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# DISTRIBUTION, ABUNDANCE AND VEGETATION ANALYSIS OF THE SCALY ANT-EATER (*Manis crassicaudata*) IN MARGALLA HILLS NATIONAL PARK ISLAMABAD, PAKISTAN

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## ABSTRACT

The knowledge of distribution and habitat use of a species, whose conservation status are under concern, is crucial to get information useful to establish any conservation plan. The Scaly ant-eater (*Manis crassicaudata*) is an "Endangered" insectivore lacking vital ecological studies in the Asian region. The current study investigated its distribution, abundance and habitat use in the Margalla Hills National Park, Islamabad. The animal species showed a patchy distribution in the park ranging from 462m to 1046m above sea level. The depths of its two types of burrows (feeding and sleeping) and the numbers of active and inactive sleeping burrows were found significantly different ($p< 0.05$, and $p < 0.01$, respectively). A very low population density (0.36/km$^2$) of the Scaly ant-eater was recorded in the park. Vegetation analysis of the study area revealed *Dalbergia sissoo, Acacia modesta*, and *Pinus roxburghii* as dominant trees, *Dodonaea viscosa* and *Lantana camara* as dominant shrubs and *Cynodon dactylon* as dominant herb species. The Scaly ant-eater showed a phyto-association with *Lantana camara*, and *Punica granatum* for making its permanent burrows, and *Dalbergia sissoo* and *Acacia modesta* tree species for obtaining its insect food.

**Keywords:** Indian pangolin, Pakistan, habitat, population, distribution.

## INTRODUCTION

The Scaly ant-eater (*Manis crassicaudata*) is one of the four extant pangolin species found in Asia (IUCN, 2008). It is distributed in Bangladesh, India (South of Himalayas), Nepal, Myanmar, Western China, Sri Lanka and Pakistan. In Pakistan, its populations are reported from few localized places in Sind, Baluchistan, Khyber Pakhtoonkhawah (KPK) and Punjab provinces. The Potohar Plateau is one of its important distribution regions in the country where it occurs in various unprotected as well as protected areas including mainly Domeli-Diljaba Game Reserve (Jhelum), Chumbi Surla Wildlife sanctuary (Chakwal), Loi Bher wildlife Park (Rawalpindi/Islamabad) and Margalla Hills National Park (MHNP) Islamabad (Roberts 1997).

The Scaly ant-eater naturally occurs in low population densities and prefers forested environments (Gaudin *et al.*, 2006). Generally, it is found scattered in different kinds of forests; mostly dry, moist, wet to semi-evergreen, deciduous, grassland in addition to thorn forests. It is also found in ruined wasteland near human surroundings (Yang *et al.* 2007),

The Scaly anteater has unique adaptations for digging burrows; it has powerful forelimbs with tough claws, adapted for digging (Swart *et al.*, 1999). Like many other semi-fossorial species, it frequently excavates burrows in the earth for its living purpose. Its body is roofed over by hard scales and these scales are anti-wear along with characteristics of anti-adhesion against soil and rock (Tong *et al.*, 1995). Its keratinized scales are exploited as these are utilized in Traditional Chinese Medicines (TCM) in local and international markets, for which tremendous illegal hunting pressure exists for this species in Pakistan (Mahmood *et al.*, 2012). The IUCN Red List of Threatened species (2014) categorizes *Manis crassicaudata* as "Endangered" (IUCN, 2014). The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) lists this species in Appendix-II (Inskipp and Gillett, 2005). Since it can be easily hunted, so it is extremely vulnerable to over-exploitation (Lim and Ng, 2007).

A major portion of the published literature about various pangolin species deals either with the African pangolins; *Manis temminckii*, *Manis tricuspis* (Heath and Coulson, 1998) or Chinese pangolins *Manis pentadactyla* (Wu *et al.*, 2003) while scientific studies on population ecology of *Manis crassicaudata* are scanty in the Asian region. According to IUCN (2012), no density estimates are currently available for this species from south-east Asia. Therefore, the current study was designed to determine distribution, habitat use and abundance of the Scaly ant-eater in the Margalla Hills National Park (MHNP) Islamabad, one of its important habitats in the country.

## MATERIALS AND METHODS

**Study area:** The current study was carried out in Margalla Hills National Park (MHNP) Islamabad, located between 33°43'N and 72°55'E, having a total area of approximately 17,386 ha (Fig.1). It covers Margalla Hills (12802 ha), Rawal Lake (1702ha) and Shaker Parian (1376 ha). Its topography is uneven comprising mostly of sheer slopes and gullies and the rock composition is basically limestone. Its elevation ranges from 450 to 1580 m above sea level (Jabeen *et al.* 2009). On the western side, elevation of the mountain is about 1600 m, which increases towards the eastern side (Anwar, 2001). The soil is colluvial, wind deposited, ranging dark brown to yellowish brown in color with a fine texture (Hijazi, 1984) while the climate is sub-tropical to semi-arid. Average maximum and minimum temperatures of the area are 34.3ºC and 3.4°C, respectively (Shinwari, 1998). Climatically, there are five seasons including winter (December-February), spring (March-April), summer (May-June), monsoon (July-September) and autumn (November) (Anwar and Chapman, 2000). The area receives a reasonably high monsoon rainfall and the annual rainfall is up to 1200 mm. Underground water table is in moderate condition having pH of 7.4 (Shinwari, 1998). There are many small and scattered villages in the MHNP at different elevations.

