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Re-assessing the status and distribution of Indian Pangolin (*Manis crassicaudata*) in Pothwar Plateau, Punjab, Pakistan

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Abstract

The current study was carried out to re-asses the population status and to determine the distribution of Indian pangolin (*Manis crassicaudata*) in the Pothwar Plateau, Punjab, Pakistan. For this purpose, a field surveys were conducted from September 2018 till July 2019. The data on distribution of the species were collected by recording direct (field sightings) and indirect signs (like burrows, fecal matter etc.). There were numerous old burrows, indicating a previous abundance of Indian pangolin in the study area. The Indian pangolin is still found in all four districts of the Pothwar Plateau, according to our findings. In Attock district, the highest density of Indian pangolins was reported. The average species density was calculated to be 1.01 individuals/km² in the study area. The Indian pangolin is the only pangolin species recorded in Pakistan and is likely the least studied of all Asiatic pangolin species. Concerns over the Indian pangolin's population loss due to poaching and trade have prompted a move to add the species to Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). However, a fundamental constraint in the conservation of the Indian Pangolin is a lack of reliable and complete scientific information on its behavior, ecology, and risks to its existence. Therefore, the government and concerned organizations must identify basic research practices and awareness programs for the better conservation planning of the species.

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Introduction

Pangolins are unique mammals of the Family Manidae in the Order Pholidota (Botha & Gaudin, 2007). They are also called as “scaly anteaters” due to the presence of keratinized plate-like protective scales covering most part of their bodies, and their highly specialized diet which predominantly consist of ants and termites. Eight different pangolin species have been described from Afro-tropical and Indo-Malayan regions of the world (Gaubert & Antunes, 2005). Pangolins are at a greater conservation risk due to excessive hunting and poaching, and they may be the most illegally trafficked group of mammals in the world (Aisher, 2016; Challender & MacMillan, 2014). All eight pangolin species have been recently included in the Appendix-I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and have been recorded as Endangered species (Baillie *et al.*, 2014). The Indian pangolin is reported from five different countries including Pakistan, India, Bangladesh, Sri Lanka and Nepal (Wu *et al.*, 2004). It is the only pangolin species recorded in Pakistan and in Sri Lanka.

It has been considered as an iconic species with a cultural significance in Sri Lankan tradition and history (Perera *et al.*, 2017). The Indian Pangolin is the only pangolin species reported from Pakistan, is adapted to desert regions and prefers more tree less districts (Roberts, 1997) but it is found in forests, grassland and open land has been revealed from surroundings of human dwellings in rural areas.

The Indian pangolin has a scattered distribution in Pakistan, occurring in Kasur, Lahore, Jhelum, Sialkot and Gujrat Districts in the North-west of the Pakistan Punjab and spreads crosswise the Pothwar Plateau and the Salt Range to Kohat District, Peshawar, Mardan up to Galiat area of Khyber Pakhtunkhwa (KP). In Sindh, in the mountainous regions of District Larkana, it inhabits Indus River at the right banks, Dadu, Jamshoro up to Malir area of Karachi, also recorded from Hyderabad, Sanghar, Umarkot Districts of Sind up to Run of Kuche. In Baluchistan province, it has been recorded from Makran and

Lasbela (Roberts, 1997). Estimates show that more than 70 million insects can be consumed annually by an adult pangolin (Weerakoon, 2012).

The percentage of termites and ants eaten differs season wise and depending upon geographical range, naturally 90 to 95% food consists of ants and 5 to 10% of termites left (Baillie *et al.*, 2014). The data concerned with ecology, distribution, population and threats to the Indian Pangolin in Pakistan is light generally; however, it is well deliberate in Pothwar region of Pakistan by Mahmood *et al.* (2012); Mahmood *et al.* (2016).

The Indian Pangolin is classified under the IUCN Red List of “Endangered” (Baillie *et al.*, 2014). It is listed in Appendix-I of CITES. The current study was designed to focus on Indian pangolin in the Pothwar Plateau, to re-asses the population status of species in the study area and to determine the distribution of Indian pangolin in the Pothwar Plateau.

Materials and methods

Study Area

This study was designed and conducted in the regions of Pothwar Plateau (32°33' and 34°3' N, and 71°89 and 73°37' E), including four districts (Rawalpindi Jhelum, Attock and Chakwal), in collaboration with World Wide Fund for Nature (WWF) Islamabad, Pakistan (Fig. 1). Field surveys were carried out during the years 2018-2019, at the selected sampling sites of the Pothwar region in all four districts. The study area (Pothwar Plateau) is situated between the River Jhelum and Indus which are bounded to the North by Hazara Hills and on the South it is present by the Salt Ranges. The total area of this Plateau is about 2.2 MH (Irshad *et al.*, 2015). Its elevation varies i.e. about 300-600 m in enduring hills and small hill of this system (Baral & Shah 2018). The lunges of Kala Chita Range east-ward crossways the plateau towards the Rawalpindi. The Soan and Haro valleys cross the plateau from eastern foothills to the Indus. It is bounded by district Attock and Rawalpindi and in the North regions Jhelum is present in east. Mianwali lies in the west and

Khushab in the south regions. Rivers and Hills are surrounded by divided gulley ties. Semi-arid environment covers the Plateau includes average annual rainfall of 350 to 500mm.

