First camera-trap evidence of the Critically Endangered Chinese pangolin *Manis pentadactyla* in Kavrepalanchok community forests, Nepal

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Abstract The Chinese pangolin *Manis pentadactyla* is categorized as Critically Endangered on the IUCN Red List but little is known about its status in Nepal. Although indirect sign surveys have reported its presence in several community forests in Kavrepalanchok district, no photographic or video evidence has previously been documented. We used camera traps to investigate the occurrence of pangolins in 20 community forests in Panauti Municipality in Kavrepalanchok. A total of 75 0.01 km² plots were surveyed using camera traps during September 2022–February 2023, with a total survey effort of 803 trap-days. The cameras recorded a total of 16 individual video footage events of Chinese pangolins in six of the community forests. This is the first camera-trap evidence of the species' presence in these forest patches, and in Kavrepalanchok district. The pangolins displayed behaviours such as sniffing, gathering plant material and digging, between 18.00 and 1.00. The camera-trap records provide more accurate species identification and reliable information than indirect sign surveys, indicating camera traps are a useful surveying tool for rare, nocturnal and elusive pangolins.

Keywords Behaviour, camera trap, Chinese pangolin, common leopard, *Manis pentadactyla*, Nepal, Panauti, presence

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The Chinese pangolin *Manis pentadactyla* is categorized as Critically Endangered on the IUCN Red List and is one of the most traded mammals globally, yet there is limited knowledge of the species' status throughout its range (Challender et al., 2019). Most studies of the Chinese pangolin have relied on indirect sign surveys, which only provide information on matters such as habitat preferences and burrow density, and could be subject to observer bias (Khwaja et al., 2019; Willcox et al., 2019). The lack of detailed information on the species has hindered efforts to identify priority populations and implement appropriate conservation strategies.

Recent evidence suggests Nepal is both a source and transit location for the illegal pangolin trade (Paudel et al., 2020; Bashyal et al., 2021; Suwal et al., 2023). Approximately 94% of the potential habitat for the Chinese pangolin in Nepal lies outside protected areas, primarily in community forests (Sharma et al., 2020b). In the district of Kavrepalanchok, Bagmati province, these forests could provide important habitat for the Chinese pangolin, although this district has become a significant hub for illegal pangolin trade (Bashyal et al., 2021). Chinese pangolins have been reported from some community forests in Kavrepalanchok, through indirect sign surveys (Shrestha et al., 2021), but no photographic or video records have previously been reported. Here we provide the first camera-trap records of the Chinese pangolin, including details of activity patterns and behaviours, in community forests in Panauti Municipality, Kavrepalanchok (Fig. 1).

We considered 26 community forests, c. 43% of the community forests of Panauti Municipality, as potentially suitable for a camera-trap survey, and conducted the survey in 20 of these, based on our observations of indirect pangolin signs, during September 2022–February 2023 (Fig. 1). The 118 km² municipality lies at 1,340–2,782 m altitude, and 78 km² is forest. Using *QGIS 3.22* (QGIS Development Team, 2023) we overlaid 25 600 × 600 m squares (0.36 km², the approximate home range of the Chinese pangolin; Lu, 2005) on the forested area, and within each square we overlaid a grid of 36 100 × 100 m plots. We did not survey areas with inaccessible, steep slopes or those over 2,000 m as pangolins are unlikely to use such locations (DNPWC & DoF, 2018). We randomly chose three of the plots within each square for foot surveys. In these we searched for indirect signs of pangolins such as footprints, tracks and burrows. At burrows where we observed pangolin signs or tracks, we positioned an unbaited camera trap facing the entrance, on a nearby tree or on a pole, 30–50 cm above the ground. Six Browning Strike Force Apex (Browning Trail Cameras, USA), three Stealth Cam P14 (Stealth Cam, USA) and one Bushnell HD (Bushnell Outdoor Products, USA) cameras were set to record 10-sec videos. All 10 camera traps operated for at least 10 days. We deployed nine cameras across three squares for at least 10 days at a time (three cameras in each of the three plots in a square). The remaining camera was rotated among the three squares, and functioned as a backup in case of