**Study Design:** In the start of the current study, surveillance surveys were conducted on a double Cabin motor vehicle, four wheel drive (average speed 10-30 Km/h) in natural, wild areas of the park to explore potential habitat of the Scaly ant-eater (*Manis crassicaudata*). After finding suitable potential site of the Scaly ant-eater in the park, we got /dropped down from the vehicle and carried out data collection, area searches and burrow counts by walking. Geographical coordinates of the sites were recorded and details of the burrows were quantified and photographed. After assessing the potential sites and collecting the secondary information from the local residents in the MHNP, six (N=6) sampling sites were selected for more detailed data collection about burrow counts and vegetation analysis at various elevations in the park ranging from 500 m up to 1500 m above sea level, although indirect signs of the scaly ant-eater were recorded at fifteen different sites in the park (Tables 1, 2 and 3). Each sampling site comprised of one square kilometer area (1 $km^2$). Regular visits to the selected sites were made fortnightly from July 2011 through June 2012.

**Distribution:** The distribution of the Scaly ant-eater in the Margalla Hills National Park was determined thorough surveys of the park on motor vehicle at slow speed, by walking along different trails, and also through questionnaire survey from local residents. The survey team comprised of four people including the driver of the van. During questionnaire surveys, people of the area were asked whether they were familiar with the scaly ant-eater? Have they seen the species? When did they the species was seen last time? Where they saw it and at what time? How many individuals of the species were there when they saw it? Had they seen any young ones of the species also? Do they know about capturing or hunting of pangolins in the area? What is their perception about the Indian pangolin? and will they kill it on sight? Is the species useful or harmful for their agriculture?

Most of the sampled areas of the park were surveyed by walking on foot at different elevations in the park. Presence of the species in the area was confirmed through direct and indirect signs like its feeding and sleeping burrows, fecal matter, and also by finding its foot prints or body prints, especially around the newly dug burrows. Geographical coordinates of the locations were recorded by using GPS (GarminTrex Vista H), which were used later on to construct distribution map of the species in the MHNP.

**Abundance estimates:** The abundance of Scaly ant-eater in the park was estimated by using indirect method of counts of its permanent, active living burrows. Data regarding measurements of the burrows; depth of the burrows, diameter and associated vegetation type, were also recorded. The number of active burrows, and their comparative sizes in each sampling site were used for estimating the population density of the species in that area in each study site using formula N = n/A, where, N= total population of the Scaly ant-eater, n= No. of active living burrows, and A= area of site (Mahmood *et al.*, 2011; Biggins *et al.*, 1993). There is considerable evidence in published literature that each burrow is utilized by only one individual of the scaly ant-eater, merely because of the burrow depth and size that correspond to the body size of one individual of the species, except during breeding season.

**Vegetation analysis:** Vegetation in the park at selected sites was analyzed by quantifying tree, shrub and herb species and analyzing an association between specific vegetation type and the activity of the Scaly ant-eater. Tree species were quantified by "Point-Centered-Quarter" method (Cottom and Cartis, 1956) while shrubs and herbs species by "Quadrate Method" (Emlen, 1956; Schemnitz, 1980). For shrub species, quadrates of 4m x 4m and for herb species quadrates of 1m x 1m size were used.

**Phyto-associations:** Whether the Scaly ant-eater prefers for any particular vegetation species in the study area, the location of its feeding and permanent burrows, and the existence of ants and termites colonies were recorded below and around the various vegetation species available in the habitat.

## RESULTS

**Distribution of scaly ant-eater:** The scaly ant-eater wash found having a patchy distribution in the MHNP Islamabad, it occurred at various elevations including at site-I (Malpur) near Rawal Lake, site-II (Phalwari), site-III ( Gandian valley), site-IV (Talhar village), around Rumli stream, Shadara valley, Ratta Hottar, Bari Imam area and site-VI (Shah-Allah-Ditta) area in the park (Fig.2), at elevations ranging from 462 m to 1046 m. Presence of some old living/permanent burrows but absence of fresh feeding burrows of the species at Trail-3 and Trail-5 areas of the park at site-V (Sangjani) and site-VI (Talhar area) indicates its occurrence at these sites in the near past but not now. In the park no signs of presence of the species could be found at an elevation of 579 m to 869 m (Daman-e-Koh).

**Burrows quantification:** Two kinds of burrows of scaly ant-eater were observed in the study area; sleeping or permanent burrows, and the feeding or temporary burrows. The feeding burrows were less deep and excavated by the Scaly ant-eater during foraging on ants and termites, whereas the permanent burrows were much deeper and used by the species for sleeping/resting during day time.

**Feeding Burrows:** A total of N= 244 feeding burrows were recorded at fifteen different sampling sites (Table 3); N=131 were quantified from six different sites (Table 1). Average height and width of feeding burrow opening (Table 1) was found to be 8.92 ± 0.19 and 8.85 ± 0.13 inches, respectively, while its average depth was 14.56 ± 1.37 inches. Maximum numbers of feeding burrows (Fig. 3) were recorded at site-I (Malpur; n = 77) and minimum at site-VI (Shah Allah Ditta; n = 7). No feeding burrows were found at site-V (Sangjani).

**Living/sleeping Burrows:** A total of N= 104 permanent/ sleeping burrows of Scaly anteater were found at fifteen different sampling sites (Table 3) while N=71 were quantified from six different sites (Table 1). Maximum burrows were observed at site-I (Malpur). Only nine burrows were found active and all others were inactive (Fig.3). Only sampling site-I and II harbored active burrows while the remaining four selected sampling sites did not have any single active permanent burrow, although these sites had many inactive burrows (Fig.3).
Average height and width of permanent burrow opening was found to be 9.42 ± 0.06 inches and 9.09 ± 0.08 inches, respectively, whereas the average depth of the permanent burrows was 46.03 ± 2.75 inches. Thus the burrow opening was almost circular in shape.