Study Design

Preliminary Reconnaissance Survey

An initial survey was carried in the study area (in all the four districts comprising Attock, Rawalpindi, Chakwal and Jhelum) to hypothesize and to identify the situation in potential sampling sites where Indian Pangolin had been reported earlier. Preliminary meetings were conducted with staff members of the PWPDP i.e. Punjab Wildlife and Parks department, university researchers, local people, shepherds, and local hunters to confirm the existence of the Pangolin in the study area. Extensive survey of the identified areas was conducted with local people that depends on the pre-information produced from focus group discussion which determines the occurrence and distribution of this specie in the study area. The potential sampling sites were selected on the presence and identification the specie for further data collection.



Fig. 1. Study site map showing the location of the four districts of the Pothwar Plateau.

Selection of Sampling Site

Total thirty-one sites from all four districts were selected. Area survey method was used having one km length and variable width. Eight sites from district Jhelum (Jhelum, Dina, Mera Dina, Amral Sohawa, Banth, Bangla, Nala Khurd, Choi Ghulam), seven sites from district Chakwal (Basharat Ara, Dohk Surla Nali Sireali, Khichchi, Dhermund, Dhok Awan, Noorpur Kalarkahar). Ten sites from district Attock (Mianwala, Langar, Sabey Wali, Pariote Jungle, Bagh

Nilab, Sojhanda Village, Akhori Village, Khari Murat, Hassanabdal, Kohlian Village, Hazro). Six from district Rawalpindi (Kahuta, Gaggari, Kahuta, Kallar Syedan, Mandra, Sadakamal Pull, Gulyana). The study area was surveyed for recording the direct and indirect signs of Indian Pangolin see (Table 1 to 4).

Methodology- Data Collection

Distribution of Indian Pangolin

For estimating the current dispersal of Indian Pangolin in the study area, standard ecological methods were followed including direct field sightings and records of indirect signs (like its feeding and living burrows, scats, footprints etc.) following Mahmood *et al.* (2014). For this purpose, an extensive survey of the different parts of study area was conducted with involvement of local people and Wildlife staff of the Punjab Wildlife and Parks Department to collect information on distribution status of the species, and it lasts from (September 2018 to July 2019).

The study area was surveyed for recording the direct and indirect signs of Indian Pangolin. The Global Positioning System (GPS) coordinates were recorded wherever the indirect and direct sightings of the species were recorded. Map illustrating the current distribution pattern of the species in the study area was developed using ArcGIS software version 10.2.2 (Noman *et al.*, 2020).

Population Estimation by Burrow Density Method

The population of Indian pangolin was estimated in the study area using indirect method of active permanent burrow counts following Irshad *et al.* (2015). There were two different types of burrows are present; sleeping/permanent and the feeding burrows. Feeding burrows were present in large numbers as compared to the sleeping burrows.

The sleeping burrows were additional classified as active/inactive burrows. For example, active burrows were classified due to any secondary signs of the specie (Indian pangolin) by footprints, fecal materials, or body prints which are found on the soil

which were especially observed around the active sleeping burrows (Mahmood *et al.*, 2014).

The density of burrow of Indian Pangolin was assessed by the number of active sleeping-burrows

which were counted in all the sites in a study area by Area searching /surveying method using the formula:

$$D = n / A$$

Where, n represents number of active living burrows and A stands for area sampled in each study site.

