

Observations of the woolly flying squirrel *Eupetaurus cinereus* in Pakistan

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Abstract

The woolly flying squirrel *Eupetaurus cinereus* is one of the rarest and least known mammals in Asia. Previously, it has only been known from a few specimens, a few recently captured individuals, and data obtained from local residents. In 2004, two woolly flying squirrels were located in the Nanga Parbat area of Pakistan and observed for two nights. For the first time, the behavior in the wild, vocalizations, and tracks of woolly flying squirrel are described.

Keywords: behavior; *Eupetaurus cinereus*; Pakistan; tracks; vocalizations; woolly flying squirrel.

Introduction

The woolly flying squirrel *Eupetaurus cinereus* is the world's largest squirrel, weighing up to 2.5 kg. One of the rarest mammals in the world, it was known until recently only from 11 old study skins and skulls. See Zahler and Woods (1997) for an overview of the species' status, distribution and natural history.

In 1994–1996, Zahler (1996) and later Zahler and Khan (2003) conducted extensive search for this species in most of the locations where specimens had originally been collected. Six animals were captured in cave dens and released. Local residents reported that the animal lived in caves in high rock cliffs at 2400–3800 m elevation, and climbed coniferous trees to feed.

Surveys in 2002 found that the squirrel had been seen by local people in Gilgit and Hunza areas of Pakistan. Only one sighting was made during the course of study, at 2600 m elevation, also in Gilgit area (Ali 2002). In 2003, a nest and fecal pellets belonging to a large flying squirrel were found at Jutal Nala near Gilgit (Oshida et al. 2005). In 2004, a captive animal was found in a village near Gilgit (Ahmad 2004).

All recent records of the woolly flying squirrel, including the present study, were from an area of about 100×100 km. The World Conservation Union lists this species as endangered (Zahler 2010).

Study areas and methods

From October to November 2004, a search for the woolly flying squirrel was conducted at 10 locations (Table 1) in

Pakistan and Afghanistan. Each location was searched by spotlighting on foot, with preference given to areas with tall cliffs adjacent to coniferous forests. In addition, snow cover (when present) was searched for tracks, scat, and signs of feeding. A total of 106 h was spent spot lighting in 10 different areas, with a total of approximately 200 km of forest trails searched.

The only area where the woolly flying squirrel was found was Paradise valley, a 6 km long, 500 m wide terrace above Raikot glacier in Nanga Parbat range of the lesser Himalaya, Pakistan. The terrace is separated from the glacier by a rocky cliff up to 300 m high, and is bordered on the other side by a steep, sparsely forested slope (Figure 1). It is not well drained; the old-growth forest has numerous clearings formed by small creeks, bogs, and areas of windfall. The conifers are up to 40 m tall, and up to 60 cm in diameter at breast height. Some portions of the cliff have widely spaced shrubs such as *Rosa webbiana*, *Quercus baloot*, *Artemisia* spp. and *Ephedra* spp.

The access trail to Nanga Parbat base camp follows the terrace. It is one of the most popular treks in Pakistan, and is extensively used by local people and tourists in summer months, but at the time of the study no people were present above the village of Jhel (at 2660 m elevation 5 km down the valley).

Results

On 26 October 2004, the cliff edge in the lower part of the terrace, at approximately 3350 m elevation, was being surveyed. Despite full moon, the visibility was very poor due to heavy snowfall, the first one that season. By the time of the observation, up to 4 cm of snow had accumulated on the ground. Approximately 30 min after sunset, a loud call was heard from below the cliff. It could be best described as a croaking scream, reminiscent of flight calls of larger macaws (*Ara* spp.), but lower in pitch and longer in duration (approx. 1.5–2 s). Such calls have been heard after sunset from known denning areas of woolly flying squirrels by Peter Zahler (pers. comm.). A similar call was heard 3 min later from a pine tree growing on the edge of the cliff. It was followed by scratching sounds and a “qwok-qwok-qwok” call, recognizable as being produced by a squirrel. A woolly flying squirrel was located in the tree immediately. A second individual was found nearby a few minutes later.

The animals were observed for 4 h. They allowed close approach (sometimes to within 15 m from the tree), but moved away if a flashlight was pointed at them.

On the next night, both animals were easily relocated 50 min after sunset. This time the weather was clear, with

Table 1 Locations searched for the presence of the woolly flying squirrels.

