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SHORT NOTE

First confirmed record of a woolly flying squirrel (*Eupetaurus* sp.) in Bhutan

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Abstract. The three species of woolly flying squirrels of the genus *Eupetaurus* are amongst the rarest and least studied mammals in the world. The different species are known to occur from only a few locations in the western, north-central and south-eastern margins of the Himalayas. Though the genus has been recorded in Bhutan, there has been no confirmed evidence until now. Here we confirm for the first time the presence of *Eupetaurus* in Bhutan and discuss some records of mammals and birds with which it co-exists. The woolly flying squirrel was photographed by camera trap during a rapid biodiversity survey in the north-eastern part of Jigme Dorji National Park. From the three widely disjunct populations of *Eupetaurus*, the external pelage and appearance of this specimen appears to most closely resemble *Eupetaurus nivamons.* This record warrants further study to confirm identification and better understand its morphology, habitat selection and distribution in Bhutan.

Key word: camera trapping, endangered mammal, Jigme Dorji National Park

Introduction

The three species of woolly flying squirrels of the genus *Eupetaurus* are amongst the least-known mammals in the world despite being amongst the heaviest (2.5 kg) and longest (1,100 mm) species of flying squirrels (Roberts 1997, Zahler 2001). The first species to be described was *Eupetaurus cinereus*, which was described by Thomas (1888) from two skins and a skull that came from the Gilgit region of northern Pakistan. *Eupetaurus cinereus* has been considered an enigmatic species due to its uniquely high-crowned (hypsodont) dentition, taxonomic uniqueness (that was considered a monotypic genus at that time), poorly known natural history and endangered conservation status that included it being considered extinct for 70 years (1924-1994) until it was discovered in the Sai valley of Pakistan in 1994 (McKenna 1962, Zahler 1996, Jackson & Thorington 2012).

Between 1888 and 2021, this was the only species to be described, though specimens from other regions including Tibet and Sikkim were known (Jentink 1890, McKenna 1962, Thorington & Hoffmann 2005). In 2004, the woolly flying squirrels from Tibet and Yunnan were found to be deeply divergent genetically from those in the western Himalayas (Yu et al. 2004). Subsequently, Jackson et al. (2021) used genetic and morphological comparisons, and recognised three widely disjunct species of *Eupetaurus* that included *E. cinereus*, which is known to occur at elevations of 2,700-3,600 m in the western Himalayan region around

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Gilgit in northern Pakistan (Zahler 1996, Din et al. 2015, Jackson et al. 2021) and between 2,700 m to 4,800 m in the Upper Bhagirathi Basin, Uttarakhand, north-western India (Pal et al. 2018, 2020). It is also predicted to occur in western Nepal (Jackson et al. 2021). *Eupetaurus tibetensis* (Jackson et al. 2021) is known to occur at elevations of 2,700-4,000 m in southern Tibet (= Xizang) in China and Sikkim in India; and *Eupetaurus nivamons* (Jackson et al. 2021) which is known to occur between 3,400 m to 4,450 m on the River Mount Gaoligong and the River Nu and Biluo Snow Mountain. Populations of this species are also likely to occur in suitable habitats immediately across the border in north-eastern Myanmar (Fan et al. 2017) and in alpine areas of south-eastern Tibet east of the River Brahmaputra (Jackson et al. 2021).

Eupetaurus is also predicted to be present in Bhutan (Wangchuk et al. 2004) due to its range connecting Tibet and north Sikkim where the species was earlier documented. Given the proximity of Bhutan to vouchered records from south-central Tibet and north Sikkim, Jackson et al. (2021) suggested that the Bhutanese species may represent *E. tibetensis*. However, to date, there has been no confirmation of the occurrence of *Eupetaurus* in Bhutan. Therefore, the aim of this study was to confirm for the first time the presence of *Eupetaurus* in Bhutan along with records of other co-occurring high-elevation mammals and birds.

