HAYATI
Journal of Biosciences

Vol. 31 No. 4, July 2024 687-692
DOI:10.4308/hjb.31.4.687-692
ISSN: 1978-3019
EISSN: 2086-4094

Food Habits of the Common Palm Civet (*Paradoxurus hermaphroditus*) in Pangandaran Nature Reserve, West Java, Indonesia: a Preliminary Report

Yamato Tsuji[1,2*], Takafumi Tatewaki[3], Achmad Farajallah[4], Hiroyuki Tanaka[1,5], Kanthi Arum Widayati[4], Bambang Suryobroto[4]

[1]*Primate Research Institute, Kyoto University, Aichi, Japan*
[2]*Ishinomaki Senshu University, Miyagi, Japan*
[3]*University of Human Environments, Aichi, Japan*
[4]*Departement of Biology, Faculty Mathematics and Natural Sciences, IPB University, Darmaga Campus, Bogor 16680, Indonesia*
[5]*Center for Ecological Research, Kyoto University, Otsu, Japan*

ARTICLE INFO

Article history:
Received November 27, 2023
Received in revised form February 1, 2024
Accepted February 7, 2024

KEYWORDS:
Faecal analysis,
frugivore,
seasonal shift,
secondary forest,
Viverridae

ABSTRACT

We conducted a preliminary survey of the wild common palm civet *Paradoxurus hermaphroditus* in a secondary forest in Pangandaran Nature Reserve, West Java, Indonesia. We collected 125 fresh fecal samples between October 2018 and August 2019. We conducted faecal analyses after species confirmation by camera trapping and faecal DNA analysis. Almost all faeces contained fruits and seeds (frequency of occurrence: 97.6%), while the percentage of animal matter (including mammals, birds, insects, non-insect arthropods, and molluscs) was much lower (22.4%). We observed no seasonal differences in major faecal contents. Higher dependence on fruits by the common palm civets was similar to those in other study sites. Seeds of at least eight different plant species were found in the faeces of the common palm civets, which implied that the common palm civets would play roles as seed dispersal agents.

1. Introduction

Common palm civets (*Paradoxurus hermaphroditus*, family Viverridae) are widely distributed in South and Southeast Asia, from tropical to subtropical monsoon climate zones, and from primary forest to regions containing human settlements (Patou *et al.* 2010; Nakabayashi *et al.* 2016b). The common palm civets are omnivorous but noticeably dependent on fruits (Davis 1962; Bartels 1964). The food habits of the common palm civets have been studied in Eurasian countries, including India (Krishnakumar and Balakrishnan 2003; Jothish 2011; Khan *et al.* 2019), Nepal (Joshi *et al.* 1995), Myanmar (Su and Sale 2007), and the Philippines (de Guia *et al.* 2020). However, ecological studies of the common palm civets, especially on quantitative evaluation of feeding ecology on the Sunda islands, have been limited (e.g., Nakashima *et al.* 2010; Nakabayashi *et al.* 2016a). Accumulation of civets' diets in various habitats is needed to evaluate the feeding plasticity of the palm civets in response to environmental variation across their distribution, which would contribute to understand their feeding strategy.

In this study, we conducted a preliminary survey of the common palm civet in a secondary forest of West Java, Indonesia, and compared the results with those in other study sites.

2. Materials and Methods

2.1. Study Site

We conducted the study in Pangandaran Nature Reserve (PNR hereafter), West Java, Indonesia (7.7°S, 108.7°E). The average elevation is approximately 100 m a.s.l., and the climate there is classified into the tropical rainforest, with an average annual rainfall of 2,490 mm from 1990–2010 (Rosleine and Suzuki 2012) and relatively stable average annual air temperature of 25–30°C (Tsuji *et al.* 2019). The PNR is divided into

* Corresponding Author
E-mail Address: ytsuji1002@gmail.com

two zones: the Taman Wisata Alam (TWA) forest park (38 ha) and the Cagar Alam (CA) nature reserve (370 ha). TWA is composed of secondary/plantation forest; its dominant plant species are *Syzygium antisepticum* (Myrtaceae), *Dysoxylum caulostachyum* (Meliaceae), *Pterospermum javanicum* (Malvaceae), and planted *Tectona grandis* (Lamiaceae) and *Swietenia macrophylla* (Meliaceae) (Tsuji *et al.* 2015). In contrast, CA comprises old secondary forests with some man-made grasslands for grazing (Mitani *et al.* 2009).

