Short note

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Improving the detection rate of binturongs (*Arctictis binturong*) in Palawan Island, Philippines, through the use of arboreal camera-trapping

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Abstract: Although remote camera-traps are used worldwide for ecological studies, the methods of use are often based on ground-level detection. This inherently limits the ability to detect arboreal species. This study aims to test arboreal camera trapping as an alternative method to improve the detection of the binturong (*Arctictis binturong*). We obtained a total of 41 independent detections of binturongs for 2,973 trap-nights, representing a detection rate of 1.38%. Thus, although statistical comparison with other surveys is not possible, this is currently the highest detection rate for the species. This is encouraging to further develop this method for research on binturongs.

Keywords: *Arctictis binturong*; arboreal camera-trapping; canopy; detection rate.

The binturong, *Arctictis binturong* (Raffles 1821), is a small carnivore belonging to the family Viverridae and living in the primary forests of Southeast Asia. Binturongs are omnivorous but eat mostly fruits that grow at the top of the trees (McGrosky et al. 2016, Nakabayashi et al. 2016). They are formidable climbers, using the upper canopy (about 20 m high) to find their food and the mid-canopy (between 10 and 20 m high) to rest (Grassman et al. 2005). Binturongs could be keystone species because of their important role in seed dispersal; their rapid digestion promotes seed germination and their size allows dispersion of larger seeds which birds or smaller civets cannot disperse (Colon and Campos-Arceiz 2013; Corlett 2017). However, they are threatened by habitat destruction and illegal trade and as such listed as Vulnerable on the IUCN Red List (Lau et al. 2010; Shepherd 2008; Shepherd and Shepherd 2010). Information on binturong distribution and abundance, across the various habitats and regions where it is found, is crucial to preserve the species. But unfortunately, most studies on the species suffer from low detection rates or lack of detection (Debruille 2016). This in turn perpetuates a lack of knowledge on its population status and ecology. Grassman et al. (2005) managed to trap binturongs using baited live-traps which could be an effective tool in estimating binturong abundance using capture-recapture modeling. However, the detection remained low, with 31 animals caught over 27,928 trap-nights. Ground-based camera-trapping has provided higher detection rates for the binturong but still too low to process statistical analysis, including occupancy or activity patterns (Bernard et al. 2013; Coudrat et al. 2014; Lynam et al. 2003; Mohd-Azlan et al. 2018; Samejima et al. 2012; Zaw et al. 2008). The low detection of binturongs using ground-based camera-trapping can be explained by the arboreal habits of the species, which mainly descend to the ground because of canopy gaps or to visit salt licks and water sources (Esselstyn et al. 2004; Semiadi et al. 2016; Zaw et al. 2008). Improvements of camera-trapping methods to increase detection rate of this species have been suggested, such as targeting canopy gaps, using baits or target fruit trees (Chutipong et al. 2014). Among them, arboreal camera-trapping has not been tried yet to improve binturong's detection. Arboreal camera-trapping has been used in an increasing number of studies during the past few years, and showed good results in the detection of arboreal

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species despite the complexity of its implementation (Bowler et al. 2017; Gregory et al. 2014; Suzuki and Ando 2018; Whitworth et al. 2016).

The center of Palawan is predominantly covered by unlogged forests and Palawan Island has been classified as Biosphere Reserve by the UNESCO in 1990. Within these forests are Cleopatra's Needle Critical Habitat (CNCH) and the Puerto Princesa Subterranean River National Park (PPSRNP), which represent a total of more than 60,000 ha of protected reserves. Biodiversity assessments have been conducted within these parks, yet during a six-month biodiversity survey in the CNCH in 2015, no binturong was detected either by diurnal transect, live-trapping (with cages of 30 cm × 15 cm × 15 cm size), or camera-trapping (Marler et al. 2015, 2018, 2019; Mallari et al. 2016). Many reasons could explain the lack of detection, including the type of surveyed habitats, the placement of the cameras, and the size of the traps. However, the binturong is described as adaptable to disturbance and varied habitats (Semiadi et al. 2016) and another arboreal species present in the park, the Palawan Flying Squirrel, *Hylopetes nigripes*, had also not been recorded by the ground-based camera-trapping. This emphasizes the difficulty in the detection of arboreal species by ground-level surveys. It led us to test the advantages and disadvantages of arboreal camera-trapping for the detection of arboreal species. This short note aims to present and discuss the preliminary results of binturong's detection rate during an arboreal camera-trapping survey in a forest of Palawan Island.