Material and Methods

The species was recorded during a mammal survey conducted by the management of Jigme Dorji National Park. The mammal survey was carried out as a part of rapid biodiversity survey (RBS) in the park located at 27.55-28.25 N and 89.23-90.36 E in different forest types between an altitudinal range of 1,200-5,188 m. A total of 121 grids (4 × 4 km^2) were established and a trail transect of 3-5 km depending on the accessibility to the area was walked, covering the major habitat types within

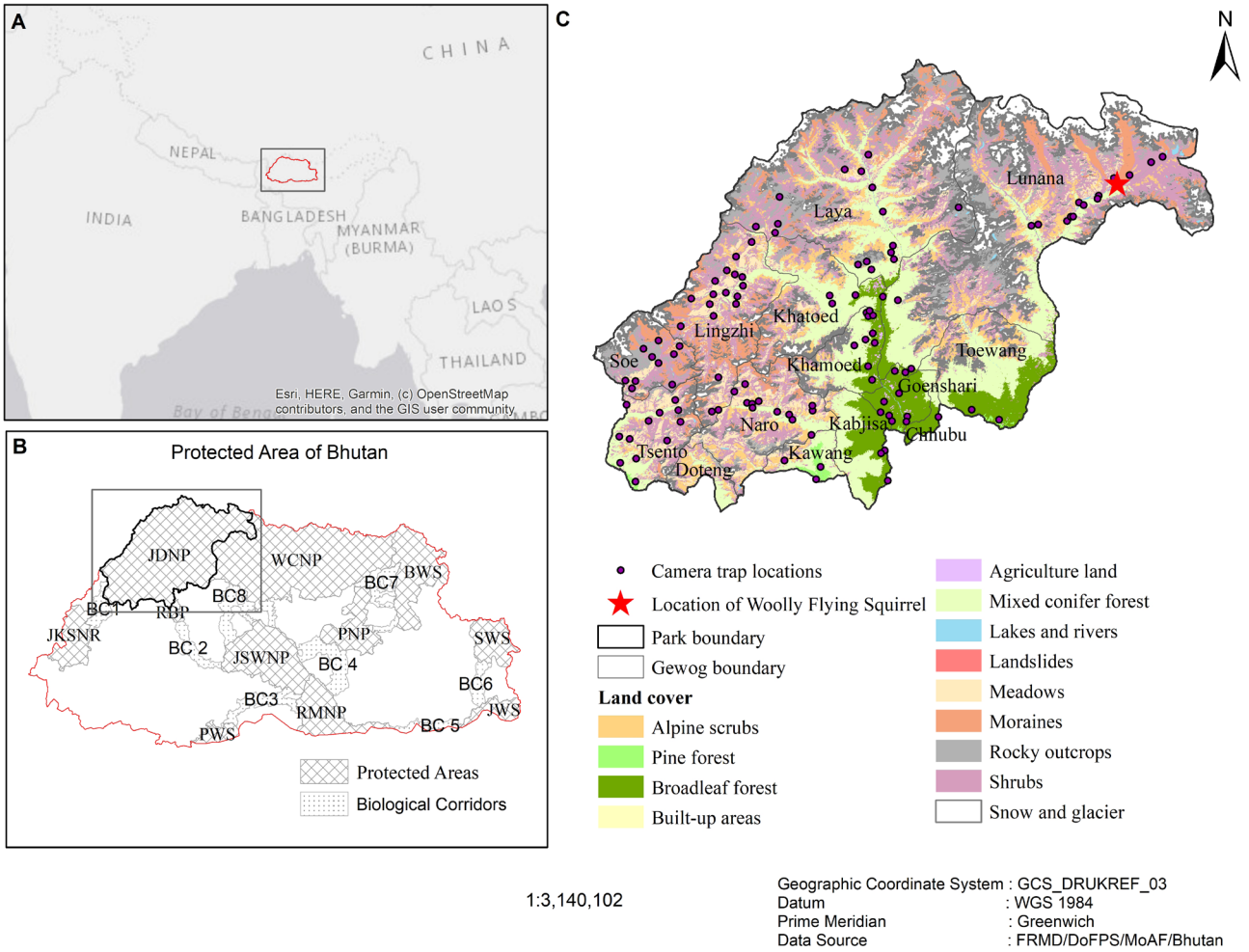

Fig. 1. The first record of woolly flying squirrel from Bhutan Himalaya. (A) Map of Asia showing the location of Bhutan. (B) Protected area map of Bhutan showing the location of Jigme Dorji National Park. (C) Rapid biodiversity survey camera trap locations and location of woolly flying squirrel plotted over land cover map of Jigme Dorji National Park.

