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Short Note

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Fruit selection of a binturong (*Arctictis binturong*) by focal animal sampling in Sabah, Malaysian Borneo

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Abstract: We investigated fruit selection of a radio-collared female binturong (*Arctictis binturong pageli* Schwarz, 1911) by focal animal sampling in Sabah, Malaysian Borneo. We recorded seven food species from 12 feeding trees over 16 months. The radio-collared binturong fed only ripe fig fruits (*Ficus* spp., Moraceae), suggesting that her diet largely depended on figs. As the present study was based on only one female individual, more efforts are needed to elucidate the feeding ecology of this cryptic carnivore.

Keywords: *Arctictis binturong*; *Ficus*; frugivory; fruit preference; radio-telemetry.

Mammalian frugivores are relatively selective of the fruits they eat. They make choices based on nutrient content and ecological factors such as the relative abundance of fruit, fruit accessibility, competition among plants and frugivores, and predation risk (Corlett 2011). The binturong [*Arctictis binturong pageli* (Schwarz, 1911)] is a mammalian carnivore belonging to the subfamily Paradoxurinae, family Viverridae. As they belong to the Carnivora, they possess carnivorous morpho-physiological characteristics such as sharp canines, carnassial teeth, and a short digestive tract with a vestigial caecum (Mitchell 1905, Anders 2005). Despite their carnivorous features, a number of reports suggest that binturongs consume fruits, especially figs (e.g. Lambert 1990, Nettelbeck 1997), and that they are effective seed dispersers for some fruit species (Colon and Campos-Arceiz 2013). Two reports described the stomach contents of two binturongs; one contained an assemblage of rubbish (Harrison 1952) and the other contained only figs (Rozhnov 1994).

Regarding the binturong's carnivorous features, fruit selection would be critical for efficient energy acquisition; however, no study has investigated such behaviour in wild individuals. In the present study, we investigated the fruit selection of a collared binturong by focal animal sampling in Sabah, Malaysian Borneo.

We conducted this study at the Danum Valley Conservation Area in Sabah, in the north-eastern Borneo, from January 2013 to May 2014. The Danum Valley Conservation Area (4°57′N, 117°48′E) is a 438-km^2 protected zone, and 90% of this area consists of matured lowland evergreen dipterocarp forest (Marsh and Greer 1992).

Trapping and handling of the animal conformed to guidelines of the American Society of Mammalogists (Sikes et al. 2011). On 13 February 2013, we set up a 60×18×18 cm-sized portable Havahart brand box trap (Woodstream Corp., Lititz, PA, USA) on a branch of a fruiting fig tree at a height of 5 m using a ripe banana as bait. On the same day, an adult female binturong was caught. The binturong was immobilised with 5 mg/kg Zoletil (Vibrac Laboratories, Carros, France) for the attachment of a radio-collar (M2940B; Advanced Telemetry Systems, Isanti, MN, USA).

We attempted to locate the feeding sites visually between 1800 h and 0000 h from February 2013 to May 2014. When we observed the radio-collared binturong feeding, we recorded the food species and its plant characteristics: life form, fruit size (width and length), and colour of ripe fruit. We followed the radio-collared binturong when she travelled, using a thermal night vision (Scout TS-24 pro; FLIR Systems, Wilsonville, OR, USA). We recorded fruiting trees that were visited by the collared binturong, and determined whether she ate the fruits (selected fruits) or not (ignored fruits).

To estimate fruit availability, we conducted a fallen fruit census every month from January to December 2013.

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We searched for fallen fruit crops on a 2-m-wide and 3.3-km-long transect. Fruit availability was estimated by calculating the total amount of ripe, fallen, soft-pulped fruits on the transect, which were considered the potential food of the binturong. Although the length of the transect was too short to estimate fruit availability of the focal area, it was included in the home range of the collared binturong (Figure 1). Therefore, this estimation could provide an indication of total fruit availability within her home range.

