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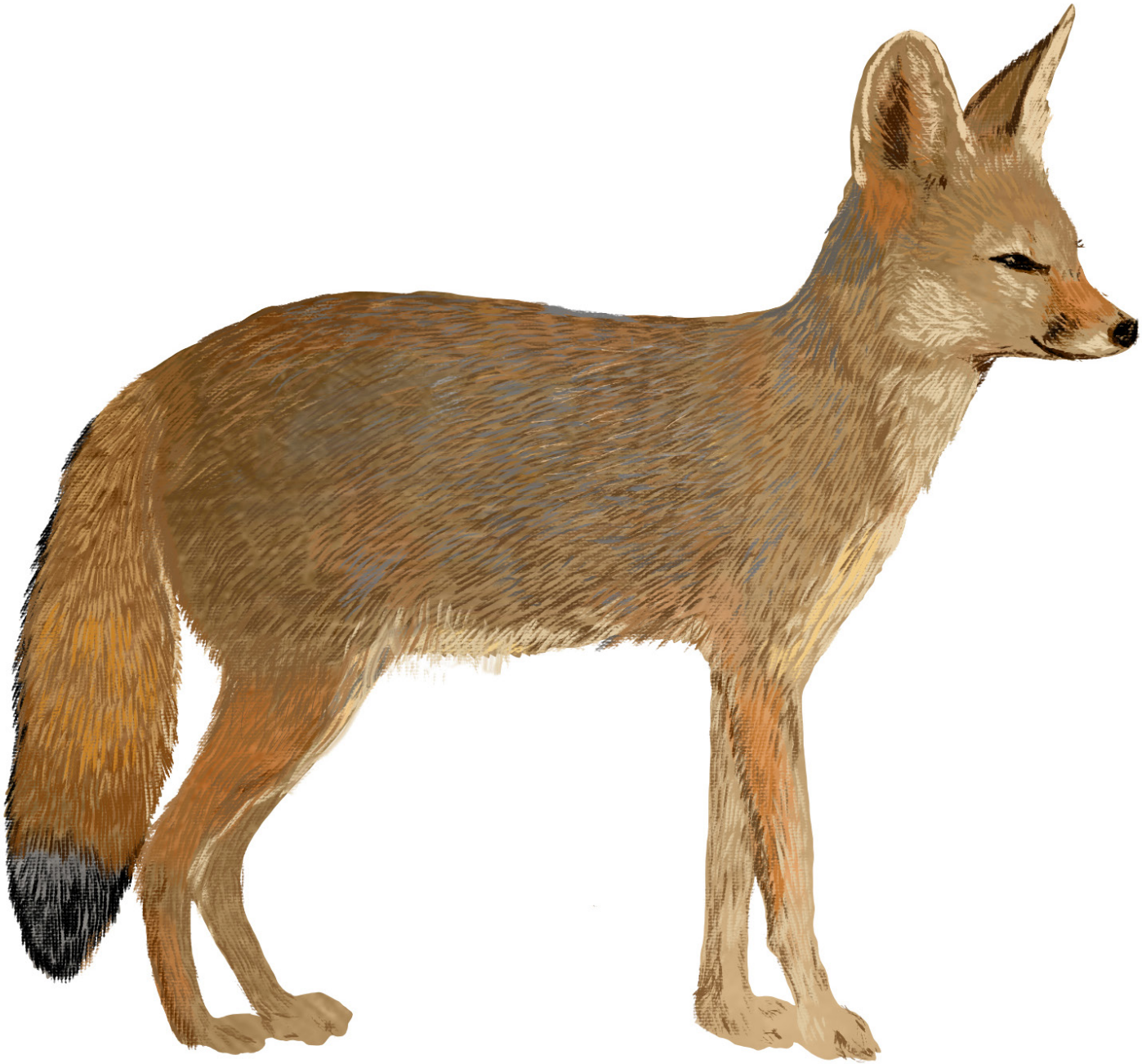

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Cover: Bengal Fox *Vulpes bengalensis*—digital illustration. © Alagu Raj.

