

Rufford Small Grant

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Distribution, Habitat, and diet composition preferences as conservation issue of three pangolins species in Deng-Deng National Park (DDNP)-Cameroon



Final Report submitted to The Rufford Foundation

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Data Availability Statement

The datasets generated during and/or analysed during the current study are not yet publicly available and could not be used without the author consent due to [REASON(S) WHY DATA ARE NOT PUBLIC] but will be available from the corresponding author on reasonable request.

Photo credit: Difouo Fopa G. & Simo Talla F. _ S. Kekeunou and D. Olson _ Rufford Foundation/ University of Yaoundé 1

Abstract

Assessment of key ecological parameters of the species which the population is facing decline is the first step to improve their conservation strategies. Little is known about the diet, habitat preferences, seasonal changes in behavior of some African pangolins. We aim to characterize the habitat and food preferences of pangolins species in the different land cover types of the Deng-Deng national park. We recorded and described six different habitat types. During rainy season, we investigated some of these habitats with 15 camera-traps (first deployment) and currently all these habitats are being surveyed with 30 camera traps established in both savannah and forest areas during the dry season. Insect prey assemblages in the potential habitats were collected during the rainy season; 2057 individuals have already been identified comprising 55 species ants and 31815 termites' individuals comprising 76 species of termites available as food resources. A white-bellied pangolin dung was collected and analyzed and the insect fragments are currently being identified. The most frequently encountered habitat recorded was the nearly primary forest (36.5 %) which also has the highest average abundance of insects available as food resources for the pangolins. The giant pangolin photographic events mostly occurred in the woodland savannah and less occurred in the grassland savannah. There were not photographic events of both two pangolin species in the forest gallery. This project gave insights into habitat and insect prey species available as food for the target species as well as the relevant habitat that can improve pangolin reintroduction programs. The project will continue in the laboratory with insect's identification and on the field where other funds will be needed to achieve all objectives.

Keywords: Deng-Deng, pangolins, habitat types, food resources, conservation

Introduction

Understanding of clear feeding ecology, habitat preferences and local distribution pattern is immensely important for any long-term species-specific conservation plan. Pangolins reintroduction programs are key component of their conservation, these species being among the most traded around the world. These programs might benefit from prior, knowledge of pangolins' geographical origin, the insect assemblages and the different types of vegetations in the potential reintroduction habitats as well as the presence of prey known to satisfy their feeding ecology (Lee et al., 2017). Today, little is known about the natural history of African pangolin species, their diet, habitat preferences, seasonal changes in behavior and these gaps impede the ability to develop effective conservation strategies for these threatened species. While an improved understanding of these ecological features will help a long-term design and management of more viable pangolins sanctuaries by ensuring that an adequate mix of different habitat is included within sanctuaries and that sufficient area of key insect prey is incorporated to be able to sustain viable populations of each species. Hence, the knowledge of the food and habitat preferences of the three species of pangolins found in Cameroon will be the first step to support viable populations of different species within protected areas. Here, we attempt to fill the gap knowledge of the food and habitat preferences of pangolins species found in the forest-savannah transition zone of the Deng-Deng National Park.