Site	Latitude/ longitude	Elevation, m a. s. l.	Habitat	Flying squirrels found
Batura glacier area, PK	36°53' N, 74°64' E	2900–3500	OGF of <i>Juniperus semiglobosa</i> ; tall cliffs	None
Southern Hunza valley, PK	36°14' N, 74°55' E	2000–4000	Forest of <i>Juniperus semiglobosa</i> ; tall cliffs	None
Palas valley, PK	35°00' N, 73°30' E	1200–2500	Forests of <i>Pinus wallichiana</i> , <i>P. roxburghii</i> , <i>P. gerardiana</i> , and <i>Picea smithiana</i> ; small cliffs	None
Kalam area, PK	36°40' N, 73°25' E	1700–2700	Extensive forests of <i>Cedrus deodara</i> , <i>P. wallichiana</i> , and <i>P. smithiana</i> ; small cliffs	None
Chitral Gol NP, PK	35°50' N, 71°40' E	1700–2700	OGF of <i>Cedrus deodara</i> , <i>P. wallichiana</i> , and <i>P. smithiana</i> ; small cliffs	<i>Eoglaucomys fimbriatus</i>
Tora Bora mountains, AF	34°07' N, 70°13' E	2000–2700	Scattered <i>J. semiglobosa</i> and <i>P. wallichiana</i> ; tall cliffs	None
Unnamed site in Nuristan, AF	34°00' N, 71°30' E	1500–3000	Scattered <i>P. wallichiana</i> and <i>C. deodara</i> ; tall cliffs	None
Machiara NP, PK	34°44' N, 73°58' E	2000–2500	Forest of <i>P. wallichiana</i> and <i>P. roxburghii</i> ; small cliffs	<i>Eoglaucomys fimbriatus</i>
Ayubia NP, PK	34°02' N, 73°25' E	2000–2500	OGF of <i>P. wallichiana</i> and <i>P. roxburghii</i> , with <i>Abies pindrowi</i> , <i>Taxus sumatrana</i> on north-facing slopes, <i>Aesculus indica</i> , <i>Prunus padus</i> , <i>Juglans regia</i> , <i>Quercus</i> spp. on south-facing slopes; no cliffs	<i>Petaurista petaurista</i>
Paradise valley, PK (see text)	35°20' N, 74°35' E	3300–3500	OGF of <i>P. wallichiana</i> , with <i>P. smithiana</i> , <i>P.</i> and <i>J. gerardiana</i> , <i>J. semiglobosa</i> , <i>Cupressus torulosa</i> , <i>Q. semicaprifolia</i> , <i>Ilex</i> spp., and <i>Betula utilis</i> ; <i>J. communis squamata</i> shrub cover in some places; tall cliffs	<i>Eupetaurus cinereus</i> , <i>Eoglaucomys fimbriatus</i>

PK, Pakistan; AF, Afghanistan; NP, national park; OGF, old-growth forest.

**Figure 1** Habitat of the woolly flying squirrel in Raikot valley, with Nanga Parbat (8125 m) in the background.

bright moonlight. The squirrels seemed more wary and did not allow approach to less than 40 m from the tree even without a flashlight, but good visibility allowed observing from 60–80 m, apparently without disturbing them.

The animals could be instantly identified as woolly flying squirrels by large size (unlike Kashmir flying squirrel *Eoglaucomys fimbriatus*), gray coloration and thick, cylindrical tail (unlike red giant flying squirrel *Petaurista petaurista*), but the most obvious and reliable field mark was small ears. They had smoky-gray fur with much paler underparts, slightly darker feet, and moderately bright yellowish eyeshine. No white or black tail tips were visible.

If the visual contact was lost, the squirrels could be relocated by the rustling sounds and calls they occasionally made. The “croaking scream” call was never heard again, but the animals produced a variety of low sounds such as “qwok-qwok-qwok”, sharp “chorp!” and soft “chirr”, the latter apparently described by Zahler (1996).

The calls could only be heard during the bouts of rapid movement, which occurred every 2–10 (usually 3–4) min, lasted for up to 30 s, and included moving through the tree crown, calling, sometimes also running up and down the trunk or gliding to another tree. They spent a long time (up to 30 min) in one tree. Between the bouts of activity, they could sometimes be seen moving slowly or feeding, but produced no audible sounds. When resting, they usually perched vertically on a large branch close to the trunk, just below the main portion of the crown, with the tail hanging down. No chases were observed, but once an animal left a tree immediately after the other one landed on it. On the second night, the squirrels seemed to move less, and to produce fewer calls, probably because of bright moonlight.