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COMMUNICATION

Occurrence and distribution of Indian Pangolin *Manis crassicaudata* (Mammalia: Pholidota: Manidae) in the protected area network of Jammu Shiwaliks, India

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Abstract: The Indian Pangolin *Manis crassicaudata*, a rare and elusive species distributed across the Indian sub-continent, remains poorly understood due to its nocturnal and solitary behaviour, resulting in a lack of understanding about its ecology. This study presents the distribution of the animal in protected areas in Jammu Shiwaliks, India using the data obtained from camera trap images. Eighteen mammals including the Indian Pangolin were recorded from 131 camera trap locations during 3,144 trap nights in a cumulative protected area of 127km^2 in an elevational range of 358–880 m. Given its ecological significance, more rigorous surveys need to be conducted to gain a comprehensive understanding of the distribution, ecology, and habitat utilization of Indian Pangolin across the Jammu Shiwaliks.

Keywords: Activity pattern, camera-trapping, conservation, distribution, ecology, mammal, poaching.

Dogri: अमूर्त: भारतीय पंगोलिन *मनिस क्रासिकाउडाटा*, इक दुर्लभ प्रजाति जेहड़ी पूरे भारतीय उप-महाद्वीप च बंड्डी दी ऐ, अपने निशाचर ते इकांत व्यवहार दे कारण खराब तरीके कन्नै समझी गेई ऐ, जिसदे फलस्वरूप इसदे पारिस्थितिकी दे बारे च समझ च कमी आई जंदी ऐ। एह् अध्ययन कैमरे ट्रैप दी तस्वीरें थमां हासल आंकड़ें दा इस्तेमाल करियै भारत दे जम्मू शिवालिक च संरक्षित इलाकें च जानवरें दे बंड गी पेश करदा ऐ। 3144 ट्रैप रातीं दौरान 131 कैमरे ट्रैप थाहरें थमां भारतीय पैंगोलिन समेत 18 स्तनधारी रिकार्ड कीते गे । इसदे पारिस्थितिक महत्व गी दिक्खदे होई, पूरे जम्मू शिवालिक च जानवरें दे बंड, पारिस्थितिकी, ते आवास दे उपयोग दी व्यापक समझ हासल करने आस्तै होर सख्त सर्वेक्षण करने दी लोड़ ऐ।

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Author details: Ajaz Ansari is a UGC junior research fellow working on a Ph.D on large carnivores in a mountainous protected area in Jammu and Kashmir. After completing his M.Phil on mammals of a subtropical protected area in the Jammu Shiwaliks, he developed an interest in studying high-altitude mammals in Lesser and Great Himalayan landscapes of upper Chenab catchment. He has developed vast expertise in collecting and analyzing the field data. Neeraj Sharma is an assistant professor in the faculty of Life Sciences IME, Bhaderwah Campus where he is actively involved in research on high altitude biodiversity, wildlife ecology, interface ecology, avian ecology, and hill stream dynamics, as well as conducting scientific outreach and extension activities on different facets of mountain environment.

Author contributions: NS conceptualized the idea; AA and NS conducted the field surveys, and camera trapping; AA performed the data analysis and mapping; NS assisted the first author in writing and editing the manuscript and communicated with the journal.

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INTRODUCTION

The Indian Pangolin *Manis crassicaudata* is a medium-sized toothless, myrmecophagous mammal characterized by the presence of dorsal plate-like protective overlapping keratinized scales (Mahmood et al. 2020). Placed in the family Manidae and order Pholidota, it is one of the two species of pangolins found in India (Kumar et al. 2016), the other being the Chinese Pangolin *Manis pentadactyla*, restricted to the northeastern states (Challender et al. 2019). The Indian pangolin inhabits a range of habitats, including sub-tropical, tropical, dry-mixed evergreen, riverine forests, agricultural fields, and nearby human settlements (Irshad et al. 2015). This elusive mammal is predominantly nocturnal, solitary, and fossorial, with a specialized diet that primarily consists of ants and termites, which it captures using its long adhesive tongue (Karawita et al. 2018; Ram et al. 2022). The species plays a vital ecological role as a critical biological pest regulator, highlighting its ecological importance in the ecosystem (Akrim et al. 2017; Chao et al. 2020).