We located the site of the binturong with high accuracy (error within 10 m) 37 times; 28 of the 37 sites were feeding sites (75.7%). We found no fruiting trees at nine of the 37 sites. We recorded seven food species from 12 feeding trees (Figure 1), and all of them were ripe fig fruit (*Ficus* spp., Moraceae). The seven fig species consisted of two climbers and five hemi-epiphytic stranglers (Table 1). Three of the seven fig species bore dark red-coloured fruits, one species bore red-coloured fruit, and three species bore orange-coloured fruits when ripe (Table 1). Five of the seven species changed their pericarp colour during ripening. The collared binturong usually visited the feeding fig trees continuously until fruiting finished. The longest visit was six continuous days recorded at *F. stupenda* (tree No. 6 in Figure 1). However, she left *F. binnendijkii* (No. 9), which still had a large number of fruits.

The percentage of available figs relative to the total amount of available fruits each month ranged from 0% to 98% (Figure 2). In 7 of the 9 months, the percentage of figs was 0%.

The total observation time was about 300 min for five nights. We succeeded in following the radio-collared binturong for about 30–90 min per night. The binturong visited 16 fruiting trees, feeding on seven of them (selected: *F. binnendijkii*, tree No. 1 in Figure 1; *Ficus* sp., No. 2; *F. trichocarpa*, No. 3; *F. punctata*, No. 5; *F. stupenda*, No. 6; *F. trichocarpa*, No. 7; *F. benjamina*, No. 11), while nine of them were not fed on (ignored; *Artabotrys* sp., *Alangium javanicum, Palaquium* sp., *Aglaia odoratissima*, *Urophyllum glabrum*, *Nephelium cuspidatum*, *Irvingia malayana*), including two fig species (*F. heteropleura* and *F. sundaica*). The fruit of *F. heteropleura* was ripe, but that of *F. sundaica* was not.

These results indicate that the radio-collared binturong largely depended on various sizes and types of figs, even though fig trees were not common within her home range. The radio-collared binturong fed on the same fruiting figs continuously, and spent most of her time on a single tree. As she used the same *F. binnendijkii* (No. 1) tree