One-way Analysis of Variance (ANOVA) was applied to compare the results of the burrow characteristics. The depths of feeding and living burrows were significantly different (One way –ANOVA, $p < 0.05$), the diameter and the number of the two types of burrow openings showed non-significant difference (one way-ANOVA, $p = 0.06$, and $p = 0.07$, respectively). However, $t$ - test showed that numbers of inactive and active permanent burrows at six selected sites were significantly different from each other (student's paired $t$ - test, $p < 0.01$; $df = 5$; $t = 3.34$).
Both feeding and permanent burrows of scaly ant-eater were recorded at different elevations in the park (Fig. 4); lowest elevation where burrows occurred was 462 m (Malpur) while the highest elevation was 1046 m (Trail-3) and 932 (Talhar). Beyond Trail-3 no burrows of the scaly ant-eater were found.

**Abundance estimates:** On the basis of counts of active, permanent, living burrows, recorded at fifteen different sites at different elevations in the MHNP (Table 3), average population density of the scaly ant-eater has been, estimated to be 0.36 /km$^2$.

**Vegetation analysis:** Data collected from six selected sampling sites showed *Dalbergia sissoo, Acacia modesta*, *Zizyphus nummularia* and *Pinus roxburghii* as dominant tree species (Table 4). Highest density of trees (88 ± 62.06 /ha) was recorded at site-III (Gandian valley) followed by at site-IV (Talhar; 64.67 ± 45.26 /ha). Dominant shrub species included *Dodonaea viscosa* and *Lantana camara* (Table 5). Highest density of shrubs (5.92 ± 1.08 /4m$^2$) was noticeable at site-VI (Shah Allah Ditta) followed by at site-IV (Talhar; 5.5 ± 2.31/4m$^2$)). Among the herb species, dominant was *Cynodon dactylon* which occurred at all six sampling sites (Table 6). Maximum density of herbs was recorded at site-IV (Talhar) followed by at site-II (Phalwari).

**Phyto-associations of Scaly ant-eater:** Most of the living or permanent burrows of Scaly anteater were found under *Lantana camara* at site-I and –III, whereas at site-IV, many of its burrows were found excavated under the *Punica granitum*. Similarly, most of the termites and ants colonies (which are prey species of the Scaly ant-eater) were recorded on and around *Dalbergia sissoo* and *Acacia modesta* tree species in the study area. These results suggest preference of the Scaly ant-eater for these vegetation species in its habitat. Hence, Scaly ant-eater shows phyto-association with *Lantana camara, Punica granitum*, *Dalbergia sissoo* and *Acacia modesta* species.

**Table 1. Size of feeding burrows of the Scaly ant-eater, quantified at six selected sampling sites of the MHNP, Islamabad during the current study period.**

| Site Name | Elevation asl (m) | Area ($km^2$) | N | Height (inches) | Width (inches) | Depth (inches) |
|---|---|---|---|---|---|---|
| Site-I (Malpur) | 564 | 2 | 77 | 9.05±0.147 | 8.85±0.13 | 15.08±0.70 |
| Site-II (Phalwari) | 638 | 1 | 18 | 9.27±0.23 | 9.1±0.21 | 16.68±1.26 |
| Site-III (Gandian) | 620 | 1 | 16 | 9.34±0.24 | 9.2±0.22 | 9.27±0.21 |
| Site-IV(Talhar) | 930 | 2 | 13 | 8.5±0.24 | 8.61±0.23 | 15.03±1.03 |
| Site-V (Sangjani) | 560 | 1 | 0 | 0 | 0 | 0 |
| Site-VI (Shah-Allah-Ditta) | 708 | 1 | 7 | 8.42±0.33 | 8.5±0.34 | 16.78±1.64 |
| **Mean ± SE** | | **8** | **131** | **8.92± 0.19** | **8.85± 0.13** | **14.56± 1.37** |

*N= total numbers of feeding burrows*

**Table 2 Average parameters of living burrows (permanent burrows) of Scaly ant-eater quantified at six selected sampling sites of MHNP, Islamabad, during the current study period.**

| Study site/ elevation asl (m) | Area ($km^2$) | N | Height (inches) | Width (inches) | Depth (inches) |
|---|---|---|---|---|---|
| Site-I (Malpur) (564) | 2 | 34 | 9.4±0.13 | 9.05±0.11 | 48.17±1.79 |
| Site-II (Phalwari) (638) | 1 | 14 | 9.48±0.22 | 9.35±0.22 | 52.35±2.30 |
| Site-III (Gandian) (620) | 1 | 11 | 9.3±0.25 | 9.09±0.20 | 51.63±2.53 |
| Site-IV (Talhar) (930) | 2 | 2 | 9.65±0.35 | 9.35±0.35 | 40.5±2.5 |
| Site-V (Sangjani) (560) | 1 | 6 | 9.5±0.24 | 8.95±0.28 | 48.33±2.91 |
| Site-VI (Shah-Allah-Ditta) (708) | 1 | 4 | 9.2±0.42 | 8.8±0.46 | 35.25±3.59 |
| **Mean ± SE** | **8** | **71** | **9.42± 0.06** | **9.09± 0.08** | **46.03±2.75** |

*N = total numbers of living burrows*

**Table 3. Location of feeding and living burrows of the Scaly ant-eater at fifteen different sampling sites in the Margalla Hills National Park Islamabad, Pakistan.**

