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Photographic evidence of the Spotted linsang *Prionodon pardicolor* (Mammalia: Carnivora: Prionodontidae) from the Tashigang Forest Division, Eastern Bhutan

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Abstract

A rarely recorded small carnivore, the Spotted linsang (*Prionodon pardicolor*), is among Asia's least studied members of the family Prionodontidae. We report the first photographic evidence of its presence from the Tashigang Forest Division of eastern Bhutan. A non-invasive camera trap survey during the nationwide tiger survey in 2014–2015 and an opportunistic wildlife monitoring exercise in 2020 photo trapped the species on two independent occasions. On the first occasion the individual was recorded at the altitude of 2,308 m a.s.l. and the later at 2,952 m a.s.l. The main threats to the species in the region are not currently well known, highlighting the importance of additional studies to ascertain its distribution and status in the Tashigang Forest Division.

Key words: Camera trapping, small carnivore, threatened species

Introduction

The Spotted linsang *Prionodon pardicolor* Hodgson, 1841 is widely distributed in eastern Himalaya, across Nepal, Bhutan, and northeast India into southern China (Ghose et al., 2012; Jennings and Veron, 2015; Duckworth et al., 2016; Khatonier and Lyngdoh, 2021). Elsewhere in non-Sundaic southeastern Asia, it occurs in Myanmar, Thailand (Baker et al., 2012), Lao PDR, Cambodia, and Vietnam (Borah, 2010; Mahar and Kaul, 2012; Jennings and Veron, 2015; Duckworth et al., 2016). It is listed under Appendix I of CITES and of 'Least Concern' on the IUCN Red List of Threatened Species (Duckworth et al., 2016; Ghimirey et al., 2018; Khatonier and Lyngdoh, 2021).

Previously placed in the civet family (Viverridae Gray, 1821), *Prionodon pardicolor* is now under a new monogeneric family, Prionodontidae Gray, 1864– a sister group of the family Felidae Fischer von Waldheim, 1817 from which it is considered to have diverged about 33 Mya (Khatonier and Lyngdoh, 2021). In addition to *P. pardicolor*, its only congener, the Banded linsang *Prionodon linsang* (Hardwicke, 1821), is also found through Asia (Lyngdoh et al., 2011; Jennings and Veron, 2015). *Prionodon pardicolor* is a solitary, partly arboreal, ambush predator, which is nocturnal with a great deal of the species' activity documented at night (Borah, 2010; Lyngdoh et al., 2011; Baker et al., 2012). Occasional daytime sightings have also been reported elsewhere across the species' range (Jennings and Veron, 2015). Individuals of the species are known to prey mostly on small vertebrates (Borah 2010); however, reports of carcass feeding by *P. pardicolor* indicate that it might also be an opportunistic scavenger (Duckworth et al., 2016).

Prionodon pardicolor has been recorded in a wide variety of forest habitats from lowland to montane forest, as well as in degraded areas (Jennings and Veron, 2015).

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The species is known to occur at elevations of 80 to 3,308 m a.s.l. and may possibly occur beyond 4,000 m a.s.l. across its geographical range (Lyngdoh et al., 2011; Ghose et al., 2012; Duckworth et al., 2016; Khatonier and Lyngdoh, 2021). *Prionodon pardicolor* is among Asia's least studied members of the family Prionodontidae, despite its wide distribution (Duckworth et al., 2016). Across its distribution range, the species has been considered as common in parts of southern China, Myanmar, Lao PDR, and Vietnam (Duckworth et al., 2016). In Nepal, Thailand, and Cambodia, *P. pardicolor* is reported to be uncommon (Duckworth et al., 2016). Likewise, in India the current distribution of the species is restricted only to northeastern hill tracts such as in north Bengal, Sikkim, Arunachal Pradesh, Assam, Nagaland, Manipur, and Meghalaya. Additional records of *P. pardicolor* are increasingly being reported by camera trap surveys (Ghose et al., 2012; Khatonier and Lyngdoh, 2021).

Despite extensive efforts of camera trapping surveys, the current distribution of *P. pardicolor* in Bhutan is limited to few localities of western Bhutan such as the Jigme Dorji National Park in northwestern Bhutan (Thinley et al. 2015) and Gedu Forest Division in southwestern Bhutan (Dhendup and Dorji, 2018). These records were obtained as by-catch images during camera trapping surveys targeting *Panthera tigris* (Thinley et al., 2015; Dhendup and Dorji, 2018). Our study reports the first evidence of *P. pardicolor* from the Tashigang Forest Division (TFD), eastern Bhutan with camera trap images that have extended the known distribution range of the species in the country.

