

## New Distribution Information on Woolly Flying Squirrel (*Eupetaurus cinereus* Thomas, 1888) in Neelum Valley of Azad Jammu and Kashmir, Pakistan

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**Abstract.-** Woolly flying squirrel (*Eupetaurus cinereus*) is among the least recorded mammals of the world. Most records come from Pakistan's northern mountainous regions. Presence of this species has not been reported in Azad Jammu and Kashmir in the existing literature. Present study investigated the presence of this species in Shounthar Valley of district Neelum, Azad Jammu and Kashmir. Local residents, hunters and *Salaajeet* collectors were consulted to identify the probable habitat of woolly flying squirrel in the study area. After preliminary consultation, nine sites were selected in Shounthar Valley for further field investigation through attempts at direct observation of the animal in its natural habitat as well as indirect evidence. Evidence suggesting the presence of woolly flying squirrel was found in all nine sites; these lay between 3270m and 3660m elevation. A live animal captured from the study area was confirmed by measurements and photographs to be a woolly flying squirrel, and presence at the other sites is provisionally recorded based on calls, collection of hairs, faecal material, etc. Occupied habitat was characterized by steep slopes, difficult to approach cliffs and mixed vegetation including *Abies pindrow*, *Betula utilis*, *Juniperus macropoda*, *Pinus wallichiana*, *Taxus wallichiana*, *Skimmia laureola*, *Potentilla eriocarpa*, *Poa bactriana*, *Bergenia stracheyi*, *Artemisia vulgaris* and *Bistorta affinis*. Habitat degradation due to deforestation and livestock grazing may be the major factors adversely affecting the general habitat in the study area and this species might have negative consequences.

**Key words:** Woolly flying squirrel, Distribution, New record, Shounthar Valley, district Neelum, Azad Jammu and Kashmir, Pakistan

### INTRODUCTION

Woolly flying squirrel (*Eupetaurus cinereus*) is among the lesser known mammals in the world, listed as endangered at national level and internationally (Sheikh and Molur, 2005; IUCN, 2011). The genus also occurs in Sikkim, Tibet and Yunnan (Srinivasulu, *et al.*, 2004; Zahler and Woods, 1997); mtDNA analysis showed striking differences suggesting that the genus may contain two distinct species (Yu *et al.*, 2004), of which *E. cinereus* might turn out to be endemic to Pakistan. However, these authors were admirably cautious in their conclusion and neither they nor anyone else has formally proposed that the genus contains a second species so standard sources continue to treat the genus as monospecific. Woolly flying squirrel

remained mysterious to the scientific community until late 20<sup>th</sup> century (Zahler and Woods, 1997; Pradhan and Talmale, 2011). It was first identified by Thomas in 1888 on the basis of preserved skins (Thomas, 1888) but no live animal could be examined for long time (Dar, 1996). Subsequently, woolly flying squirrel was not recorded for over a century in Pakistan, until it was reported in Northern Areas of Pakistan (Zahler, 1996; Lee and Liao, 1998; Yu, 2002). This species can easily be distinguished from other flying squirrels due to its high crowded dentition pattern and highest length and weight when compared with others flying squirrels (Zahler, 1996). Other species of flying squirrels, Small Kashmir flying squirrel (*Eoglaucomys fimbriatus*) and Giant Red flying squirrel (*Petaurista petaurista*) inhabit this region of Northern Pakistan (Dar, 1996; Zahler and Woods, 1997; Zahler and Karim, 1998).

As woolly flying squirrel has been

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rediscovered only a few years back, little research has been conducted on its habitat and ecological characters. Zahler and Woods (1997) summarized some initial information on its ecology in Northern Areas of Pakistan, reporting that it inhabits caves in steep rocks and cliffs of high alpine zones, characterized by cold desert dominated by *Artemisia* spp. and *Juniperus* spp. above 2,000m elevation (Yu, 2002). It apparently shows quite unique ecological adaptations for surviving in regions that are inhospitable to any other flying squirrels (Roberts, 1997; Yu, 2002). A nest stated to be of this species was observed at 3200m elevation at Jutal Nala in Northern Pakistan (Oshida *et al.*, 2005) but no animal was seen in association with the nest so this statement requires credible corroboration. Vegetation of the known distribution area of woolly flying squirrel in Northern Areas of Pakistan included mixed forest of pine (*Pinus*), spruce (*Picea*), juniper (*Juniperus*) and oaks (*Quercus*), with scattered *Pinus wallichiana* and *Juniperus excelsa* trees along with grass cover (Dar, 1996; Zahler and Woods, 1997; Shafique *et al.*, 2006). Zahler and Khan (2003) suggested that the genus's strikingly distinct hypsodont dentition is probably for handling the thick, waxy pine needles which are hard to digest, as its diet composed of pine needle ranging from 92-100 %.

