

Food Choices of Long-Tailed Monkeys (*Macaca fascicularis*) in the Pulaki Temple Area, Bali

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Abstract

Macaca fascicularis, a member of the *Cercopithecidae* family, plays a significant ecological role, particularly as a seed disperser for the fruits it consumes. *M. fascicularis* exhibits tolerance towards various types of natural and non-natural food, including human food waste and rubbish, making it an omnivorous species. It inhabits primary and secondary forests and areas adjacent to human settlements. In Bali, *M. fascicularis* populations can be found in sacred sites such as temples, including the Pulaki Temple area. This research aimed to investigate the dietary preferences of *M. fascicularis* in the Pulaki Temple area. Data collection took place from June to October 2023. As a result, *M. fascicularis* groups in the Pulaki Temple area were categorized into four: *Madya*, *Medal*, *Pabean*, and *Parkiran*. Their observed daily activities included sleeping, grooming, sexual activity, moving, eating, caring for offspring, playing, and agonistic behaviors. Analysis revealed a higher frequency of non-natural foods (87.18%) than natural foods (12.78%). During the research period, *M. fascicularis* preferred *Gemitir* (Marigold) flowers (n=2299), commonly offered as part of Hindu prayers. The elevated consumption of non-natural foods in this area could be attributed to several factors, including the scarcity of natural food sources and low human awareness regarding the impact of feeding non-natural foods to wildlife, leading to changes in the animal's natural behavior. Such changes might disrupt their ecological roles, potentially destabilizing the ecosystem. Therefore, measures are needed to preserve the natural behaviors of these animals, including increasing natural food availability and implementing clear guidelines prohibiting wildlife feeding by visitors.

Keywords: Food choices; *Macaca fascicularis*; pulaki

Introduction

M. fascicularis belongs to the *Cercopithecidae* family. In Indonesia, it is known as the long-tailed monkey and is a type of primate that is highly adaptive to various habitat types, including lowlands and highlands (Wheatley, 1989). Geographically, *M. fascicularis* is distributed across Southeast Asia to mainland Asia, including Indonesia, Malaysia, the Philippines, Cambodia,

Thailand, Vietnam, Laos, Burma, and India (Subriansyah et al., 2014). In Indonesia, it is found in Sumatra, Java, Kalimantan, Bali, Lombok, and Nusa Tenggara Islands. However, comprehensive data on population density throughout its distribution area still needs improvement (Fitriana et al., 2024).

This species can be found in primary and secondary forests (Fooden, 1995).

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Additionally, it inhabits canopy forests, river forests, coastal areas, mangroves, swamps, and tourist forests (Fakhri, 2012; Gumert, 2011).

Density and competition for food can occur within primate populations, including *M. fascicularis* in nature. Their habitat influences daily food variations and can result in ecological changes due to the abundance of food (Nila et al., 2014).

The availability of food, both from natural sources and provided by humans, significantly influences the survival of *M. fascicularis* (Zairinia et al., 2015). It is primarily herbivorous, with fruit being the main food source. The preference for certain fruits is influenced by color, smell, weight, and nutritional content. Additionally, they consume leaves, tubers, flowers, seeds, and insects (Farida et al., 2008). According to Hadi et al. (2007), *M. fascicularis* demonstrates tolerance for various food types, including natural foods found in their habitat and non-natural foods such as human food waste and rubbish, placing them in the category of omnivores.

The habitat of *M. fascicularis* in Bali is predominantly within sacred temples that serve as religious tourism areas. The presence of humans in these environments, which also function as tourist attractions, affects the natural behavior of the animals in fulfilling their dietary needs.

Pulaki Temple, situated on the Singaraja-Gilimanuk street, precisely in Banyupoh Village, Gerokgak District, Buleleng Regency, is one of the Hindu holy places in Bali and serves as a habitat for the *M. fascicularis* population (Syah et al., 2023). Previously, no research had been conducted regarding the variety of food choices of *M. fascicularis* in the Pulaki Temple area, making it necessary to investigate. Moreover, the recorded data can serve as a reference in addressing the

issue of natural behavioral changes among *M. fascicularis* in the Pulaki Temple area.

Research Methods

Time and Location of Research

This research was conducted from June to October 2023 in the Pulaki Temple area in Banyu Poh Village, Gerokgak District, Buleleng Regency, Bali. The temple occupies an area of approximately 5 hectares.

Habituation

Habituation was necessary to familiarize *M. fascicularis* with the presence of researchers, facilitating investigation so the animals would not feel threatened. To acclimate them to human presence, they were fed in the morning and evening for two weeks (Rizaldy et al., 2016).

At this stage, the number of *M. fascicularis* groups was also calculated by employing the concentration point counting method (Rinaldi, 1992) and the feed spreading method to collect animals, simplifying the calculation of group numbers.

Behavioral Observation

The daily activity of *M. fascicularis* at the observation site was monitored from morning to evening using the *ad libitum* method (Altman, 1974). It involved collecting data on the daily activities of all visible animals from each group for six hours in one observation period (Syah, 2020). The results included the duration and frequency of observed behaviors (Martin & Bateson, 1993).

