Habitat and Distribution of Chinese Pangolin *(Manis Pentadactyla* Linnaeus, 1758*)* in Nagarjun Forest of Shivapuri Nagarjun National Park, Nepal

Namrata Bhandari and Mukesh Kumar Chalise

Central Department of Zoology, Tribhuvan University, Kirtipur, Kathmandu, Nepal

For correspondence: mukesh57@hotmail.com

Abstract

Pangolins belong to the least studied burrowing mammals whose information on distribution and ecology is still scarce in Nepal. Their distribution was studied in the Nagarjun forest of Shivapuri Nagarjun National Park (SNNP) during April 2013. We surveyed 700×60 m^2 strip transects for indirect data collection, 140 quadrates of 10×10 m^2 were used for vegetation analysis. Total 235 burrows were recorded which were not uniform in distribution. Burrows were mostly distributed in the habitat dominanat by *Schima wallichii*, *Castonopsis tribuloides*, *Castonopsis indica* and *Betula alnoides* with canopy cover between 25-50% in brown soil and in northwest aspect in the elevation range between 1450-1550 m. Chi-square test revealed that there was a significant difference in the distribution of burrows according to different transects, altitude, aspects, soil, vegetation and crown cover. Wilcoxon test revealed there was a significant difference in the burrows dimension distributed in red and brown soil. Fresh burrows density was found to be 0.8333 burrows per hectare.

***Key words*:** Burrows, *Castanopsis*, Pangolins, *Schima*, SNNP

Introduction

There are only eight extant species of Pangolins confined to the Afrotropical and Indomalayan regions (Gaubert and Antunes 2005). Only two species are recorded in Nepal: Chinese pangolin (*Manis pentadactyla*) and Indian (*M. crassicaudata*) (Chalise 2008). Chinese pangolin is one of the Asian species representing the intermediate form between Malayan and Indian pangolin (Pocock 1924). Their range partially overlaps with those of Asian species (Heath 1992). They occur in the Himalayan foothills in eastern Nepal, Bhutan, India, Bangladesh, Myanmar, Vietnam, Thailand, China and Taiwan (Shrestha 2003, Duckworth et al. 2008). In Nepal they are distributed in sunny shaded hills of Kathmandu, Dhading, Kavre, Ramechap, Sindhulli Gorkha, Bardia (Chalise 2008, 2012). They are widely distributed in primary and secondary tropical forests (Chakraborty et al. 2002), limestone forests, bamboo forests, grasslands and agricultural fields (Gurung 1996). They dig their own burrows by moving their bodies side to side and excavating both sides and the roof of the passage (Heath 1992). They are the only species from Nepal that has prehensile tail and can hang by it in tree branches. Their tail is also used to carry infants (Chalise 2000, 2008).

They belong to susceptible species due to their taxonomic uniqueness (monotypic order: Pholidota, family: Manidae and genus: Manis), feeding habit is stenophagy (only eating several species of ant and termites), very low reproductive rate (usually one cub per litter, one litter per year) and strict requirement for habitat and very poor defense like moving slowly, shy, curling up into a ball when threatened (Wu et al. 2004). These are solitary, nocturnal, good climber though terrestrial and like other pangolins swims well (Chao 1989, Heath and Vanderlip 1988).

Data are insufficient on pangolin distribution, population status and life histories to enable an assessment of their conservation needs and one of the major difficulties in studying wild pangolins has been the difficulty in locating those (Newton et al. 2008). It is known that pangolins are in serious decline throughout their range because of its illegal trades for food and medicines (Wu et al. 2004, Liou 2006 and Yang et al. 2007). In Nepal, Chinese pangolin is protected by National Parks and Wildlife Conservation Act, 1973 (Chalise 2008). It is listed as endangered in IUCN Red List Data (IUCN 2008) and under Appendix II of the Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES 2000). As an additional protective measure, the CITES authority passed a zero export quota in 2000, which bans all commercial trade in pangolins (Kang and Phipps 2003).

Materials and Methods

Study site

The present study was carried out in the Nagarjun forest (from 27° 43' 37.13" to 27° 46' 22.84" N and from 85° 13' 52.97" to 85° 18' 14.38" E), part of the Shivapuri Nagarjun National Park which covers an area of 16 km^2. The study area extends from base of Nagarjun forest (around 1350 m asl) to top of Nagarjun hill (2100 m asl). It represents a typical intact of mid hill forest ecosystems and bears mostly sub-tropical type of climate and partly temperate climate (SNNP 2011, Chalise et al. 2013). The southern side is sunny and is evidently much drier than the northern forested side (Chaudhary 1998). Mean monthly rainfall ranges from 3.43 mm to 444.56 mm (July, August and September were the most precipitous months). The climatic data of the Nagarjun area is not available. According to the climatic data of nearest meteorological stations i.e. Panipokhari, Kathmandu, the average monthly relative humidity (at morning) ranges from 80.73% (April) to 87.42% (August) and average monthly relative humidity (at evening) ranges from 78.73% (April) to 87.73% (September). The mean monthly minimum temperatures of the area recorded was 3.9°C (January) to 20.35°C (July) and the mean monthly maximum temperatures of the area was recorded 18.63 °C (January) to 29.56°C (June).

