Short Communication

Tropical Conservation Science
Volume 11: 1–5
© The Author(s) 2018
Reprints and permissions:
sagepub.com/journalsPermissions.nav
DOI: 10.1177/1940082917749224
journals.sagepub.com/home/trc
SAGE

Locating Giant Ground Pangolins (*Smutsia gigantea*) Using Camera Traps on Burrows in the Dja Biosphere Reserve, Cameroon

Tom Bruce[1], Romeo Kamta[2,3], Roger Bruno Tabue Mbobda[4], Stephane Talla Kanto[4], Djibrilla Djibrilla[4], Ituka Moses[4], Vincent Deblauwe[2,5,6], Kevin Njabo[2,5], Matthew LeBreton[2], Constant Ndjassi[1], Chris Barichievy[7,8], and David Olson[1]

Abstract
Giant ground pangolins (*Smutsia gigantea*) are poorly known and difficult to study due to their nocturnal and burrowing habits. Here, we test the efficacy of using camera traps on potentially active burrows identified by local Ba'Aka guides to rapidly locate giant ground pangolins in the wild for subsequent observation and tagging for telemetry studies. We deployed nine cameras on potential giant ground pangolin burrows in the Dja Biosphere Reserve, Cameroon. One camera photographed an adult male giant ground pangolin using a burrow within 2 days of camera deployment. The pangolin used the same burrow several times over a 25-day period and possible scent-marking behavior was recorded.

Keywords
Smutsia gigantea, burrow, giant pangolin, Dja Biosphere Reserve, Cameroon

Introduction

The giant ground pangolins (*Smutsia gigantea* [Illiger, 1815]) of African lowland forests and savanna gallery forests remain one of the planet's least studied animals (Kingdon, Hoffmann, & Hoyt, 2013). What little information there is describes an animal that is largely nocturnal, burrowing, and primarily restricted to remote areas where hunting pressure is low. The steep rise in demand for pangolin scales driven by traditional remedies in Asia has greatly increased black market prices and is now driving intensive commercial hunting of all pangolin species in Africa (Challender & Hywood, 2012; Cheng, Zing, & Bonebrake, 2017). Giant ground pangolins are coveted by illegal wildlife traffickers for their large scales and by hunters for bushmeat (Ingram et al., 2017; Waterman, Pietersen, Hywood, Rankin, & Soewu, 2014).

Kingdon et al. (2013) warn that, "the large size, slow reproductive rate and terrestrial habits make the giant ground pangolins vulnerable to over exploitation, and that more research is required to address the currently inadequate conservation situation of the species" (p. 399). Understanding resource and area requirements for *S. gigantea* is essential for conservation management. This can be achieved through generating baseline natural history information and in developing and testing spatial habitat use models that can predict the species' potential

[1]Zoological Society of London—Cameroon, Yaoundé, Cameroon
[2]Congo Basin Institute, Yaoundé, Cameroon
[3]University of Dschang, Dschang, Cameroon
[4]Ministry of Forestry and Wildlife, MINFOF, Dja Faunal Reserve, Yaoundé, Cameroon
[5]Center for Tropical Research, Institute of the Environment and Sustainability, University of California, Los Angeles, CA, USA
[6]International Institute of Tropical Agriculture, Yaoundé, Cameroon
[7]Zoological Society of London, Conservation Programmes, Regent's Park, London, UK
[8]Institute for Communities and Wildlife in Africa, University of Cape Town, Rondebosch, South Africa

Received 3 November 2017; Revised 29 November 2017; Accepted 29 November 2017

Corresponding Author:
Tom Bruce, Zoological Society of London—Cameroon, Yaoundé, Cameroon.
Email: Thomas.Bruce@zsl.org

range and habitat use. Knowledge gained from such models can inform conservation-relevant estimates of home range size and variation, overlap of home ranges among individuals, population densities (and range of variation) within major habitat types, and minimum area requirements for maintaining viable populations of giant ground pangolins in different habitats or regions and under different hunting pressure regimes—presently no data or estimates exist for any of these for this pangolin species.