In Pakistan, woolly flying squirrel was mainly distributed in the Himalayas at around 35–36°N in latitude (Zahler and Woods, 1997), Hindukush range in Chitral and Gilgit (Yu, 2002; Yu *et al.*, 2004) but current data on distribution of the species are inadequate. The estimated distribution range of woolly flying squirrel in Pakistan was a smaller area covering 100 miles east-to-west and 50 miles north-to-south in the Northern Areas of Pakistan. This area is bounded by Gilgit River in the north and Babusar Pass in the south, although some uncertain statements have been reported concerning the presence of woolly flying squirrel in the upper Hunza Valley, which is exterior to the known distribution range, however eastern and western boundaries are not fully determined (Zahler and Woods, 1997). Oshida *et al.* (2005), based upon a nest, claimed to discover new habitat and location of woolly flying squirrel in Jutal Nala, near Gilgit city, which was out of the distribution

range reported by Zahler and Woods (1997), but this claim requires confirmation as the animal was not observed, and the faecal-pellet-based identification did not consider the characters of the taxon of *Petaurista* in this part of northern Pakistan, instead comparing it with a form from Taiwan. No literature has yet supported its presence in Azad Jammu and Kashmir territory. However, local inhabitants, particularly *Salaajeet* collectors (*Salaajeet* is considered as the mixture of rock leachate, pellets and urine of woolly flying squirrel (Zahler and Karim, 1998) and is used as a cure for various diseases) and hunters indicated its presence in the Neelum Valley.

Woolly flying squirrel is considered endangered in Pakistan by the national red list assessment (Sheikh and Molur, 2005), supposing that habitat degradation from overexploitation of natural resources is reducing its survival chances. The present study looked for woolly flying squirrel in Neelum Valley of Azad Jammu and Kashmir. This area was selected on the basis of its habitat characteristics similar to those described by earlier researchers for this species (see above) and reports of its presence here from local residents. The area is situated on Line of Control (LoC) between Pakistan and Indian occupied Kashmir and cross-firing between Pakistan and Indian armies, harsh weather conditions, inappropriate means of transportation and remoteness from nearest city (152 km away from Muzaffarabad) restricts free approach of researchers here. Hence, this area had never been searched for this species, although it is adjacent (roughly estimated at the distance of 10 Km from previous known distribution) to the areas searched earlier by Zahler (1996). Enlisting the new distribution record will surely be helpful for future studies and efforts to conserve this lesser known endangered species in Pakistan.

## MATERIALS AND METHODS

### *Study area*

Neelum Valley is located in the inner Himalayas in Azad Jammu and Kashmir, situated between 34°28–34°48 N and 73°47–74°58 E and covers an area of 345,026 ha. The valley is 220 Km long, running along the Neelum River (Ali *et al.*,

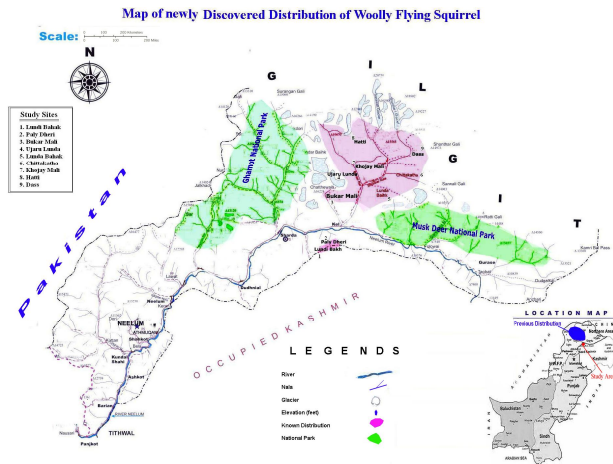


Fig. 1. Distribution of Woolly flying squirrel in the Neelum Valley, Azad Jammu and Kashmir, Pakistan during 2011. In location map, blue spot showing the previous distribution of woolly flying squirrel in Northern Areas of Pakistan.

2007). The study area, the Shounthar valley, is one of the sub-valleys of Neelum valley, branching off from Kel and ending at Shounthar Pass. This valley falls in the Western Himalaya system which is identified as a biodiversity hotspot, a global priority for biodiversity conservation (Myers *et al.*, 2000). Study area is surrounded by district Chilas and Ghamot National Park (GNP) from North-western side, Astor and Deosai National Park on North-eastern and Musk Deer National Park (MDNP) on Southeastern side and covers an area of 19,631 hectares (Qureshi, 1990) (Fig. 1). Topographically, this area constitutes lofty mountains with broken outcrops, gorges, glaciers, sub-valleys, steep and rolling slopes of alpine pastures. Cold desert areas, alpine pastures, alpine scrub forest, dry temperate and coniferous forest are found in the area constituting compartments number 10-15 of the Kel Forest (Qureshi, 1990). Usually these forests grow up to 3350m elevation, but they occur at even higher elevation on southern slopes of the area. Study area receives heavy snow fall and severe northern cold winds during long winter season, from November to April. A total of nine sites, ranging from 3270m (Dass) to 3680m (Khojay Mali) elevation, were selected and searched systematically for the species (Table I).

