

How does the Chinese Pangolin behave in the wild - observations on activities of Chinese Pangolin, *Manis pentadactyla* in the agro ecosystems of Darjeeling, Eastern Himalaya, India

Abstract

Information on the behavioral activities of the critically endangered Chinese Pangolin, *Manis pentadactyla* is scarce with most of the existing information on activities and life history coming from captive studies on the species. *M. pentadactyla* is severely threatened by illegal trade and habitat loss. Knowledge of its ecology and behavioral activities in the wild is imperative as a scientific basis for their conservation both in captivity and in the wild. This study was focused on better understanding activities and burrow use habits of *M. pentadactyla* in the wild. Purposely targeted deployment of camera traps in high pangolin use areas was done to video record activities of the species from December 2016 to April 2017. Findings include three significant *M. pentadactyla* behavioral activities which were that of collecting plant materials for their burrow, adult-offspring interactions and co-use of burrow by Malayan porcupine, *Hystrix brachyura* and *M. pentadactyla*. These behavioral findings contribute to building on the existing knowledge of *M. pentadactyla* in the wild, essential for pangolin husbandry in captivity and enhance species survival. The presence of breeding population of *M. pentadactyla* in the agroecosystems, draws attention to conservation management in the socio-ecological production landscapes, where wildlife, like *M. pentadactyla* afford inadequate legal attention. Human-wildlife interface events are also higher in these landscapes, some of which are threatening species survival and persistence.

Keywords: behavioral activities, wild, camera trap, socioecological production landscapes, Eastern Himalaya

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Introduction

The Pangolins (Order: Pholidota; Family: Manidae) are a group of scaly insectivorous mammals exclusive to the Afrotropical and Asian regions, with eight extant species recognized,^{1,2} all of which are globally threatened. Pangolins are one of the most trafficked mammals in the world.^{3,4} There are four Asian Pangolin species of which two, namely the Indian Pangolin *Manis crassicaudata*, É. Geoffroy, 1803 and the Chinese Pangolin *Manis pentadactyla*, Linnaeus, 1758 occur in India. India holds two pangolin species, the *M. crassicaudata* and the *M. pentadactyla*, both of which are protected as Schedule I species under the Indian Wildlife (Protection) Act (1972). Chinese Pangolin is Critically Endangered.^{3,4}

The Pangolins are understudied, the reasons attributed to the difficulty in locating them in the wild, and their predominantly nocturnal habits.³⁻⁵ Pangolins largely use burrows and tree hollows to reside, get food, give birth and rear young making burrows and tree hollows, a major component of pangolin habitat and ecology.⁶⁻⁹ Burrows thus are important evidence of pangolin presence in the wild. An earlier study on Chinese pangolin in Darjeeling Himalaya, recorded an encounter of approximately 300 burrows without any sighting of the species in the agroecosystem landscapes of tea plantations and agroforests. In continuation of the preceding work, this study sought to study burrow use and understand pangolin activities using camera traps in high pangolin use areas in the agroecosystem of Darjeeling

Himalaya. Insights on pangolin behaviour mostly come from captive and few studies from the wild.¹⁰⁻¹⁵ Very little is so far reported on the pangolin species and their activities in the wild from the Indian range of the species distribution and this study contributes to this existing knowledge gap.

Material and methods

Study area

The Darjeeling Himalayas (26°31'–27°13'N & 87°59'–88°53'E), falls within the Indian state of West Bengal, covering an area of 3149 km². Darjeeling is better known for its globally famous Darjeeling Tea, its sprawling tea plantations and the majestic Kanchenjunga at its backdrop. The region forms an important bio-geographic link between Nepal, the Indian state of Sikkim and Bhutan extending into Assam and Arunachal Pradesh in Northeast India, while also significantly representing three important eco regions - Himalayan subtropical broadleaf forests, Eastern Himalayan broadleaf forests and the Subalpine conifer Forests with an elevation of < 500 m to 3636 m. With an indicated forest cover of almost 40%, Darjeeling has a rich biodiversity with globally threatened mammals such as Rufous-necked hornbill, *Aceros nipalensis*, Chinese pangolin, *Manis pentadactyla*, Indian pangolin, *Manis crassicaudata* and the Red panda, *Ailurus fulgens* along with many other wildlife species of conservation significance. However, on the other hand, Darjeeling is