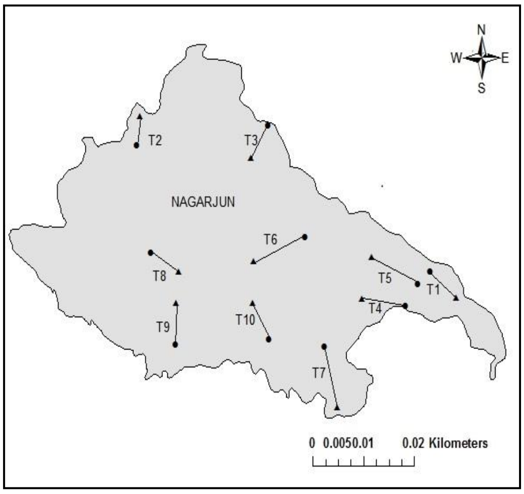

Figure 1: Map of study area with transects used for study

Methods

The potential habitats of pangolins were surveyed by using of strip transects (700×60) m^2 for their indirect signs in the month of April. Burrows were taken as the most prominent indirect signs and were searched on either side of centerline up to 30 m. Burrows were classified as: Fresh burrows (recently very active), new (no active this year) and old burrows (more than one year old). Only fresh burrows were used for the density calculation. Dominancy of vegetation in each transect was find out by the vegetation analysis (Zobel et al. 1987) where frequency, relative frequency, density, relative density, dominance and relative dominance were calculated to get important value index (IVI), i.e.

IVI= relative frequency+ relative density+ relative dominance.

For this, a quadrate size of 10 m×10 m for tree species was used. Each quadrate was alternatively placed at 50 m distance apart from one another. Total 140 quadrates were laid and number of tree species within the quadrate was recorded and their girth at breast heights (circumferences) was measured. Visual estimation was done for the canopy cover.

Data Analysis

We used R-Software (R-Console version 2.15.2) and microsoft excels for the statistical analysis while ArcGIS 9.3 was used for mapping. Chi- Square test was used to find out significant differences in the distribution of burrows of Pangolin in altitudes, transects, aspects, soil, vegetation and canopy cover. Wilcoxon test was used to find out the significant differences of depth and diameter of burrows distributed in red and brown soil.

Results

We recorded 235 burrows in the study area. Among them 35 were fresh, 41 were new and 159 were old which were not uniform in distribution. Distribution of burrows according to different attributes was studied (Table 1). The distribution of burrows was higher in Mudkhu (T3) followed by Sanagaun (T2) but least was in the Jamacho (T6), whereas most of the very active burrows were recorded at Helipad (T5). The distribution of burrows was higher at the altitude range of 1450 -1550 m (43.8%), followed by the range 1350-1450 m (23.4%) and the least was recorded from 1750-1850 m (1.3%). But more fresh burrows were at 1550-1650 m (34.28%). Aspect wise, distribution was higher at northwest aspect (45.3%) while least was observed from southeast and south west. The distribution was higher in the brown soil (83%) and 17% recorded from red soil. The distribution of burrows was high in the forest dominated by Chilaune (*Schima wallichii*) (40%) where as least in saur (*Betula alnoides*) (15.7%). The distribution was higher in the canopy cover of 25-50% (71%) while least above 75%.

Table 1. Burrows distributed along different attributes studied

Transects		1	2	3	4	5	6	7	8	9	10
BA	F	2	1	8	1	16	0	3	4	0	0
	N	5	3	16	1	4	0	6	1	2	3
	O	17	34	35	7	6	4	26	18	4	8
Altitudinal Range (m)		**1350-1450**	**1450-1550**	**1550-1650**	**1650-1750**	**1750-1850**	**1850-1950**	**1950-2050**			
BA	F	5	10	12	4	0	3	1			
	N	8	23	2	4	0	4	0			
	O	42	70	12	3	3	23	6			
Aspect		**North**	**North East**	**North West**	**South**	**South East**	**South West**	**West**			
BA	F	0	5	12	10	1	1	6			
	N	5	10	21	10	0	0	4			
	O	13	22	71	13	3	3	34			
Dominant vegetation		**Chilaune**	**Dhale Katus**	**Musure Katus**	**Saur**						
BA	F	22	4	8	1						
	N	16	4	18	3						
	O	56	30	39	34						
Canopy Cover %		**0-25**	**25-50**	**50-75**	**75-100**						
BA	F	1	34	0	0						
	N	8	28	3	2						
	O	37	107	13	2						
Soil		**Brown**	**Red**								
BA	F	21	14								
	N	33	8								
	O	141	18								