### Methodology

The study was conducted from May, 2011 to August, 2011 in Shounthar Valley, district Neelum of Azad Jammu and Kashmir. A comprehensive questionnaire was prepared and distributed among local inhabitants of the study area including; shepherds, hunters (mainly Himalayan Ibex, musk deer, grey wolf, red fox, black bear, stone martin, pheasants and leopard are hunted for fur, meat, trophy or trade; in most of the cases, hunting is illegal) and professional *Salaajeet* collectors (Annexure 1). They were asked to define any squirrel species describing its notable characteristics in order to assess their level of observation. Self-postured photographs, one each of flying squirrels (Woolly, Small Kashmir and Giant Red) were shown to them and asked them to identify the species. Woolly flying squirrel is locally known as “*Chitti Ghoshi*” or “*Mim-may-ain Wali Ghoshi*” where “*Ghoshi*” means squirrel, “*Chitti*” means white color, *Wali* stands for belong to (of) and “*Mim-may-ain*” is name of *Salaajeet* in local language. Small Kashmir flying squirrel is called “*Nikki Ghoshi*” locally which means small squirrel. Red giant flying squirrel is called “*Ratti Ghoshi*” in local language; the name is given due to its coloration as “*Ratti*” stands for red color in local language. Persons having strong positive response regarding identification of “*Chitti Ghoshi*” or “*Mim-may-ain Wali Ghoshi*” were selected and discussion was made with them to explore the potential sites of its presence. Based on the discussion, nine sites were chosen for thorough investigation. Most of the sites were characterized with steep slopes thus ropes were used to approach the cliffs. *Salaajeet* was reported also at all nine sites with persuasive reports of the species, and this material is found in small cavities of overhanging cliffs. Professional *Salaajeet* collectors were sent first to those cliffs which were difficult to approach, because it would be a routine matter for them. At their positive sign (regarding the presence of squirrel), researcher itself visited the cliff. Evidence like pellets, partly eaten food material, hairs, etc. were collected and photographed. A small cage was used to capture an injured woolly flying squirrel from Palydheri, which was photographed (Fig. 2).

Table I.- Description of various study sites of woolly flying squirrel occurrence and corresponding observation data during 2011.

S. No.	Site name	Coordinates		Elevation (m)	No. of Caves examined	Evidences						Habitat
		N	E			Aspect	Pellets	PEM*	Hairs	Calls	Sightings	
1	Palydheri	34° 47' 29.31	74° 19' 10.82	3340	1	Northern	+	+	+	No	1	Scattered trees with alpine scrub and grass land with steep slopes and cliffs
2	Lundi Bahk	34° 47' 48.48	74° 17' 19.48	3330	1	North-Western	+	+	+	No	-	Scattered trees with alpine scrub forest and grass land
3	Lunda Bahk	34° 46' 41.67	74° 18' 40.69	3420	2	Southern	+	+	+	Yes	-	Scattered trees with alpine scrub forest and grass land
4	Bukhar Mali	34° 55' 07.02	74° 23' 42.56	3300	1	North-Eastern	+	+	+	Yes	1	Dry temperate forest and steep cliffs
5	Ujaru Lunda	34° 56' 14.64	74° 21' 51.98	3335	2	North-Eastern	+	+	+	No	-	Dry temperate forest and steep cliffs
6	Khojay Mali	34° 59' 23.92	74° 25' 44.26	3680	2	North-Eastern	+	+	+	No	-	Scattered trees with alpine scrub and grass land with steep slopes and cliffs
7	Haati	35° 00' 30.67	74° 25' 31.00	3440	2	North-Eastern	+	+	+	+	-	Alpine scrub forest and steep cliffs
8	Dass	34° 58' 41.13	74° 31' 48.79	3270	1	Southern	-	-	+	No	-	Alpine scrub with open grass land and steep cliffs
9	Chitta Katha	34° 56' 19.12	74° 29' 29.18	3390	1	Northern	+	-	+	No	-	Scattered trees with alpine scrub and grass land with steep slopes and cliffs

\*Partially Eaten Matter

## RESULTS AND DISCUSSION

Based on preliminary information collected from local people about the potential distribution of woolly flying squirrel, nine selected sites were thoroughly investigated (Table I). During night stay in Palydheri, a site near Arangkail village, a mix noise of owl and squirrel was noticed and suspected area was searched with flash light. An injured woolly flying squirrel (probably by its predator, an eagle owl, *Bubo bubo*), was found which was unable to glide. This squirrel was captured and photographed (Fig.2). Earlier, Zahler (1996) had also reported the eagle owl to be a natural predator of woolly flying squirrel. Measurements of captured specimen were matched with earlier studies (Table II). Specimen was probably a young male. Body was covered with extremely thick, long and silky hairs comparatively larger on its dorsal region with brownish grey color. Ventral fur was of lighter hue. Head and ears were covered with shorter and uniformly colored hairs. Eyes were bulging and more blackish than other flying squirrel species. Fur covering the feet was black in color on both surfaces. Tail was longer, having taper end and covered with comparatively longer hairs (Fig. 2). Most important mark of identification was its high crown dentition that clearly indicated the specimen was of woolly flying squirrel (Zahler, 1996; Dar, 1996; Roberts, 1997).