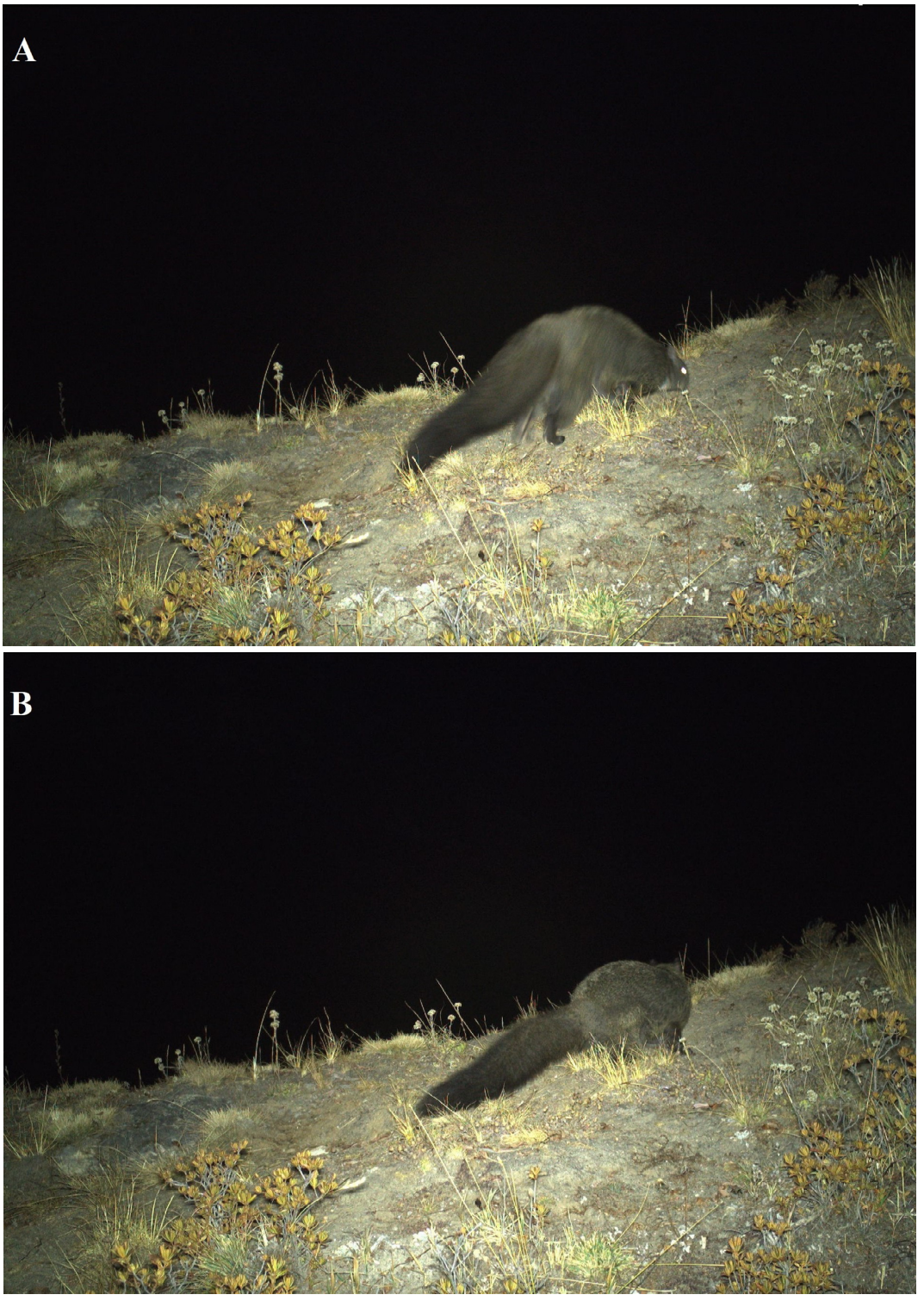

Fig. 2. Camera trap photographs of a woolly flying squirrel in Jigme Dorji National Park. (A) Side view. (B) Hind view.

the grid. Direct sightings and signs, including tracks, scats, dung, pellets and scratch marks, were recorded. Camera traps were installed in 87 grids to supplement the inventory of mammals recorded through sighting/sign surveys. The camera trap locations were selected to cover different elevation classes and habitat types (Fig. 1). Due to accessibility issues, the survey was conducted in two phases; the grids falling below 3,500 m (36 grids) were surveyed during November-December 2019 and above 3,500 m (85 grids) in September-October 2020.