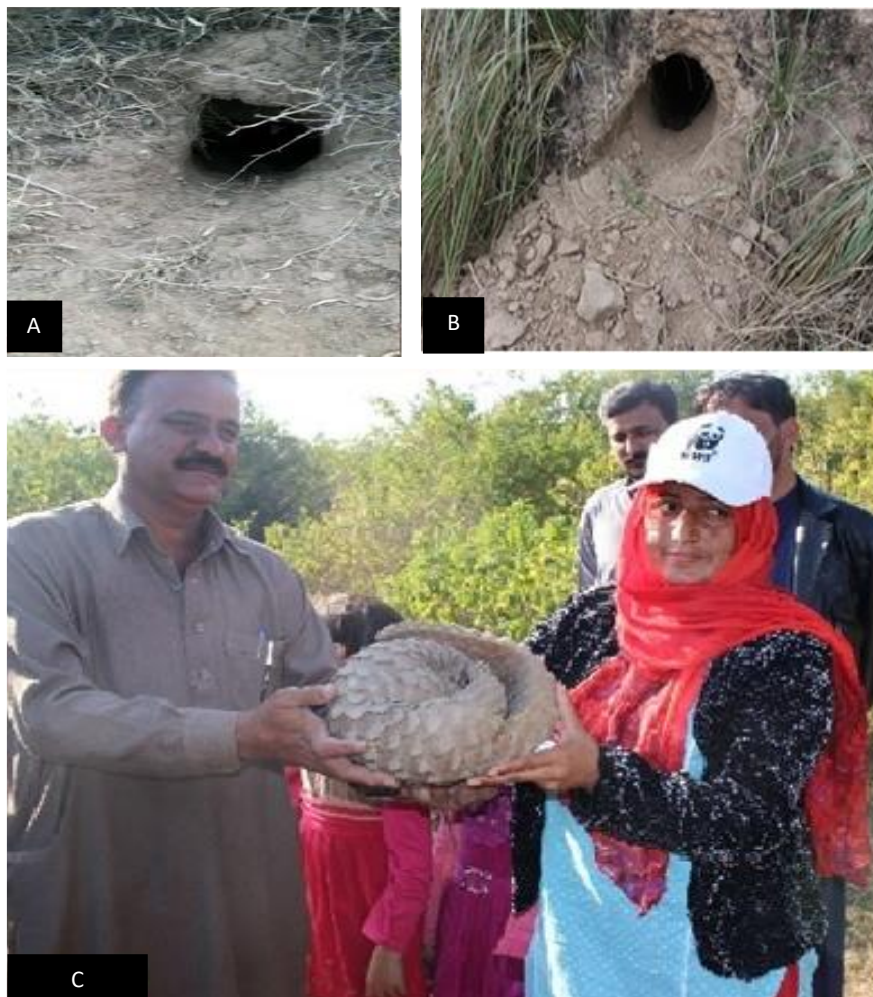


Fig. 2. Field photographs of the burrows of Indian Pangolin (A to B) recorded in the study area, C) a live specimen of Indian pangolin captured in the field during survey.

Table 1. Details of selected sampling sites in district Attock of the Pothwar Plateau for data collection about Indian pangolin.

SN.	Site Name	Area Km ²	GPS Coordinates and Elevation		
			Latitude	Longitude	Elevation (m)
1	Mianwala, Dhook Sar, Sawal Dam	2	N33°24.382'	E72°16.248'	460
2	Langer Sabey Wali	2	N33°28.404'	E72°03.138'	324
3	Pariote jungle	1	N33°22.405'	E71°50.466'	314
4	Bagh Nilab	2	N33°45.485'	E72°09.079'	315
5	Sojhanda Village	2	N33°45.222'	E72°05.060'	371
6	Akhori village	1	N33°39.498'	E72°26.180'	423
7	Kharimurat-Fateh Jang	2	N33°27.231'	E72°43.216'	558
8	Hassanabdal	2	N33°51.419'	E72°41.039'	404
9	Kohlian Village	1	N33°51.346'	E72°37.335'	421
10	Hazro	2	N33°54.419'	E72°36.171'	411

Table 2. Details of selected sampling sites in district Chakwal of the Pothwar Plateau for data collection about Indian pangolin.

SN	Site Name	Area Km ²	GPS Coordinates and Elevation		
			Latitude	Longitude	Elevation (m)
1	Basharat Ara	2	N32°48.526'	E73°08.293'	721
2	Dhok Sahla, Khokher Zer Dam	2	N32°48.421'	E72°51.106'	578
3	Nali+Sireali, Karungal	1	N32°41.20'	E73°01.424'	724
4	Khichchi, Sagar	2	N32°44.458'	E72°22.590'	624
5	Dhermund	2	N32°55.276'	E72°12.533'	428
6	Dhok Waen	2	N32°47.402'	E72°44.251'	707
7	Kalarkahar (Nurpur)	2	N32°40.373'	E72°35.217'	731

Table 3. Details of selected sampling sites in district Jhelum of the Pothwar Plateau for data collection about Indian pangolin.

SN	Site Name	Area Km ²	GPS Coordinates and Elevation		
			Latitude	Longitude	Elevation (m)
1	Jhelum (Saeela Village)	2	N33°07.166'	E73°35.590'	316
2	Dina (Lahri Wildlife Park)	2	N33°06.011'	E73°37.213'	262
3	Mara Dina	2	N33°06.204'	E73°33.080'	383
4	Amral Sohawa	2	N33°05.511'	E73°29.247'	398
5	Banth	2	N33°07.015'	E73°30.377'	358
6	Bagala	2	N33°09.128'	E73°31.218'	440
7	Nala khurd	2	N33°46.031'	E73°26.082'	247
8	Choi Ghulam	2	N33°47.292'	E73°22.370'	283

Table 4. Details of selected sampling sites in district Rawalpindi of the Pothwar Plateau for data collection about Indian pangolin.