also home to 1.85 million people with a population density of 586 people/km²,¹⁶ receives more than half a million tourists annually,¹⁷ while also is one of the poorest in the entire Indian Himalayas,¹⁸ strewn with political conflicts and uncertainty for last 30 years.¹⁹ As in other parts of India, tea plantations in Darjeeling came up in the mid-1800s when natural Middle-hill broadleaf forests within 600-2000m were cleared and converted to plantations of tea.²⁰ Today, 87 tea

plantations cover nearly 16% of the geographical area of Darjeeling, along with agriculture which makes approximately 22% of land-use.²¹ Three protected areas are found in a matrix of these tea plantations and agriculture. This study was conducted in the agroforests of Pokhribong Khasmal, in the Sukhia Pokhari administrative block of Darjeeling, India (Figure 1).

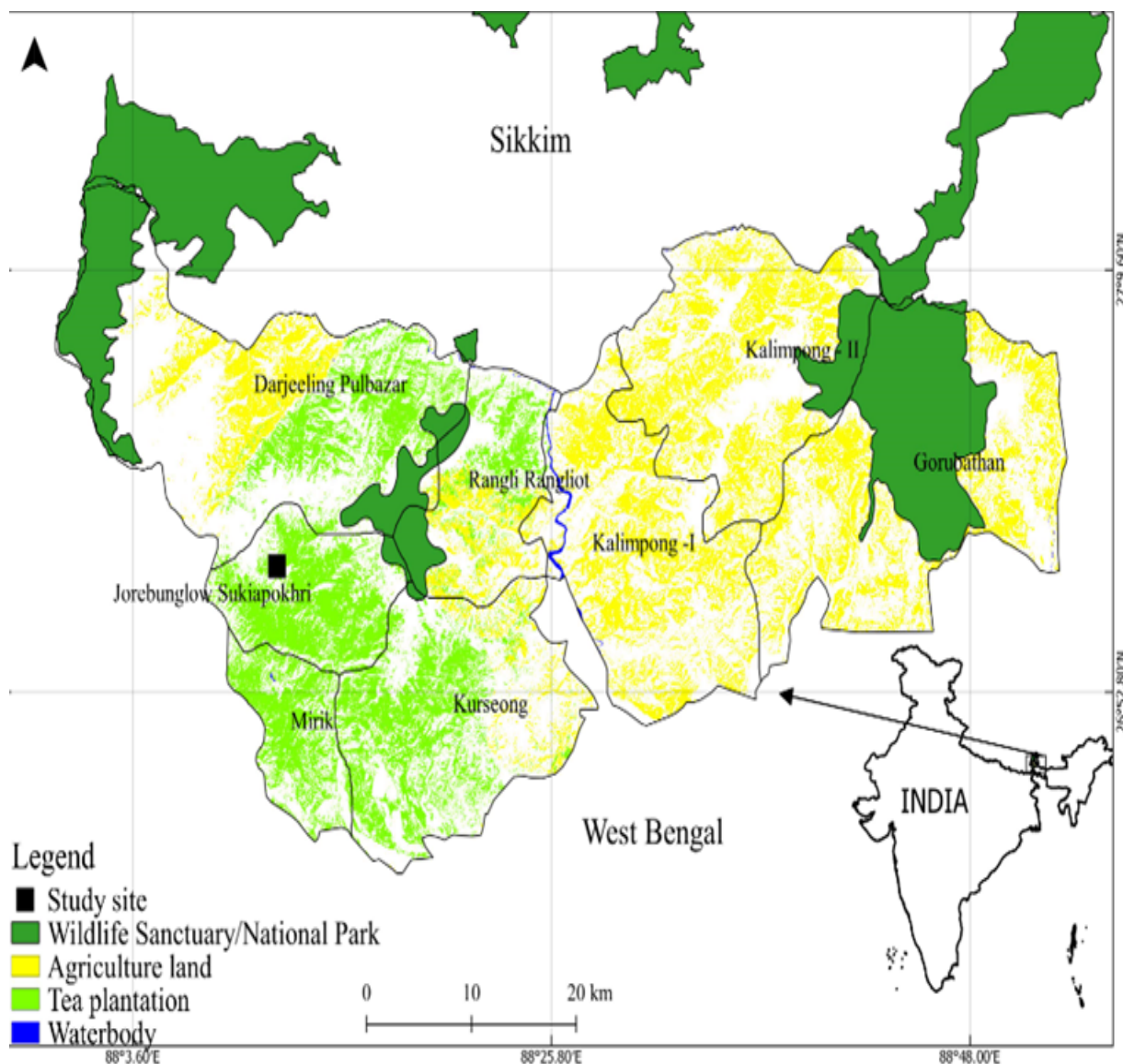


Figure 1 Map of study area.

Camera trapping

Based on our previous field surveys in 2014-2015, 19 Cuddy back digital long-range IR Silver model camera traps, were initially deployed in the high use areas of the Chinese Pangolin in two agroforest sites of Pokhriabong, Darjeeling Himalaya at the end of December 2016. After 1 month, monitoring of six cameras in Site 1 was abandoned for logistic reasons and only 13 cameras in Site 2 were monitored, the data of which are presented in this paper. Nine cameras (70 %) were targeted on burrows and 4 cameras (30%) on

trails leading to these burrows (Table 1). The cameras were adjusted after many trials, at a distance of 1.5-2 meters from the target burrow and trails, which gave the best view and photo captures. The cameras were operational 24 hours a day and checked every three days. The cameras were set to take successive images and videos at intervals of 5 seconds. Video records were set to 30 seconds. The monitoring took place from 21 December 2016 to 30th April 2017 generating a total of 1872 camera trap nights, and 194 useable videos, which were taken for analysis.