Material and Methods

Study area

The national tiger survey (NTS) and the wildlife monitoring study covered the whole Tashigang Forest Division (TFD) (Fig. 1), the non-protected region of two eastern districts, Tashigang (27°19'48.00" N, 91°32'60.00" E) and Trashiyangtse (27°36'36.00" N, 91°29'24.00" E), of Bhutan. This is the state reserved forest land outside the protected area (PA) network system in the east with altitudes as low as 480 m to higher than 4,400 m a.s.l. (Koirala et al., 2021).

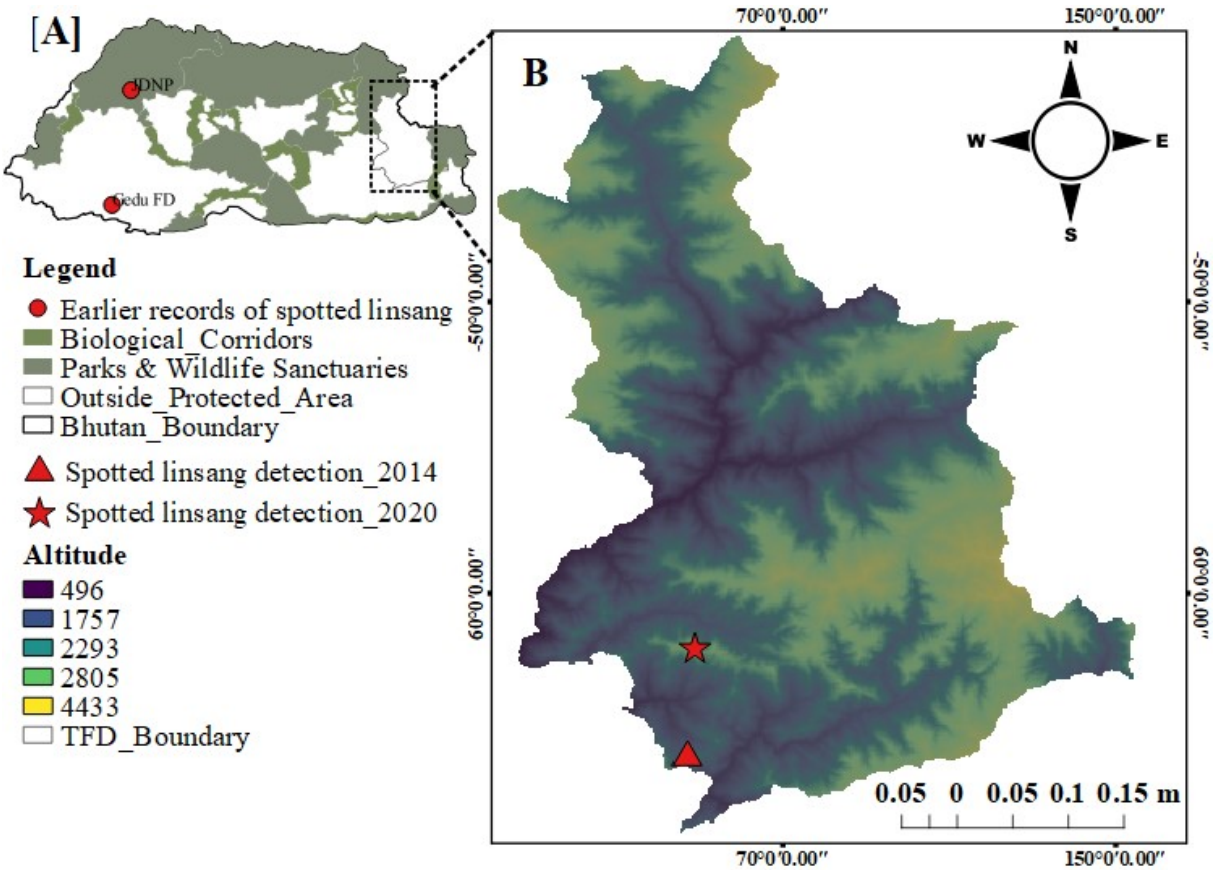

Figure 1: Conservation map of Bhutan with study location (A), and the Spotted linsang *Prionodon pardicolor* capture sites in the Tashigang Forest Division (B).