The Barangay (Filipino word for district) Langogan is located around 80 km North of Puerto Princesa City. A large part of this Barangay is included in the CNCH. Our study was conducted in Barangay Langogan adjacent to CNCH in a logged forest, next to a coffee plantation (10°04.426′ N; 119° 06.370′E; Figure 1). A total of 15 camera-trapping stations were set up between February 2017 and February 2019. During the study, 20 camera-traps of four models were used: Moultrie® M1100i, Campark® T40, Apeman® H70 and Coolife® trailcamera. The cameras were all installed in the low to middle canopy (Table 1) of trees in the *Ficus* family. *Ficus* trees were preferred as binturongs are known to forage on these trees (Allam and Fernandez 2019; Nakabayashi and Ahmad 2018) and also because of the accessibility of their canopy for camera-trap placement. The survey and implementation team attended a tree-climbing training course in France (Libertree, Paleville, France and Profil Evasion Nature, Fontainebleau, France) and their safety was secured through the use of professional tree-climbing material (Hévéa®). The selected trees were chosen after an assessment of pathways in the canopy and the camera-traps were fixed to the trunk using a nylon belt and facing branches that could be used as paths by animals, as suggested by Bowler et al. (2017). The camera-traps were checked every one to 3 months with memory cards and batteries changed when necessary.

Cameras were set to take series of two or three photographs, depending on the model, when triggered with a 5 s interval between trigger events. Events were considered independent when separated by at least 1 h following

Table 1: Description of the 15 camera-trapping sites in the forest of the Barangay Langogan, Palawan, Philippines (in bold: the sites where Binturongs were detected).

Site number	Trap-nights	Elevation (m)	Canopy height (m)	Canopy density (%)	Camera height (m)	Pictures of Binturong	Independent detections of Binturong	Detection rate of binturong (%)
1	79	124	25	50	8	0	0	0.00
2	121	92	23	30	10	0	0	0.00
3	534	142	25	60	18	1	1	0.19
4	117	141	15	40	8	0	0	0.00
5	66	92	23	30	1.7	0	0	0.00
6	87	124	25	50	4	4	4	4.60
7	299	109	20	75	15	30	17	5.69
8	271	122	10	75	8	0	0	0.00
9	392	44	5	75	5	0	0	0.00
10	130	83	15	40	10	0	0	0.00
11	350	194	25	50	10	14	7	2.00
12	49	183	20	80	10	0	0	0.00
13	135	201	20	60	10	2	2	1.48
14	164	145	20	50	15	1	1	0.61
15	179	145	20	80	10	11	9	5.03