| | | | | | Living Burrows | |
|---|---|---|---|---|---|---|
| **Sr. No.** | **Sampling sites** | **Geographical Coordinates** | **Elevation (m)** | **No. of Feeding Burrows** | **No. of Active Living Burrows** | **No. of Inactive Living Burrows** |
| 1 | Malpur | 33° 43'43.80"N 73°08'53.62"E | 564 | 77 | 7 | 27 |
| 2 | Lake view | 33°42'43.46"N 73°07'54.03"E | 536 | 3 | 0 | 9 |
| 3 | Bannigalla | 33°41'47.60"N 73°09 15.09"E | 514 | 6 | 0 | 4 |
| 4 | Shahdara | 33°46'43.21"N 73°10'04.02"E | 691 | 0 | 0 | 1 |
| 5 | Rumli | 33°46'47.25"N 73°06'45.81"E | 591 | 1 | 0 | 2 |
| 6 | Phalwari | 33° 45'34.70"N 073° 08'20.7"E | 638 | 18 | 2 | 12 |
| 7 | Gandian | 33° 08.502'N 071°54.276'E | 620 | 16 | 0 | 11 |
| 8 | Kalinjir | 33°43'45.55"N 73°01'06.32"E | 613 | 2 | 0 | 8 |
| 9 | Bari Imam | 33°44'37.93"N 73°06'34.37"E | 597 | 0 | 0 | 2 |
| 10 | Ratta Hottar | 33°45'01.43"N 73°05'59.09"E. | 626 | 1 | 0 | 1 |
| 11 | Daira Jangala | - | 630 | 1 | 0 | 3 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 12 | Trail-3 | 33°44'33.24"N 73°04'55.69"E | 1046 | 0 | 0 | 3 |
| 13 | Talhar | 33° 46'04.33"N 073° 02'57.78"E | 930 | 13 | 0 | 2 |
| 14 | Sangjani | 33° 42'02.63"N 072° 51'10.89"E | 560 | 0 | 0 | 6 |
| 15 | Shah-allah-Ditta | 33° 43'20.86"N 072° 55'02.81"E | 708 | 7 | 0 | 4 |
| **Total** | | | | **244** | **9** | **95** |

**Table 4. Density, frequency, relative cover and ImportanceValue Index (IVI) of tree species at six selected study sites of MHNP, Islamabad during current study period.**

| Study site/elevation asl (m) | Sr. No. | Tree species | D/ ha | R.D | R.F | R.C | IVI |
|---|---|---|---|---|---|---|---|
| **I –Malpur** | **1** | *Dalbergia sissoo* | 3 | 50 | 35.8 | 54.65 | 140.45 |
| | **2** | *Zizyphus nummularia* | 1.8 | 30 | 35.8 | 5.93 | 71.73 |
| | **3** | *Acacia nilotica* | 0.6 | 10 | 14.3 | 0.92 | 25.22 |
| | **4** | *Berberis lycium* | 0.3 | 5 | 7.2 | 6.49 | 18.69 |
| | **5** | *Acacia modesta* | 0.3 | 5 | 7.2 | 32.8 | 45 |
| | | **Mean ± SE** | 1.2±0.52 | 20±8.80 | 20.06±6.55 | 20.16±10.26 | 60.21±22.08 |
| **II- Phalwari** | **1** | *Dalbergia sissoo* | 2.1 | 70 | 50 | 5.204 | 125.2 |
| | **2** | *Acacia nilotica* | 0.15 | 5 | 10 | 3.041 | 18.041 |
| | **3** | *Zizyphus nummularia* | 0.15 | 5 | 10 | 0.057 | 15.057 |
| | **4** | *Acacia modesta* | 0.15 | 5 | 10 | 0.057 | 15.057 |
| | **5** | *Broussonetia papyrifera* | 0.15 | 5 | 10 | 2.46 | 17.46 |
| | **6** | *Olea ferruginea* | 0.3 | 10 | 10 | 0.092 | 20.092 |
| | | **Mean ± SE** | 0.5±0.32 | 16.67±10.69 | 16.67±6.67 | 1.81±0.86 | 35.15±18.02 |
| **III- Gandian** | **1** | *Acacia modesta* | 211.2 | 80 | 55.56 | 85.67 | 221.24 |
| | **2** | *Grewia optiva* | 39.6 | 15 | 33.33 | 14.26 | 62.59 |
| | **3** | *Zizyphus nummularia* | 13.2 | 5 | 11.11 | 0.062 | 16.172 |
| | | **Mean ± SE** | 88±62.06 | 33.34±23.51 | 33.33±12.83 | 33.33±26.48 | 100±62.08 |
| **IV- Talhar** | **1** | *Pinus roxburghii* | 155.2 | 80 | 55.56 | 99.46 | 235.03 |
| | **2** | *Bauhinia variegate* | 19.4 | 10 | 22.22 | 0.128 | 32.35 |
| | **3** | *Olea ferruginea* | 19.4 | 10 | 22.22 | 0.412 | 32.632 |
| | | **Mean ± SE** | 64.67±45.26 | 33.34±23.33 | 33.34±11.11 | 33.33±33.06 | 100±67.51 |
| **V- Sangjani** | **1** | *Melia azedarach* | 5.2 | 10 | 15.38 | 6.69 | 88.65 |
| | **2** | *Dalbergia sissoo* | 13 | 25 | 23.07 | 40.57 | 88.65 |
| | **3** | *Acacia modesta* | 23.4 | 45 | 38.46 | 30.33 | 113.8 |
| | **4** | *Ficus carica* | 5.2 | 10 | 15.38 | 14.84 | 40.21 |
| | **5** | *Eucalyptus camaldulensis* | 5.2 | 10 | 7.69 | 7.55 | 25.25 |
| | | **Mean ± SE** | 10.4±3.58 | 20±6.89 | 19.99±5.21 | 20±6.66 | 71.32±16.57 |
| **VI- Shah-Allah-Ditta** | **1** | *Zizyphus nummularia* | 16.6 | 20 | 18.75 | 22.83 | 61.59 |
| | **2** | *Acacia modesta* | 24.9 | 30 | 18.75 | 32.48 | 81.24 |
| | **3** | *Dalbergia sissoo* | 12.45 | 15 | 18.75 | 12.72 | 46.48 |
| | **4** | *Acacia nilotica* | 16.6 | 20 | 25 | 18.73 | 63.74 |
| | **5** | *Ficus carica* | 12.45 | 15 | 18.75 | 13.24 | 47 |
| | | **Mean ± SE** | 16.6±2.27 | 20±2.73 | 20±1.25 | 20±3.63 | 60.01±6.40 |