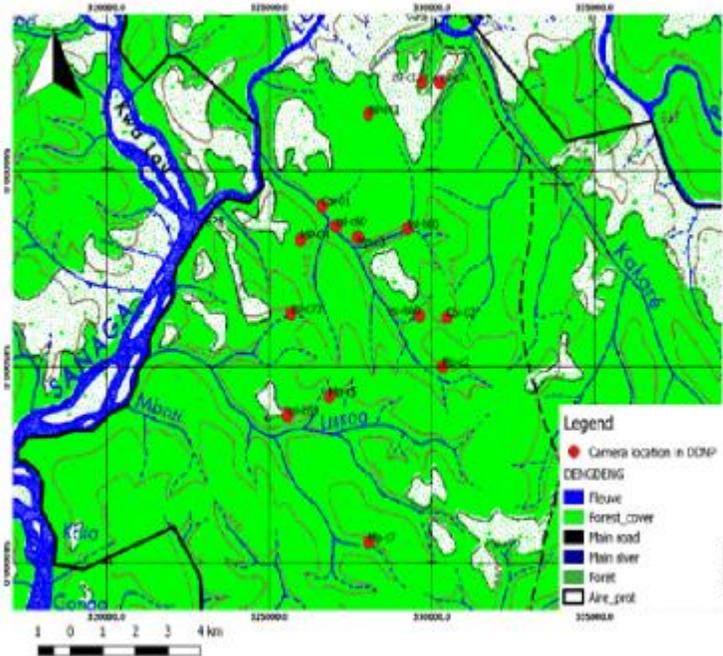
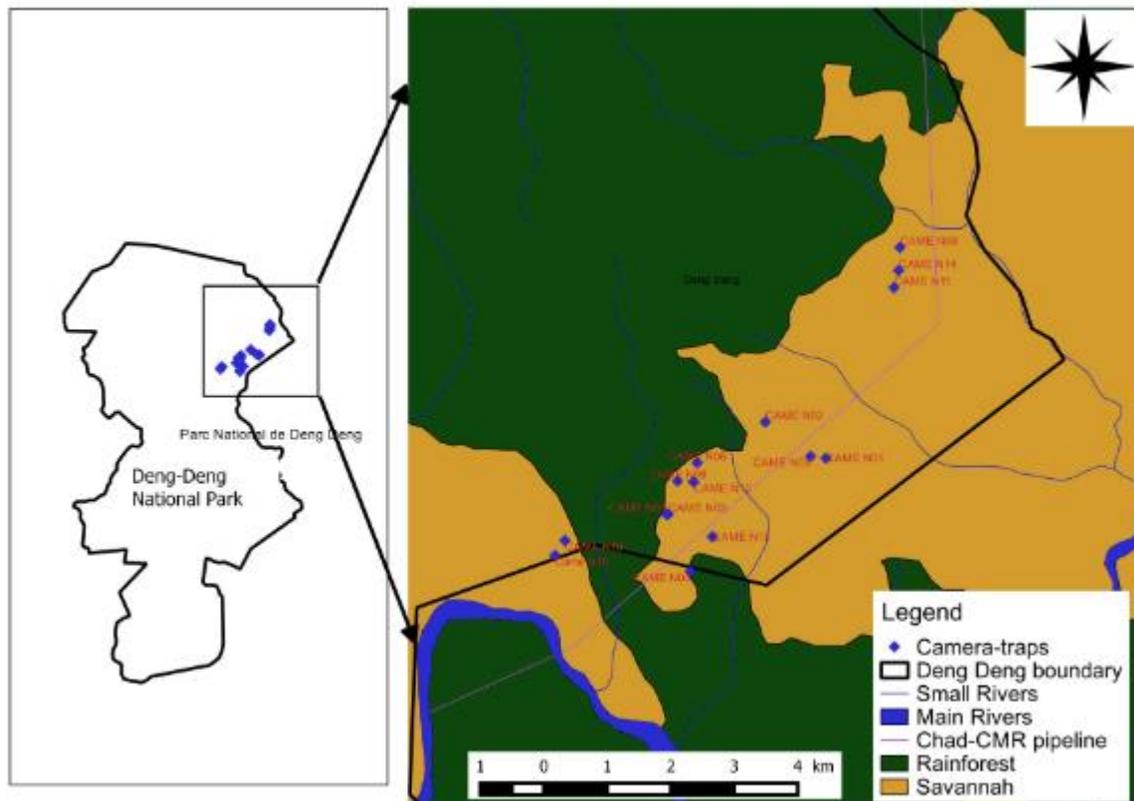
General objective: This study aims to characterize the habitat and food preferences of pangolins species in the different land cover types Deng-Deng national park.

Specific objectives

- (1) to record and describe the different types of habitat with the pangolins signs of presence;
- (2) to seasonally collect data from camera traps in order to confirm the pangolin species presence in the various habitats of the park;
- (3) to seasonally collect and identify ants and termite species available as food resources for pangolins in the various habitats;
- (4) to identify the pangolins diet composition based on stomach and dung content analysis, and compare it to the assemblage of insect prey collected in their potential habitats;

Survey area

Deng-Deng National Park is located in the Eastern Region of Cameroon in the Lom & Djerem division (5°-5° 25' N / 13°- 23° 34' E, 682 km², average altitude of 703 m) in the North-Eastern part of the lower Guinean forest. Deng-Deng National Park is characterized by an equatorial and humid climate with annual rainfall ranged from 1500-1600 mm³ per year. Seasonal pattern in the park area is characterized by dry and wet season of unequal periods. With a mean annual temperature of 23 °C.



Location of the camera -traps in the Deng-Deng national park savannah and forest zone

Field work

Awareness raising of local people

We have participated to many awareness campaigns with other conservationist stakeholders and had the opportunity to educate youths and older people on the knowledge of pangolins species and the need of their conservation.