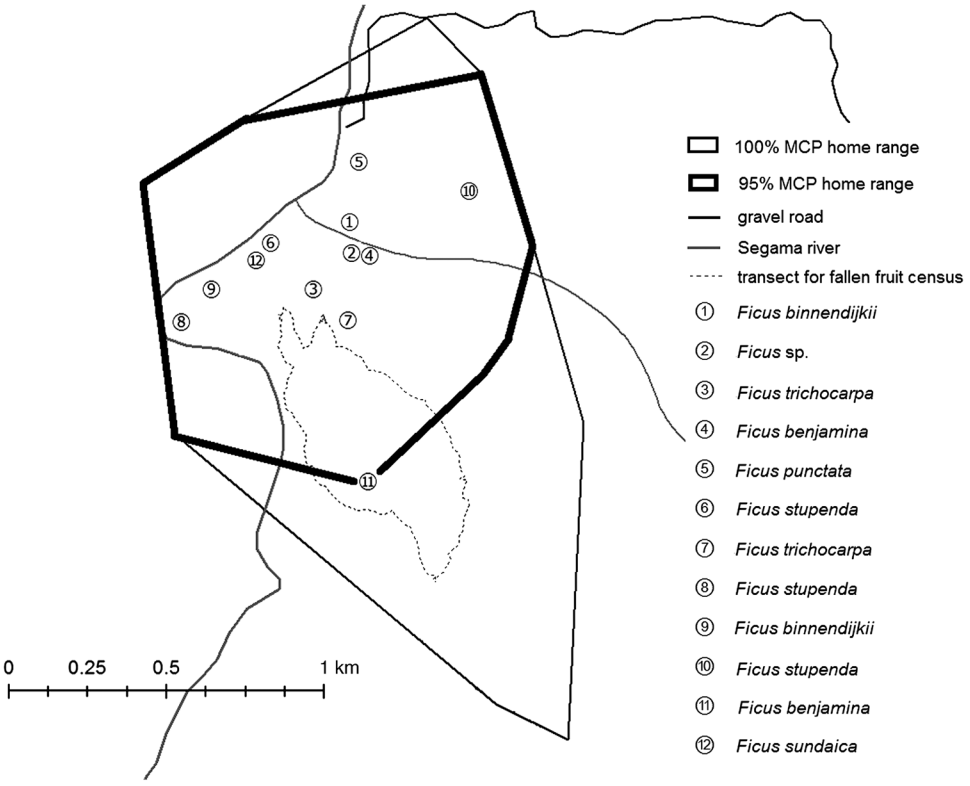

Figure 1: Location of the fig trees used for feeding and minimum convex polygon (MCP) home range of the radio-collared binturong.

Table 1: List of the fruit species, consumed by the radio-collared binturong.

Food species	Life form	Mean fruit (width×length, mm)	Colour when ripe	Colour change as being ripen	No. of recorded feeding tree
Ficus stupenda	Hemi-epiphyte	63.7×80.5	Orange		3
Ficus benjamina	Hemi-epiphyte	16.9×16.5	Dark red	○	2
Ficus trichocarpa	Climber	25.9×22.9	Dark red	○	2
Ficus binnendijkii	Hemi-epiphyte	20.8×19.3	Dark red	○	2
Ficus sp.	Hemi-epiphyte	32.6×45.7	Orange	○	1
Ficus punctata	Climber	66.5×84.4	Red		1
Ficus sundaica	Hemi-epiphyte	15.5×17.3	Orange	○	1

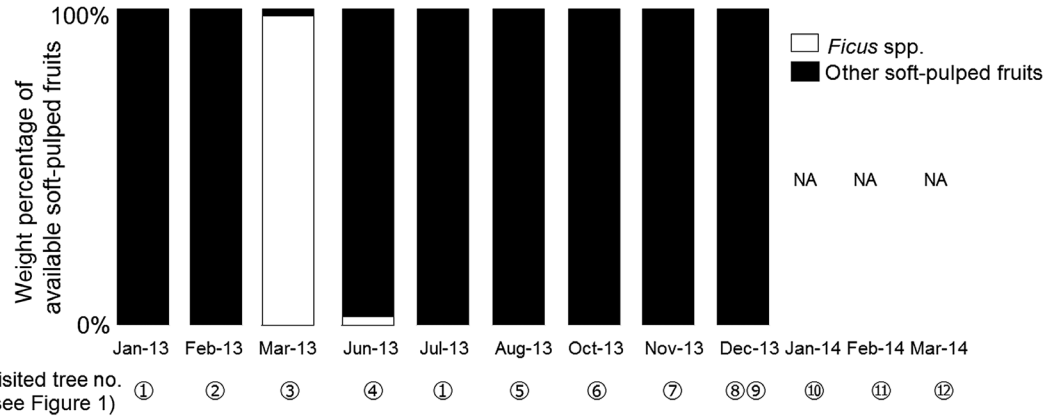

Figure 2: Monthly fruit availability and visitation at each feeding tree numbered in Figure 1 of these months.

after 6 months from the first observation, she probably did not forage opportunistically. Although it is certain that the radio-collared binturong preferentially fed on figs, she also might not accept all fig trees equally.

Figs are not particularly nutrient-rich, and most mammalian frugivores use figs as backup food (Shanahan 2000). The binturong is the largest arboreal frugivorous civet species, and therefore, it needs larger quantities of foods than smaller-sized animals (Kleiber 1961). The most striking features of figs are their exceptionally large crop size and year-round availability (Shanahan 2000) though they are extremely rare (Harrison 2005). Thus, it might be more efficient for the binturong to use the surely available large-cropped figs rather than feed opportunistically in search of smaller-cropped fruits.

Although we found that the radio-collared binturong predominantly fed on figs, the evidence was not sufficient to comprehensively understand the feeding ecology of this species based on only one female individual. More efforts are needed to elucidate the feeding ecology of this cryptic carnivore.

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