**Table 5. Density, frequency, relative cover and Importance Value Index (IVI) of Shrub species at six selected sampling sites of MHNP Islamabad during current study period.**

| Study site | Sr. No. | Tree species | D/ 4m² | R.D | R.F | R.C | IVI |
|---|---|---|---|---|---|---|---|
| I –Malpur | 1 | *Dalbergia sissoo* | 2.6 | 45.6 | 30 | 34 | 109.6 |
| | 2 | *Zizyphus mauritiana* | 1.6 | 28.07 | 40 | 36 | 104.07 |
| | 3 | *Lantana camara* | 1.5 | 26.31 | 30 | 30 | 86.31 |
| | | **Mean ± SE** | **1.9± 0.35** | **99.58± 6.15** | **33.34±3.33** | **33.34±1.76** | **99.99 ±7.02** |
| II-Phalwari | 1 | *Dodonaea viscosa* | 1.5 | 24.19 | 46.16 | 71.99 | 142.34 |
| | 2 | *Carissa opaca* | 3.6 | 58.06 | 30.76 | 16.8 | 142.34 |
| | 3 | *Justicia adhatoda* | 1.1 | 17.74 | 23.08 | 11.21 | 52.03 |
| | | **Mean ± SE** | **2.06±0.77** | **33.33±12.50** | **33.34±3.91** | **33.34±19.39** | **112.24±30.10** |
| III-Gandian | 1 | *Carissa opaca* | 6.6 | 33 | 22.72 | 20.93 | 76.65 |
| | 2 | *Dodonaea viscosa* | 4.8 | 24 | 22.72 | 36.63 | 83.35 |
| | 3 | *Lantana camara* | 2.8 | 14 | 22.72 | 16.16 | 52.88 |
| | 4 | *Maytenus rolyleanus* | 1.3 | 6.5 | 13.64 | 5.99 | 26.13 |
| | 5 | *Justicia adhatoda* | 4.5 | 22.5 | 18.19 | 20.29 | 60.98 |
| | | **Mean ± SE** | **4.00±0.90** | **20±4.52** | **19.99±1.81** | **21±4.94** | **59.99±10.05** |
| IV- Talhar | 1 | *Punica granatum* | 16.3 | 48.94 | 23.8 | 31.09 | 103.83 |
| | 2 | *Dodonaea viscosa* | 7.1 | 21.32 | 23.8 | 26.25 | 131.43 |
| | 3 | *Mallotus phillipensis* | 2.1 | 6.3 | 23.8 | 16.24 | 46.34 |
| | 4 | *Pyrus pashia* | 1.1 | 3.3 | 14.28 | 10.09 | 27.67 |
| | 5 | *Maytenus rolyleanus* | 4.1 | 12.31 | 4.76 | 8.45 | 25.52 |
| | 6 | *Quercus leucotrichophora* | 2.6 | 7.8 | 9.52 | 7.89 | 25.21 |
| | | **Mean ± SE** | **5.5± 2.31** | **16.66 ±6.94** | **16.66 ±3.42** | **16.67±4.03** | **60.0 ±18.84** |
| V-Sangjani | 1 | *Lantana camara* | 8.8 | 30.5 | 14.29 | 5.86 | 50.65 |
| | 2 | *Dodonaea viscosa* | 5 | 17.36 | 19.05 | 26.67 | 63.08 |
| | 3 | *Maytenus rolyleanus* | 4.5 | 15.6 | 14.28 | 22 | 51.88 |
| | 4 | *Calotropis procera* | 3 | 10.4 | 19.05 | 17 | 46.45 |
| | 5 | *Justicia adhatoda* | 3 | 10.4 | 14.28 | 11.19 | 35.87 |
| | 6 | *Zizyphus mauritiana* | 4.5 | 15.6 | 19.05 | 15.63 | 50.28 |
| | | **Mean ± SE** | **4.8 ±0.86** | **16.64 ± 3.01** | **16.66 ± 1.06** | **16.39 ±3.03** | **49.70 ± 3.59** |
| VI- Shah-Allah-Ditta | 1 | *Calotropis procera* | 4.1 | 17.29 | 23.53 | 26.35 | 67.17 |
| | 2 | *Lantana camara* | 7.8 | 32.91 | 23.53 | 22.58 | 79.02 |
| | 3 | *Maytenus rolyleanus* | 7.8 | 32.91 | 23.53 | 19.83 | 76.27 |
| | 4 | *Dodonaea viscosa* | 4 | 16.87 | 29.41 | 39.96 | 86.24 |
| | | **Mean ± SE** | **5.92 ± 1.08** | **24.99±4.57** | **25±1.47** | **27.18±4.46** | **77.18±3.88** |

**Table 6. Density, frequency, relative cover and IVI of herb species quantified at six selected study sites of MHNP, Islamabad during current study period.**