**Table II.- Comparison of woolly flying squirrel specimen captured at Palydheri with earlier specimens.**

Parameters	Body length (cm)	Weight (Kg)
Specimen of present study	83	1.5
Zahler's specimen *	89	2.5
Museum specimen I **	99	Not available
Museum specimen II **	69.5	Not available

\* Figures taken from Zahler (1996)

\*\* Figures taken from Dar (1996)

Captured specimen was shown to various *Salaajeet* collectors, hunters, nomads and local people independently. Majority (82.35%) of the respondents identified it as *Chitti Ghushi*, local name of woolly flying squirrel (Fig. 3). *Salaajeet* collectors, hunters and nomads' identification

abilities evidently exceeded those of ordinary local people, probably due to their frequent visits in WFS habitat that resulted higher chances of their encounter with WFS as compared to the ordinary local people.



Fig. 2. Woolly flying squirrel captured at Palydheri in the study area.

Only 19.78% respondents among the local people could not identify it as woolly flying squirrel, instead majority (n=6) of them identified it as small Kashmir flying squirrel, with others suggesting giant red flying squirrel (n=1), stone marten (n=3) and not known (n=5) (Fig. 4). This level of error in identifying a flesh animal under close views underlines the importance of treating all the local information suspected to refer to woolly flying squirrel, including *Salaajeet* collectors' identifications of signs, as provisional and in need of corroboration. The captured squirrel died after six hours of collection, it was stuffed and donated to the Department of Wildlife and Fisheries of Azad Jammu and Kashmir for future reference.

Nine selected sites were thoroughly searched for animal signs such as pellets, hairs, calls and partly eaten matter (Table I). These signs were found in all study sites in caves or at cliffs, where *Salaajeet* was found. Local people attributed all these signs to "*Chitti Ghoshi*", and indeed neither of the other flying squirrels known from the general area (Giant Red and Small Kashmir) was reported in the habitat of woolly flying squirrel, from all of the nine study sites. Therefore, these signs may well be from woolly flying squirrel. Roberts (1997) and Yu (2002) considered that habitat of woolly flying squirrel is inhospitable to other flying squirrels, but Zahler (1996) and Zahler and Karim (1998) found

that woolly flying squirrel overlaps in habitat use with giant red and small Kashmir flying squirrels at least locally in Northern Areas of Pakistan. This urges caution over sign identification for such a little-known mammal.

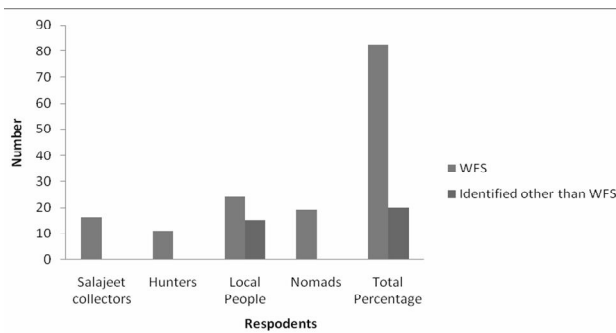


Fig. 3. Number of respondents who identified the Palydheri specimen (flesh) as woolly flying squirrel when shown to them during study period.

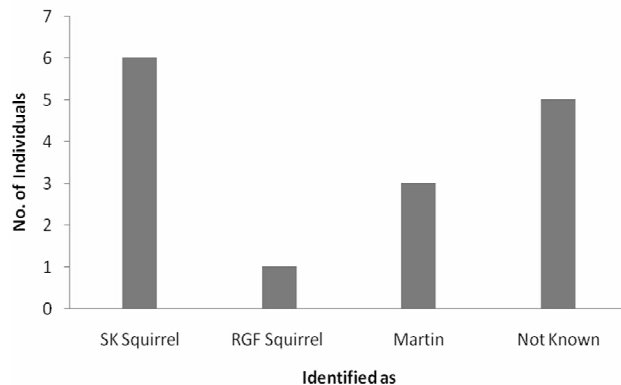


Fig. 4. Number of respondents who identified woolly flying squirrel as another animal when shown to them during study period.

