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Ant species consumed in diet as prey species by Indian pangolin (*Manis crassicaudata*) in northern Western Ghats of Maharashtra India

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Abstract
The Indian Pangolin is known as a thick-tailed pangolin distributed across the Indian Subcontinent. Indian pangolin is one of the least studied species in the country and lacks literature data on their diet. Pangolin being insectivorous the major diet of the species consist of ants and termites. In the current study, we investigated ant species in the diet of Indian Pangolin in the Konkan region of Northern Western Ghats, Maharashtra, India. During the field visit to deploy the camera trap, faecal matters of the pangolin collected from two different sites near the resting burrow of the species. The filtration technique was used for the analysis of the faecal sample. The faecal matter of the species contains soil, rocks, plant matters and heads, abdominal, legs of the ant species. Total Seven ant's species were identified consumed as prey species in diet of the Indian Pangolin in the Konkan region. The data on the diet of Indian pangolin will serve as a baseline for the captive breeding and ex-situ conservation of the species.

Keywords: Indian pangolin, faecal analysis, diet, ants, prey species and conservation

Introduction

Pangolin derived from the Malay word peng-goling, meaning "one who rolls up". The Pangolin belongs to the order Pholidota has the only single-family Manidae comprised of eight extant species of Pangolin distributed through tropical and subtropical Asia, as well as Africa (Challender D et.al 2014). The four species from tropical and subtropical Asia belong to the *Manis* genus, and four species from Africa belong to the genus *Smutsia* and *Phataginus*. The scaly anteater has unique morphological features are overlapping epidermal scales covered body, and myrmecophagous diet comprises of Ants and Termites.

The Indian Pangolin (Manis crassicaudata) is unique scally mammal distributed in South Asia from northern and southern Pakistan, Nepal, Sri Lanka, and throughout the Indian Subcontinent south of Himalayas including few parts of northeastern India. The species has been locally distributed in Maharashtra, recorded two individuals were camera trapped in the Prachitgadh community forest reserve in 2017 (Freedman, 2017) [8]. The presence of the species confirmed at Vasota fort, Mahabaleshwar, Koyna (Sayyed, A., 2016) [27]. The camera traps survey confirmed presence of species in Ratnagiri district of the Konkan region in Northern Western Ghat of Maharashtra, India (Katdare et.al 2021) [15]. Indian Pangolin is very well adapted to inhabit diverse habitat, tropical and Sub-tropical forest, dry-mixed evergreen, monsoon, sub-mountain and riverine forest (Phillips, 1981; Roberts, 1977) [23, 25]. It has been recorded that species inhabit the mangrove forest, grasslands, agricultural land, artificial landscapes (plantations), home-garden, scrubland, and desiccated areas (Roberts, 1977; Pabasara *et al*., 2015; Karawita *et al*., 2018). The species was recorded at 1850 m from Nuwara Eliya District in Central Sri Lanka (Pabasara *et al*., 2015; Karawita *et al*., 2018) [21, 13]. Species recorded on flat terrain in forest dominated by Anogeissus pendula and Acacia catechuoides in Mukundara Tiger Reserve Rajasthan, India (Latafat and Sadhu, 2016) [16].

There is very limited knowledge available on Indian Pangolin ecology, behavior and diet across the nation. Pangolin is shy and fossorial mammal (Thapa *et al*; 2014) occurring at low densities their solitary, nocturnal and mysterious behaviors make them difficult to study (Prater 1971) [24]. Pangolin being fossorial burrow-dwelling mammals, excavates burrows both for shelter and to find prey. The claws of the species are good for excavating even in the quite hard rocky ground (Roberts, 1997) [25]. The living burrow of the species is much larger and deeper with specific characteristic vary with habitat and soil type (Mahmood *et al*., 2013) [18]. The species is nocturnal in behavior, shelters and sleeps curled up in a burrow during the day (Prater, 1971; Israel *et al*., 1987) [24, 12]. Indian pangolin is being utterly insectivorous play vital role in the ecosystem and agricultural areas by consuming insects that cause considerable damage (d'aularie & d'aularie 1983). The species lack teeth and use their salivary coated sticky

tongue measure up to 42.5 cm in length, which constitutes 37% of total body length (Irshad *et al*., 2016) [11]. Indian pangolin, after reaching an occupied insect nest, and feeds rapidly by extending its thin cylindrical protrusible tongue into the galleries (Roberts, 1997) [25], but the species specialized morphological adaptations for myrmecophagy (H. Karawita *et al*. 2020) [14] and their major diet consist of ants, and termite display species myrmecophagous nature.