| Sampling site | Sr. No. | Tree species | D/1m² | R.D | R.F | R.C | IVI |
|---|---|---|---|---|---|---|---|
| I –Malpur | 1 | *Cynodon dactylon* | 17 | 64.88 | 21.05 | 42 | 127.21 |
| | 2 | *Saccharumbengalense* | 4 | 15.26 | 21.05 | 13.2 | 49.99 |
| | 3 | *Carthamus oxycantha* | 0.6 | 2.3 | 15.8 | 6.3 | 24.63 |
| | 4 | *Cannabis sativa* | 2.3 | 8.8 | 21.05 | 21.9 | 51.76 |
| | 5 | *Convolvus arvensis* | 2.3 | 8.8 | 21.05 | 16.6 | 46.46 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | **Mean ± SE** | **5.24± 2.98** | **20.0± 11.40** | **33.34±3.33** | **33.34±1.76** | **60.01±22.58** |
| II-Phalwari | 1 | *Cynodon dactylon* | 33.33 | 68.53 | 29.49 | 58.81 | 156.57 |
| | 2 | *Saccharum bengalense* | 9.3 | 19.12 | 23.53 | 25.06 | 67.72 |
| | 3 | *Cannabis satzva* | 4 | 8.22 | 23.53 | 8.14 | 40.21 |
| | 4 | *Convolvus arvensis* | 2 | 4.11 | 23.53 | 7.99 | 35.62 |
| | | **Mean ± SE** | **12.15 ±7.22** | **24.99±14.85** | **33.34±1.72** | **33.34±19.39** | **75.03±32.43** |
| III-Gandian | 1 | *Cynodon dactylon* | 19 | 58.9 | 23.04 | 37.46 | 119.48 |
| | 2 | *Saccharum bengalense* | 10.5 | 32.54 | 30.72 | 35.98 | 99.02 |
| | 3 | *Carthamus oxycantha* | 1.6 | 4.95 | 23.04 | 19.14 | 47.32 |
| | 4 | *Cannabis satzva* | 1.16 | 3.59 | 23.04 | 7.42 | 34.06 |
| | | **Mean ± SE** | **8.06±4.23** | **24.99±13.12** | **24.96±1.81** | **21±4.94** | **74.97±18.25** |
| IV- Talhar | 1 | *Cynodon dactylon* | 40 | 90.29 | 44.46 | 63.06 | 197.79 |
| | 2 | *Convolvus arvensis* | 2.5 | 5.64 | 33.33 | 6.24 | 45.2 |
| | 3 | *Achyranthes aspera* | 1.8 | 4.06 | 22.21 | 30.7 | 57.04 |
| | | **Mean ± SE** | **14.76±12.61** | **33.33±28.48** | **33.33±3.42** | **16.67±4.03** | **100±34.65** |
| V-Sangjani | 1 | *Cynodon dactylon* | 9.1 | 66.9 | 36.36 | 55.89 | 159.15 |
| | 2 | *Saccharum bengalense* | 3 | 22 | 27.28 | 31.48 | 80.76 |
| | 3 | *Cannabis sativa* | 1.5 | 11 | 36.36 | 12.63 | 59.99 |
| | | **Mean ± SE** | **4.53±2.32** | **33.3±17.09** | **33.33±2.14** | **33.33±8.85** | **99.96±30.19** |
| VI- Shah-Allah-Ditta | 1 | *Cannabis sativa* | 0.66 | 4.12 | 15.44 | 6.06 | 25.62 |
| | 2 | *Saccharum bengalense* | 6.67 | 41.7 | 30.76 | 29.47 | 101.93 |
| | 3 | *Carthamus oxycantha* | 1.16 | 7.25 | 23.06 | 14.56 | 44.87 |
| | 4 | *Cynodon dactylon* | 7.5 | 46.9 | 30.76 | 49.89 | 127.55 |
| | | **Mean ± SE** | **3.99±1.79** | **24.99±11.21** | **25±3.66** | **24.99±9.60** | **74.99±23.86** |

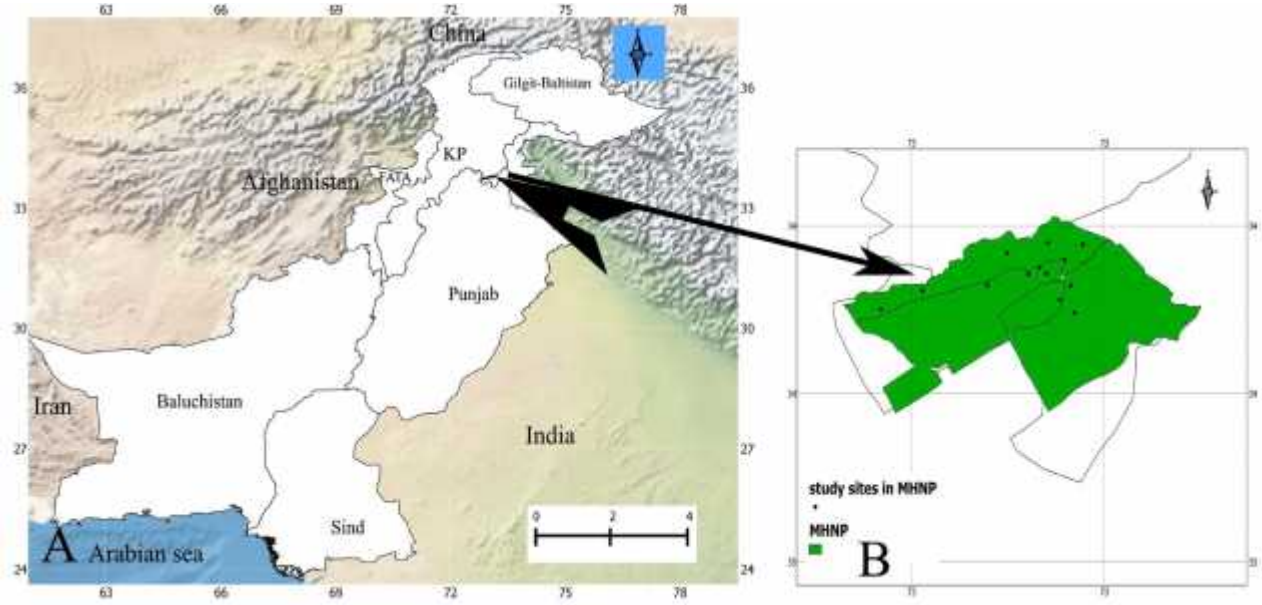


**Fig. 1. A) Map of Pakistan showing location (arrow head) of the Margalla Hills National Park (MHNP) Islamabad, in the north west of the country. B) Location of different sampling sites in the MHNP Islamabad.**