Table 1 Details of camera trap videos used for activity analysis of *Manis pentadactyla* in the agro ecosystem site of Darjeeling Himalaya

Camera trap no.	Location	Burrow no.	Videos with only pangolin activities (n=179)	Total videos used for activity analysis (n=194)
1	Trail	-	5 (2.8%)	5
4	Trail	-	1 (0.6%)	1
5	Burrow	5	2 (1.1%)	2
6	Burrow	6	38 (21.2%)	39
7	Trail	-	2 (1.1%)	2
9	Trail	-	5 (2.8 %)	5
10	Burrow	10	1 (0.6 %)	1
11	Burrow	11	2 (1.1%)	2
13	Burrow	13	6 (2.8%)	6
14	Burrow	14	8 (4.5%)	8
16	Burrow	16	90 (50.3%)	91
17	Burrow	17	3 (1.7 %)	3
18	Burrow	18	16 (8.9%)	29

Results

The 194 videos captured activities of Chinese pangolin, *M.pentadactyla* along with that of the Malayan porcupine, *Hystrix brachyuran* and other mammals like the Masked palm civet, *Paguma larvata*, wild boar, *Sus scrofa*, Barking deer, *Muntiacus muntjak*, domestic dog, *Canis lupus familiaris* and two other unidentified small rodents. A total of 179 videos out of the 194 were that of the *M.pentadactyla* activities. The rest of the videos were majorly that of the *H. brachyura* activities. *M.pentadactyla* was captured in all the 13 camera traps deployed in the area, with 50% of the captures from burrow 016, 21 % in burrow 006 and almost 9 % of the captured videos from burrow 018. It was found that the activity of the species in burrow 016, the pangolins were active from around 19.30 h to 5.00 in the morning from December to April, which is winter and early spring. The three most significant activities recorded during the period were that of collecting dry leaves for burrow by *M.pentadactyla*, mother-offspring interactions of *M.pentadactyla* and co-use of burrow by *H. brachyura* and *M.pentadactyla*.