Indian Pangolin is an endangered species as per the IUCN Red List of threatened species (Baillie, J. *et al* 2014) [5]. The species has a higher degree of protection and comes under Schedule I species as per Wildlife protection act 1972, India. The Indian pangolin is protected under CITES Appendix I due to demand for live pangolins, scales, and meat in the domestic and International market. The major threat for Indian pangolin is illicit hunting and poaching for local consumption ((e.g. as a protein source and traditional medicine) and international trade for its meat and scale. The diet of the species is important for understanding and determining its conservation requirements and developing conservation plans (Redford 1986, Challender 2008) [26, 4]. Therefore, the objective of the current study is to investigate the prey species consumed as prey through faecal analysis of the lesser-known species Indian pangolin in Northern Western ghats of Maharashtra, India.

Material and Methodology

Study Area

The current study was conducted from May 2017 to May 2018 in the Konkan region, located between latitudes 17°27'51.02"N and 17°21'28.62"N and longitude 73°29'40.63"E and 73°36'17.94"E. The Konkan region formed of mostly secondary lateritic plateaus, hilly tracks, and the coastal sandy low land belts lies in between the Arabian Sea and Western Ghats of Maharashtra, India. The study area is in Chiplun (Tehsil or block) administrative unit Ratnagiri district, Maharashtra, India. The study area has primary and secondary forest, open scrub forest, and herbaceous flora of laterite plateaus are the main components of vegetation adjoining cashew-mango plantation and agricultural land.

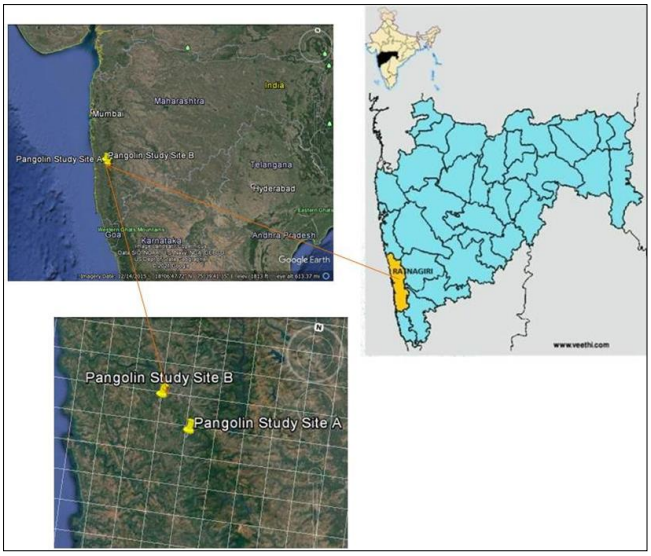

Fig 1: Pangolin Study Map

Methodology

Faecal analysis of Indian Pangolin was done by filtration technique and investigated the diet of the species. The baseline data on the presence of the species was collected through random conversational interview with the villagers with the help of the volunteer. The villagers had confirmed the presence and sighting of the species in the region. The traditional knowledge of local forest dwellers was used and conducted random-trail-based field surveys for the direct-indirect sign of the species. Total 12 Camera traps Cuddeback E2, Spy point solar, and 5K deployed purposely directing the resting burrow and near the possible trails leading towards the resting burrow of the species. In previous ecological research on pangolins such mixed methods for camera trapping have been used (Newton et.al 2008; Trageser et.al 2017) [20, 29]. The faecal dropping of the species were collected from the resting burrow. The Faecal samples of the species were collected from two different study sites A and B, to investigate the prey species consumed in the diet.