Results and Discussion

Out of 150 camera traps, one that was placed at an elevation of 4,330 m (28.06892 N, 90.16676 E) captured six photographs of a woolly flying

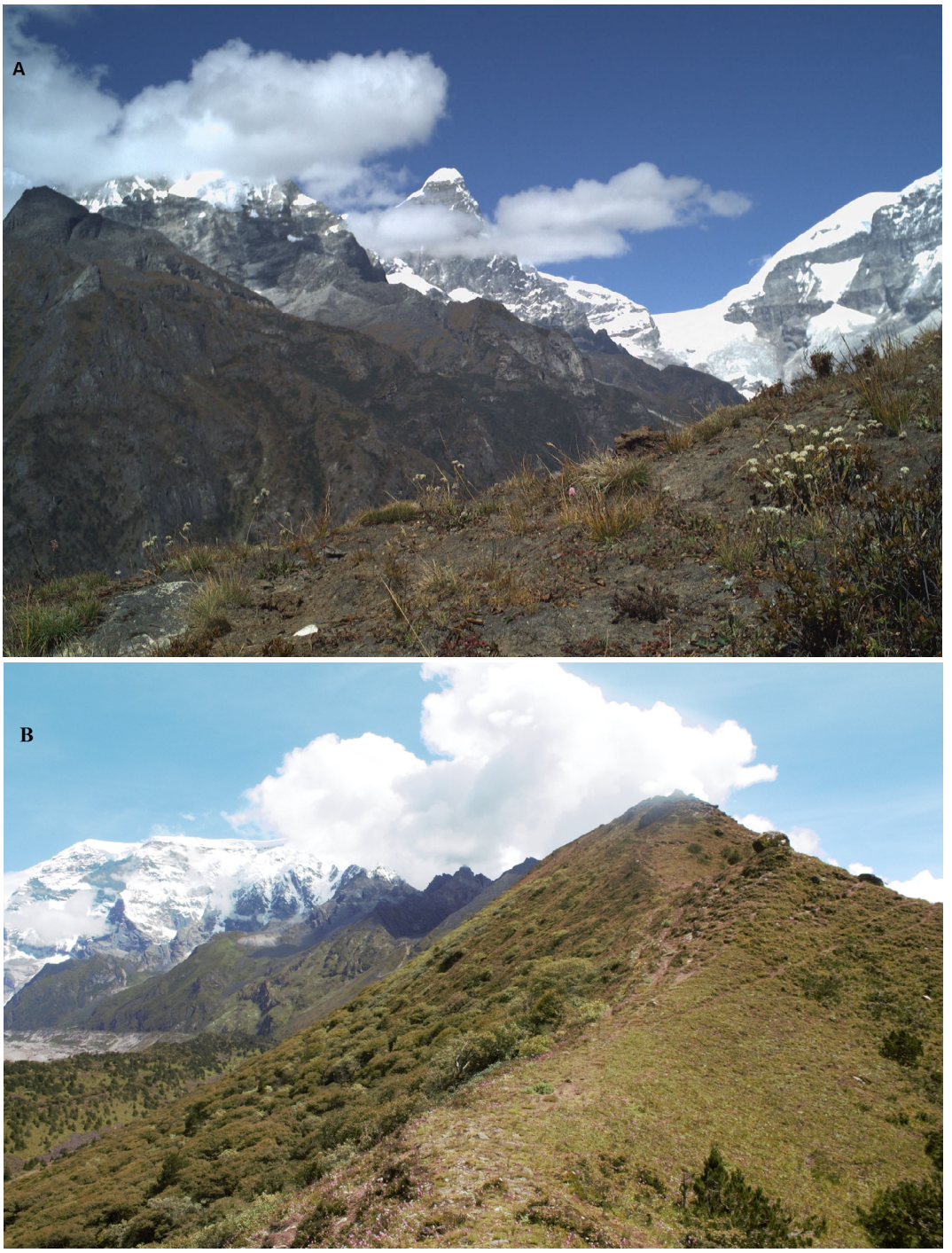

Fig. 3. Ground vegetation cover at the location of the camera trap that photographed the woolly flying squirrel. (A) Camera trap image showing the ground vegetation cover. (B) Landscape image showing vegetation cover of the eastern and western aspects from the camera trap location.

squirrel on 30 October 2020 at 19.10 hours (Fig. 2). Only one camera was installed in that habitat for 44 trap days. The temperature at that time was –2 °C. This animal had long, thick fur with the pelage on the dorsal surface of the head, body and basal part of the tail being grizzled grey. The distal half of the tail was black. Both fore and hind limbs were black. The dorsal surfaces of the manus and pes were black. The ears were pointed and hairy, externally black and internally a washed white. Based on these attributes, the external pelage of this animal most closely resembles *E. nivamons*.