A spatial habitat use model would be derived, in part, from quantified habitat covariates combined with a species' activity model that can inform how the animals engage with their habitat. However, gathering data to support this is challenging due to the species' largely nocturnal and reclusive habits. Encounter rates of giant ground pangolins from previous studies are low (e.g. 0.22 [0.08 SE] independent photographic events/100 days; Bruce et al., 2017]). These traits make direct observational studies to understand how it utilizes its habitat difficult as it is not easy to find or to relocate the animal. An understanding of the habitat requirements and activity patterns, as well as natural history observations, will need to be augmented with remotely sensed data, such as telemetry and camera-trap studies. Giant ground pangolins have never been tagged or tracked to date, though other pangolin species have (Nebo & Rankin, 2011; Pagés, 1975; Pietersen, McKechnie, & Jansen, 2014; Sun, Lin, Lai, & Pei, 2015). Temminck's ground pangolin (*Smutsia temminckii* [Smuts, 1832]) habitat use has been studied by following animals that have radio transmitters attached and remotely sensed information collected through GPS receivers (Pietersen et al., 2014). However, simply finding a giant ground pangolin to attach a tracking device to begin such research can be difficult given their apparent rarity and furtive habits. For these reasons, we tested a field survey method to cost-effectively locate a giant ground pangolin in order to deploy a tracking tag by a research team. As camera traps have been used previously to document elusive species (Whitworth, Braunholtz, Huarcaya, MacLeod, & Beirne, 2016), we placed camera traps on potential pangolin burrows identified by local Ba'Aka guides to test if it was possible to locate an active burrow within 2 to 3 weeks. We also assessed the feasibility of using camera traps for longer term surveillance of active burrows to learn more about the natural history of giant ground pangolins.

Methods

Study Area

The camera-trap burrow survey was conducted in south central Cameroon in the 526,000 ha Dja Biosphere Reserve (DBR; Figure 1). The reserve is among the largest protected areas in Cameroon and surrounded by community forests, forestry management units, and rural roads and settlements. Nine camera traps were placed on nine possible pangolin burrows (see below for selection criteria) in the vicinity of the Congo Basin Institute's Bouamir Research Station in the DBR (3°11′27″N, 12°48′41″E; 650 m–800 m elevation) situated

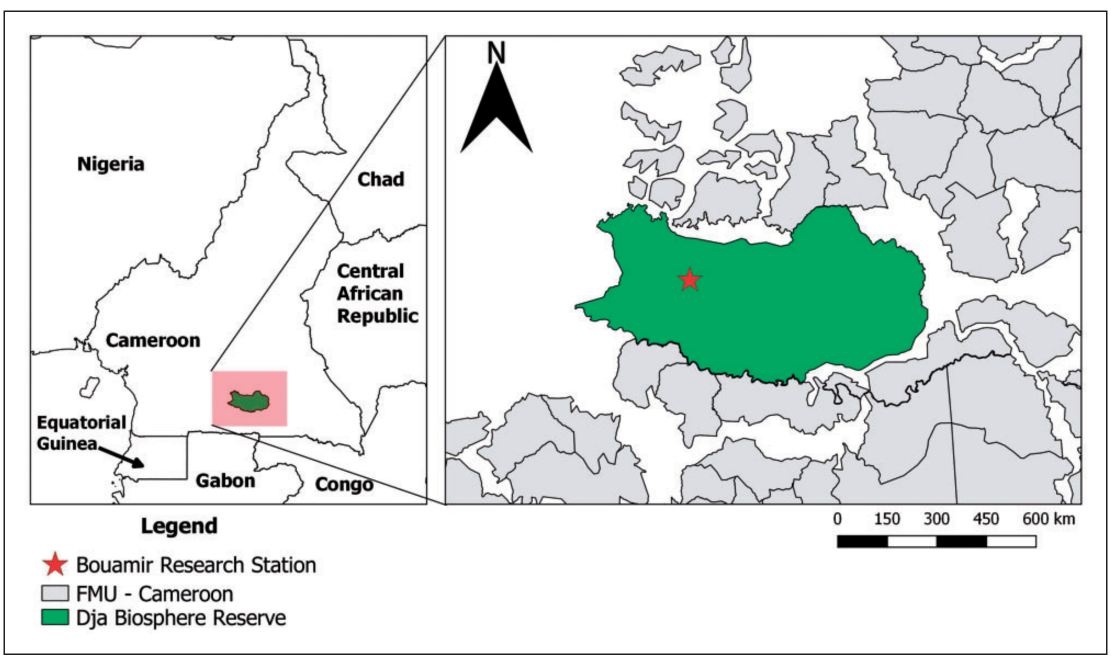

Figure 1. Location of Bouamir Research station in the Dja Biosphere Reserve (DBR), Cameroon. FMU are surrounding forestry management units.