SN	Site Name	Area Km ²	GPS Coordinates and Elevations		
			Latitude	Longitude	Elevation (m)
1	Kahuta, Pindi	2	N33°40.352'	E73°24.581'	609
2	Gagaari, Kahuta	2	N33°34.054'	E73°24.509'	653
3	Kalar Syedan	2	N33°28.174'	E73°24.228'	520
4	Sadakamal Pul	2	N33°25.545'	E73°27.293'	565
5	Mandra, sang Bhakkar	2	N33°17.371'	E73°10.414'	461
6	Gulyana Gujjar Khan	2	N33°12.216'	E73°17.212'	446

Results and discussion

Distribution

Distribution of the Indian pangolin was determined in each of the four districts of the Pothwar Plateau, by recording direct and indirect signs of the species.

District Attock

A total ten selected sampling sites were surveyed in District Attock for pangolin distribution. The sites were searched for direct and indirect signs of the species, especially its two types of burrows; feeding and living burrows, at each site (Table 5). During surveys of the selected sites, a total of 19 km² area was searched for recording signs of the species. Soil type of the study area varied from loamy to sandy and

somewhere rocky soil was also present. Habitat type also varied from agricultural to forest land type. The distribution of Indian pangolin was confirmed by recording its field signs including burrows of the species, its footprints and scats.

Out of all ten sampling sites surveyed during the current study, eight sites were found negative as no signs of Indian pangolin were recorded there (Table 5; Table 9). Only two sampling sites (Langer Sabey Wali and Khari Murat) were found positive; at Langer Sabey Wali site, only burrows (n=11, living active burrows) of Indian pangolin were found, however, at this site, no footprints or fecal matter of the species was found. At the other positive site, Kheri Murat,

burrows (n=16, living, active) of Indian pangolin were recorded as well as its footprints (Table 5; Table 9).

District Rawalpindi

In district Rawalpindi, a total of six sampling sites (covering a total of 10 km² area) were surveyed for recording the signs of Indian pangolin (Table 6).

Three out of six sites surveyed were found positive, while remaining three sites were negative regarding occurrence of pangolin.

At first positive sampling site, Bandnar, Kahuta, one live encounter, one active living burrow, five inactive living, 10 active feeding, three inactive feeding burrows, were recorded (Table 6 and 10). At second positive site, Gagaari, Kahuta, one active living burrow, eight inactive living burrows, two fresh feeding burrows and 19 old feeding burrows were recorded. At the third positive site in Kallar Syedan, one active living burrow, five inactive living, three fresh feeding and 13 old feeding burrows of the species were found (Table 6 and 10).

Table 5. Details of direct and indirect signs of the Indian pangolin recorded at different sampling sites of Attock District in the Pothwar Plateau.

SN	Site Name	Area Km ²	Habitat type	Soil type	Vegetation composition	Latitude	Longitude	Elevation (m)	Burrow	Foot prints	Faecal
1	Mianwala, Dhok Sar, Sawal Dam	2	forest land	rocky soil	Snatha, phulai, bahaker, hranda	N33°24.382'	E72°16.248'	460	-ve	-	-
2	Langer Sabey Wali	2	Agricultural land	sandy	kabuli kikar, phulai	N33°28.404'	E72°03.138'	324	+ve	-	-
3	Pariote jungle	2	forest land	sandy	Phulai, beri, grasses	N33°22.405'	E71°50.466'	314	-ve	-	-
4	Bagh Nilab	2	forest type	loamy	Kikar, snatha, phulai	N33°45.485'	E72°09.079'	315	-ve	-	-
5	Sojhanda Village	2	Agricultural land	sandy	phulai, granda, beri, kikar	N33°45.222'	E72°05.060'	371	-ve	-	-
6	Akhori village	2	Agricultural land	loamy	kikar, phulai, kana, beri	N33°39.498'	E72°26.180'	423	-ve	-	-
7	Kharimurat-Fateh Jang	2.5	forest land	Clay, Red or brown	wild olive, bahaker, snatha, phulai	N33°27.231'	E72°43.216'	558	+ve	yes	-
8	Hassanabdal	1.5	forest land	loamy	kikar, phulai, kana, beri	N33°51.419'	E72°41.039'	404	-ve	-	-
9	Kohliah Village	1.5	agricultural land	sandy	kikar, phulai	N33°51.346'	E72°37.335'	421	-ve	-	-
10	Hazro	1.5	forest land	rocky soil	Phulai, granda, dwarf beri	N33°54.419'	E72°36.171'	411	-ve	-	-
Total		19							02	01	-