Collecting plant materials for burrow

As many as 15 observations from 174 videos, were on an adult *M.pentadactyla* which was observed to pull, collect and take plant materials into its burrow, as captured in camera traps 016. This activity was observed on four occasions on 31.1.2017, 5.3.2017, 22.3.2017 and 28.4.2017 which gives approximately three-four weeks between the events. Burrow 016 had an offspring with an adult pangolin in the burrow. The burrow was placed in the lower slope on the side of a trail at an altitude of 1280 m. The habitat had bamboo clumps, was sunny and northeast facing, with almost no human interference. The diameter of the burrow entrance was 18.8 cm. The adult pangolin collected loose plant materials such as dry bamboo leaves, fallen twigs and bamboo sheaths found in the vicinity of the burrow. The

pangolin also walked a distance of approximately 2 m downslope from its burrow to pull, collect and drag the bunch of leaves into its burrow. The pangolin used its forearm to adeptly collect and drag the plant materials. When it entered the burrow with the plant materials, it entered with its tail first with its head towards the burrow entrance. This mode of entering burrow differed from that the pangolin entered burrow with its head first, in instances when it was not engaged in this activity.

Adult-offspring interactions

Burrow 016 with 50% of the photo captures had an offspring with an adult, presumably a female and mother of the offspring (Figure 2). An adult pangolin was the first photo captured in burrow 016 on 30.01.2017, after 10 days of its installation. An offspring with an adult pangolin was first recorded on 2.2.2017 in burrow 016. From 18 selected videos from 2.2.2019 to 29.4.2019, which gave a series of continued observations, it was seen that the adult-offspring interaction included activities like adult staying with the offspring in the burrow, adult coming out of the burrow with and without the offspring along with foraging by the offspring outside the burrow. There were 11 (61%) occasions when the adult pangolin and offspring were together either in the burrow or outside the burrow, six (22%) occasions when the adult pangolin was without the young, and 3 (17%) occasions when offspring foraged independently outside the burrow. The maximum time an adult stayed with the offspring in the burrow was 11 hours and the minimum was 15 minutes. This range gave an average of 6 hours 30 minutes \pm 4 hours 36 minutes. The adult was out of the burrow with the cub for a very short time with a mean of 4 ± 7 minutes. The adult pangolin was out, leaving the offspring in the burrow for a mean time of 3 hours 41 minutes \pm 2 hours 44 minutes with a range of approximately 2 hours to 6 hours. Towards the end of April, the offspring pangolin was seen foraging alone for short periods, outside the burrow in three events towards the end of April 2017.