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Table 1: Published altitudinal records of spotted linsang in Bhutan.

Sl. No.	Elevation (m a.s.l)	Location	Region	Source
1	2,063–4,105	Jigme Dorji National Park (JDNP)	Northern and Western Bhutan	Thinley et al. (2015)
2	2,150–2,718	Gedu Forest Division (GFD)	Southwestern Bhutan	Dhendup and Dorji (2018)

The 2,447.40 km^2 large study area is composed of a mosaic of habitat types dominated by subtropical forest, warm and cool broadleaved forests (CBL), mixed conifer forest (MCF), pine forest, mixed pine-cool broadleaved forest, chirpine forest, alpine shrubs and meadows at higher altitude region, and a few plantations (FRMD, 2017; Norbu et al., 2021). Nestled between the international border with Arunachal Pradesh, India in the east, TFD is a strategic connecting linkage to the larger landscape of many other PAs and Forest Divisions (FD) in Bhutan (Thinley et al., 2020). The landscape further supports habitat linkage along the Northern Forest Complex-Namdapha-Manas Landscape that connects with habitats in eastern Assam and Arunachal Pradesh, and Myanmar (Wikramanayake et al., 2011).

In addition to the habitat mosaic within TFD of varying altitude, topographical aspect, slope, and forest types, the region also experiences unpredictable climatic conditions of warm and wet summers and relatively cold and dry winters (Norbu et al., 2019). The mean annual temperature and precipitation may ascend to a maximum level of 20.2° C and 2,000 mm respectively (Norbu et al., 2021). TFD also supports many rare flora and fauna, including Tiger (*Panthera tigris*), which is an important apex predator in the region, Common leopard (*Panthera pardus*), Dhole (*Cuon alpinus*), and other small carnivore species (Thinley et al., 2020; Thinley et al., 2021).

Survey method

During the camera trapping studies, three infrared camera-trap models were deployed; the HCO-ScoutGuard™ (HCO ScoutGuard, Norcross, Georgia, U.S.A.), UWay™ (Uway Outdoors, Norcross, Georgia, U.S.A.), and CuddeBack™ (Non Typical, Inc., Park Falls, Wisconsin, U.S.A.). Remotely non-invasive camera traps were deployed either in pairs or singly. These were non-baited and were attached to the base of the tree trunk or a pole approximately 40–50 cm above ground level (NCD, 2019). Camera traps were placed opportunistically along forest roads, trails, ridge lines, and water holes at random distances from each other to increase the chance of capturing tiger and other wildlife species. In the case of the NTS, camera trapping points were operated inside identified survey grids each measuring 5 x 5 km^2 (DoFPS, 2015).

In total, 87 camera trap stations ran for 30 to 180 days and were set to function 24 hours per day with a five second time lapse between consecutive photographs, and three shots per trigger. After 15 to 45 days, camera batteries were changed, memory cards were replaced, and data was retrieved. Coordinates and altitude of each camera trap were determined using a GPS Garmin e-Trex® 30 device (Garmin International Inc., Olathe, Kansas, U.S.A.) set to WGS 84 datum.

Results and Discussion

The NTS and the wildlife monitoring study in the TFD had a total sampling effort of 7,830 camera days across 87 camera locations. Two independent pictures of *P. pardicolor* were photographed from two different camera locations. The first picture was obtained during the NTS in 2015 (Fig. 2a, b). The second was obtained during the wildlife monitoring study in 2020 (Fig. 2c). These represent the first ever verifiable photographic evidence for the occurrence of *P. pardicolor* in the Tashigang Forest Division and in eastern Bhutan.

The NTS photograph was captured from a camera trap that was deployed along the ancient trail of Mukhazoor at an elevation of 2,308 m a.s.l. (27°5'2.29" N, 91°31'36.60" E) on 7th January 2015 (8:21 hrs) (Fig. 2a, b). Later, another solitary *P. pardicolor* image was recorded on 24th March 2020 at 12:04 AM during the wildlife monitoring study from the Kharungla Forest Range at an elevation of 2,952 m a.s.l. (27°5'2.29" N, 91°31'36.60") (Fig. 2c). People of the local community often use the ancient trail, *i.e.* the location of the first sighting, for fetching small bamboos from the nearby forest area. The second trail location is frequently used by livestock and herders, with intense cattle grazing. The aerial distance between the two photo-captured locations is approximately 11 km, and both occurrence areas fall under the Lumang block of the Tashigang District.