Identification of pellets, hairs and partly eaten food material was solely based on the expert opinion of professional *Salajeet* collectors. They say that they can easily differentiate among the evidences of woolly, small Kashmir and giant red flying squirrels, based upon squirrel size, coloration, habitat, pellets and nest size (woolly squirrel has larger pellet size, as they claimed, ranged between 10-12 mm and comparatively rounded in shape). However, these assertions were not tested. Given widespread evidence of overconfident species-level

identification of mammal signs by both researchers and local amateurs (Davison *et al.*, 2002; Glen and Dickman, 2003; Birks *et al.*, 2004; McKelvey *et al.*, 2006; Hibert *et al.*, 2008; Janečka *et al.*, 2008; Lyrá-Jorge *et al.*, 2008; Theuerkauf *et al.*, 2008; van Vliet *et al.*, 2008; Bowkett *et al.*, 2009), even in communities with fairly few apparent confusion species (as here) and between animals far less closely related to each other than are the three flying squirrels of northern montane Pakistan, these identifications are here regarded as provisional and in need of confirmation. These signs suggested that woolly flying squirrel inhabits all study sites. Palydheri, Lundi Bahk, Bukar Mali and Ujaru Lunda were reported to host denser populations of woolly flying squirrel than other sites such as Dass and Chitta Katha. The Neelum Valley was not included within the species range in any previous studies including Zahler and Woods (1997), Lee and Liao (1998), Yu (2002), Zahler and Khan (2003) and Pradhan and Talmale (2011). This distribution area is adjacent to district Chilas in its north-west and Astore in north direction, where the distribution of woolly flying squirrel has been recorded (Zahler and Karim, 1998). The lofty snow clad ridges separating the territories of Chilas and Astore from AJ&K are as high as 4,400m and fall in the cold desert zone, which seems a barrier for the movement of woolly flying squirrel across the territories, but its presence in study area showed the extension of distribution range from Northern Areas.

Palydheri was reported to be the most preferred site of this squirrel by *Salajeet* collectors; hence, a camp was set up near the cliff for three days to explore the area. Palydheri was a steep sloped and northward oriented site. Traps were set but only two stone martens (*Martes foina*) were captured. Pellets and hairs were collected from the cave in the vicinity of camp. Only one squirrel was seen at Bukhar Mali side during early evening which glided from one tree to the next one as described by Zahler (2001). He reported that despite the large size of woolly flying squirrel, it is relative gracile and is a capable glider.

At Lunda Bahk, three calls of the same tone were heard; first at 12:10 am and last at 1:40 am, having almost 45 minutes interval. Woolly flying



squirrel produced sound like *Oowaainy* which was higher in frequency in the beginning and progressively declined giving a gradual end to the sound. *Salajeet* collectors stated that it is the normal call of animal. Another call was heard at Bukar Mali which was similar to *ghurrr*, *ghurrr*, again call frequency was high at start and gradually it declined toward the end. The call was different from the earlier one and thought to be an alarming call. Majority of the respondents (65%) supported the observation as they had heard such type of calls before leaving the nest or at the start of glide, however no pertinent literature is available for the vocal characterization of woolly flying squirrel.

Partly eaten matter was collected from a total of 13 caves and consisted mostly of *Pinus* foliage (Table I). This matter may have been left by woolly flying squirrel: pine-needles are rarely eaten by mammals (Dar, 1996; Zahler, 1996; Zahler and Woods, 1997; Yu, 2002; Zahler and Khan, 2003), but local diet of other mammals in this area is poorly known and thus further information is required before a balanced judgment can be made. The forest dweller yellow-throated marten (*Martes flavigula*) and Alpine scrub forest dweller Stone marten (*M. foina*) were frequently seen in woolly flying squirrel habitat and are probably its potential predators, supporting the earlier findings of Zahler (1996).

#### Habitat description

Habitat of the species mainly consisted of steep slopes rock, mostly northern aspect and characterized with almost inaccessible cliffs. Palydheri, the site where woolly flying squirrel presence was confirmed by trapping the injured animal, was located at an elevation of 3340m, characterized by *Pinus wallichiana*, *Betula utilis* and *Abies pindrow* as prominent tree species along with dominant shrubs including *Rhododendron hyperythrum*, *Skimmia laureola* and *Salix flabellaris* (Table 1). A diversity of grass species was observed in the area including *Bergenia stracheyi* and *Poa bactriana* as leading species. At Lundi Bahk (3330m), main tree species were *Pinus wallichiana*, *Juniperus macropoda* and *Abies pindrow* along with shrub species of *Skimmia laureola*, *Berberis wallichii*, and *Juniperus communis*. Grass cover

included *Poa bactriana*, *Bergenia stracheyi* and *Artemisia vulgaris* as leading species. Lunda Bahk (3420m) was characterized with steep slopes covered with *Betula utilis*, *Abies pindrow*, *Skimmia laureola*, *Juniperus communis*, *Bistorta affinis* and *Anaphalis triplinervis* as leading species (Table I; Fig. 5).