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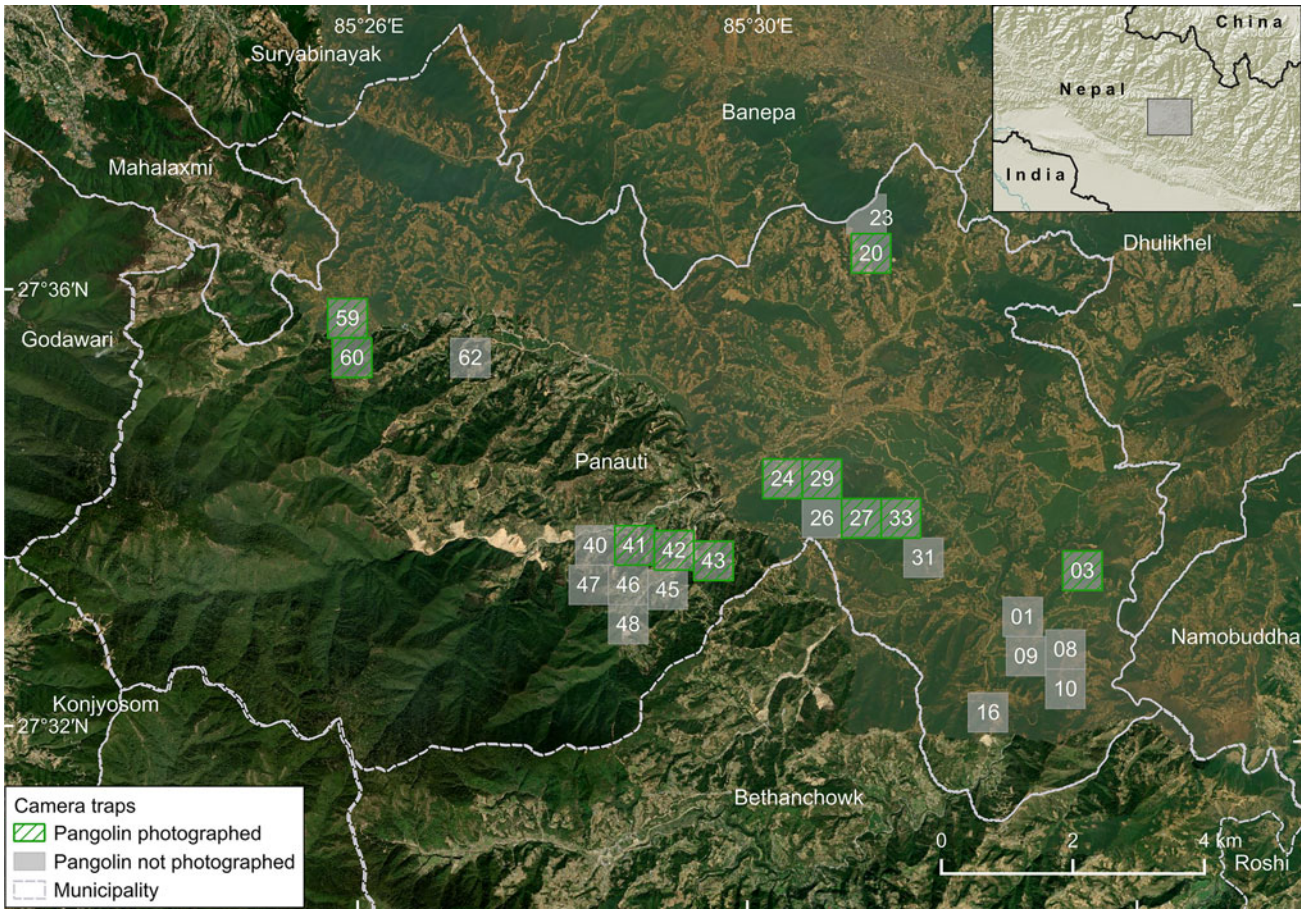

FIG. 1 Panauti Municipality, showing the 25 600 × 600 m grid squares in which we conducted camera-trap surveys, and the 11 squares in which we recorded the Chinese pangolin *Manis pentadactyla*. Each such grid square was divided into 0.01 km² plots (see text for details).

TABLE 1 Independent Chinese pangolin *Manis pentadactyla* video footage events recorded in 11 of the 25 surveyed grid squares in community forests in Panauti Municipality, Kavrepalanchok district, Nepal (Fig. 1), with grid square number, number of events, duration and dates.