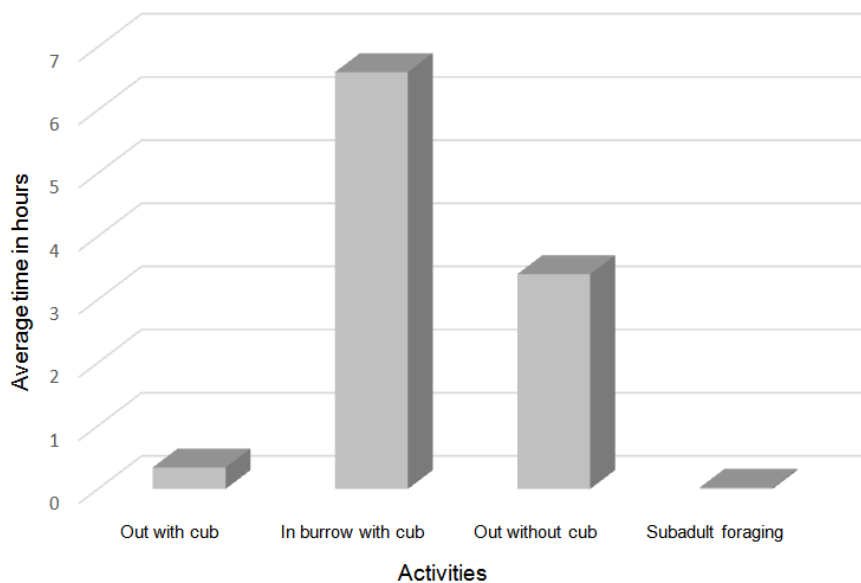


Figure 2 Activities of adult *M. pentadactyla* and off spring.

Burrow co-use by *H. brachyura* and pangolin

Out of the 13 burrows, burrow 018 had 29 video capture, which shows activities of pangolin and the *H. brachyura* using the burrow. It can be seen that the Chinese pangolin made 8 visits or attempts to enter or use the burrow 018 but its use of the burrow was very short and not more than 2 minutes. This was because the burrow was actively used and occupied by the *H. brachyura*. As many as 2 occasions of actively burrowing the burrow 018 by the *H. brachyura* and 12 instances of entering it and remaining inside are recorded from 27.1.2018 to 27.3.2019. In the morning after the burrowing activity, burrow 018 was found to be freshly dug. No instances of the pangolin burrowing were recorded during the tenure of the study.

Discussion

The Asian species of pangolins have been subjected to very few studies²²⁻²⁴ resulting in insufficient data on the species to enable an assessment of their conservation needs and formulation of effective conservation strategies.²⁵⁻²⁷ Greater knowledge of activities and behaviour of pangolin species in the wild would greatly enhance both captive and wild species conservation efforts.⁴ Camera traps, in this case, has been very useful in documenting activities of the pangolin in the agro forests of Darjeeling Himalaya. Most pangolins are nocturnal,^{4,5} occasionally active during the day, and are generally shy and timid.²⁸ The findings of this study also show that pangolin was active mostly in the night with all the three significant activities recorded within 19.30 h to 5.00 am.

The activity of collecting loose fallen twigs, leaves and bamboo sheaths for their burrow as observed during this study by *M. pentadactyla* has been reported in captivity by Heath et al.¹² The authors refer to the vegetation taken into the burrow as nest material and describe the nest material to be gathered in a pile with their forefeet and pulling it toward their ventral surface as they back into the nest, very similar to the observations made in the present study. Liu et al.,⁸ found the entrance of *M. pentadactyla* burrow being closed with earth, leaving a small gap, to warrant minimum fluctuations in burrow temperature, by preventing airflow in and out of the burrow. Wu et al.,²² also describe the location of burrows with their temperature regulation

stating that burrows are located in habitats with higher canopy closure, or hidden under a dense shrub or herb layers to reduce air convection around the burrow. Such burrow microhabitats have been observed in the present study area. Burrow 016 was located in a habitat with good canopy cover mostly formed by bamboo clumps. The burrow entrance, however, did not have an overhanging closure of shrubs or herbs. However, plant materials that consisted of loose fallen twigs, leaves and bamboo sheaths were collected by the adult pangolin for the burrow. The plant material could aid maintaining burrow temperature, or in rendering the burrow safer for the young, or used as bedding. Heath et al.,¹² report the chamber inside the burrow, used for sleeping and rearing infant to be about a meter from the main termite nest and lined with weed for insulation. Burrow temperature in winter for *M. pentadactyla* showed a fluctuation between 17.8°C and 21.0°C, even when the air temperature outside the burrow fluctuated indicating temperature changes outside the burrow had almost no significant influence on thermal conditions inside the burrow.⁶ Therefore, it was proposed by Bao et al.⁶ that the most optimum ambient temperature for *M. pentadactyla* in winter is not less than 18°C.