Education of visitor during exposure concept in the city



Education on pangolin conservation



Education of local people at Deng-Deng village



Assessment of pangolin's habitat

The coordinates of habitats likely belonging to pangolins were recorded after each 250 m walk along the transect or recces followed by the team in both forest and savannah areas. Their characteristics were described and relevant parameters like altitude, slope, canopy cover, undergrowth composition (herb, lianas ...) and visibility were recorded (Bhandari & Chalise, 2014). Camera traps were installed in all recorded habitat types, having suspected signs of presence where pangolins could return regularly. The camera traps were installed in six types of habitats including Near Primary Forest, Secondary Forest, Swamp; Gallery Forest, transition of forest and savannah hereafter Woodland Savannah or ecotone and Grassland Savannah.



Figure: Principal investigator behind a potter during a trek in woodland savannah corridor made by human activity

Camera trap setting

Camera traps were established in savannah habitats in the northern part of the park and in the forest habitats in the western part of the DDNP during the rainy season. A total number of 30 camera traps were established during the dry season including 15 in the savannah and 15 in the forest, and 15 cameras during the rainy season only in the savannah. The first deployment of 15 cameras in the savannah during the rainy season including 6 Cuddebacks, 4 Bushnells, and 5 Moltrie 30i camera traps set on the giant pangolin active living burrows (LB), the fallen logs used by the white-bellied pangolin and other feeding sites including feeding burrows (FB) and ground feeding site or termite mounds with scratches (feeding activity) and feeding sites including feeding burrows termite mounds with scratches to monitor the giant pangolin presence. During the second deployment of 28 camera traps, we have established 13 camera traps in the savannah area of the Deng-Deng National Park and 15 camera traps in the forest area for the dry season. The cameras installed include 6 Cuddebacks, 7 Bushnells, 10 Bestocks and 5 Moltrie 30i camera traps set on the giant pangolin active living burrows (LB), the fallen logs used by the white-bellied pangolin and other feeding sites including feeding burrows (FB) and ground feeding site or termite mounds with scratches (feeding activity).

Notes: We could not install three camera-traps in their previous locations because they were flooded by water from the Lom-pangar hydroelectric dam. One new location of giant pangolins living burrow was recorded and monitored.





Figure: A) Principal investigator setting on camera trap; B) camera trap installed beside the fallen dead trunk, C) test of camera functioning; F) Old living burrow in the forest.

We sampled termites manually on assumed pangolins' feeding sites by collecting soil from surface to 10 cm depth containing subterranean nest using an auger, then sieved the soil and hand-sorted in search of termites collected for 2 min with forceps (Eggleton, 2002). Termites were also collected at various sites, including termite mounds with scratches, dead tree trunks with feeding signs and also any dead wood found (trunks and twigs), randomly selected in the different types of potential habitat. We also sampled termites on epigeal tree nests and tree galleries up to 2 m height, on the litter, and termite's mound randomly in each potential habitat encountered.

Ants were sampled using pitfall and sardine bait methods on 100 m line transect (White and Edwards, 2000 modified) established in each type of potential habitat encountered in the study area. Ten pitfalls of 15 cm depth containing soapy water were placed 10 m apart and recovered after 48 hours, and the trapped ants were collected using forceps. Sardine baits method was used to capture ant species belonging to foragers guild. 10 baits constituted of sardine fish and oil arranged on a piece of 10 x 10 cm white papers were placed at 20 m apart and retrieved after 10 minutes and the encountered ants on each paper and within a 50 cm radius were collected. The sampled insects were conserved in a 4 ml tube labeled containing 70° alcohol for termites; and 90° alcohol for ants.



Figure: Termites and ants sampling: AB) sites of sampling on tree termite's nest and ground termite's mound; CD) pitfall and sardine bait established to sample ants.

Dung content analysis

During the second trip in the savannah, one fecal sample was collected near a termite's mound where the white-bellied pangolin presence was previously confirmed on camera trap photographs. The sampling was brought to the laboratory for analysis following a protocol adapted from (Andrew & Ruth, 2005). After weighing the dung in the laboratory, the sample was soaked in an appropriate amount of water. After 24 hours on a blotting paper, the dry contents remaining was macroscopically examined to sort out fragments of insect bodies, stones, plant matter, eggs, and soil, then under a magnifying glass for the small size insects. All the feces components were weighed. Based on the remains fragment of both ants and termites, particularly the heads and thorax for some species, it was possible to identify morphologically with the dichotomous key, the prey components present in the dung.



Identification of ants and termites

Insect identification based on morphological criteria has been done in the laboratory of Zoology of the University of Yaoundé 1, with a stereomicroscope and the dichotomous keys of Bouillon and Mathot 1965; Grasse, 1986; Takematsu et al., 2003; Sornnuwat et al., 2004 for termites. Holldöbler *et al.* (1990) et Bolton (1994) for ants.