Grid square number	Number of video footage events	Duration (s)	Date
3	2	72	9 Sep. 2022, 15 Sep. 2022
20	1	15	31 Oct. 2022
24	1	31	17 Nov. 2022
27	4	828	10 Nov. 2022, 12 Nov. 2022, 16 Nov. 2022, 17 Nov. 2022
29	1	15	15 Nov. 2022
33	1	18	23 Nov. 2022
41	1	10	25 Jan. 2023
42	1	20	24 Dec. 2022
43	2	257	31 Dec. 2022, 31 Dec. 2022
59	1	72	13 Jan. 2023
60	1	10	15 Jan. 2023
Total	16	1,348	

technical problems. After surveying a set of three squares, the cameras were deployed in three new squares. This rotation was continued until all 25 squares had been surveyed. After the survey, camera traps were retrieved and videos were downloaded and archived, noting the dates and locations of any videos of pangolins. Only the Chinese pangolin was recorded (the Indian pangolin *Manis crassicaudata* also occurs in Nepal), identified by its distinctive external ears, small scales on the head, and soft, off-white hair on the underside and face (Wu et al., 2020).

We walked a total of 38.4 km searching for indirect signs such as pugmarks, scats and scratch marks, and identifying burrows to set up camera-traps. A total of 75 100 × 100 m plots across the 25 600 × 600 m squares (i.e. three plots per square) were surveyed, resulting in a total of 803 trap-days. A total of 16 independent Chinese pangolin events, defined as pangolin activity documented by a camera trap, with a minimum 60-minute interval between triggers (Rovero & Zimmermann, 2016; Matthews et al., 2023), were recorded in 13 plots within 11 of the 25 squares (Fig. 1, Table 1). As it is not possible to identify individual Chinese pangolins from camera-trap images or videos, we could not determine the number of pangolins captured. These captures were in six

PLATE 1 Camera-trap video stills of the Chinese pangolin *Manis pentadactyla* from community forests in Panauti Municipality, Kavrepalanchok district, Nepal (Fig. 1).

of the 20 community forests surveyed (Birta, Chaleshwori, Chunkhani, Dhungandada, Indreshwori and Simle Bheer; Plate 1). This is the first camera-trap evidence of the presence of the Chinese pangolin in these areas. On average, it took 1.6 days for a camera trap to record a Chinese pangolin. In the total of 22.47 minutes of video footage, Chinese pangolins had a peak of activity between 18.00 and 1.00.

Camera-trap videos captured Chinese pangolins approaching, looking inside and entering burrows (often leaving shortly afterwards), exiting burrows tail- or head-first, and in two instances entering a burrow but not emerging. Pangolins were twice recorded collecting plant material, which they accumulated between their ventral side and limbs and then dragged inside the burrow, entering tail first. One pangolin spent 14 minutes digging in a pre-existing burrow, accumulating soil material between its ventral part and limbs, and eventually exiting the burrow tail-first with the soil. It then left the burrow. In one video, a pangolin emerged from its burrow in a quadrupedal manner, engaged in bipedal sniffing, and then returned to the burrow. Masked palm civets *Paguma larvata* and yellow-throated martens *Martes flavigula* were recorded in Chinese pangolin burrows, indicating potential use of pangolin burrows by other species. In addition to the Chinese pangolin we obtained videos of nine other mammal species (Supplementary Table 1, Supplementary Plate 1).

Our camera-trap survey in Panauti Municipality confirmed the presence of the Chinese pangolin in the community forests of Kavrepalanchok, and provided information on the activity patterns and behaviour of the species. Although the Chinese pangolin has been recorded by camera traps in other regions of Nepal (Dhital et al., 2020; Khatiwada et al., 2022), use of camera traps to study the species in Nepal is uncommon. Our findings indicate that camera traps are a useful tool for studying the rare, elusive and largely nocturnal Chinese pangolin, and facilitates identification of the species in areas where both the Chinese and Indian pangolins occur. We are now using data from camera-trap surveys to gain a better understanding of Chinese pangolins in the study area and more widely through occupancy modelling.

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Conflicts of interest None.

Ethical standards This research was conducted with permission from the Division Forest Office, Kavrepalanchok, followed appropriate ethical standards for camera trapping (Sharma et al., 2020a), and abided by the *Oryx* guidelines on ethical standards. The cameras only recorded wildlife.

Data availability The data supporting the findings of this study are available from the corresponding author, AB, upon reasonable request.

References

BASHYAL, A., SHRESTHA, N., DHAKAL, A., KHANAL, S.N. & SHRESTHA, S. (2021) Illegal trade in pangolins in Nepal: extent and network. *Global Ecology and Conservation*, 32, e01940.