Forest rangers have recorded five Viverridae species within PNR: the common palm civet, small-toothed palm civet (*Arctogalidia trivirgata*), small Indian civet (*Viverricula indica*), masked palm civet (*Paguma larvata*), and otter civet (*Cynogale bennetti*) (Bambang Prayitno, personal communication); however, no detailed information on the civets including population density has been reported.

2.2. Camera Trapping

To confirm that the common palm civet inhabits the PNR, we performed a camera trap survey in the CA from 19 to 28 August 2019. We selected five sites along a path and set a camera trap at each site. We installed automatic cameras (Stealth Cam G42NG; GSM Outdoors, Grand Prairie, TX, USA) on trees at 30–50 cm height and placed banana, mango, or peanut butter bait near the camera trap to attract animals. The camera traps recorded 30-s movies, and the delay period between movies was 0.5 s. For security against theft, we moved each camera trap to a new site (>10 m away) every 3 days, for a total of 15 sites (five cameras, three sites per camera).

2.3. DNA Analysis

Fresh faeces from carnivorous animals were collected along a forest path in TWA, and sometimes in CA, from October 2018 to August 2019 (N = 10 per month, except in August 2019, where 25 samples were collected). Faecal samples were stored in plastic bottles filled with 70% ethanol until analysis. To confirm that the common palm civet produced collected faecal samples, we performed a DNA analysis of the ethanol used to preserve faecal samples. We randomly selected 11 and 7 faecal (ethanol) samples collected in the wet and dry seasons, respectively. DNA extraction was performed using the Genomic DNA Mini Kit for tissues (Geneaid Biotech, Ltd., New Taipei City, Taiwan) following the manufacturer's instructions. Partial sequences of 12S ribosomal RNA (12S) and 16S ribosomal RNA (16S) from mitochondrial DNA (mtDNA) were amplified by polymerase chain reaction (PCR) using a 25-µL GoTaq MasterMix reaction mixture (Promega Corp., Madison, WI, USA). The PCR primers were as follows: 12S forward primer AF581, 5'-CCCAAACTGGGATTAGATACCC-3'; 12S reverse primer AF582, 5'-GTTTGCTGAAGATGGCGGTA-3'; 16S forward primer AF583, 5'-CCCGCCTGTTTACCAAAAACAT-3'; 16S reverse primer AF584, 5'-CTCCATAGGGTCTTCTCGTCTT-3'. The thermal cycling conditions consisted of initial denaturation at 94°C for 3 min, 30 cycles of denaturation at 94°C for 1 min, annealing at 58°C for 1 min, and extension at 72°C for 1 min, with a final extension at 72°C for 2 min. After PCR, 1 µL PCR product was electrophoresed to verify the amplification. PCR products were purified using the Wizard SV Gel and PCR Clean-Up System (Promega). The sequencing reaction was performed using the BigDye Terminator Cycle Sequencing Kit (Applied Biosystems, Foster City, CA, USA), and DNA sequencing was performed using the 3130 Genetic Analyzer (Applied Biosystems). Sequence data for both directions were confirmed using the Sequence Navigator software (Applied Biosystems). To identify DNA sequence data, we performed BLAST analysis using the BLASTIN program, accessed via the DNA Data Bank of Japan (DDBJ) (http://blast.ddbj.nig.ac.jp/blastn?lang=ja).

2.4. Dietary Analysis

We washed faecal contents using 0.5-mm mesh sieves under fresh water and sorted their contents visually into 11 categories: mammals, birds, reptiles, amphibians, insects, non-insect arthropods, mollusc, fruits and seeds, fungi, other plant parts, and others including unidentified materials. We identified seeds to the best of our ability using our previous study as a reference (Tsuji *et al.* 2017).