Note: BA = Burrow activities, F= Fresh Burrows, N= New Burrows, O= Old Burrows

Dominancy of vegetation (tree species) in each transects was find out by calculating IVI (Table 2)

Table 2. Transect wise total no. of tree species recorded with highest and lowest value

Transects	No. of Tree species	Highest IVI	value	Lowest IVI	value
1.	21	*Schima wallichii*	76.33	*Syzygium cumini*	1.98
2.	27	*Betula alnoides*	79.02	*Ficus neriifolia*	1.567
3.	20	*Castonopsis tribuloides*	89.48	*Myrsine semiserrata*	3.62
4.	24	*Schima wallichii*	63.38	*Myrsine semiserrata*	2.5
5.	26	*Schima wallichii*	86.45	*Acer oblongum*	1.62
6.	22	*Castonopsis indica*	71.22	*Maytenus rufa*	1.12
7.	21	*Schima wallichii*	67.45	*castonopsis indica*	2.04
8.	15	*Castonopsis indica*	78.15	*Cinnamomum tamala*	1.9
9.	7	*Castonopsis tribuloides*	108.58	*Myrsine semiserrata*	4.13
10.	7	*Castonopsis indica*	130.61	p7*(unknown)*	4.2

There was a significant difference (Chi-square test) in the distribution of burrows according to different altitude, aspect, soil, vegetation and crown cover since $P < 0.05$ for each attributes studied (Table 3). The average diameter and depth of the burrows distributed in the red soil were 22.17 cm and 2.31 m and in the brown soil were 18.98 cm and 1.36 m respectively. There was also a significant difference in the burrows dimension in red and brown soil $P<0.05$ (Table 4). Fresh burrows density was found to be 0.8333.

Table 3. χ^2 test on burrows distribution with different attributes

χ^2 test	χ^2 Value	df	P-value	Remarks
Transects	69.20	18	0.0020	significant
Altitude	35.45	8	0.0085	significant
Aspect	24.95	12	0.0150	significant
Soil	16.92	2	0.0002	significant
Vegetation	21.77	6	0.0013	significant
Canopy cover	15.79	6	0.0148	significant

Table 4. Wilcoxon test for dimension of burrows

Wilcoxon test	W-value	P-value	Remarks
Depth in two type of soil	6950.5	0.0000038	significant
Diameter in two type of soil	6282.5	0.00054	significant

The distribution map of the Chinese Pangolin showing their recent activities are plotted (Figure 2). They were mostly active in Helipad (T5) followed by Mudkhu (T3) whereas no fresh and new burrows were recorded in the T6 (Jamacho) which could show the recent activity of pangolin in that region. Only one new burrow was recorded from Ichnagu (T9).