Statistical analysis

Frequencies were generated using the package Microsoft Excel 2016. We calculated the frequencies of independent photographic events defined as two consecutive events of different species, or consecutive events of two different individuals and finally consecutive events of the same individual in the space of 1 hour (Sollmann et al. 2012). We calculated the detection rate (DR) of each species in each type of habitat as the number of events of the species divided by the sampling effort (accumulated total number of days that the camera works) multiplied by 100.

We calculated the average abundance of each group of the insects available as food resources for pangolins in each types of habitat. The insect's species collected in the pangolins potential habitat will be compared with the fragment found in the scat and stomach content to determine the termites and ants prey species selectivity. The species abundance between sites and habitat was also analyzed with one-way ANOVA. Prior to performing ANOVA, the assumption of homogeneity of variance was tested and satisfied using Shapiro Wills test. In case of significance differences, average abundances were separated with Student test. In data cases where the assumptions of ANOVA were violated (variances not homogenous), the nonparametric Kruskal–Wallis tests was performed.

Results

Characteristics of the potential habitats for pangolins

We described different vegetation patterns recorded along 50 Km in the study area; seven different types of vegetation including savannah wetland (1.3%), woodland savannah (17.0%), grassland savannah (22.0%), swamp (2.0%), forest gallery (7.0%), secondary forest (14.0%) and near primary forest (36.5%). The near primary forest was characterized by a relatively close canopy and open undergrowth made up with the shrubs and lianas, whilst the secondary forest canopy was open with a very closed undergrowth made up with the Herbs and shrubs as well as the swamp with the slight difference of rattans and maranthaceae in the undergrowth. Gallery forest has relatively open canopy cover and undergrowth constituted of the shrubs and lianas as well as the woodland savannah which has a slight difference with a closed undergrowth. The grassland savannah has no canopy with the herbs having a high closure percentage (no visibility).

Ecosystem	Type of habitats	Fi%(n)	Canopy cover	Underground	Visibility	Slope
Forest	Primary Forest	36.5 (73)	Close	Shrubs + Lianas	open	Gentle
	Young Secondary Forest	14 (28)	Open	Herbs + shrubs	Very close	Gentle

	Swamp	2 (4)	Open	Rapphia + Maranthace ae	Very close	Gentle
	Forest Gallery	7 (14)	Open	Herbs + shrubs	Open	Gentle
Savannah	Woodland Savannah	17 (34)	Open	Herbs + shrubs	Close	Gentle
	Grassland savannah	22 (44)	Very open	Herbs	Very close	Gentle
	savannah wetland	1.5 (3)	Very open	Herbs	Very open	Gentle
Total		200				

Six of these cover lands have been assumed to potentially be the habitats of pangolins in which cameras were installed. We relied on a questionnaire survey results carried out before this study to choose the survey area in the park and also on the encounter rate of suspected pangolin's presence signs found in each habitat type. These signs include mainly active living and feeding burrows in the savannah area, but also feeding sites: termite's mounds with scratches and other feeding marks on the ground. In the forest we mostly recorded fallen tree trunks showing termites and considered as potential feeding sites for pangolin and also as pathways.



Near to primary forest



Secondary forest



Woodland savannah



Grassland savannah

Some type of habitats investigated in the Deng-Deng National Park

Results

Pangolin presence in the Deng-Deng National Park savannah area

Out of the 15 camera traps installed during the rainy season, four did not work properly during the 90 days as expected. We recorded nine independent pangolin events comprising five white-bellied pangolin events and 4 giant pangolin events. Giant pangolin and white-bellied pangolin presence in the Deng-Deng National Park savannah area were confirmed with photos from camera traps (Figure below). No evidence of the Black-bellied pangolin was recorded. The 28 camera-traps installed in both savannah and forest during the dry season (*Mid-December 2019 to Mid-March 2020*) are not yet retrieved.

Photo credit: Difouo Fopa G. & Simo Talla F. _ S. Kekeunou and D. Olson _ Rufford Foundation/ University of Yaoundé 1



White-bellied pangolin footage in the Deng-National Park

Pangolins events according to the potential habitats

Amongst the giant pangolin photographic events, the highest percentage (33.33) occurred in the forest-savannah transition zone hereafter woodland savannah and the higher percentage (11.1) occurred in the grassland savannah. There was no photographic event of both two-pangolin species in the forest gallery. The white-bellied pangolin events were all recorded in the woodland savannah. The following figures are showing different species of pangolin detected with the associated habitat where the species was mostly detected.

(Photo credit: Difouo F.G. & Simo T.F. S. Kekeunou and D. Olson _ Rufford Foundation/ University of Yaoundé 1).