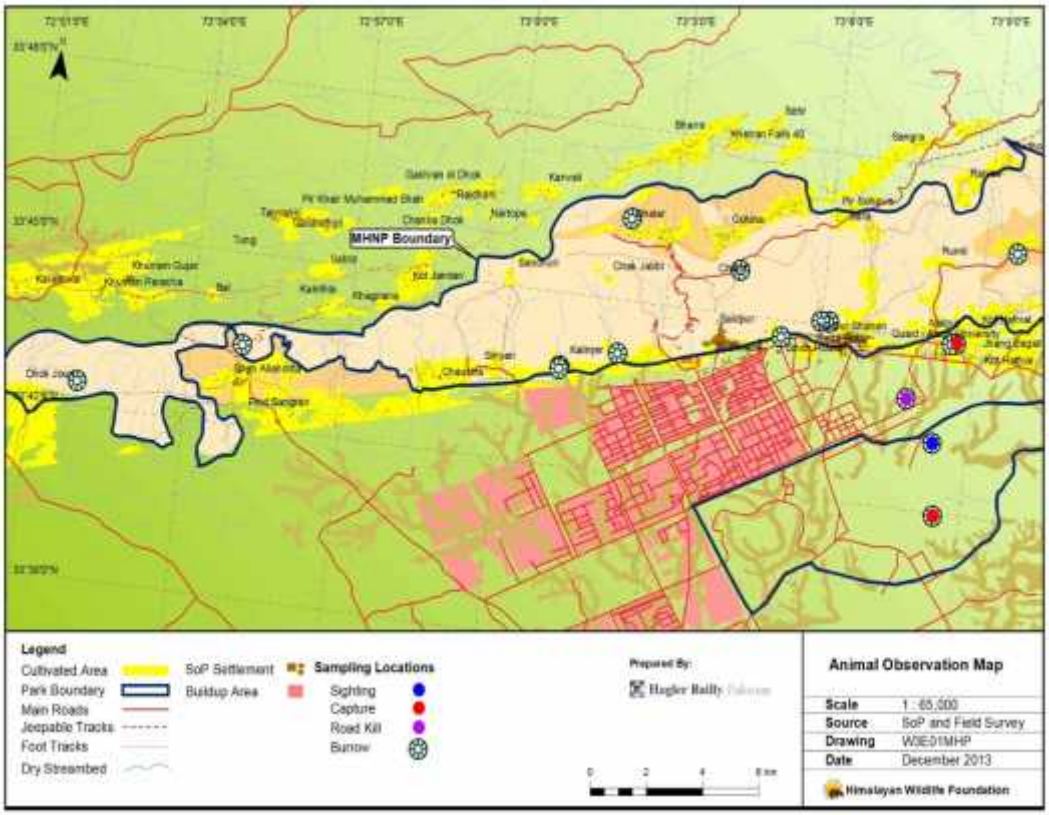


**Fig. 2. Distribution map of the Scaly ant-eater (*Manis crassicaudata*) in the MHNP Islamabad, the figure depicts sightings, capture, road kills and burrow occurrences of the species in the park.**

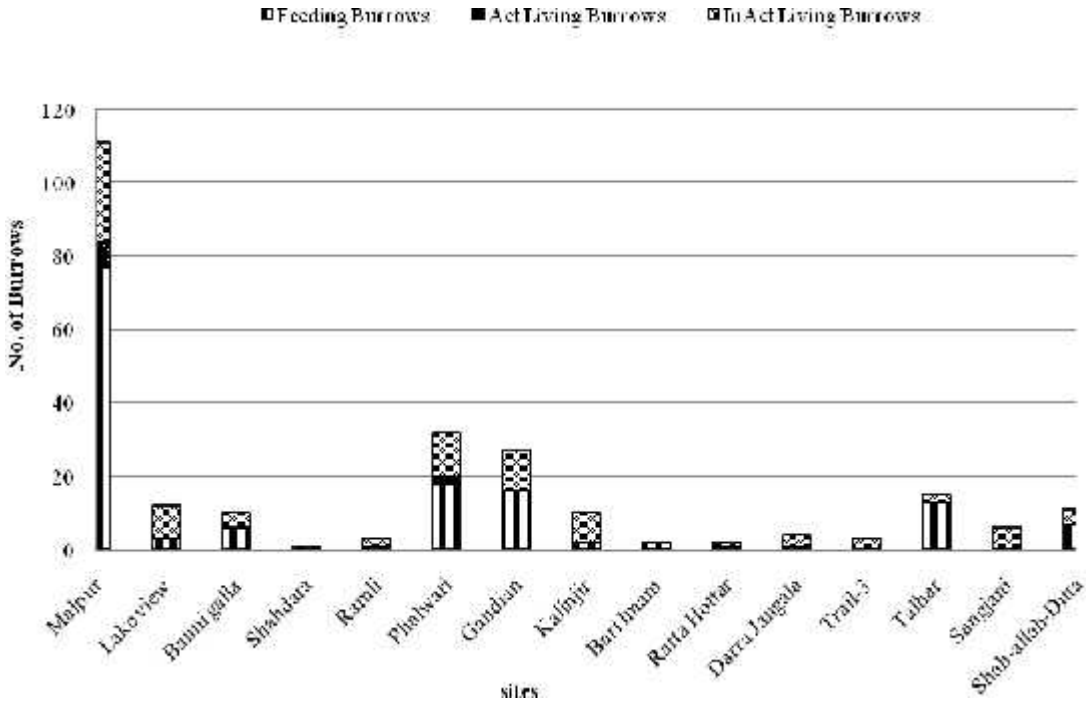


**Fig. 3. Numbers of feeding burrows, and active and inactive living permanent burrows of the Scaly ant-eater (*Manis crassicaudata*) recorded in different areas of the MHNP, Islamabad, during current study period.**

## DISCUSSION

Scaly ant-eater (*Manis crassicaudata*) is being hunted and killed for its keratinized scales, meat and trade purposes from its natural habitat (Mahmood *et al.*, 2012) and it is suspected that its population is declining rapidly. Also the species has got a low reproductive output (Roberts, 1997). In such scenario, it is pertinent to monitor regularly the distribution range and population of this unique insectivorous mammal in its natural habitat. Unluckily, the species has stayed neglected in the region regarding scientific investigation and so very little information (Roberts, 1997) exists about its habitat use and population estimates (IUCN, 2012). Here we investigated its population, and vegetation analysis in the MHNP Islamabad, a potential habitat of the species.