Though cryptic in nature, the Indian Pangolin is subject to multiple threats, including habitat alterations, degradation, and fragmentation (Challender 2014) which are amplified by its limited reproductive capacity and low population densities (Mishra & Panda 2012). It is widely recognized as the most trafficked wild mammal globally (Zhang et al. 2022) for its scales, bones, skin, and meat throughout its range (Kumar et al. 2016; Aditya et al. 2021; Chhabra 2023). Owing to its declining population and range constriction (Aditya et al. 2021), the animal has been listed as 'Endangered' (Mahmood 2019), 'Schedule I' in WPA, 2022 amendment, and, Appendix I by the CITES (2017). As habitat use and their characteristics vary with environmental conditions (Karawita et al. 2018), identifying potential hotspots is critical for designing conservation strategies for the animal (Katuwal et al. 2017; Lyngdoh et al. 2020).

Several studies have reported the presence of Indian Pangolin across the Shiwalik hills in Himachal Pradesh (Singh et al. 2023), Uttarakhand (Joshi 2016; Lyngdoh et al. 2020; Kumar et al. 2022) and Jammu & Kashmir (Noor et al. 2016; Ahmad et al. 2020). Noor et al. (2016) during their surveys, reported a sole sighting of the animal from Jasrota Wildlife Sanctuary prompting further investigations in the region. Intensive surveys were therefore undertaken to establish its presence as well as to investigate behavioural patterns and habitat preferences in three protected areas of Jammu Shiwaliks.

MATERIAL AND METHODS

As pangolins are difficult to observe in the wild (Khwaja et al. 2019), a combination of field surveys, camera-trap monitoring, opportunistic questionnaire and fact-finding interviews with local communities was adopted in three protected areas located in the lower Shiwalik range of the outermost foothills of the western Himalaya. These included Jasrota Wildlife Sanctuary (hereafter JWS, area coverage: 10 km^2, elevation: 353–623 m), Surinsar-Mansar Wildlife Sanctuary (SMWS, 95 km^2, 547–843 m), and Thein Conservation Reserve (TCR, 19km^2, 370–825 m) (Image 1). The vegetation comprises of subtropical scrub, broad-leaved associates interspersed with patches of Chirpine at the hilltops.

The protected areas were divided into 143 sampling units of 1 km^2, each (JWS = 16; SMWS = 91, TCR = 36), henceforth referred as grid-cells using QGIS, version 3.22 (QGIS Development Team, 2021). Two camera traps (Model – Cuddeback h-1453) each were deployed in 131 trapping stations (JWS: September 2020–December 2020 & March 2023; SMWS: January 2020–May 2021; TCR: January 2021–October 2021). The IR cameras were placed between 30 and 50 cm above the ground (Tobler et al. 2008; Jenks et al. 2011) along paths, forest trails, animal tracks, water holes, ridgelines, each spaced at least 400–600 m apart following Sathyakumar et al. (2011) and Colyn et al. (2018). The camera traps were programmed to take at least five photographs with a five-second delay for each encounter in rapid-fire mode (Perera et al. 2022). Camera trap nights were taken as number of days, the camera traps were deployed in the field. Relative Abundance Index (RAI) was determined using photo capture rates (Carbone et al. 2001), while naive occupancy was estimated following MacKenzie et al. (2002). Additional surveys were conducted in JWS for more photo-captures, and signs, including the burrow distributions following Shrestha et al. (2021). The burrows were counted according to Karawita et al. (2018) and Lyngdoh et al. (2020) and classified as 'old' or 'new' following Suwal (2011).