in the western portion of the Northern Sector (Figure 1). Semideciduous lowland forest is the dominant habitat. Low areas support *Raphia* and *Uapaca* swamps. Annual rainfall is ca. 1,600 mm with two wet (September maximum) and two dry (December to January and July) seasons (Laclavére, 1980). The forests surrounding the research station have never been commercially logged or farmed and are approximately 16 km from the nearest village or road. Giant pangolins are fully protected in Cameroon (Ministry of Forests and Wildlife [MINFOF], 2017). However, poaching for bushmeat and the illegal trade in elephant ivory, great apes, and pangolin scales is increasing within the DBR (MINFOF and International Union for the Conservation of Nature [IUCN], 2015), though populations of many species of wildlife (giant ground pangolins remain unassessed) in the immediate vicinity of the research station appear to have remained stable over the past decade (Chen, Garcia, Kameni, & Roswall, 2017).

Burrows

Two experienced forest guides who work with the Bouamir Field Station identified nine potentially active burrows. Burrows were identified based on diameter, location, and the presence of scratch marks on surrounding ground and roots. All the burrows were within 2.5 km of the Bouamir Field Station. We made the reasonable assumption that burrows used by giant ground pangolins have to be relatively large to accommodate an adult pangolin. Burrows that ranged in diameter from 30 cm to 60 cm were, therefore, selected for monitoring by camera traps. Giant ground pangolins are reported to be commonly associated with swamps, though they are reported to forage in diverse habitats (Kingdon, Hoffman, and Hoyt, 2013). Six out of eight localities discovered by local guides were within 100 m of swamp habitat. In addition to distance to swamp, we recorded covariate data about burrows, such as diameter breast height (dbh) of associated trees, if present, aspect, slope, and canopy cover. Several burrows had entrances at the base of trees and roots. Some trees had multiple entrances that may lead to a single interconnected burrow.

Camera Traps

Cuddeback Long Range IR E2 camera traps were set on trees 3 to 5 m from the burrows. The cameras were strapped to trees roughly 30 to 50 cm above the ground. The cameras were set to take ambient light photos and videos in the day and infrared photos and video at night. The first cameras were installed on June 29, 2017, and the last on July 4, 2017. The cameras were not checked until retrieval on either July 27, 2017, or July 28, 2017. The cameras were active between 23 and 29 days.

Results

One camera trap out of nine at eight localities (two burrow entrances were associated with a single tree) photographed a pangolin at a burrow in this survey (Figure 2). The burrow was adjacent to a tree located on a northeast facing slope at the edge of a swamp. The tree had multiple burrow entrances around its trunk and roots, and cameras were placed to capture

Figure 2. Giant pangolin photographed by camera trap leaving a burrow at Bouamir Research Station in the Dja Biosphere Reserve, Cameroon.

images of the two largest burrow entrances. The active burrow (30 cm in diameter) was located under extended roots, and the tree diameter at 1.3 m (dbh) was 152 cm. Another camera on a 60-cm diameter burrow located directly on the other side of the large root on the same tree produced overexposed images, and we could not tell if a pangolin was active there. At the active burrow, we photographed at least one single, adult male—testicles are clearly discerned in several images and video—giant ground pangolin entering and exiting the burrow multiple times. The camera was placed on June 30, 2017, and retrieved on July 25, 2017, and was thus active for 25 nights. The pangolin visited this burrow on July 1 at 7:55 p.m. (2 days after camera set-up; the pangolin appears to be departing the burrow, though in this case and the others that follow, it may have been simply investigating the burrow and not residing there), July 7 at 7:55 a.m. (the pangolin is assumed to be departing the burrow), July 8 at 10:17 p.m. (possibly departing, possibly scent-marking), July 18 at 11:55 p.m. (possibly returning), July 20 at 11:21 p.m. (possibly returning, possibly scent-marking), July 21 at 6:38 p.m. (possibly departing), July 21 at 6:42 p.m. (possibly returning), and July 22 at 1:25 a.m. (possibly returning). All the activities of the giant ground pangolin recorded at the burrow occurred at night. We cannot be certain if the pangolin was staying inside the burrow or simply investigating it. As there were several burrow entrances greater than 30 cm in diameter on the same tree and these were not effectively monitored, one cannot surmise any further on the activity patterns of the giant ground pangolin photographed at Camera 56 as it may have been able to exit and enter the burrow complex from another burrow entrance. The giant ground pangolin was observed in the videos to be actively sniffing the tree root on several occasions and appears to scent mark twice by prominently pressing its anal glands to the top of the root (Zoological Society of London [ZSL], Congo Basin Institute [CBI], and MINFOF, 2017).