District Chakwal

In Chakwal district, in total seven selected sites were surveyed for recording the sign of Indian-pangolin presence, covering an area of 12 km². The soil was mostly sandy, clay red, red brown while the forest type is sub-tropical, most of the land is agricultural fields (Table 7 and 11). Two sampling sites out of seven surveyed were found positive for occurrence of Indian pangolin in Chakwal District. The positive sites included, first Basharat Ara, where eight active living burrows of the species were found along with three inactive living burrows, 22 fresh feeding burrows, and 30 old feeding burrows. From this site, one fecal dropping of Indian pangolin was also recovered (Table 7 and 11). At the second positive site, namely Dhok Sahla near Khokhar Zer dam, a total of

nine active living burrows, one inactive living burrow, 18 fresh feeding burrows, and 20 old feeding burrows were recorded here (Table 7 and 11). However, during current study, we could not survey the sites like Jubairpur, Chumbi Surla, and Mureed Village, in Chakwal District which were reported previously to be positive sites for pangolin occurrence.

District Jhelum

In Jhelum district, a total 8 sites were surveyed for recording occurrence of Indian pangolin. The total distance covered during survey period was 14 km² (Table 8 and 12). Out of eight sites, only two sampling sites were found positive for pangolin distribution. At first positive site, Dina, four active living burrows of the species were recorded along with one inactive

living, one fresh feeding burrow, and 2 old feeding burrows were recorded. At the second positive site in Jhelum District, namely Mara Dina, 2 active living burrows, one inactive living burrow, three fresh feeding and one old feeding burrow, were recorded (Table 8 and 12). However, during current study, we could not survey the areas like Rohtas Fort, and Pind Dadan Khan, in district Jhelum where pangolin occurrence was previously reported.

Sopyan (2009) reported that Indian pangolin occurs in different areas of the country, from district Kasur, through Lahore, Gujranwala, Sialkot, Jhelum, Salt range, extending into Kohat, and Peshawar. The species inhabits barren hilly areas and subtropical thorn forests, usually ranging from moist to dry and thorn to grassland (Lihua *et al.*, 2010).

Similarly, Mahmood *et al.* (2012) reported that the Pothwar Plateau is the core distribution range of the Indian pangolin in Pakistan, with only localized, patchy distributions in other areas. Mahmood *et al.* (2018) also reported its occurrence in few areas of Mansehra district of Khyber Pakhtunkhwa province. However, during current study, we could not survey the areas like Rohtas Fort, and Pind Dadan Khan, in district Jhelum where pangolin occurrence was previously reported.

Roberts (1997) reported that Indian pangolin occurs in different areas of the country, from district Kasur, through Lahore, Gujranwala, Sialkot, Jhelum, Salt range, extending into Kohat, and Peshawar. The species inhabits barren hilly areas and subtropical thorn forests, usually ranging from moist to dry and thorn to grassland (Challender *et al.*, 2015). Similarly, Mahmood *et al.* (2012) reported that the Pothwar Plateau is the core distribution range of the Indian pangolin in Pakistan, with only localized, patchy distributions in other areas. Mahmood *et al.* (2018) also reported its occurrence in few areas of Mansehra district of Khyber Pakhtunkhwa province.

Population Estimation

The population density of Indian pangolin in the Pothwar Plateau was estimated using indirect method of "Active Living Burrows Count".

District Attock

In District Attock, out of total 10 sites surveyed in an area of 19 km², active living burrows of Indian pangolin were found only at two sampling sites, namely "Langer Sabey wali" and Kheri Murat site (Table 9). At Langer Sabey wali sampling site, a total 11 active living burrows were noted while at Kheri Murat Site 16 active living burrows were found.

Table 6. Details of direct and indirect signs of the Indian pangolin recorded at different sampling sites of Rawalpindi District in the Pothwar Plateau.

SN	Site Name	Area Km ²	Habitat type	Soil type	Vegetation	Latitude	Longitude	Elevation (m)	Burrow	Footprints	Faecal
1	Kahuta, Band Nar	2	forest land	Clay, Red or brown	Chir pine, Granda, Sanatha, Jhand, Phulai	N33°40.352'	E73°24.581'	609	+ve	no	-
2	Gagaari, Kahuta	2	forest land	Clay, Red or brown	Grass, Granda, Phulai, Ber	N33°34.054'	E73°24.509'	653	+ve	no	-
3	Kalar Syedan	1.5	forest land	Clay, Red or brown	Granda, Phulai, Beri, Bahekar	N33°28.174'	E73°24.228'	520	+ve	no	-
4	Sadakamal Pul	1.5	forest land	Clay, Red or brown	Shisham, Bushes, Phulai, Bahekar	N33°25.545'	E73°27.293'	565	-ve	no	-
5	Mandra, sang Bhakkar	1.5	grass land	Clay, Red or brown	Phulai, Grasses	N33°17.371'	E73°10.414'	461	-ve	no	-
6	Gulyana, Gujjar Khan	1.5	agricultural land	Clay, Red or brown	Phulai, Kiker	N33°12.216'	E73°17.212'	446	-ve	no	-
Total		10							03	-	

Table 7. Details of direct and indirect signs of the Indian pangolin recorded at different sampling sites of Chakwal District in the Pothwar Plateau.