The collection of the plant materials were done at almost an interval of three to four weeks during the four events of this activity was observed. The precise reasons for this activity cannot be stated but taking the plant material at intervals could probably be to replenish the burrow after the vegetation taken in dried and got compacted.

A study on burrow ecology by Wu et al.,²² reports preference of burrows by *M. pentadactyla* in areas of less human disturbance, with good hiding conditions at burrow entrance, located in the middle or lower slope with size of burrow entrance to range from 14.20 ± 2.79 cm to 12.50 ± 2.83 in diameter.²² The activities of the adult *M. pentadactyla* in the present study also shows similar results with the most important burrow 016 with a rearing offspring in a habitat with fairly good canopy cover (> 40- 60%) mostly made of bamboo clumps, where the species were able to get enough fallen and lose ground vegetation for them to use to as nest material. The burrow 016 was also located in the lower slope in an area with the least anthropogenic disturbance out of all the other 9 burrows and 4 trails monitored, indicating a need for a relatively safe, undisturbed

and secluded habitat during its rearing period. The entrance of burrow 016 where the pangolin activities were recorded during the present study was 18.8 cm. Wu et al.,²² found a preference for burrows with moderate elevation (760–1500 m) by the species. The present study also had the burrow 016 located at 1280m.

Information on the reproductive parameters of *M.pentadactyla* is piecemeal, being collected from hunters, from captivity or rescued pangolins.¹⁵ Estrus and mating of *M.pentadactyla* are known to occur in late summer and early autumn (Fang and Wang 1980) which by months corresponds to February to July.^{14,15} The estimated gestation period records from captivity differ from 101–169 days,^{28,30} 318–372 days¹¹ and 180–210 days.¹⁵ Parturition is recorded to be around September to February.^{12,15} In the present case, the offspring was first seen on February 22 2017 after cameras were first installed at the end of December, indicating parturition around January. A usual birth of one offspring has been suggested for *M.pentadactyla*¹⁵ as was observed in this study. Burrow 016 was used by the adult and the offspring for 90 days during the study period of 100 days, being left intermittently for foraging.

Burrow 018 has the second-highest frequency of use after burrow 016. Burrow 018 had 9 events (39%) of pangolin activity while 12 events (52%) were of that of a Malayan porcupine with 2 events (9%) of that of an unidentified rat. This indicates that burrow 018 was actively used, occupied and dug afresh twice by the *H.brachyura*, while the pangolin was observed to visit the burrow 9 times without occupying it. Pangolin was not observed to dig a burrow during the entire study period. Goodyear³⁰ reported that *M.pentadactyla* rarely dug their burrows, instead they search for and rely on abandoned holes which they use on rotation. The locals usually on seeing a freshly dug burrow, associate it with a pangolin presence and its visit. But having seen that the freshly dug burrow (burrow 018) was dug by a Malayan porcupine and not a pangolin, burrow as pangolin evidence during surveys for information on pangolin ecology and abundance must take note of this.

The mean residing duration of pangolin in a burrow reported by Wu et al.,²³ was 12.25±2.25 days which was less than that reported 90 days in this study in burrow 016. Pangolin rarely utilized the used burrows, and the utilization rate of used burrows was only 8.33%.²³ Presence of the *M.Pentadactyla* and that too a breeding population, in the tea plantations and agro-forests outside protected areas are evidence of the agro-ecosystems in the socio ecological production landscapes (SEPL) being a significant refuge for these threatened species. However, wildlife including the threatened *M.pentadactyla* do not receive adequate legal attention in the SEPLs as would be given to species in Protected Areas. This renders Pangolin vulnerable to various human-Pangolin interface events like poaching, meat consumption and trade, which also could have human health risks due to emerging zoonotic disease threats. These agro ecosystems, being private properties are also susceptible to land-use change, as and when needed by the proprietor-farmer. This can have far-reaching implications on the current pangolin habitats which are unsafe and their existence uncertain, as land-use change.

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Conflicts of interest

There is no conflict of interest to declare regarding publication of this paper.

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