeva and Ma, 2006; Mayers et al. 2008; Bahuguna and Upadhyay, 2009). The classifications published on species level by different authors (Allen, 1938; Ognev, 1940; Ellerman and Morrison-Scott, 1951 and 1966) are based on the same peculiar characteristics i.e. skull morphology, dentition and coat color of body. According to Mayers et al. 2008, the Ochotonidae family, having single genus (*ochotona*) having more than 30 species throughout the world. Over all the systematic context is uncertain, while the morphological differentiation is inadequate to support the phyletic relationships among species, it is crucial to look for other, non-morphological, methods (i.e. the comparison of chromosome structure) allowing for the identification of different lineages within the genus (Capanna et al. 1991). Definitely, karyotypic relationships among species within a genus offer a suitable tool. Accordingly, cytotaxonomical data accumulating on pikas up to 2010, so that currently the karyotypes of fifteen out the thirty living species of pikas are known (Nadler et al. 1969; Hayata and Shimba, 1970; Adams, 1971; Hsu and Benirschke, 1971; Wurster et al. 1971; Rausch and Ritter, 1973; Vorontsov and Ivanitskaya, 1973; Stock, 1976; Kimura et al. 1983; Capanna et al. 1991; Puget and Berland, 2008). About cyto-taxonomy, Capanna et al. (1991) proposed classification of *Ochotona* in different karyological groups. The updated with recent data were shown in table 5.

In past few years little information related to the presence of Himalayan mouse hare in Indian Himalaya (Kawamichi, 1971; Inskipp and Lachungpa, 2003; Tambe and Rawat, 2006; Khanal, 2007; Ballabh *et al.* 2007; Jha and Avasthe, 2007) at different snowfed areas of Garhwal and Kumaon region at elevation between 3400 to 5500 m asl (Sharma, 1998; Uniyal, 2002; Ilyas and Baiju, 2006; Kunwar and Tiwari, 2007; Bahuguna and Upadhyay, 2008) have been reported. Himalayan mouse hare (*Ochotona roylei*) feeds on high altitudinal valuable medicinal and aromatic plants (Bahuguna and Upadhyay, 2009) and also destroy a sizeable quantity of medicinal plants in snowfed areas (Dhyani and Kala, 2005). Till date, no reference is available from this area especially on bio-molecular and cytogenetic aspects on this mammal. Hence an effort has been made to study the cyto-taxonomical and bio-molecular status of the Himalayan mouse hare. This will help in monitoring its appearance in the Himalayan

CHAPTER - 7: Phylogenetic Analysis

7.1. Introduction

DNA based phylogenetic and molecular systematic study exploit diversity among DNA sequences and this can be used to identify species. Mitochondrial DNA (mtDNA) is a small, double stranded, circular molecule coded for proteins, mainly involved in the electron transport and oxidative phosphorylation in the mitochondria. The mtDNA has a high nucleotide substitution rate at identical sites and lacks recombination (Brown et al. 1979; Rand, 1996; Cantatore et al. 1994) with advantage to evolving faster than nuclear DNA (Brown et al. 1982), probably due to inefficient replication repair (Clayton, 1984). Within the mitochondrial genome, different regions evolve at different rates. Therefore, analysis of only single gene, partial gene regions or both in combination has become a common approach in molecular systematic and phylogenetic studies; the mtDNA is very useful in the resolving phylogenetic relationships between closely related taxa (Moritz et al. 1987). Different regions of the mitochondrial genome evolve at different rates (Saccone et al. 1991) allowing suitable regions to be chosen for inferring evolutionary relationship among higher taxa, species, recently divergent groups, populations or even individuals (Avise, 1994). Mitochondrial DNA is maternally inherited in most species (exceptions with paternal leakage including mice, Gyllesten et al. 1991; biparental inheritance in marine mussels, Zouros et al. 1992). Mitochondrial DNA does not recombine (Hayashi et al. 1985), but some data of recombination events has also been reported (Eyre-Walker et al. 1999; Hagelberg et al. 1999). Mitochondrial DNA (mtDNA) sequences are used extensively to reconstruct evolutionary relationships among recently diverged animals. However, most studies to date have employed relatively small portions of the mtDNA. In contrast, complete mtDNA primarily have been used to investigate deep divergences, including several studies of the amount of mt DNA sequence necessary to recover ancient relationships. Nearly 30 years ago, single gene sequence analysis of ribosomal DNA was being used to investigate evolutionary relationships at a high level (Woese and Fox, 1977) and mtDNA approaches dominated molecular systematics in the late 1970s and 1980s (Avise, 1994). Cummings et al. (1995) explored the ability of single mtDNA genes to recover the same trees found when using whole mtDNA genomes; assuming that whole genomic phylogenies are a better measure of the true phylogeny. During the past 20 years, molecular phylogenetics has dramatically reshaped our views of organism relationships and evolution at all taxonomic levels of the hierarchy of life (Soltis and Soltis, 2000). Tautz et al. (2002 and 2003) made the case for a DNA-based taxonomic system. Even though mtDNA is still the most popular genetic marker and has been widely used for inferring phylogeny of animals. For phylogenetic studies, the commonly used mtDNA genes are cytochrome b (cyt b), cytochrome c oxidase I (COI) and 16S rRNA genes.