The faecal analysis done by filtration technique following steps were performed as follows:

a. Both the dried faeces sample soaked in the beaker containing 200ml of 75°C water and stirred faeces slowly for 10-15 minutes to soften and grind the faecal sample.
b. The small bubbles formed in the beaker attached insect chitinous body part allow to float on the surface.
c. Repeated same process 3-4 times to filter out as many ants and termite remains as possible using filter paper.
d. Discarded all the debris obtained from the faecal sample of the species.
e. The filtered ants and insect specimen's body parts send to the Ant Systematics and Molecular biology lab Department of Zoology and Environmental science Punjab University Patiala for identification.
f. The specimens were identified with the help of keys available with the author and compared with reference collection housed in the laboratory.

Fig 2: Faecal dropping of Indian Pangolin)

Results

Traditional ecological knowledge of local forest dwellers employed during a field survey to track resting burrow of the species, direct-indirect sign. Twelve camera traps were deployed targeting the Indian Pangolin resting burrows and on probable trails used by species. Camera trap data used to identify active resting burrow, four active burrows revealed the activity of Indian Pangolin. The camera trap had photographed 243 photos and record 125 videos of Indian Pangolin (*Manis crassicaudata*) activity. Camera traps images revealed the activity of pangolin in the study area as well burrows were used by other burrow dwelling and

ground species such as Indian Crested porcupine (Hystrix indica), Grey junglefowl (Gallus sonneratti), Indian grey mongoose (Herpestes edwardsii), and Rudy tailed Mangoose (Herpestes smithii).

Fig 3: *M Crassicaudata* photographed in camera trap)

The two faecal samples of Indian Pangolin were collected from two different study areas in Chiplun block of Ratnagiri district in Konkan region of Northern Western Ghats of Maharashtra, India. The Faecal analysis of Indian Pangolin revealed the presence of soil, small stones, body parts of ants, insects, and plant matters. The soil and small stone component is the highest recovered component, and the second-highest recovered component was ant body parts from the faeces samples of the species. A minor amount of plant matter, insect, and bug wings present, but no traces of termite body part found in the sample. Total seven ant species identified four species of black ants, including *Camponotus compressus*, *Camponotus angusticollis*, *Camponotus parius*, and *Polyrhachis menelas*, and three species of red ants *Oecophylla smaragdina*, *Carebara affinis*, and *Pheidole malinsii* identified as prey species consumed in the diet by Indian Pangolin. *Camponotus angusticollis* and *Camponotus compressus* common ant species recovered from both the faeces sample collected from study site A and study site B (Table.1.).

Table 1: Identified ant species from both the faeces sample of Indian Pangolin.

Sr. No	Study Area	Ant species as Prey of Indian Pangolin
1	Study Site A	1. Camponotus angusticollis (Jerdon, 1851) 2. Camponotus compressus (Fabricius, 1787) 3. Polyrhachis menelas (Forel,1904) 4. Carebara affinis (Jerdon, 1851) 5. Pheidole malinsii (Forel, 1902)
2	Study Site B	1. *Camponotus angusticollis (Jerdon, 1851)* 2. *Camponotus compressus (Fabricius, 1787)* 3. *Camponotus parius (Emery, 1889)* 4. *Oecophylla smaragdina (Fabricius, 1775)*

