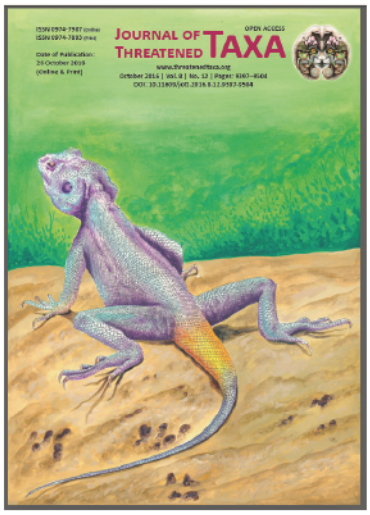

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SHORT COMMUNICATION

CAMERA TRAPPING THE PALAWAN PANGOLIN *MANIS CULIONENSIS* (MAMMALIA: PHOLIDOTA: MANIDAE) IN THE WILD

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Camera trapping the Palawan Pangolin *Manis culionensis* (Mammalia: Pholidota: Manidae) in the wild

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Abstract: The Palawan Pangolin *Manis culionensis* is restricted to the Palawan faunal region in the Philippines. The species' distribution and natural history are poorly known due, in part, to it only recently being recognized as a distinct species. Pangolin species around the world are threatened due to habitat loss and the illegal wildlife trade. Understanding the conservation requirements of the Palawan Pangolin will inform efforts to avert its extinction. Presently, information on the status, distribution, and natural history of pangolins is largely derived from interviews with local people, radio-telemetry, transect surveys for pangolin sign, and camera trapping. Here we test the ability of fish oil- and pig blood-baited camera traps to document the presence of Palawan Pangolin. We obtained three photos at two localities in Palawan in mangrove, lowland forest, and riverine forest.

Keywords: Camera trap surveys, Manidae, *Manis culionensis*, Palawan, pangolin.

The order *Pholidota* comprises eight *Manis* species in the family *Manidae*. All eight *Manis* species hold an IUCN Red List category and are listed under Appendix II in the Convention on International Trade in Endangered Species (CITES). *Manis culionensis* Palawan Pangolin is listed as Endangered by the IUCN with habitat loss from deforestation and human expansion driving population declines (Schoppe & Cruz 2009; Lagrada et al. 2014). *Manis* species, worldwide, are also threatened by intense hunting for meat and scales in traditional Asian medicines (Challender 2011). In 2000, in response to the great hunting pressure, CITES established a zero annual export quota for Asian Pangolins removed from the wild; illegal trade has continued despite this regulation (Lagrada et al. 2014; CITES 2016). The most recent CITES meeting has proposed the transfer of all eight species in the genus to Appendix I due to the high threat of extinction among the species (CITES 2016).

The Palawan Pangolin, endemic to the Palawan faunal region in the Philippines, is one of the least studied *Manis* species (Piper et al. 2011). *Manis culionensis* has only recently been recognized as its own species, distinct from its Bornean relative *M. javanica* (Esselstyn et al. 2004; Gaubert & Antunes 2005). Ecological information on *M. culionensis* is limited, especially in predicting the effects hunting and habitat loss will have on the species (Schoppe & Cruz 2009). Given the presumed small geographic range of 14,649km^2 (the size of Palawan Faunal Province) and the assumed small population

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size of *M. culionensis,* the recent appearance of the species in the illegal international wildlife trade suggests the potential for a rapid loss of the species (Lagrada et al. 2014). Other pangolin species reproduce slowly, and if this is the case for the Palawan species, it could exacerbate the impact of the wildlife trade (Challender 2008).

Basic knowledge about the species is lacking and hampers developing an informed conservation strategy for the species. Information on the status and ecology of different *Manis* species has been gathered through interviews with local people, tagging and subsequent radio-telemetry, transect surveys for pangolin sign, and camera trap surveys (Lim & Ng 2007; Akpona et al. 2008; Newton et al. 2008). Here we test the use of baited camera traps as a method to document the presence or absence of Palawan Pangolin in different natural habitats of Palawan.

Study Area

Two localities in Palawan were surveyed using camera traps and baits. Camera trap Site 1 was in Santa Lucia, Palawan, Philippines (09^{0}41'52.8"N & 118^{0}42'48.0"E; 1m) on coastal property leased by Centre for Sustainability, inside the Environmental Estate of 'Barangay' (Tagalog: District) Santa Lucia (Fig. 1). The property is approximately two km from the main highway with surrounding beach forest, mangrove, and secondary forest habitats.