The topography of the landscape where this animal was photographed is rugged with steep hills rising from south to north. Climatically it is cold, windy and snowy, and characterized by a low growing season temperature and short frost-free periods. The dominant tree species include those of the genera *Rhododendron* (*R. lepidotum*,

R. setosum, *R. anthopogon*, *R. cinnabarinu* and *R. campanulatum*) and *Juniperus* (*J. recurva* and *J. squamata*). Trees at the site are sparsely distributed with a canopy cover less than 15% and tree heights varying from 0.8 m to 5.5 m. The canopy density, however, increases (75%) as it extends westwards. The average distance between trees at the site where the photos were obtained is 4 m. The herbs present at the site included *Acanthocalyx nepalensis*, *Aster diplostephioides*, *Bistorta* spp., *Cynanthus lobatus*, *Iris clarkei*, *Onosma hookeri*, *Narodostachys jatamansi*, *Meconopsis simplicifolia* and *Hippophae salicifolia*. The area is used by seasonal grazers and non-wood forest produce collectors, particularly for *Ophiocordyceps sinensis*, medicinal plants and incense raw materials (Fig. 3).

Consistent with our findings, *E. nivamons* found in Mount Gaoligong and Biluo Snow Mountain in China are also reported in alpine areas characterized by vegetation including juniper scrub *J. squamata*. The species was also suspected to occur in alpine areas of south-eastern Tibet east of the River Brahmaputra (Jackson et al. 2021). Woolly flying squirrels were also captured at 4,800 m in alpine areas near Srikant glacier in the western Himalayas in India (Pal et al. 2018).

As was found on Mount Gaoligong (Jackson et al. 2021), *E. nivamons* is suspected to feed on juniper species (*J. recurva* and *J. squamata)* in the park. This species has been captured far beyond the distribution of pine forest and shilajit production areas that are known to be its food (Zahler & Khan 2003, Datta & Nandini 2013). Both pine forests and shilajit production areas are found below 3,500 m in the park. Shilajit is a sticky substances derived from the decomposition of plant material and is found primarily as an exudate of rocks in the Himalayas. Woolly flying squirrels that occur near the Srikant Glacier of Harsil in India are suspected to feed on alpine plants (Pal et al. 2018). Consistent with previous reports of its nocturnal activity (Zahler & Karim 1998, Pal et al. 2018), the species was found feeding at night.

The observation of the woolly flying squirrel in Bhutan demonstrates that they share their habitat with other mammals, including the snow leopard *Panthera uncia*, red fox *Vulpes vulpes* and musk deer *Moschus* spp., and birds such as the Tibetan snowcock *Tetraogallus himalayensis*, as revealed by camera trap images from the same location. In the Indian Himalayan region, there are records of snow leopard, red fox, stone marten *Martes foina*, pale weasel *Mustella altaica*, snow partridge *Lerwa lerwa*, and Himalayan snowcock with woolly flying squirrels (Pal et al. 2018); snow leopard and red fox are known predators of woolly flying squirrels (Zahler 1996, Qamar et al. 2012, Pal et al. 2020). The RBS also revealed the presence of parti-coloured flying squirrel *Hylopetes alboniger*, Bhutan giant flying squirrel *Petaurista nobilis*, and red giant flying squirrel *Petaurista petaurista* in the park.

This record of *Eupetaurus* in Bhutan warrants further study to confirm the species identity and better understand its morphology, habitat selection and distribution in Bhutan. The discovery of a species of woolly flying squirrel in Bhutan adds to recent sightings of a spotted linsang *Prionodon pardicolor* in 2010 and Pallas's cat *Otocolobus manul* in 2012 in Jigme Dorji National Park (Thinley 2013), highlighting the Park's rich biodiversity and conservation significance.

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Author Contributions

Study design and fieldwork: Y. Jamtsho, P. Dendup, L. Wangdi, R. Dorji, R. Dorji and B. Tshering; Data analysis and writing the article: Y. Jamtsho.

Data Availability Statement

All required data/information is provided in the manuscript.

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