Discussion

The Indian pangolin is top 100 Edge (Evolutionary distinct and Globally Endangered) species due to their unique evolutionary distinction. The species has unique morphological features for foraging, a powerful limb tipped with sharp, clawed digits used for digging into anthills and termite mounds (Atkins 2004) [2]. The Indian pangolin activity trapped in deployed camera trap at the study site, camera trap methodology is effective to study rare elusive species (Cutler and Swann 1999) [6]. In the current study Indian Pangolins recorded within 2-30 nights of trapping using 12 camera traps. The previous camera trap study in Asia Palawan Pangolin recorded soon after the camera trap deployed (Marler, 2016) [19], and Sunda Pangolin was photographed soon after the camera trap set up in the region (Lim and Ng, 2007). In this study, it was observed the resting burrow of Indian Pangolin associated with ground-dwelling species. Insects, ants, and termites adhere to the sticky tongue of Indian pangolin during the process, soil, rotting wood, and rocks ingested by the species. In the present study, we observed ant's body part and soil-stone highest recovered component in both faeces samples. The faeces sample of the Indian pangolin has been reported previously contains more than 50% of grit and clay (Mahmood *et al*. 2013; Irshad *et al*. 2015; Ashokkumar *et al*. 2017) [18, 10]. The species is insectivorous, predominantly feeding on ants and termites. The long sticky tongue and specific muscles in the mouth stop prey species from escaping once captured (Heath, 1992). In the present study total of seven ant species identified in the diet of Indian Pangolin as prey species - namely *Camponotus compressus*, *Camponotus angusticollis*, *Camponotus parius*, *Polyrhachis menelas*, *Oecophylla smaragdina*, *Carebara affinis*, and *Pheidole malinsii*. The previous study from Pakistan reported two black ant species *Camponotus confucii*, and *Camponotus compressus* (Mahmood *et al*. 2013; Irshad *et al*. 2015) [18, 10]. Based on stomach content analysis, the study reported a female Indian pangolin collected in Kerala, India had predated on the ant genera *Leptogenys sp.* (Ashokkumar *et al*., 2017). In Srilanka, reported the presence of *Monomorium sp.*, *Camponotus sp.*, *Anoplolepis sp.*, and *Oecophylla sp.*, in the diet of the Indian pangolin as a prey species (Karawita *et al*., 2020) [14]. Phillips (1926) [22] had reported that the observer of the captive pangolin had revealed that pangolins prefer some ant species (black colored) and rejected others (red ants). In the current study, the ant prey species consumed by Indian Pangolin include both red and black ant species. The presence of red ant *Oecophylla sp.* reported from Srilanka (Karawita *et al*., 2020) [14]. The study suggests the Indian Pangolin prefers to consume both red and black ants. The wings of insect beetles recovered in minor proportion revealed the Indian Pangolin occasionally feeds on beetles and insects other than ants and termites. Similar, findings reported by Hutton (1949), the stomach content analysis from the Nilgiris revealed the presence of black ants, beetle wing sheath, remains of cockroaches, and skins of worms. The termites are soft-bodied insects and completely digested, due to which the study showed no remains of termite from both faeces samples of the species.

Table 2: Review of Previous and Present study to understand the faecal or gut content analysis for Diet of Indian Pangolin (*Manis Crassicaudata*).

Pangolin species	Methodology	Sample Size	Species Identification Method	Number of Ants species identified	Number of termite specie identified	References
Indian Pangolin	Non Filtering	50 (faeces) from two sites	Microscopy	2	0	Mahmood *et al.* 2013
Indian Pangolin	Non Filtering	44 (faeces) from four sites	Microscopy	2	1	Irshad *et al.* 2015
Indian Pangolin	Non Filtering	1 gut	Microscopy	1	0	Ashokkumar *et al.* 2017
Indian Pangolin	Filtering	32 (faeces) from 5 sites	Microscopy	4	1	Karawita *et al.*, 2020
Indian Pangolin	Filtering	2 (faeces) from 2 sites	Microscopy	7	0	This Study

Fig 4: M. Crassicaudata photographed in camera trap

Conclusion

The field survey data, camera trap data, and faecal dropping of the specie confirmed the presence of the Indian Pangolin (*Manis crassicaudata*) in the Study area. Seven ant species identified as prey species consumed by the Indian Pangolin. Indian Pangolin is immensely insectivorous mammals species consumed seven ants species as prey in Konkan region of Northern Western Ghat of Maharashtra, India. The current study shows the higher diversity of ant species in the diet of the pangolin recorded till now. The Indian pangolin also consumes non-ant and termite insect species as prey further deep research study is needed to understand the variation of prey species in dietary ecology. The study is also showed the Indian pangolin not only selects to consume black ant. The species consumed both black and red ant as prey species in diet. Indian Pangolin is threatened across the Indian subcontinent, in the current study area observed poaching and trafficking incident. It's a necessary and urgent need to protect species, as well as instigate further research study to streamline further specific species conservation action plan.

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