Fig. 5. Typical habitat of woolly flying squirrel at Lunda Bahk site in the study area.

Bukhar Mali, situated at 3300m, consisted of steep slopes with large patches of open pastures. The dominant plant species of the site were *Abies pindrow*, *Betula utilis*, *Taxus wallichiana*, *Skimmia laureola*, *Potentilla eriocarpa*, *Poa bactriana* and *Bistorta affinis*. Ujaru Lunda (3335m) was also characterized by steep slopes with main vegetation of *Pinus wallichiana*, *Abies pindrow*, *Rosa macrophylla*, *Skimmia laureola*, *Berberis wallichii*, *Bistorta affinis* and *Artemisia vulgaris*. Khojay Mali (3680m) was having *Betula utilis* as main species along with the scattered and stunted growth of *Pinus wallichiana*, *Skimmia laureola*, *Juniperus macropoda* and *Abies pindrow*. Main shrub species were *Salix flabellaris* and *Skimmia laureola* with grass cover of *Saussurea lappa* and *Anaphalis triplinervis*. Hatti was characterized by steep slopes with various cliffs located at 3440m elevation. Vegetation included *Betula utilis*, *Juniperus macropoda*, *Salix flabellaris*, *Skimmia laureola*, *Poa bactriana* and *Bergenia stracheyi*. The main tree species distributed in Chitta Katha (3390m) was *Betula utilis* along with favorable composition of

*Abies pindrow*. Main shrub species were *Skimmia laureola*, *Juniperus communis* along with *Potentilla eriocarpa* and *Poa bactriana* grasses. Dass (3270 m) was characterized by comparatively high floral diversity, particularly grasses. Scattered tree species of *Betula utilis* was noted in the area. *Juniperus communis*, *Skimmia laureola* and *Salix flabellaris* along with *Berberis wallichii* were the leading species of shrubs. It was an open pasture with main grass species of *Anaphalis triplinervis*, *Artemisia vulgaris*, *Aconitum heterophyllum*, *Bergenia stracheyi*, *Dactylis glomerata*, *Bistorta affinis*, *Potentilla eriocarpa* and *Poa bactriana* (Table III). Earlier researchers also reported mixed forest of pine, spruce, juniper and oaks, with scattered *Pinus wallichiana* and *Juniperus excelsa* along with grass cover as major vegetation in its habitat (Dar, 1996; Zahler and Woods, 1997; Shafique *et al.*, 2006).

#### Conservation status

Exploitation of natural resources by increasing human population is general phenomenon in the world and Neelum Valley is no exception. Currently, forests are being degraded at fast rate and AJK Government statistics showed that the overall forest cover reduced from 45 % (in 1948) to 12 % in recent years (Anonymous, 2010). Study area is located far away from the city and majority of the people are dependent upon natural resources for living. Large herds of livestock (both of nomads and local) have resulted in overgrazing in the pastures of the area. Increase in demand for fuel wood has also posed great threat to the forests of the area that resulted thinning of these forests at an alarming rate. Moderate hunting activities also take place in the study area and hunter usually shoot whatever is encountered. *Salaajeet* collection has also become a source of income for local people. These factors have contributed toward general habitat degradation, probably including that of woolly flying squirrel. It is strongly recommended that in future studies should be conducted to explore the potential habitat of woolly flying squirrel in surrounding areas and to assess the precise level of habitat degradation, so that conservation of this little known and threatened species could be ensured in this area.

## CONCLUSIONS

After an analysis based on the body color and measurements of captured specimen, field observations, indirect evidences (including hairs, calls, faecal matter) and information gathered from local inhabitants (through questionnaire and group discussion), it was confirmed that woolly flying squirrel is present in district Neelum of Azad Jammu and Kashmir. This pioneer study to confirm its existence there should be followed by searches in other areas of Azad Jammu and Kashmir, prioritizing uncontroversial records, *i.e.*, direct encounters rather than signs and local information, habitat use, food requirements, threats being faced (directly and through habitat change) and other aspects. Such data would be helpful for the conservation of this endemic species in Azad Jammu and Kashmir territory. Most importantly, future surveys should pay equal attention to the other species of flying squirrel, to allow progress on the vexing issue of the confidence level appropriate to indirect records (signs and local reports) attributed to woolly flying squirrel.