Of five glides between trees observed on the first night, and eight glides observed on the second night, most were approximately 5–10 m long, and only one 20 m long. Glides up to 40–60 m common in other large species of flying squirrels were not seen. Unlike in giant flying squirrels (Stratford et al. 2002), all observed glides started below the canopy, and no audible sound was produced during glides and landings.

All movements were within a 100 m wide strip of forest along a 200 m long stretch of the cliff. The squirrels were never seen to descend below 10 m from the ground.

On both nights, the squirrels were only present for a few hours after sunset (4 h on the first night, and 2 h on the second), and then left, apparently both at the same time. On the first night, the actual moment of departure was seen. The animal moved into the same pine tree where one of the squirrels was first located, then took off towards the cliff, glided over the edge, made a 180° turn approximately 30–50 m away from the cliff, and disappeared in the fog filling the valley below.

On the first night of observation, the snowfall ceased soon after the squirrels left the area, and the second night had no precipitation, so the snow could be searched for tracks. On each morning, two lines of tracks leading from under the cliff to cliffside trees were located, but no other woolly flying squirrel tracks were found anywhere along the terrace. The tracks were somewhat small for a squirrel that size: each

set of four footprints approximately 17 cm wide and 20 cm long, stride 60–140 cm, hind foot 8–9 cm long (measured according to Halfpenny 1986). The relative position of four footprints was typical for squirrels. The tail did not leave any prints.

Both animals were seen feeding on pine cones and dropping them on the ground, and a total of 23 *P. wallichiana* cone remnants with scales removed (Figure 2) were found under the trees where the squirrels were observed during the night. This pine species was seeding abundantly at the time, as evidenced by large flocks of spotted nutcrackers (*Nucifraga caryocatactes*) feeding in the trees during the daytime. It is possible that the squirrels also ate pine needles, but that would be difficult to see.

At least three Kashmir flying squirrels were observed in the area in two nights, and their tracks were found in numerous locations, up to the tree line at 3700 m elevation. They were also seen feeding on *P. wallichiana* cones. No difference between remnants of pine cones fed upon by the two species was noticed.

Tracks of possible predators recorded in the area (but not within 1 km from the observation site) included red fox (*Vulpes vulpes*) and yellow-throated marten (*Martes flavigula*). No presence of eagle owls (*Bubo*), found by Zahler (1996) to prey on the woolly flying squirrel, or of any other owl species was detected.

Unfortunately, slippery snow cover and lack of ropes made it impossible to search for dens below the cliff edge. Video footage obtained was of very poor quality.

Discussion

The only food source recorded during present study was pine cones. *P. wallichiana* cones are 20–30 cm long, with seeds



Figure 2 Cone remnants left by feeding woolly flying squirrels.

up to 7 mm long (Farjon 1984). Zahler and Khan (2003) report needles of conifers as the primary food source, based on fecal samples from animals captured in July and early November. This difference might reflect seasonal changes in diet, similar to those reported for Japanese giant flying squirrel (Kawamichi 1997), or an adaptation to irregular availability of pine seeds. The latter hypothesis seems more likely, since some of the observations by Zahler and Khan were made at the same time of the year as the present study.

Information about the behavior and habitat use of the woolly flying squirrel gathered by Zahler (1996) during his extensive research proved very accurate. Unfortunately, his assessment of the conservation status of the species also seems to be realistic. Very few high-altitude old-growth forests remain in Pakistan; most are either on ridge crests, away from cliffs forming the sides of glacial valleys, or on very steep slopes where trees are widely scattered. The terrace of Paradise Meadow is unusual; no forest of similar type was found anywhere else during the present study.

A logging road had been recently built to Jhel, but at the time of observation there was no commercial logging at Paradise Meadow. At least five wooden hotels were in operation on the terrace in the summer of 2004 (one of them just 500 m from the observation area), and three more were being built. Fortunately, most of the development was either 1–2 km further down or 4–5 km further up the trail. Being nocturnal and arboreal, the squirrels are probably little affected by tourists. However, negative effects of intensive foot traffic and of livestock herds passing along the terrace twice a year on forest growth are possible.

The entire Nanga Parbat massif is one of the most scenic, accessible, and pristine mountain ranges in Pakistan with numerous rare species of flora and fauna, and seems to be a prime location for a national park.

Acknowledgements

I thank S. Akbar, M. Kosoy, J.K. Lepson, P.J. Polechla Jr., J. Sayad, P. Zahler and the anonymous reviewer for helpful comments on the manuscript.

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