SN	Site Name	Area Km ²	Habitat type	Soil type	Vegetation	Latitude	Longitude	Elevation (m)	Burrow	Footprints	Faecal
1	Basharat Ara	2	Forest land	Sandy	Granda, Phulai, Bahaker, Beri, Wild anjeer	N32°48.526'	E73°08.293'	721	+ve	yes	+
2	Dhok Sahla, Khokher Zer Dam	2	Agricultural land	Sandy	Granda, Bahker, Beri, Grasses	N32°48.421'	E72°51.106'	655	+ve	no	-
3	Nali+Sireali, Karungal	1	Forest land	Clay, Red or brown	Granda, Bahaker, Snatha, Phulai	N32°41.20'	E73°01.424'	724	-ve	no	-
4	Khichchi, Sagar	2	Forest land	Sandy	Granda, Beri, Grasses	N32°44.458'	E72°22.590'	619	-ve	no	-
5	Dhermund	1	Forest land	Sandy		N32°55.276'	E72°12.533'	428	-ve	no	-
6	Dhok Waen	2	Forest, agricultural land	Clay, Red or brown	Kabuli Kikar, Phulai, Grasses	N32°47.402'	E72°44.251'	707	-ve	No	-
7	Kalar Kahar	2	Forest land	Clay, Red or brown	Granda, Phulai, Bahaker, Beri, Wild anjeer	N32°40.373'	E72°35.217'	731	-ve	no	-
Total		12							02	01	

Table 8. Details of direct and indirect signs of the Indian pangolin recorded at different sampling sites of Jhelum District in the Pothwar Plateau.

SN	Site Name	Area Km ²	Habitat type	Soil type	Vegetation	Latitude	Longitude	Elevation (m)	Burrow	Footprints	Faecal
1	Jhelum Saeela Village	2	Forest land	Stony	Phulai, Bahaker, Grasses	N33°07.166'	E73°35.590'	316	-ve	no	-
2	Dina Lahri Wildlife Park	2	Grass land	Clay, Red or brown	Grasses, Kana, Granda, Phulai	N33°06.011'	E73°37.213'	262	+ve	no	-
3	Mara Dina	1.5	Forest land	Rocky soil	Phulai, Granda, Beri, Kikar	N33°06.204'	E73°33.080'	383	+ve	no	-
4	Amral Sohawa	1.5	Forest land	Rocky soil	Kikar, Phulai, Granda, Kikar	N33°05.511'	E73°29.247'	398	-ve	no	-
5	Banth	2	Forest land	Rocky soil	Phulai, Beri, Kana	N33°07.015'	E73°30.377'	358	-ve	no	-
6	Bagala	1.5	Forest land	rocky soil	Kikar, Phulai, kana,	N33°09.128'	E73°31.218'	440	-ve	no	-
7	Nala khurd	1.5	Agricultural land	Rocky soil	Kikar, Phulai, Beri	N33°46.031'	E73°26.082'	247	-ve	no	-
8	Choi Ghulam	2	Forest land	Rocky soil	Bahaker, Beri	N33°47.292'	E73°22.370'	283	-ve	no	-
Total		14							02	-	-

In the study area of District Attock, the burrow density was estimated to be 1.42 per km², corresponding to same numbers of pangolin individuals, considering the fact that each active living burrows was being used by only one pangolin.

The relative burrow density of active living burrows in this district was found to be 12.92%, among all kinds of burrows recorded such as inactive living, fresh feeding and old feeding burrows (Table 9). In District Attock, other burrow types recorded included inactive

living burrows (4.84 per km²), fresh feeding (1.68 per km²) and old feeding burrows (3.05 per km²).

District Rawalpindi

In District Rawalpindi, a total of six sampling sites were searched for recording burrows of Indian pangolin, covering an area of about 10 km². Three sites were found positive showing live encounter of the species, and active living burrows (Table 10). At band Nar site in Tehsil Kahuta, one live encounter of the species was recorded, while at Gagaari site (Tehsil

Kahuta), and one of the sites in Tehsil Kallar Syedan, one each active living burrow of pangolin was recorded.

The density of active living burrows of the species in District Rawalpindi was estimated to be 0.30 per km², with a relative density of 2.54 per km², among all types of burrows recorded.

Therefore, considering the active living burrows, the population density of 0.30 per km² of Indian pangolin was estimated in District Rawalpindi (Table 10). The other types of burrows of Indian pangolin in this district included Inactive living burrows

(33.90%), fresh feeding (15.25%) and old feeding burrows (48.31%).