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## REFERENCES

- ALI, U., AHMED, K. B., AWAN, M. S., ASHRAF, S., KHAN, B. AND AWAN, M.N., 2007. Distribution and population estimation of Himalayan Ibex (*Capra ibex sibirica*) in upper Neelum valley, district Neelum Azad Kashmir. *Pak. J. Biol. Sci.* **10**: 3150-3153.
- ANONYMOUS, 2010. Planning and Development Department, State of Azad Jammu and Kashmir. <http://www.pndajk.gov.pk/>, cite dated, 23, April, 2012.
- BIRKS, J., MESSENGER, J., BRAITHWAITE, T., DAVISON,



- A., BROOKES, R. AND STRACHAN, C., 2004. Are scat surveys a reliable method for assessing distribution and population status of Pine Martens? In: *Martens and fishers (Martes) in human-altered environments: an international perspective* (eds. D.J. Harrison, A.K. Fuller and G. Proulx), Springer, New York, U.S.A. pp. 235–252.
- BOWKETT, A.E., PLOWMAN, A.B., STEVENS, J.R., DAVENPORT, T.R.B. AND VAN VUUREN, J.B., 2009. Genetic testing of dung identification for antelope surveys in the Udzungwa Mountains, Tanzania. *Conserv. Genet.*, **10**: 251–255.
- DAR, N.M., 1996. *Survey of woolly flying squirrel in northern Pakistan*. Final report submitted to WWF-Pakistan. 14pp.
- DAVISON, A., BIRKS, J.D.S., BROOKES, R.C., BRAITHWAITE, T.C. AND MESSENGER, J.E., 2002. On the origin of faeces: morphological versus molecular methods for surveying rare carnivores from their scats. *J. Zool. London*, **257**: 141–143.
- GLEN, A.S. AND DICKMAN, C.R., 2003. Monitoring bait removal in vertebrate pest control: a comparison using track identification and remote photography. *Wildl. Res.*, **30**: 29–33.
- HIBERT, F., FRITZ, H., POILECOT, P., ABDOU, H.N. AND DULIEU, D., 2008. Morphological criteria to identify faecal pellets of sympatric ungulates in West African savanna and estimates of associated error. *African J. Ecol.*, **46**: 523–532.
- IUCN, 2011. The IUCN Red List of Threatened Species. <http://www.iucnredlist.org/apps/redlist/details/8269/0>
- JANEČKA, J. E., JACKSON, R., YUQUANG, Z., DIQIANG, L., MUNKHTSOG, B., BUCKLEY-BEASON, V. AND MURPHY, W.J., 2008. Population monitoring of Snow Leopards using noninvasive collection of scat samples: a pilot study. *Anim. Conserv.*, **11**: 401–411.
- LEE, P.F. AND LIAO, C.Y., 1998. Species richness patterns and research trend of flying squirrel. *J. Taiwan Museum*, **51**: 1–17.
- LYRA-JORGE, M. C., CIOCHETI, G., PIVELLO, V. R. AND MEIRELLES, S.T., 2008. Comparing methods for sampling large- and medium-sized mammals: camera traps and track plots. *Eu. J. Wildl. Res.*, **54**: 739–744.
- McKELVEY, K.S., VON KIENAST, J., AUBRY, K.B., KOEHLER, G.M., MALETZKE, B.T., SQUIRES, J.R., LINDQUIST, E.L., LOCH, S. AND SCHWARTZ, M.K., 2006. DNA analysis of hair and scat collected along snow tracks to document the presence of Canada Lynx. *Wildl. Soc. Bul.*, **34**: 451–455.
- MYERS, N., MITTERMEIER, R. A., MITTERMEIER, C. G., DA-FONSECA, G. A. AND KENT, J., 2000. Biodiversity hotspots for conservation priorities. *Nature*, **403**: 853–858.
- OSHIDA, T., SHAFIQUE, C.M. AND BARKAKTI, S., 2005. A note on a new habitat of the woolly flying squirrel *Eupetaurus cinereus* in the northern area of Pakistan. *Mammal Study*, **30**: 73–76.
- PRADHAN, M.S. AND TALMALE, S.S., 2011. *A checklist of valid Indian rodent taxa (mammalian: rodentia)*. Online Version. 5 pp.
- QURESHI, A.R., 1990. *Revised forest management plan for the forests of Neelum Valley, Keran and Sharda Forest Divisions*. AJK Forest Department. 215 pp.
- ROBERTS, T.J., 1997. *The mammals of Pakistan*. Revised edition. Oxford University Press, Karachi. 525 pp.
- SHAFIQUE, C. M., BARKATI, S., OSHIDA, T. AND ANDO, M., 2006. Comparison of diets between two sympatric flying squirrel species in Northern Pakistan. *J. Mammal.*, **87**: 784–789.
- SHEIKH, K. M. AND MOLUR, S. (Eds), 2005. *Status and Red list of Pakistan's Mammals. Based on conservation assessment and management planning for mammals*. IUCN- Pakistan. 344pp.
- SRINIVASULU, C., CHAKRABORTY, S. AND PARDHAN, M.S., 2004. Checklist of sciurids (Mammalian: Rodentia: Sciuridae) of south Asia. *Zoo's Print*, **19**: 1351–1360.
- THEUERKAUF, J., ROUYS, S. AND JĘDRZEJEWSKI, W., 2008. Detectability and disappearance of ungulate and hare faeces in a European temperate forest. *Annl. Zool. Fenn.*, **45**: 73–80.
- THOMAS, O., 1888. *Eupetaurus*-A new form of flying squirrel from Kashmir. *J. Asiatic Soc. Bengal*, **57**: 256–260.
- VAN VLIET, N., ZUNDEL, S., MIGUEL, C., TABERLET, P. AND NASI, R., 2008. Distinguishing dung from blue, red and yellow-backed duikers through noninvasive genetic techniques. *African J. Ecol.*, **46**: 411–417.
- YU, F., 2002. *Systematics and biogeography of flying squirrels in the Eastern and the Western Trans-Himalayas*. Unpublished Ph.D. dissertation, University of Florida. USA. 228 pp.
- YU, F., YU, F., MCGUIRE, P. M., KILPATRICK, C. W., PANG, J., WANG, Y., LU, S. AND WOODS, C.A., 2004. Molecular phylogeny and biogeography of woolly flying squirrel (Rodentia: Sciuridae), inferred from mitochondrial cytochrome b gene sequences. *Mol. Phylogen. Evolut.*, **33**: 735–744.
- ZAHLER, P., 1996. Rediscovery of the woolly flying squirrel (*Eupetaurus cinereus*). *J. Mammal.*, **77**: 54–57.
- ZAHLER, P. AND WOODS, C.A., 1997. The status of the Woolly flying squirrel (*Eupetaurus cinereus*) in northern Pakistan. In: *Biodiversity of Pakistan* (eds. S.A. Mufti, C.A. Woods and S.A. Hasan). Pakistan Museum of Natural History, Islamabad and Florida Museum of Natural History, Gainesville, U.S.A., pp. 495–514.
- ZAHLER, P. AND KARIM, A., 1998. New distribution, elevation, habitat and diurnal refuge for the Kashmir flying squirrel *Eoglaucomys fimbriatus*. *Mammalia*, **62**: 588–591.