We evaluated the food habits of the palm civets in terms of the percent frequency of occurrence in faeces (%FO = a number of faecal samples containing a specific food item/total number of faecal samples × 100). Because of the small sample size, we pooled samples for two seasons based on a 200-mm rainfall threshold: November–April (wet season) and May–October (dry season). Rainfall data were obtained from the AccuWeather website (https://www.accuweather.com). We applied Fisher's exact test to analyse seasonal variation in %FO for each food category. All statistical analyses were performed using R software ver. 4.3.0 (R Core Team 2023), with significance at $P<0.05$.

3. Results

3.1. Camera Trapping

We identified eight mammal species/families from 106 movies captured at 15 trapping sites during the study period. The common palm civet was recorded most frequently (N = 65; Figure 1). No other *Viverridae* species were recorded during the study period. An adult common palm civet was filmed running after two juveniles, which confirmed their reproduction in the PNR. Besides the common palm civet, we recorded at least seven different mammalian species in CA: long-tailed macaque (*Macaca fascicularis*; N = 9), Sunda porcupine (*Hystrix javanica*; N = 6), Javan lutung (*Trachypithecus auratus*; N = 3), Rusa deer (*Rusa timoriensis*; N = 2), Javan mouse deer (*Tragulus javanicus*; N = 1), *Muridae* spp. (N = 12), and *Callosciurus* spp. (N = 8).

Figure 1. Images of common palm civets captured by camera traps in Cagar Alam, Pangandaran Nature Reserve, West Java, Indonesia

3.2. DNA Analysis

DNA sequencing was successful in 7 of 18 faecal samples, including 3 wet-season and 3 dry-season samples for 12S and 1 wet-season sample for 16S. The 12S sequences (177 bp) obtained from 6 samples were identical. We deposited the 12S and 16S sequence data (203 bp) to the DDBJ (accession nos. LC537284 and LC537283, respectively). BLAST analysis confirmed that the 12S and 16S sequences belonged to the common palm civet.

3.3. Dietary Analysis

Almost all faecal samples collected in each season contained fruits and seeds (%FO: 97.6%), followed by mammals (4.0%), birds (0.8%), insects (9.6%), non-insect arthropods (e.g., millipedes and crabs) (7.2%), other animals (e.g., snails) (4.8%), non-fruit plant parts (e.g., leaves) (24.0%), and other contents including anthropogenic materials such as fishing line or plastic fragments (3.2%) (Table 1). We detected no seasonal changes in the eight categories (Table 1). We identified at least eight different types of seeds in the faeces of the palm civets (Table 1): *Decaspermum fruiticosum* (local name, ipis kelit), *Vitex pubescens* (laban), *Hypobathrum frutescens* (ki hapit), *Tectona grandis* (jati), *Eugenia polyantha* (salam), *Ficus* spp. (ki ara), *Fabaceae* sp., and unidentified liana species. On an annual basis, *V. pubescens* and *Ficus* spp. appeared frequently in faeces (28.0% and 25.6%, respectively). *Ficus* spp. and *T. grandis* seeds occurred significantly more frequently in wet than dry seasons (Fisher's exact test, P = 0.008 and 0.002, respectively). *V. pubescens* seeds occurred only in the dry season (Fisher's exact test, P<0.001).

4. Discussion

According to the local forest rangers, five *Viverridae* species inhabit the PNR: the common palm civet, small-toothed palm civet, small Indian civet, masked palm civet, and otter civet (Bambang Prayitno, personal communication), whereas Sumardja and Kartawinata (1977) reported that only the small Indian civet inhabit the PNR. Based on our preliminary camera trap survey, the common palm civet was the most frequently recorded animal in the PNR. Since the type of bait and/or camera trap sites might affect the capture frequency, the results in this study do not represent the density of animals. Continuous camera trap surveys for a whole year are required to evaluate the presence of each animal species. By contrast, our faecal DNA analysis showed that the common palm civet produced almost all samples for which we obtained successful mtDNA sequence reads. Thus, the common palm civet appears to have been the major *Viverridae* species in PNR during our study period.