District Chakwal

In District Chakwal, a total of 12 km² area was surveyed at seven sampling sites for recording burrows of the Indian pangolin. Active living burrows of the species were recorded at only two sites, namely “Bahsarat Ara” and “Dhok Sahla, Khokhar Zer Dam” sites. At Bahsarat Ara, site eight active living burrows were found while at Dhok Sahla site nine active living burrows were recorded.

Table 9. Details of living and feeding burrows of Indian pangolin recorded in District Attock.

Site Name	Area Km ²	Living active	Living inactive	Feeding active	Feeding inactive
Mianwala, Dhook Sar, Sawal dam	2	0	20	0	21
Langer Sabeywali	2	11	10	10	19
Pariote Jungle	2	0	3	0	0
Bagh Nilab	2	0	0	0	0
Sojhanda village	2	0	0	0	0
Akhori village	2	0	0	0	0
Kheri Murat-Fateh Jang	2.5	16	49	22	13
Hassanabdal	1.5	0	10	0	5
kohlian village	1.5	0	0	0	0
Hazro	1.5	0	0	0	0
Total	19	27	92	32	58
Burrow density/km ²		1.42	4.84	1.68	3.05
Burrows Relative Density		12.92	44.02	15.31	27.75

Table 10. Details of living and feeding burrows (density per km²) of Indian pangolin recorded in District Rawalpindi.

Site Name	Area Km ²	Living active	Living inactive	Feeding active	Feeding inactive
Band Nar, Kahuta	2	live	5	10	3
Gagaari, Kahuta	2	1	8	2	19
Kalar syedan	1.5	1	5	3	13
Sadakamal pul	1.5	0	8	1	11
Mandra, Bhakkar	1.5	0	8	1	10
Gulyana gujjarkhan	1.5	0	6	1	1
Total	10	3	40	18	57
Burrow density/km ²		0.30	4.00	1.80	5.70
Burrows Relative Density		2.54	33.90	15.25	48.31

The density of active living burrows including all selected sampling sites in the district Chakwal was only 1.42 per km², while their relative density among all types of burrows of the species found here was 7.98% (Table 11).

Again, considering the fact that each living active burrow being utilized by only one pangolin individual, the population density of the species in district Chakwal is estimated to be 1.42 individuals per km². The other types of burrows of Indian pangolin

recorded at different sites (Table 11) included inactive living burrows (13.15% relative density), feeding active 26.29%, and feeding old burrows (52.58%).

However, during current study, we could not survey the areas previously inhabited by Indian pangolin in District Chakwal, including Jubairpur, Chumbi Surla Wildlife Sanctuary, Mureed Village, and Bhaun area.

There is a possibility that Indian pangolin still exists on these sites.

Table 11. Details of living and feeding burrows (density per km²) of Indian pangolin recorded in District Chakwal.

Site Name	Area Km ²	Living active	Living inactive	Feeding active	Feeding inactive
Basharat ara	2	8	3	22	30
Dhok Sahla, Khokher Zer Dam	2	9	1	18	20
Nali Sireali, Karungal	1	0	9	5	40
Khichchi, Sagar	2	0	9	10	20
Dhermund	1	0	1	1	1
Dhok waen	2	0	4	0	1
Kallar Kahar	2	0	1	0	0
Total	12	17	28	56	112
Burrow density/km ²		1.42	2.33	4.67	9.33
Burrow Relative Density		7.98	13.15	26.29	52.58

District Jhelum

Total 8 sites from District Jhelum were surveyed (Table 12) during current study, covering an area of approximately 14km². Active living burrows of the species were recorded at four out of eight sampling sites, with burrow density of active living burrows being 0.46perkm², corresponding to the same population density of Indian pangolin in the Jhelum district. Highest numbers of active living burrows were observed at Dina and Mara Dine sites (n=4 and

n=2, respectively). The active living burrows showed a relative density of 8.26perkm² in the district.

However, the other types of burrows found at the sampling sites in district Jhelum included inactive living burrows (relative density 12.84%), fresh feeding burrow (14.68% Relative density) and old feeding burrows (64.22% relative density). The living inactive burrows in the study area are also indicative of existence of the species in the area in near past.

Table 12. Details of living and feeding burrows of Indian pangolin (density per km²) recorded in District Jhelum.

Site Name	Area Km ²	Living active	Living inactive	Feeding active	Feeding inactive
Jhlum	2	0	0	1	0
Dina	2	4	1	1	2
Mara Dina	1.5	2	1	3	1
Amral Sohawa	1.5	0	4	4	2
Banth	2	2	7	5	30
Bagala	1.5	0	0	0	0
Nala khurd	1.5	0	0	1	30
Choi Ghulam	2	1	1	1	5
Total	14	9	14	16	70
Burrow Density/km ²		0.64	1.00	1.14	5.00
Burrow Relative Density		8.26	12.84	14.68	64.22

The population of Indian pangolin in the study area was estimated at a total of 31 selected sampling sites by counts of active “living burrows” of the species. The numbers of active living burrows were recorded in the area and utilized for estimating the population of the species, considering the fact that one burrow is being utilized by only one pangolin individual, following Zhou *et al.* (2014). Total area was 55 km² and total numbers of active living burrows n = 56, feeding active n = 122.