The predominant forest vegetation common to both capture locations were *Quercus* sp., *Castanopsis* sp., *Pinus bhutanica* (Bhutan white pine), *Alnus nepalensis*, *Rhododendron* sp., moist cool broadleaved (CBL) montane forest, *Borindia grossa*, and other smaller bamboo species (*Arundinaria racemosa* and *Drepanostachum* sp.) with dense undergrowth shrub species (Tshering et al., 2021). Both records occurred at night. Some additional wildlife species were repeatedly recorded from both camera trap locations. These species included Leopard *Panthera pardus* (Linnaeus), Asian golden cat *Catopuma temminck* (Vigors and Horsfield), Marbled cat *Pardofelis marmorata* (Martin), Dhole *Cuon alpinus* (Pallas), Asiatic black bear *Ursus thibetanus* G. Cuvier, Red panda *Ailurus fulgens* F. Cuvier, Yellow-throated marten *Martes flavigula*

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Boddaert, Large Indian civet *Viverra zibetha* Linnaeus, Common palm civet *Paradoxurus hermaphroditus* (Pallas), Barking deer *Muntiacus muntjak* (Zimmermann), Samber deer *Rusa unicolor* (Kerr), Serow *Capricornis sumatraensis* (Bechstein) and Wild pig *Sus scrofa* Linnaeus. The findings indicate that *P. pardicolor* co-exists spatially with many larger predators and other small carnivores. In addition to mammals, our empirical photographic data indicates that both trails inside the woodland bamboo forests were also frequented by many ground dwelling birds such as the Satyr tragopan *Tragopan satyra* (Linnaeus), Temminck's tragopan *Tragopan temminckii* (Gray), Kalij pheasant *Lophura leucomelanos* (Latham), and Hill partridge *Arborophila torqueola* (Valenciennes), and rodent species (rat, squirrel, etc.), which may indicate these species as potential prey for *P. pardicolor* in the habitat.

In Bhutan, *P. pardicolor* is so far known from only few locations, most commonly in the western region. During a tiger inventory in the Jigme Dorji National Park (2011–2012) in northwestern Bhutan by Thinley et al. (2015), a single image of *P. pardicolor* was recorded at elevations between 2,063 and 4,105 m a.s.l. in mixed-conifer forests. Later, during the NTS (2014–2015), the species was recorded at two different locations in the Gedu Forest Division in southwestern Bhutan, at elevations between 2,150 and 2,718 m a.s.l. in cool broadleaf forest with sparse stands of *Rhododendron arboretum* (Dhendup and Dorji, 2018). These findings indicate that cool broadleaf forest and mixed conifer montane forest of Bhutan support significant habitat niches for such rare species and important wildlife corridor to the larger landscape of the eastern Himalayas.

Figure 2: Camera-trap images of the Spotted linsang *Prionodon pardicolor* from the Tashigang Forest Division, recorded in 2014–2015 (a, b), and 2020 (c). ©TFD

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The Spotted linsang *P. pardicolor* was previously feared to be threatened by habitat loss and degradation (Borah, 2010). Forest conversion is also occurring in many habitats distributed across its range (Duckworth et al., 2016). The species is also threatened by indigenous communities through indiscriminate snaring, hunting, reprisal, and is often observed to be traded in local markets in most of its range countries (Borah, 2010; Lyngdoh et al., 2011; Mahar and Kaul, 2012; Duckworth et al., 2016). Historically, *P. pardicolor* was common in the mountains of Nepal and Sikkim Himalaya, however, a significant population reduction has resulted in the present rarity of sighting records (Duckworth et al., 2016). In eastern Bhutan, increased anthropogenic activities including a large amount of forest clearance, increased developmental activities, and logging extraction, could be a major driving force affecting the status of the species in Bhutan. Therefore, it is important to conserve this habitat and minimize destruction where *P. pardicolor* was recently recorded in eastern Bhutan.

The present study contributes important information to the understanding of *P. pardicolor* distribution and status in Bhutan, as very limited previous information is available on distribution of this species from the country. This study presents the documentation of the first evidence of *P. pardicolor* in the Trashigang Forest Division from eastern Bhutan emphasizing that further exhaustive investigation is needed to advance understanding of the species' overall characteristics, habitat, and ecology.

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Conflict of interest

The authors declare that there are no conflicting issues related to this research article.

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