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A) Giant pangolin near a living burrow in WS, B) White-bellied on the termites mound

Ants average abundance according to the habitat

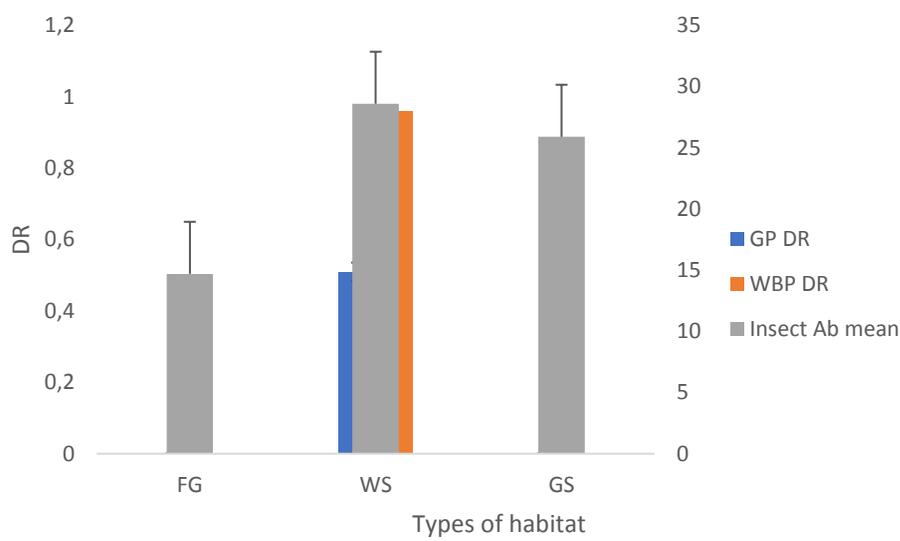
A total of 7857 ants was collected in both forest and savannah area comprising 55 species. The near to primary forest has the highest average abundance (136.5 ± 27.56) of ants available as food resources, the secondary forest has shown a higher average abundance (108.2 ± 22.59) followed respectively by the woodland savannah (28.6 ± 6.75), forest gallery (14.7 ± 4.10) and the grassland savannah (25.9 ± 11.35). We recorded a lowest average of insect's abundance in swamp (6.1 ± 5.23).

Table: average abundance of the insect's species available as food resources

	GF	NPF	WS	GS	SF	SW	Kruskal wallis	p-value
Mean \pm	147	1365	286	259	1082	61	64.81	<0.00001
Std. error	(14.7 \pm 4.10)	(136.5 \pm 27.56)	(28.6 \pm 6.75)	(25.9 \pm 11.35)	(108.2 \pm 22.59)	(6.1 \pm 5.23)		

Detection rate according to the abundance of food resources

The giant and the white-bellied pangolin detection rate was high in the habitat with the highest number of insect's species and average abundance. The higher detection rate 0.96 % from white-bellied and 0.51 % from giant pangolin was recorded in the woodland savannah which has shown a high food resources available for pangolins with 64.11% of the biomass and the highest number of species of the insects collected. A higher detection rate of the giant pangolin was obtained in the grassland savannah which has shown a higher relative abundance despite its higher species richness. We have recorded no pangolin's detection in the forest gallery which has shown the lower relative abundance and insect's species richness.



Detection rate of the two pangolins species according to the habitats types

White-bellied pangolin feces' components

The white-bellied pangolin's dry fecal sampled weighed grams. The feces analysis revealed the presence of ant's and termites body part including (termite and ants heads, ant legs, ant abdomen, ant thorax), ant egg shells, clay (termites' mounds), sands, plant matter, and stones.



Component of the white-bellied pangolin scat after analysis

Conclusion

We recorded six habitats for pangolins species; we have already investigated three and the cameras are installed in three others. We have already assessed ants' communities of these six habitats and identified 55 species of ants and 76 species of termites available as food resources. We intend to assess the seasonal variation of Ant and termites during the next dry season. Collect the stomach content or dung of white-bellied pangolin for analysis in order to identify the insect species satisfying the feeding behavior of the species. The main habitat recorded

in the parks was the nearly primary forest which also have the highest abundance mean of ants available as food resources. The giant and white-bellied pangolins presence was confirmed only in the woodland savannah, and the gallery forest and we need to continue the investigation in the forest habitat. The white-bellied and giant pangolin presence in the forest area of the Deng-Deng national park will be confirmed with cameras that have been installed there at the beginning of the dry season. We have not yet recorded an evidence of the Black-bellied pangolin during this survey.

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