Discussion

Our observations indicate that camera traps placed on potentially active burrows (i.e., burrows where pangolins are residing in them or are investigating them on a regular basis) can potentially detect animal presence within 2 days of placement. Identifying candidate burrows may be facilitated through the assistance of indigenous guides with knowledge of pangolin signs and habits. Based on this limited data set, we can profile an active giant ground pangolin's burrow as being at least 30 cm in diameter, it may possibly be located under roots that appear to have the moss and lichens on the upper surface abraded by passage of the pangolin and may have scent-marking sign. This latter feature may mean that trained dogs may potentially be useful in finding active burrows. Multiple burrow entrances may be present.

This survey further confirms that giant ground pangolins are active at night. However, several anecdotal reports (Gabon, J. Bailie, personal communication, 24 November 2016) of animals encountered in the day (Mbam et Djerem National Park, Cameroon, I Goodwill, personal communication, August 2017; Lopé NP, Gabon. K. Abernethy, personal communication, July 2017) indicate that giant ground pangolins may be active in the day as well. This is not without precedent as white-bellied pangolins (*Phataginus tricuspis* [Rafinesque, 1821]), black-bellied pangolins (*P. tetradactyla* [Linnaeus, 1766]) and Temminck's ground pangolins are known to be active in the day (Pietersen et al., 2014). The presence of multiple burrow entrances around the active pangolin burrow prohibits any confident conclusions about the activity patterns of giant ground pangolins, such as how long they remain in burrows, when they enter and exit, on average, and whether they use multiple burrows. It is also not known if giant ground pangolin share burrows with other individuals, either together or at different times, though recent camera-trap surveys in the same protected area have twice captured two adult animals walking one after another. The current understanding is that giant ground pangolins are solitary (Kingdon et al., 2013).

Camera 56 also photographed Emin's pouched rat (*Cricetomys emini* [Wroughton, 1910]) and African brush-tailed porcupine (*Atherurus africanus* [Gray, 1942]) going in and out of the active giant ground pangolin burrow on the same evening, and the porcupine was photographed within 15 min following giant ground pangolin activity. This suggests that the burrow may be complex below ground with multiple chambers or, alternatively, burrow residents have high tolerance for one another. It remains unknown which animals dig the burrows in the DBR, though. Aardvarks (*Orycteropus afer* [Pallas, 1766]) are active burrowers and have recently been recorded in the Reserve. *Smutsia temminckii* is known to utilize aardvark burrows (Pietersen, McKechnie, and Jansen, 2014).

Implications for Conservation

For any researcher intent on learning more about giant ground pangolins, camera traps on potential burrows offer a cost-effective means of locating and observing the animals as they use single or multiple burrows. Researchers hoping to place a tag on an animal to learn more about its activity patterns and habitat requirements may potentially use this survey technique to rapidly locate an animal for tag placement. If active burrows can be identified through physical characteristics, camera trapping or eDNA sampling could help develop a habitat/predictive model for active burrows and could be used to build a picture of local giant pangolin populations. Gaining a better understanding of giant pangolin natural history could help to characterize and identify viable refugia for this threatened species and shed light on its vulnerability to exploitation, and help inform conservation management of the species.

Acknowledgments

The authors would like to thank the government of the Republic of Cameroon and the Ministry of Forests and Wildlife for their continuing support of this effort as part of their overall program to protect and manage Cameroon's wildlife. The authors would also like to thank Conservator H Ndinga of the Dja Faunal Reserve and the Chef d'Antenne SJ Meye for their ongoing support of conservation research within the protected area. The authors thank T Smith of the Congo Basin Institute and the University of California, Los Angeles for his guidance and ongoing support of this research. The authors greatly appreciate the assistance of A David, S Augustin, and M Mebengue, the Ba'Aka guides who work with the Congo Basin Institute's Bouamir Research Station, and who shared their knowledge and ably identified candidate giant pangolin burrows. The authors thank Cuddeback (Non Typical, Inc) for their contributions towards making camera traps affordable for our wildlife research work. The authors also thank C Waterman, T Smith, P De Ornellas, T Wacher, and C Ransom for review of earlier drafts. We thank Dan Challender and an anonymous reviewer for their reviews of the final manuscript. We thank R Sennett Day, S Winteringham, and J Ridley for assistance with the giant ground pangolin videos.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Supplementary material

Supplementary material is available for this article online.