Camera trap Site 2 and 3 were located at the proposed Cleopatra's Needle Forest Reserve (CNFR) in Puerto Princesa City Municipality, Palawan Province (Fig. 1). The proposed CNFR is approximately 35,000ha in size, consisting of seven barangays that converge inward to the centerpiece of the reserve: Cleopatra's Needle Mountain (10^{0}07'26"N & 118^{0}59'43"E; 1,593m). Three transects of 10 cameras each were surveyed (Fig. 2), one in each of the following barangays: Binduyan, Tanabag and Concepcion. The camera trap sites in transect 1 had elevations ranging from 267–1,233 m. The camera trap sites in transect 2 had elevations ranging from 192–756 m. Finally, the camera trap sites in transect 3 had elevations ranging from 156–1,516 m. Camera trap site 2 was the center site for the Binduyan transect, while camera trap site 3 was the center site for the Concepcion transect. Habitat types in the proposed CNFR include riverine forest, montane forest, beach or littoral forest, lowland evergreen forest, secondary forest, and swamp forest. The Puerto Princesa Subterranean River National Park (PPSRNP) is adjacent to the proposed CNFR and extends west from Cleopatra's Needle. The proposed CNFR and the PPSRNP comprise a relatively undisturbed forest corridor that connects the northern and southern portions of the island.

Survey Methods

Camera trapping took place throughout the island's dry season (January 2015 to June 2015). At this time, the average temperature was 29.07^{0}C and the average monthly rainfall was 0.1mm (www.wunderground.com, 11 June 2015).

Bushnell Trophy Cams were used. Model #119537C was used to take photographs and videos simultaneously and Model #119436C was used to take photographs. The trail cameras use a passive infrared motion sensor to detect heat within the detection cone of the infrared sensor, triggering the camera. A five-second trigger time was used between trigger events. The cameras functioned for 24-hour cycles using built-in infrared LED's to capture low light images, such as those at night, and color flash to capture daytime images. All cameras were set to take three photographs. When Model #119537C was used, a 10-second video was also recorded. Sites 1 and 2 were surveyed with camera Model #119436C. Site 3 was surveyed with camera Model #119537C.

At Site 1, 10 cameras were set randomly throughout the property to test bait efficacy. Cameras were left to run for two camera trap nights (13 January to 15 January 2015). Each camera was set at least 200m away from another camera and approximately 30 cm above the ground attached to a tree (Gerber et al. 2011; Meek 2012). Baits included uncooked chicken egg, canned sardines, fish oil, fresh pig small intestine, and fresh pig blood (Trolle & Kery 2003; Giman et al. 2007; Scott et al. 2009). One bait type was used at each camera site with two cameras used per bait type. Bait was placed approximately two m in front of the camera. Bait choice for each site was random. We analyzed photographs and recorded the species found for each camera. Baits were determined to be effective if the animal was captured smelling the bait. A fish oil bait was used at the *M. culionensis* capture site (Site 1).

During the camera trap survey in the proposed CNFR, three transects were created within three barangays: Binduyan, Tanabag and Concepcion. Transects were relatively straight and 10km in length, extending from the eastern edge of the proposed reserve inward, towards Cleopatra's Needle (Fig. 2). Regular trail routes created by hunters and Almaciga Tree *Agathis philippinensis* resin collectors were used to set camera sites (Gerber et al. 2010; Gerber et al. 2012). Trails were created when the existing trails ended. Due to terrain and challenges

Figure 1 . The solid red circle on Palawan is camera trap survey Site 1. The square on the right-hand map locates the proposed Cleopatra's Needle Forest Reserve for Site 2 and 3 surveys.