Roberts (1997) had reported that scaly ant-eater occurs in the sub-tropical thorn forest of the Potohar plateau and in Rawalpindi foothills up to 750 m elevation above sea level. But in the current study, we have recorded the scaly ant-eater at various elevations at scattered places in the park up to an elevation of 1046 m. However, no signs of occurrence of the species were found above this elevation in the park, this could be because of many factors, especially, the rocky type of soil unsuitable for digging burrows above this elevation. Frick (1968) and Mitchell (1975) had reported that *Manis pentadactyla*, another species of pangolin commonly known as Chinese pangolin, occurs in eastern Nepal and Bhutan at the foothills of the Himalayas, apparently confined to elevations below approximately 1,500 m in Nepal.

The scaly ant-eater has been found to dig two types of burrows; one temporary called feeding burrows (which it excavates during foraging on ants and termites), and the other permanent called sleeping or living burrows. In general, much more numbers of feeding burrows were found in the park than those of living or permanent burrows, and the numbers of two types of burrows differed significantly ($p < 0.05$). Similarly, the depth of two types of burrows also showed significant difference ($p < 0.05$); whereby the feeding burrows are less deep compared to those of living permanent burrows which are much more and significantly deeper. However, the diameter of burrow opening of the two types of burrows is not much different. Earlier on Pai (2008) had reported that depth of burrows of the Scaly ant-eater varies in different habitats depending upon the soil composition; in the soft soil its depth may be more than 6 meters while in rocky soil it varies from 1.5 m-1.8 m (up to 70 inches). Similarly, the Chinese pangolin (*Manis pentadactyla*) is also a burrowing species capable of digging up to eight feet within five minutes, although it will inhabit abandoned burrows that have been previously constructed. Once inside a burrow, it will close off the opening in order to protect itself. This species mainly consumes ants and termites, using its strong claws to dig into colonies and its tongue to extract the insects (Red Orbit, 2013). Ground burrows of different pangolin species may range around 15 to 20 cm in diameter with a depth of several meters and terminating in a circular chamber as much as 2 m in circumference. Burrow entrances are generally closed with dirt when occupied. Similarly, Giant Pangolin burrows may be as much as 5 m deep and 40 m long (Nowak, 1991).

Despite of the thorough search about the published data on various aspects of the scaly ant-eater, the authors could find no published records about population estimates of scaly anteater, not only in the country but also in South Asia (IUCN, 2012). Among fifteen different sites where indirect signs of the scaly ant-eater were recorded in the MHNP, very few permanent active living burrows of the species were found; some sites in the park did possess old inactive permanent burrows, although now they were being utilized by some other species.Therefore, only two sampling sites, that is, site-I (Malpur area) and site-II (Phalwari area) showed existing active population of the Scaly ant-eater in the park. Depending upon the area of the sites and the fewer numbers of active living burrows, average population density of Scaly ant-eater has been estimated to be 0.0036 individuals/ha (0.36/km$^2$) in the study area. We have the difficulty to compare these results since there is no previous published data available about the population of this species in the country or Asian region for comparison. Although according to IUCN Red List of Threatened species (IUCN, 2013), virtually no information is available on population levels of any species of Asian pangolins. But there are some reports about population trend for some other pangolin species such as Chinese pangolin (*Manis pentadactyla*). These pangolin species are rarely observed due to their secretive, solitary, and nocturnal habits, and there is not enough research on population densities or global population (WCMC *et al*., 1999; CITES, 2000). Therefore, very little information is available on population status anywhere in the species' range, but it appears to be decreasing over much of its range. This species was reported in the 1980s as common in the undisturbed hill forests of Arunachal Pradesh, however, little is known about the total population in India (Tikader, 1983; Zoological Survey of India, 1994). Reports from the late 1980s and early 1990s suggest that the total population of this species in Taiwan was decreasing due to poaching and habitat destruction (Chao, 1989; Chao Jung-Tai *et al*., 2005).

Vegetation analysis of the habitat of the scaly ant-eater in the MHNP shows that dominant tree species, among others, are *Dalbergia sissoo, Acacia modesta,* and *Pinus roxburghii*, dominant shrub species include *Dodonaea viscosa* and *Lantana camara,* while among herb species dominant was *Cynodon dactylon.* It was

noticeable that most of permanent/sleeping burrows of scaly ant-eater were found under *Lantana camara* at site-I and III while at site-IV, its permanent burrows were recorded under *Punica granitum*. Earlier on, it was reported that humid environment at the roots of some plant species might provide assistance in making burrows and also these roots are favorable for ants and termites nests (Akhter and Rashid, 2001). Most termites and ants colonies were recorded on and around *Dalbergia sissoo* and *Acacia modesta* species.

There are some recent reports about the illegal capture and trade of Scaly ant-eater from some areas of the MHNP, also especially from around Malpur site (Mahmood *et al.,* 2012). One road kill of the species was also recovered from around Lake View Park area during the current study. Under such circumstances, the scaly ant-eater requires special conservation measures to save its thinly distributed, low and scattered population in the study area.

**Conclusion:** The scaly ant-eater occurs in very low density in the MHNP, its distribution ranges from 500 m up to 1046 m above sea level. The depth of its feeding and sleeping burrows and the number of active and inactive permanent living burrows differ significantly and the species prefers for *Lantana camara* and *Punica granitum* for excavating its burrows and *Delbergia sissoo and Acacia modesta* for getting its insect food.

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