References

Bruce, T., Wacher, T., Ndinga, H., Bidjoka, V., Meyong, F., Ngo Bata, M., . . . Olson, D. (2017). *Camera-trap survey for larger terrestrial wildlife in the Dja Biosphere Reserve, Cameroon*. Yaoundé, Cameroon: Zoological Society of London (ZSL) & Cameroon Ministry of Forests and Wildlife (MINFOF).

Challender, D. W. S., & Hywood, L. (2012). African pangolins under increased pressure from poaching and intercontinental trade. *TRAFFIC Bulletin*, *24*, 53–55.

Chen, E., Garcia, J., Kameni, M., & Roswall, T. (2017). *Interdecadal alterations in frugivore abundance and diversity in a Congo Basin tropical rainforest: The Bouamir story* (Unpublished report). Yaoundé, Cameroon: Congo Basin Institute.

Cheng, W., Zing, S., & Bonebrake, T. C. (2017). Recent pangolin seizures in China reveal priority areas for intervention. *Conservation Letters*. Advance online publication. doi:10.1111/conl.12339.

Ingram, D. J., Coad, L., Abernethy, K. A., Maisels, F., Stokes, E. J., Bobo, K. S., . . . Scharlemann, J. P. W. (2017). Assessing Africa-wide pangolin exploitation by scaling local data. *Conservation Letters*. Advance online publication. doi:10.1111/conl.12389.

Kingdon, J. S., Hoffmann, M., & Hoyt, R. (2013). *Smutsia gigantea* Giant Ground Pangolin. In: J. S. Kingdon, & M. Hoffmann (Eds.). *The mammals of Africa. Volume 5: Carnivores, pangolins, equids, rhinoceroses* (pp. 396–399). London, England: Bloomsbury Publishing.

Laclavére, G. (Ed.). (1980). *Atlas of the United Republic of Cameroon*. Paris, France: Editions Jeune Afrique.

Ministry of Forests and Wildlife [MINFOF]. (2017). *Lettre Circulaire No 0007/LC/MINFOF/DFAP/SDVEF du 11 JAN 2017: Relative a l'Exportation du Perroquet Gris a Queue Rouge et du Pangolin.* Yaoundé, Cameroon: Cameroon Ministry of Forests and Wildlife.

MINFOF & International Union for the Conservation of Nature [IUCN] (2015) *Caractérisation de la population de grands et moyens mammifères dans la Reserve de Faune du Dja: Potentiel et menaces*. Yaoundé, Cameroon: IUCN.

Nebo, B., & Rankin, P. (2011.) Tagging Okulunu with a GPS/GSM unit. *Pangolin Research Mundulea: Pangolin survival strategies in dry-land Savannahs: A pilot study in Namibia.* Retrieved from http://pangolins-namibia.blogspot.com/2010/12/tagging-okulunu-with-gps-combination.html.

Pagés, E. (1975). Etude éco-éthologique de *Manis tricuspis* par radio-tracking. *Mammalia*, *39*, 613–641.

Pietersen, D. W., McKechnie, A. E., & Jansen, R. (2014). Home range, habitat selection and activity patterns of an arid zone population of ground pangolins, *Smutsia temminckii*. *Africa Zoology*, *49*, 365–276.

Sun, C-M., Lin, J-S., Lai, C-Y., & Pei, K. J-C. (2015). *Home range, density, habitat preference and modelling of pangolins* (Manis p. pentadactyla) *in southeastern Taiwan*. Presentation at the 1st International Conference on Pangolin Conservation, Trade and Rehabilitation, Mabula Lodge, South Africa, October 12–15, 2016.

Waterman, C., Pietersen, D., Hywood, L., Rankin, P., & Soewu, D. (2014). *Smutsia gigantea*. *The IUCN Red List of Threatened Species 2014*: e.T12762A45222061. Retrieved from http://dx.doi.org/10.2305/IUCN.UK.2014-2.RLTS.T12762A45222061.en.

Whitworth, A., Braunholtz, L. D., Huarcaya, R. P., MacLeod, R., & Beirne, C. (2016). Out on a limb: Arboreal camera traps as an emerging methodology for inventorying elusive rainforest mammals. *Tropical Conservation Science*, *9*, 675–698.

Zoological Society of London, Congo Basin Institute, & MINFOF. (2017). Giant pangolin video from Bouamir Research Station, Dja Biosphere Reserve, Cameroon. Video clips can be viewed at: https://youtu.be/7oiqZDQf-G8; https://youtu.be/vaLpunbjAHo; https://youtu.be/vdXelgj5PlM.