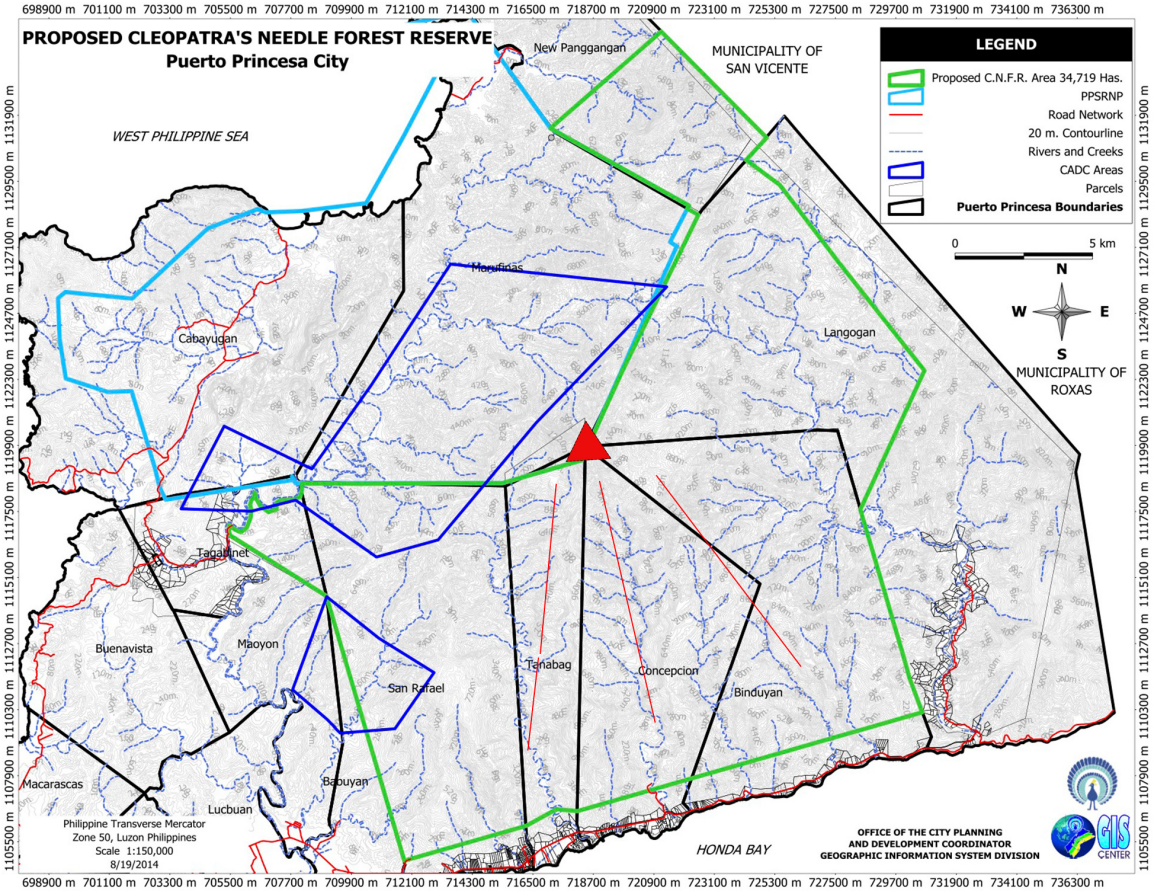

Figure 2. Map of three, 10km transects surveyed in the proposed CNFR. The triangle represents the peak of Cleopatra's Needle. Site 2 was in the transect on the far right on the map. Site 3 was found in the center transect. The proposed CNFR is delineated in green. Map provided by Centre for Sustainability.

involving access with local communities, spacing of the three transects from one another in a regular grid was not possible. Pre-selected UTM coordinates designated sites for camera deployment, with one km spacing between pre-selected sites (Ancrenaz et al. 2012). Upon reaching these coordinates, cameras were placed 10m away from the main trail near animal trails or near signs of mammal presence, such as scat, pangolin scratching or dig marks in the ground (O'Brien et al. 2003; Ancrenaz et al. 2012; Meek 2012). New coordinates were taken using a handheld GPS unit at each site. Cameras were strapped to large trees at 30–40 cm from the ground with 150ml of domestic pig blood bait placed approximately 2m in front of the camera (Scott et al. 2009; Gerber et al. 2011; Meek 2012). From the GPS coordinates taken in the field, cameras were spaced approximately 1.05±0.1 km (mean±SD) away from each other in each transect (O'Brien et al. 2003; Ancrenaz et al. 2012).