Challender, D., Wu, S., Kaspal, P., Khatiwada, A., Ghose, A., Ching-Min Sun, N. et al. (2019) *Manis pentadactyla*. In *The IUCN Red List of Threatened Species* 2019. dx.doi.org/10.2305/IUCN.UK.2019-3.RLTS.T12764A168392151.en.

Dhital, S., Paudel, S.M., Thapa, S., Bleisch, W.V., Shrestha, A. & Koju, N.P. (2020) Distribution of Chinese pangolin (*Manis pentadactyla*) in Nagarjun forest of Shivapuri Nagarjun National Park, Nepal. *Nepalese Journal of Zoology*, 4, 1–7.

DNPWC & DoF (2018) *Pangolin Conservation Action Plan for Nepal (2018–2022)*. Goverment of Nepal, Department of National Parks and Wildlife Conservation, and Department of Forests, Kathmandu, Nepal. pangolinsg.org/wp-content/uploads/sites/4/2018/07/Nepal_pangolin_action_plan_2018-2022.pdf [accessed September 2024].

Khatiwada, A.P., Wright, W., Kunkel, K., Khatiwada, M.P., Waterman, C., Bhattarai, S. et al. (2022) Human influence on burrow activity of the Chinese pangolin in Nepal. *Wildlife Research*, 50, 76–83.

Khwaja, H., Buchan, C., Wearn, O.R., Bantlin, D., Bernard, H., Bitariho, R. et al. (2019) Pangolins in global camera trap data: implications for ecological monitoring. *Global Ecology and Conservation*, 20, e00769.

Lu, S. (2005) *Study on the Distribution, Status and Ecology of Formosan Pangolin in Northern Taiwan* (2/2). Taiwan Forestry Research Institute, Taipei, Taiwan. [In Chinese]

Matthews, N., Nixon, S., von Hardenberg, A. & Geary, M. (2023) Targeting burrows improves detection in giant pangolin *Smutsia gigantea* camera-trap surveys. *Oryx*, 57, 718–726.

Paudel, P.K., Acharya, K.P., Baral, H.S., Heinen, J.T. & Jnawali, S.R. (2020) Trends, patterns, and networks of illicit wildlife trade in Nepal: a national synthesis. *Conservation Science and Practice*, 2, e247.

Qgis Development Team (2023) *QGIS Geographic Information System*. Open Source Geospatial Foundation. qgis.org [accessed September 2024].

Rovero, F. & Zimmermann, F. (2016) Camera features related to specific ecological applications. In *Camera Trapping for Wildlife Research* (eds F. Rovero & F. Zimmermann), pp. 8–21. Pelagic Publishing, London, UK.

Sharma, K., Fiechter, M., George, T., Young, J., Alexander, J.S., Bijoor, A. et al. (2020a) Conservation and people: towards an ethical code of conduct for the use of camera traps in wildlife research. *Ecological Solutions and Evidence*, 1, e12033.

Sharma, H.P., Rimal, B., Zhang, M., Sharma, S., Poudyal, L.P., Maharjan, S. et al. (2020b) Potential distribution of the Critically Endangered Chinese Pangolin (*Manis pentadactyla*) in different land covers of Nepal: implications for conservation. *Sustainability*, 12, 1282.

Shrestha, S., Bashyal, A., Rijal, R., Shrestha, J., Shrestha, P., Shrestha, N. et al. (2021) An ecological assessment of Critically Endangered Chinese pangolin *Manis pentadactyla* (Mammalia: Pholidota: Manidae) in the Midhills region of Nepal. *Open Journal of Ecology*, 11, 344–356.

Suwal, T.L., Gurung, S. & Pei, K.J.C. (2023) Pangolin seizures in Nepal indicate priority areas for conservation interventions. *Oryx*, 57, 727–734.

Willcox, D., Nash, H.C., Trageser, S., Kim, H.J., Hywood, L., Connelly, E. et al. (2019) Evaluating methods for detecting and monitoring pangolin (Pholidata: Manidae) populations. *Global Ecology and Conservation*, 17, e00539.

Wu, S., Sun, N.C.M., Zhang, F., Yu, Y., Ades, G., Suwal, T.L. & Jiang, Z. (2020) Chinese Pangolin *Manis pentadactyla* (Linnaeus, 1758). In *Pangolins: Science, Society and Conservation* (eds D.W. Challender, H.C. Nash & C. Waterman), pp. 49–70. Academic Press, Cambridge, USA.