The protein-coding gene, cytochrome b (cyt b) has proven to be a robust evolutionary marker, revealing phylogenies at various taxonomic levels in animals.

CHAPTER - 8: Summary

In this study an attempt has been made to study the "Distribution, external morphometry, foraging behave, breeding biology, chromosomal study and phylogenetic study of Himalayan tail-less mouse (Pika: *Ochotona spp*., order: Lagomorpha)". The research work is completed in the form of thesis entitled **"Studies on foraging behave with morpho-cytogenetic and bio-molecular level of Himalayan tail-less mouse (Pika: *Ochotona spp*., Order: Lagomorpha)".** The treatise consists of **eight chapters** included **seventeen photo and graph plates** containing **thirty two photographs**, **one graph** and **twelve tables** in support of the text. The findings of the research work are summarized as follows:

1. The survey was conducted to find out the distribution of Himalayan mouse hare in different areas of Garhwal Himalaya (30°01'N to 30°58'N **latitude** and 78°27'E to 78°32'E **longitude**) viz. Tungnath, Badrinath, Kedarnath, Yamunotri and Gangotri. The animals captured during the above field survey from different areas of Garhwal Himalaya have been identified as *Ochotona roylei* (Royle's Pika). The identification was based upon the key (Small, egg-shaped herbivores with prominent round ears, small eyes, and no visible tail) by Ellerman and Morrison-Scott, who listed twelve species with forty nine subspecies recorded from Asia, and two species (*Ochotona roylei and Ochotona macrotis*) from Nepal. The mouse hare differentiated from rodents by two pairs of upper incisors covered by enamel, vertical or transverse jaw motion, three upper and two lower premolars, fused tibia and fibula, and a spiral valve in the cecum. Based on morphological characteristics, the observed species has been identified as Indian Pika (*Ochotona roylei*).
2. Species recorded from the Garhwal Himalaya is the *Ochotona roylei* and commonly in this region called "Runda". The distribution of Himalayan mouse hare has been recorded from all religious places including Tungnath, Badrinath, Kedarnath, Yamunotri and Gangotri in riverine slope areas at elevation between 2823 - 4500 m asl. No evidences have been recorded to their presence below 2823 and above 4500 m asl. Topographically *Ochotona roylei* lives in steep and rocky water sources areas where the degree of slope is recorded 0 - 30^0 facing having north-east as well as south west. The maximum evidences are recorded for the presence of this animal below 0 - 20^0 slope at north-east facing. The *Ochotona roylei* habited areas having medium shrub density with low shrub height and low shrub cover. In the present study maximums *Ochotona roylei* was recorded from low grass density area having medicinal herb and shrub plants.
3. *Ochotona roylei* tend to live in groups, working hard for searching and collecting food materials. They are an excellent runner and jumper, also gathering and storing food, most of its gathering is done during the day. In the field study it has been noted that *Ochotona roylei* first dries and cures the grasses it gathers in the sun, then stores it in fissures in the rocks near its nest.

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Pika, also known as "Mouse-Hare" has mostly guinea pig like appearance. Their short ears and short legs give them mouse like appearance also. The most common Pika in Himalayas with a HBT length of 17-22 centimeter. Royle's Pika has slightly arched head with rufous-grey body with chestnut-colored head and sparsed hair in front of its ears. Though their conservation status according to IUCN red list is Least Concerned, habitat loss and human habitation in hilly areas are the indirect cause of conservation threats towards them.

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