Similar to many other study sites, common palm civets in the PNR fed frequently on fruits (Table 2). The higher frugivory, regardless of the forest types,

Table 1. Seasonal food habits of the common palm civet (*Paradoxurus hermaphroditus*) in Pangandaran Nature Reserve, West Java, Indonesia, regarding frequency of occurrence (%FO) in faecal samples. ***P<0.001, **P<0.01, *P<0.05

Food types	Wet season (N = 60)	Dry season (N = 65)	Total (N = 125)	
Animals	26.7	18.5	22.4	
Mammals	3.3	4.6	4.0	
Birds	1.7	0.0	0.8	
Insects	11.7	7.7	9.6	
Arthropods	8.3	6.2	7.2	
Other animals	8.3	1.5	4.8	
Fruits and seeds	100.0	95.4	97.6	
Vitex pubescens	0.0	53.8	28.0	***
Ficus spp.	36.7	15.4	25.6	**
Decaspermum fruiticosum	16.7	20.0	18.4	
Tectona grandis	25.0	4.6	14.4	**
Hypobathrum frutescens	15.0	10.8	12.8	
Liana	13.3	6.2	9.6	
Eugenia polyantha	0.0	1.5	0.8	
Fabaceae sp.	0.0	1.5	0.8	
Other plants	16.7	30.8	24.0	.
Others	0.0	6.2	3.2	
Unidentified materials	8.3	1.5	4.8	

Table 2. Summary of annual food habits of common palm civet (based on the frequency of the occurrence) across the Asian region

Country	Study site	Latitude	Vegetation/land use	#Samples	%Fruits	#fruits types	Reference
Nepal	Chitwan	27°N	Mixed dry deciduous forest	193	84.5	5	Joshi et al. (1995)
India	Panta	27°N	Wetland forest	112	39.3	8	Khan et al. (2019)
Myanmar	Hlawga	17°N	Secondary mixed deciduous forest	2373	95.0	≥21	Su and Sale (2007)
Thailand	Kaeng Krachana	17°N	Wet evergreen forest	50	?	>13	Grassman (1998)
Thailand	Sakaerat	14°N	Evergreen and dry dipterocarp forest	162	42.0	10	Aroon (2008)
India	Kerara	8°N	Rural	94	90.1	18	Jothish (2011)
India	Kaudiar	8°N	Semi-urban	39	82.0	8	Krishnakumar and Balakrishnan (2003)
India	Kariavattom	8°N	Semi-urban	36	83.0	7	Krishnakumar and Balakrishnan (2003)
Malaysia	Borneo	5°N	Logged forest dominated by pioneer species	108	92.0	30	Nakashima et al. (2010)
Indonesia	Pangandaran	7°S	Secondary forest with teak plantation	125	97.6	8	This study

We listed the maximum percentages if a dietary summary for fruits or animals was unavailable
[a]faeces of masked palm civets were included

is a characteristic of the common palm civets. Common palm civets in PNR depended on fruits throughout the year, despite seasonal changes in available fruit species: civets fed on *V. pubescens* fruits in the dry season and *T. grandis* fruits in the wet season, when their availability was high (Tsuji *et al.* 2019). In previous studies, no dietary shift was observed in a tropical secondary forest in Borneo (Nakashima *et al.* 2010) or in a rural area in India with cultivated fruits (e.g., papaya) (Krishnakumar and Balakrishnan 2003; Jothish 2011). We detected a seasonal shift among fruits; similarly, in a secondary mixed deciduous forest in Myanmar, the common palm civet fed on fruits with little seasonal fluctuation in total intake but with species variation among the fruit and animal categories (Su and Sale 2007). In the northernmost civet range in Nepal, civets shifted from frugivorous to omnivorous diets when fruits were scarce (Joshi *et al.* 1995). These implied that common palm civets are fundamentally frugivorous but can shift their diet in response to fruit availability. By accumulating information on civets' feeding ecology, we can address the feeding strategy of Asian viverrids.