There were many old burrows in the whole study area and huge numbers of feeding inactive burrows too (Fig. 3 and 4). Density estimation of active living

burrows was very low as compared to inactive living and old feeding burrows of the species. This is an indication that Indian pangolin existed in the study area in the near past but now there and has become lowered in population.

During current study, a total of 55 km² area surveyed showed N=56, yielding a population density of the species being 1.01 individuals per km² of all sites surveyed in the Pothwar Plateau. The active living burrows of the species accounted for only 8% in relative density of all types of burrows recorded (Table 13; Fig. 3 and 4), with old feeding burrows being at maximum (51.21% relative density).

The numbers of active living burrows recorded for assessing the population of the species as previously done by Karawita *et al.* (2016) and Mahmood *et al.* (2015), Since one animal use per active living burrow gives abundance estimate of the species, correspondingly. Mahmood *et al.* (2014) had reported an average of 1 individual/km² of Indian Pangolin population density at seven

selected study sites of district Chakwal, Punjab, Pakistan. In the current study, highest population density of Indian pangolin has been estimated in District Attock while Irshad *et al.* (2015) had reported that highest number of active burrows were seen in District Chakwal. The population estimates assume that one Indian Pangolin uses only one active living burrow.

Table 13. Density of all burrow types in four districts (Attock, Chakwal, Rawalpindi and Jhelum) of the Pothwar Plateau during current study period.

District	Area surveyed km ²	Living active	Living inactive	Feeding active	Feeding inactive
Attock		27	92	32	58
Chakwal		17	28	56	112
Jhelum		9	14	16	70
Rawalpindi		3	40	18	57
Total	55km ²	56	202	134	422
Burrow Density (Km ²)		1.01	3.67	2.43	7.67
Burrow Relative Density		8.0097	24.5146	16.2621	51.2136

Threats to Indian Pangolin

In the Pothwar Plateau, during current study surveys, following major threats have been recorded being faced by Indian pangolin; Poaching/Hunting, Weak Law enforcement, Lack of awareness among local community and Agricultural extension

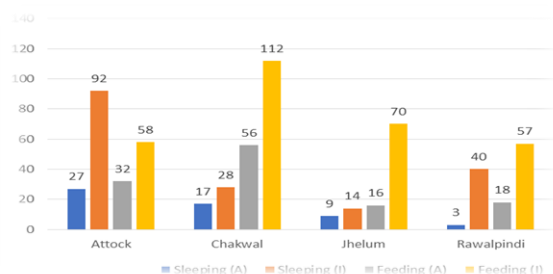


Fig. 3. A bar chart showing the numbers of all types of burrows of the Indian pangolin recorded in each of the four districts of the Pothwar Plateau.

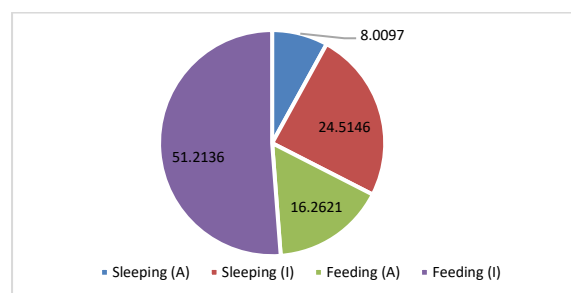


Fig. 3. A Pie Chart Showing the Relative density of all burrow types of the Indian pangolin recorded in the Pothwar Plateau.

Conclusion

The sole pangolin species that occurs in Pakistan is the Indian pangolin (*Manis crassicaudata*). Its populations were reported from some localities of the country, including the Pothwar Plateau. This mammal species has been under massive hunting pressure for its scales that are believed to have traditionally medicinal importance, and magical powers. The animal species and its products are illegally traded locally as well internationally to various countries. The current study was designed to re-assess the population status of this species in the Pothwar Plateau. Field surveys to the study area were conducted from September 2018 till July 2019. The data on distribution of the species were collected by recording direct (field sightings) and indirect signs (like burrows, fecal matter etc.). There were many old burrows which indicated the abundance of Indian pangolin in the past. Two districts are supporting more pangolin population; Chakwal and Attock. The population of the species was estimated by counts of its active “living burrows”. Results showed that all four districts of the Pothwar Plateau still have some population of the Indian pangolin. Highest density of Indian pangolin population was estimated in district Attock. The average density of the species in the study area was estimated to be 1.01 individuals/km².

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