RESULTS AND DISCUSSION

Over a course of 3,144 trap nights, 18 mammals, including a sole insectivore, the Indian Pangolin (Images 2a–d) were photo-captured and these included Rhesus Macaque, Grey Langur, Indian Crested Porcupine, Indian Hare, Common Leopard, Leopard Cat, Jungle Cat, Asian Palm Civet, Small Indian Civet, Indian Grey

Mongoose, Golden Jackal, Wild Boar, Chital, Indian Muntjac, Himalayan Goral, Nilgai, and Sambar. The first photographic record of the Indian Pangolin was obtained on the 2nd day of the camera trapping. When examined independently, six independent photo-detections (RAI = 0.94) resulting in a naïve occupancy of 0.13 were recorded for JWS, whereas three photo-detections (RAI = 0.21; ψ =0.03) were observed for SMWS. No signs of the Indian pangolin were observed in TCR during the entire sampling effort. This may be attributed to high disturbances, xeric conditions, and lack of food base. This warrants further investigation.

The animal has been observed between 132 m and 2,704 m from different habitats in the Himalayas (Irshad et al. 2015; Akrim et al. 2017; Suwal et al. 2020). During the current surveys, it was found to occur in an elevational range of 500–580 m. The investigations revealed that the Indian pangolin has a specific habitat preference, with all photo-detections and burrows occurring in undisturbed forested areas with high to moderate canopy coverage, lower elevations, proximity to termitarium, and easy access to water as supported by others as well (Karawita et al. 2018; Shrestha et al. 2021). The findings of this study indicate that the Indian Pangolin predominantly exhibits nocturnal activity patterns (88.89% of all sightings during the night), as evidenced by Mishra & Panda (2010), Aditya et al. (2021), and Perera et al. (2022).

During additional investigations in JWS, 31 burrow sites were discovered in vegetation patches dominated by *Bombax cieba - Acacia modesta - A. catechu - Dalbergia sissoo.* Similar vegetation associations with the same physiography and phytoclimate have been reported as preferred pangolin habitats in Pakistan (Mahmood et al. 2018; Yasmeen et al. 2021). Two distinct types of burrows were observed, a single large burrow with a wide entrance (the living burrow) and other smaller branching burrows with multiple entrances (the feeding burrows). Twenty-five (80.65%) of these were classified as old burrows, while six (19.35%) as new that showed signs of recent activity, including freshly excavated, claw markings, and the presence of termites, primarily *Odontotermis* sp. in faeces. The majority of the burrows (Image 3a–d) were found near trematoriums (Image 3e–f) in bamboo-dominated hill slopes, away from human disturbances but close to water sources. Similar observations have been recorded by Katuwal et al. (2017); Karawita et al. (2018);