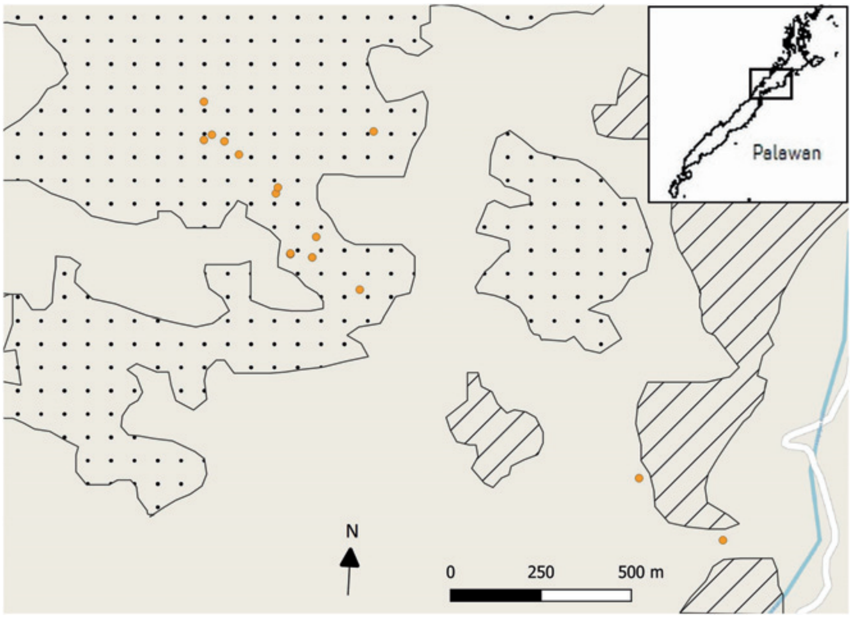

Figure 1: Location of the study site and of the camera trap stations (orange dots) in the Barangay Langogan, Palawan, Philippines. The hatched areas represent the plantations (coffee and mixed fruits); the dotted areas represent forest with no or low-intensity logging; the clear areas represent forest with moderate-intensity logging.

Rovero and Zimmermann (2016). The detection rates were calculated from the number of independent events in relation to the number of trap-nights in the given period.

A total of 73,020 photos over 2,973 trap-nights were collected. Only 3,181 pictures recorded animals of recognizable species, representing 4.35% of the total. Among those pictures, 63 photos of binturongs were obtained, representing a total of 41 independent events, and a detection rate of 1.38% (Figure 2). These events were captured across different months over the two years period. The mean detection rate was lower from February to December 2017 (0.53%) than during 2018 (1.66%); however, this difference is not significant (Student *t*-test, $p = 0.36$). Only four of those events occurred during daytime (i. e., between 6 am and 6 pm). The first detection occurred on September 3rd 2017, after 650 trap-nights. Binturongs were detected in seven of the 15 stations established in the study (Table 1) in September 2017, January, March to August, and November 2018 and January and February 2019.

In the most recent studies, binturongs appear nocturnal or crepuscular, with possible but rare activity during daytime (Grassman et al. 2005, 2006; Hedges et al. 2013; Mathai et al. 2010). Our results support this statement as most detections were at night, with only 4 (9.76%) independent events occurring during daytime.

The previous studies conducted in CNCH had failed to find evidence of the presence of binturongs over 711 camera trap-nights (Marler et al. 2015, 2018, 2019). Unfortunately, our study was not conducted within the exact same location as those of Marler et al. so we are not able to compare if our technique would confirm the presence of binturongs within other CNCH sites.

Among the 30 surveys reviewed by Debruille (2016), the highest detection rate of binturongs by camera-trapping was of 0.70% (for the study in Indonesia by Rustam et al. 2012), and the median detection rate by camera-trapping was 0.063%, with studies gathering 1–19 pictures of binturongs for between 612 and 30,169 trap-nights (Debruille 2016). Three of these previous studies (Giman et al. 2007; Kitamura et al. 2010; Rustam et al. 2012) used scents, meat or fruits as baits to attract animals in front of the camera-traps but their detection of binturongs remained low. The binturong detection rate of 1.38% in our study is higher than in previous studies, but comparisons of detection rates is not recommended without taking factors impacting detectability into account (Rovero and Zimmermann 2016). Due to the absence of marks to identify individuals, it is impossible to confirm the number of individuals or visitation rates from camera-traps. It is therefore not possible to relate the number of independent detections with abundance, nor estimate population density or individual home-ranges. Furthermore, targeting *Ficus* trees may have increased the number of detections of binturongs in our survey, as figs are known to be part of their diet (Allam and Fernandez 2019; Nakabayashi and Ahmad 2018). The impact of those factors on the detection rate obtained cannot be measured and thus it prevents us to go further in the comparison with previous studies.

In conclusion, although further research would be necessary to validate arboreal camera-trapping as a more efficient method than ground camera-trapping to detect

Figure 2: Pictures of binturong taken in the Barangay Langogan, Palawan Island, between February 2017 and February 2019 at the stations, clockwise from the upper left, 11, 3, 11 and 7. Due to malfunction of the camera, the time stamps of the station 3 and 11 are incorrect.

binturongs, the preliminary results obtained in this arboreal camera trapping survey in Palawan are encouraging, and will stimulate studies to explore further this method.

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