Ten cameras were set along each of the three, 10km transects. Transect 1 was in barangay Binduyan and was surveyed for 40 trap nights (3 February to 15 March 2015). Site 2 was the central site for Transect 1 and was approximately 8km away from the major highway. Site 2 was surveyed for 39 trap nights (3 February to 14 March 2015). Transect 2 was found in barangay Tanabag and was surveyed for 28 trap nights (23 March to 20 April 2015). *M. culionensis* photograph-captures did not occur in Transect 2. Transect 3 was found in barangay Concepcion and was surveyed for 27 trap nights (28 April to 25 May 2015). Site 3 was the central site for Transect 3 and was approximately nine km away from the major highway. Site 3 was surveyed for 26 trap nights (29 April to 25 May 2015).

Results

M. culionensis was photographed at Site 1 on the edge of a mangrove at 1m. This photograph-capture occurred on 14 January 2015 at 20:42, on the second night of trapping. This camera produced six photographs of the individual. One of these photographs of the animal was clear (Image 1). The bait was 150ml of fish oil; there is no evidence the individual was attracted to the bait.

The detection of *M. culionensis* at Site 2 occurred in lowland evergreen forest at 853m. *M. culionensis* was detected on 11 February 2015 at 02:12, during the ninth night of trapping. There were three photographs taken of the individual at Site 2. One photograph was clear (Image 2). There is no evidence that the animal was attracted to the pig blood bait.

Site 3 was the central site for the final 10km transect

Image 1. *Manis culionensis* at Site 1 in mangrove habitat.

Image 2. *Manis culionensis* at Site 2 in lowland evergreen forest.

Image 3. *Manis culionensis* at Site 3 in riverine habitat.

in the proposed CNFR. This camera was approximately 100m above a large river in this barangay. The camera was set in riverine habitat with dense forest at 431m. *M. culionensis* detection occurred on 4 May 2015 at 03:00, during the sixth night of trapping. One out of the three photographs produced at Site 3 clearly showed the individual (Image 3). There is no evidence the animal was attracted to the pig blood bait.

Other species recorded among these three sites include Palawan Porcupine *Hystrix pumila*, Common Palm Civet *Paradoxurus hermaphroditus*, Palawan Tree Shrew *Tupaia palawanensis*, Crab-eating Macaque *Macaca fascicularis*, and domestic dog *Canis familiaris*.

Discussion

Camera traps have been shown to be effective for determining the presence or absence of Palawan Pangolin in natural habitats. This study shows pangolins can be photographed at low frequency within 2 to 39 nights of trapping effort, using infrared flash, placed 30cm above the ground on trees, and using a range of baits. There is no indication from this study that pangolins were attracted to any of the baits used. Given that these pangolins presumably feed primarily on ants and termites like other *Manis*, this is not surprising.

All of the detections occurred near paths with moderate to high human foot traffic, suggesting that the Palawan species can tolerate a moderate level of human disturbance (Lim & Ng 2007; Lagrada et al. 2014). At all sites, *M. culionensis* was detected once, soon after camera deployment. The rapid detection may have been caused by the animal's curiosity in the changed environment at our camera sites and suggests they are not particularly repelled by human scent. Lim & Ng (2007) similarly photo-captured an *M. javanica* individual soon after camera deployment, but were not successful in consecutive long-term photo-captures of the animal. In the past, local informants have described *M. culionensis* as fairly common, with heavy hunting known in logged-over lowland forest areas (Esselstyn et al. 2004). The domestic dog photo-captured at Site 3 suggests *M. culionensis* can coexist with the presence of hunting or feral dogs. Our findings corroborate *M. culionensis*' tolerance of moderate human disturbance (Lagrada et al. 2014).

Habitat preferences for this species are suggested to be lowland primary and secondary forests, grassland and secondary growth mosaics, and mixed agricultural and scrublands near secondary forests (Heaney et al. 1998; Esselstyn et al. 2004). The *M. culionensis* detection at Site 1 occurred adjacent to a mangrove forest.

Camera trap surveys have been used to study pangolin activity elsewhere (Lim & Ng 2008), though chance encounters with pangolin species during general camera trap surveys are more common in the literature (Giman et al. 2007; Newton et al. 2008). Here we have shown that limited and modest camera trap surveys are effective at determining the presence of Palawan Pangolin at different forest sites. There is no evidence that the range of baits used were useful in attracting pangolins to the cameras.

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