ZAHLER, P. AND KARIM, A., 1998. Origin of the floristic components of salajit. *Hamdard Medicus*, **41**: 6-8.  
 ZAHLER, P., 2001. The woolly flying squirrel and gliding: Does size matter? *Acta Theriol.*, **46**: 429-435.  
 ZAHLER, P. AND KHAN, M., 2003. Evidence for dietary specialization on pine needles by the woolly flying squirrel (*Eupetaurus cinereus*). *J. Mammal.*, **84**: 480-486.

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**Annexure 1: Semi-Structured Interview Proforma to know about the presence of woolly fly squirrel in different Sites of the study area.**

A. Name of respondent: \_\_\_\_\_ Age: \_\_\_\_\_

Residence:

1. Local 2. Nomad 3. Others: \_\_\_\_\_

Profession:

1. Hunter [ ]  
 2. Shepherd [ ]  
 3. *Salaajeet* Collector [ ]  
 4. Other [ ]

B. How many types of squirrel do you know? \_\_\_\_\_

How they are different from each other?

1. Structural difference.....  
 2. Habitat difference .....  
 3. Color .....  
 4. Size .....  
 5. Nest .....  
 6. Others .....

Are these species found in the same area?

1. Yes [ ] 2. No [ ]

If no then which species is found in which area?

1. .... (write the name of the area)  
 2. ....  
 3. ....

Have you seen woolly flying squirrel?

1. Yes [ ] 2. No [ ]

If yes where it was seen?

..... (Name of the site and habitat characters)

What are the distinctive characteristics of woolly flying squirrel?

1. Size \_\_\_\_\_  
 2. Tail \_\_\_\_\_  
 3. Color \_\_\_\_\_  
 4. Behavior \_\_\_\_\_  
 5. Habitat \_\_\_\_\_

Could you identify which one is the woolly flying squirrel in these pictures?

1. Red giant flying squirrel Yes [ ] No [ ]  
 2. Woolly flying squirrel Yes [ ] No [ ]  
 3. Small Kashmir flying squirrel Yes [ ] No [ ]

Is there any association of the *Salaajeet* with presence of woolly?

1. Yes [ ] 2. No [ ]

Did you hear/ identify the call of woolly?

1. Yes [ ] 2. No [ ]

If yes, then describe the mode/tone of the call?

.....  
 .....

When did you see the woolly?

1. Early in the morning 2. Day time 3. In evening 4. At night

What are the main threats to the woolly flying squirrel in the area?

1. ....  
 2. ....  
 3. ....  
 4. ....

Is there any threat of natural predator to the woolly flying squirrel?

1. Yes [ ] 2. No [ ]

If yes then what are the main natural predators of woolly in the area?

1. ....  
 2. ....  
 3. ....  
 4. ....