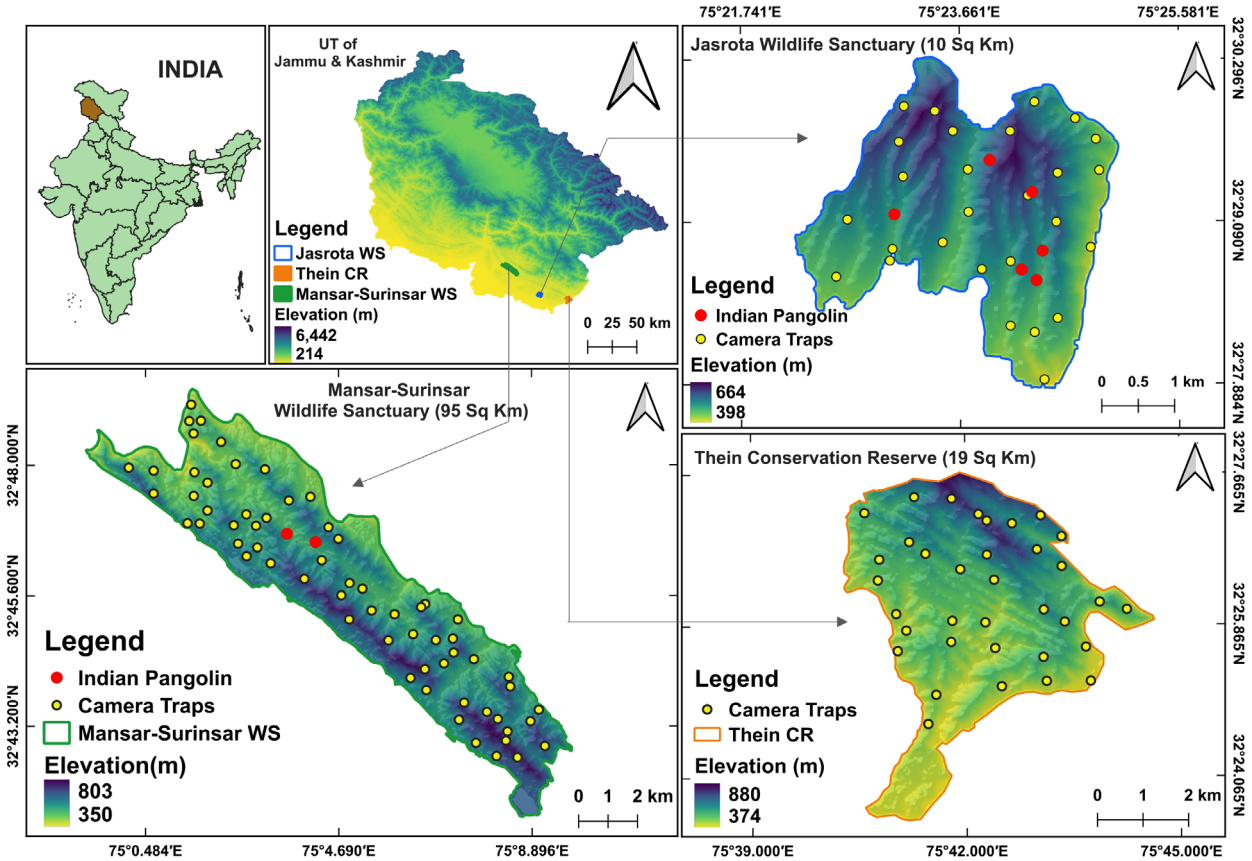

Image 1. Map of the protected areas (Surinsar-Mansar Wildlife Sanctuary, Jasrota Wildlife Sanctuary, and Thein Conservation Reserve) in Jammu Shiwaliks showing the camera trap locations, and Indian Pangolin sightings.

Image 2. Camera trap photographs of the Indian Pangolin *Manis crassicaudata*: a—Jasrota Wildlife Sanctuary (JWS) | b—Surinsar-Mansar Wildlife Sanctuary | c—New site 1 JWS | d—New site 2 JWS.

Lyngdoh et al. (2020), and Shrestha et al. (2021). At one burrow, the small mammals, including Grey Mongooses and Small Indian Civets, were also photographed thus confirming that pangolin's burrows are actively used by other small mammals as observed by Karawita et al. (2018), Lehmann et al. (2020), and Perera et al. (2022) as well.

A majority of locals were unfamiliar with the Indian Pangolin, though elderly respondents provided detailed descriptions of the animal's morphology and could correctly identify it when shown photographs. The unique animal with scales covering its body when disturbed rolls into a ball-like shape is known locally as 'challa' ('ring' in Dogri). As the evidences of hunting were minimal and there was no record of its trade or seizure so far, the poaching of Indian Pangolin is ruled out from the region. While the study provided valuable insights into the distributional patterns and habitat preferences of the Indian Pangolin in the region, it also highlights the need for effective management strategies to address the threats to the species and its habitat in the region, particularly fragmentation and habitat degradation. The study underscores the importance of conducting further research to better understand the ecological factors that influence the population dynamics and distribution of the Indian Pangolin to effectively implement conservation strategies for the vulnerable animal.

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Image 3. Habitat of the Indian Pangolin *Manis crassicaudata*: a–d—living burrows (fresh) (© Ajaz Ansari)| e–f—termitarium (© Neeraj Sharma) in Jasrota Wildlife Sanctuary.

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