The defecated seeds in our study were intact. The common palm civets ingested various kinds of plant seeds without masticating. Therefore, they would act as seed dispersal agents for many plant species (Nakashima and Sukor 2010; Nakabayashi *et al.* 2016b). In Java, Bartels (1964) listed at least 35 fruit species eaten by the common palm civet, including native trees (e.g., *Ficus* spp.) and cultivated trees (e.g., palms and coffee). Subrata and Syahbudin (2016) reported that civets in a forest containing a coffee plantation in Pekalongan, Java, fed on some cultivated plant species such as sugar palm (*Arenga pinnata*), robusta coffee (*Coffea robusta*), and figs (*Ficus annulata*). At our study site, the fruits consumed by the common palm civets were largely native, except for *T. grandis*. Further study is required to understand the potential roles of the common palm civets as seed dispersal agents in Java.

Acknowledgements

We are grateful to the forest rangers of PNR, especially Yana Hendrayana and Ukin Iskandar, for allowing us to use their facilities and to Bambang Prayitno for fieldwork assistance. A Japan Society funded this study for the Promotion of Science (JSPS) KAKENHI grant (no.16K18619) and the JSPS Core-to-Core Program (A. Advanced Research Networks).

References

Aroon, S., 2008. Diet and habitat use at vivered group at Sakaerat Environmental Research station, Nakhon Ratchasima [Thesis]. Thaliland: Suranaree University of Technology.

Bartels, E., 1964. On *Pardoxurus hermaphroditus* javanicus (Horsfield, 1824). The common palm civet or tody cat in Western Java-notes on its food and feeding habits and its ecological importance for wood and rural biotopes. *Beaufortia*. 10, 193-201.

Davis, D.D., 1962. Mammals of the lowland rainforest of North Borneo. *Bulletin of the Singapore National Museum*. 31, 3-128.

De Guia A.P.O., Chavez G.C.S., Fernandez D.A.P., 2020. Distribution and diet of the common palm civet (*Paradoxurus philippinensis*) in the Mt. Makiling Forest Reserve, Luzon Island, Philippines. *Philippine Science Letters*. 13, 28-33.

Grassman, L.I., 1998. Movements and fruit selection of two *Paradoxurinae* species in a dry evergreen forest in southern Thailand. *Small Carnivore Conservation.* 19, 25-29.

Joshi, A.R., Smith, J.L.D., Cuthbert, F.J., 1995. Influence of food distribution and predation pressure on spacing behavior in palm civets. *Journal of Mammalogy*. 76, 1205-1212. https://doi.org/10.2307/1382613

Jothish, P.S., 2011. Diet of the common palm civet *Paradoxurus hermaphroditus* in a rural habitat in Kerala, India, and its possible role in seed dispersal. *Small Carnivore Conservation.* 45, 14-17.

Khan, K. A., Khan, J. A., Ahmad, K. and Mohan, N. 2019. Winter food habits of the common palm civet *Paradoxurus hermaphroditus* (Mammalia: Carnivora: Viverridae) in Patna Bird Sanctuary, India. *Journal of Threatened Taxa*. 11, 14490-14495. https://doi.org/10.11609/jott.4165.11.12.14490-14495

Krishnakumar, H., Balakrishnan, M., 2003. Feeding ecology of the common palm civet *Paradoxurus hermaphroditus* (Pallas) in semi-urban habitats in Trivandrum, India. *Small Carnivore Conservation*. 28, 10-11.