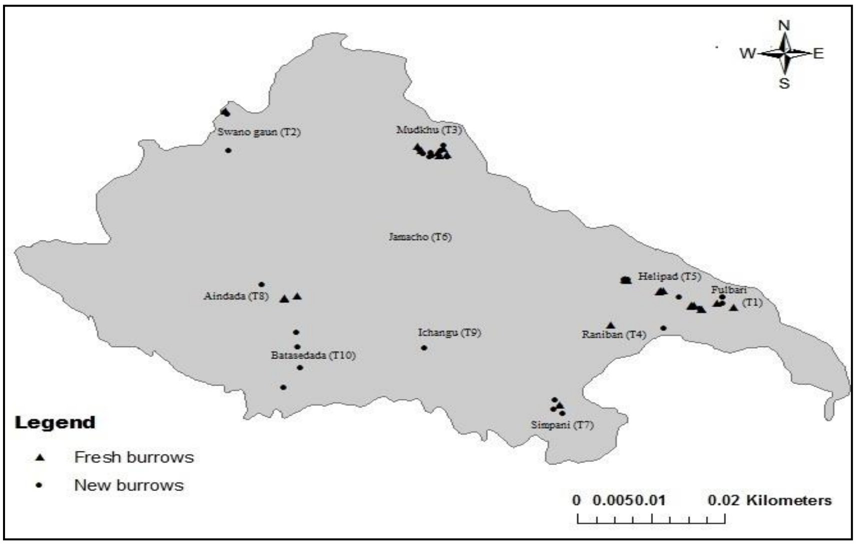

Figure 2. Map of Nagarjun with recent activities of Chinese Pangolin, 2013

Discussion

Distribution of burrows within the study area was not uniform. Maximum was recorded in Mudkhu (T3) followed by Swanagaun (T2) the reason might be the same kind of vegetation (Chilaune, Katus, Jhakrikath, etc) in both areas and the elevation range (1450 -1550 m) along with availability of food resources and the presence of water resources. Least was recorded in the Jamacho (T6), it might be due to the higher elevation range, the flow of continuous tourist to reach the Jamacho tower and also the presence of inaccessible sloppy and stiff areas. Jamacho (T6), Simpani (T7), Aindada (T8) and Batasedada (T10) all lie at the higher elevation (above 1850 m) and have similar vegetation type. But in Aindada (T8) even though it was at higher elevation more burrows were recorded the reason might be the presence of water resource, available food resources (mounds of ants were scattered) and the less human interference. In Ichangu (T9) burrows were not recorded in those areas which were dominated by Quercus species. Preference to only certain kind of vegetation could be justified with further research. The greater no. of very active (fresh) burrows was recorded in the Helipad (T5); it might be due to the reintroduction of pangolins in this area.

Burrows were mostly distributed at the range of 1450-1550 m and were also recorded beyond 2000 m, northwest aspect, in the habitat dominant with Chilaune (*Schima wallichii*), Musure katus (*Castonopsis tribuloides*), Dhale katus (*Castonopsis indica*) and Saur (*Betula alnoides*) in the canopy cover between 25-50 % in brown soil. Burrows were distributed in the vegetation of herbs and shrubs species as well: *Dryopteris* sp., Siru ghans (*Imperata cylindrica*), Paniamla (*Nephrolepis auriculata*), chutro (*Berberis asiatica*), aainselu (*Rubus ellipticus*). Heath (1992) and Wu et al. (2003) indicated the animal preference up to 1550 m while Chao (2001) and Chakraborty et al. (2002) recorded up to 2000 m. Gurung (1996) and Acharya (2001) stated the pangolins' preference to south facing slopes and in red (laterite soil) in Nagarjun which conflicts with this study finding. The reason might be that their study was concentrated only in the south facing slopes areas (Raniban, Ratamata and Jamacho) while this study was around the park. This might indicates local migration of the species since there exists a long years gap between those researches. Human disturbance can be the factor to press them towards less disturbed area. Since there is continuous flow of tourist in those areas (Raniban and Ratamata) and dense human settlements exists across the park boundary.

Wu et al. (2003) recorded burrow entrance the distance of the source of interference (< 1000 m). This suggests they try to avoid disturbances. Heath (1992) reported burrows distribution in northern parts of Fujian and Jiangxi provinces with the acidic or yellowish red soil which is similar to this study. Suwal (2011) recorded more burrows in east facing slopes with brown soil. Preference to the certain aspect in different areas might be influenced by the climatic condition, availabilities of food and degree of human interference. The study conducted by Kaspal (2008) and Suwal (2011) showed their presence in both red and brown soil and their preference to brown soil which was similar to this study. Acharya (2001) recorded that Pangolin burrows were mostly found in *Schima wallichi* and *Pine-Schima* forest. Wu et al. (2003) in winter in Dawuling Natural Reserve recorded they avoid vegetation density too high above 75% and too low less than 30% likewise in the Lama forest reserve it was recorded the vegetation cover of the pangolin habitat varied between 20% and 70% (Akpona et al. 2008).

The fresh burrow density was found to be 0.8333 burrows per hectare. The total burrow density recorded by Kaspal (2008) was $10.2/\text{km}^2$ and burrow density recorded by Suwal (2011) was 8 burrows per hectare. There was a less burrow density as compared to those researches; the reason is the use of only fresh burrows showing sorts of recent activities and area covered was large where less fresh burrows were recorded (Bhandari 2013).

Burrows in red soil were with more depth and diameter than compared for burrows in brown soil which conflicts with Kaspal (2008) showing more depth and diameter of burrows in brown soil. Soil composition might have played the role in this variation which can be justified with further researches. But average depth and diameter that was recorded for burrows in brown soil was similar to the burrows in brown soil studied by Suwal (2011), Kaspal (2008) and Yuan and Tsai (2001). Same patterns were found from the burrows of pangolin in brown soil from Sipadol forest and the Suryabinayak forest.

Conclusion

Nagarjun seems one of the prime habitats for pangolins. Time and again confiscated pangolins are released here by authority. Therefore area should be taken under special attention for the conservation and research of pangolins. The study revealed that burrows were not uniform in distribution. Their distribution seems highly influenced by the altitude, aspect, soil type and vegetation type as well as amount of the food availabilities water, degree of human interferences and also weather conditions. There was a significant difference in the burrows dimension in different type of soil.

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