Mitani, M., Watanabe, K., Gurmaya, K.J., Megantara, E.N., Purnama, A.R., Syarief, Y.S., 2009. Plant species list from the Pananjung Pangandaran Nature Reserve, West Java, Indonesia, sampled in the El Niño-Southern Oscillation year of 1997. *Human and Nature*. 20, 113-120. https://doi.org/10.24713/hitotoshizen.20.0_113

Nakabayashi, M., Ahmad, A.H., Kohshima, S., 2016a. Behavioral feeding strategy of frugivorous civets in a Bornean rainforest. *Journal of Mammalogy*. 97, 798-805. https://doi.org/10.1093/jmammal/gyw005

Nakabayashi, M., Nakashima, Y., Hearn, A.J., Ross, J., Alfred, R., Samejima, H., Mohamed, A., Heydon, M., Rustam, Bernard, H., Semiadi, G., Fredricson, G., Berkel, T.V., Brodie, J., Giordano, A.J., Hall, J., Loken, B., Persey, S., David, W., Belant, J., Kramer-Schadt, S., Wilting, A., 2016b. Predicted distribution of the common palm civet *Paradoxurus hermaphroditus* (Mammalia: Carnivora: Viverridae) on Borneo. *Raffles Bulletin of Zoology*. 33, 84-88.

Nakashima, Y., Inoue, E., Inoue-Murayama, M., Sukor, J.A., 2010. High potential of a disturbance-tolerant frugivore, the common palm civet *Paradoxurus hermaphroditus* (Viverridae), as a seed disperser for large-seeded plants. *Mammal Study*. 35, 209-215. https://doi.org/10.3106/041.035.0307

Nakashima, Y., Sukor, J.A., 2010. Importance of common palm civets (*Paradoxurus hermaphroditus*) as a long-distance disperser for large-seeded plants in degraded forests. *Tropics.* 18, 221-229. https://doi.org/10.3759/tropics.18.221

Patou, M.L., Wilting, A., Gaubert, P., Esselstyn, J.A., Cruaud, C., Jennings, A.P., Fickel, J., Veron, G., 2010. Evolutionary history of the *Paradoxurus palm* civets: a new model for Asian biogeography. *Journal of Biogeography*. 37, 2077-2097. https://doi.org/10.1111/j.1365-2699.2010.02364.x

R Core Team, 2023. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Available at: https://www.R-project.org/ [Date accessed: 16 April 2020]

Rosleine, D., Suzuki, E., 2012. Secondary succession at abandoned grazing sites, Pangandaran Nature Reserve, West Java, Indonesia. *Tropics*. 21, 91-104. https://doi.org/10.3759/tropics.21.91

Su, S., Sale, J., 2007. Niche differentiation between common palm civet *Paradoxurus hermaphroditus* and small Indian civet *Viverricula indica* in regeneration degraded forest, Myanmar. *Small Carnivore Conservation*. 36, 30-34.

Subrata, S.A., Syahbudin, A., 2016. Common palm civet as a potential seed disperser of important plant species in Java. *AIPhysics Conference Proceedings*. 1744, 20053. https://doi.org/10.1063/1.4953527

Sumardja, E.A., Kartawinata, K., 1977. Vegetation analysis of the habitat of banteng (*Bos javanicus*) at the Pananjung Pangandaran Nature Reserve, West Java. *Biotropical Bulletin*. 13, 3-49.

Tsuji, Y., Mitani, M., Widayati, K.A., Suryobroto, B., Watanabe, K., 2019. Dietary habits of wild Javan lutungs (*Trachypithecus auratus*) in a secondary plantation mixed forest: effects of vegetation composition and phenology. *Mammalian Biology*. 98, 80-90. https://doi.org/10.1016/j.mambio.2019.08.001

Tsuji, Y., Ningsih, J.I.D.P., Kitamura, S., Widayati, K.A., Suryobroto, B., 2017. Neglected seed dispersers: Endozoochory by Javan lutungs (*Trachypithecus auratus*) in Indonesia. *Biotropica*. 49, 539-545. https://doi.org/10.1111/btp.12439

Tsuji, Y., Prayitno, B., Nila, S., Widayati, K.A., Suryobroto, B., 2015. Diurnal resting site selection and daytime feeding behaviour of wild Malayan flying lemur *Galeopterus variegatus* in Western Java, Indonesia. *Mammal Study*. 40, 35-45. https://doi.org/10.3106/041.040.0107