Foraging Behavior

Foraging activities performed by *M. fascicularis* were influenced by the availability and abundance of food in their habitat. Accordingly, the present study

recorded the number of species searching for food and the types of food they consumed. The recorded food was categorized into natural food available in nature and non-natural food provided by visitors (Hadi et al., 2007). In this regard the data collected included the food preferences of *M. fascicularis* in the Pulaki Temple area.

Data Analysis

Research data regarding group composition, daily behavior, and preferred food of *M. fascicularis* were tabulated utilizing *Microsoft Excel* and analyzed descriptively.

Research Results and Discussion

The population of *M. fascicularis* in the sacred area of Pulaki Temple was divided into four groups: *Madya*, *Medal*, *Pabean*, and *Parkiran*. Figure 3 below illustrates the home range of each group at the research location.

The species composition (numbers) of each group (number) was determined by employing the concentration point counting method and the feed spreading method to attract the attention of all members of the *M. fascicularis* groups for easier counting. These counts were conducted in the morning and evening, with three repetitions to ensure accuracy. Each group was further categorized by age, as detailed in Table 3.

Figure 3. The home range of *M. fascicularis* groups in the Pulaki Temple area

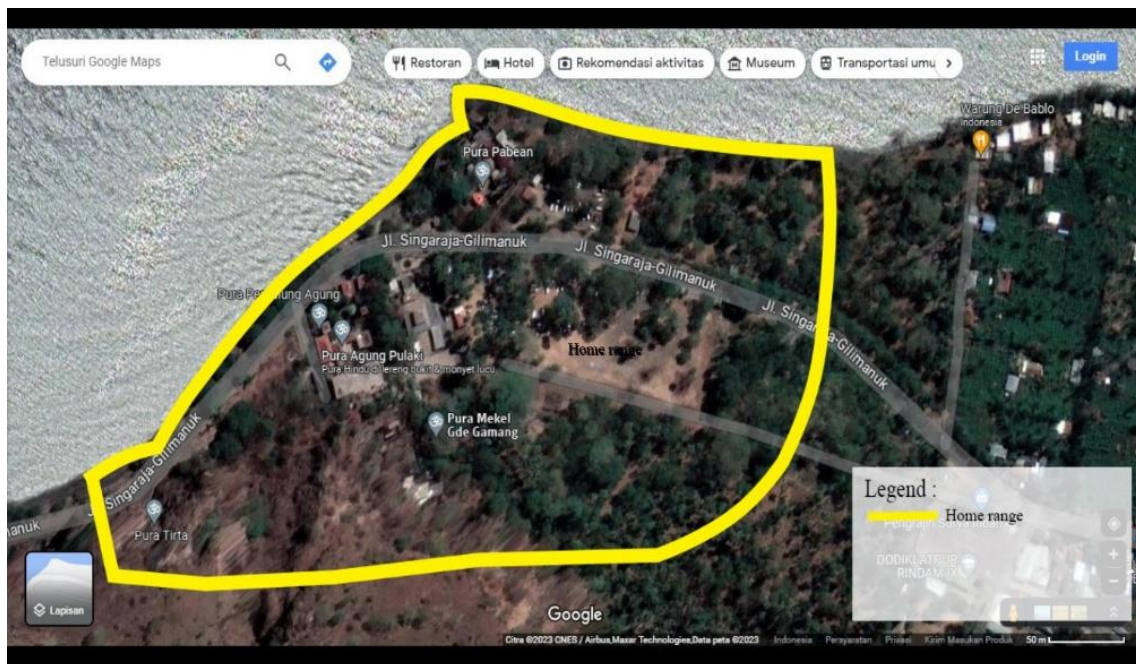
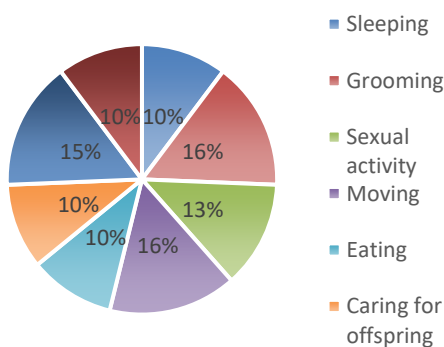


Table 3. Composition of *M. fascicularis* groups in the Pulaki Temple area

Age Category	Group			
	<i>Madya</i>	<i>Medal</i>	<i>Pabean</i>	<i>Parkiran</i>
Infant	11	14	7	10
Juvenile	6	23	20	22
Young/sub-adult	45	18	14	16
Adult male	12	24	12	19
Adult female	13	23	14	10
Total	87	102	67	77

Daily Activity of *M. fascicularis*

The daily activities observed among *M. fascicularis* encompassed sleeping, grooming, sexual activity, moving, eating, caring for offspring, playing, and agonistic behaviors. Dominant activities, based on calculation results, included moving (16%), grooming (16%), and eating (15%).



Food Choices for *M. fascicularis* in the Pulaki Temple Area

The population of *M. fascicularis* at the research location was segregated into four groups (*Madya*, *Medal*, *Pabean*, and *Parkiran*), each with its designated feeding site within their respective areas. The *Madya* group's territory was adjacent to Pulaki

Temple, experiencing the highest visitor traffic. The *Parkiran* group was situated near the bus parking lot and the merchant area on the east side. The *Medal* group's territory was in the western area of Pulaki Temple, while the merchant area was on the north side. The *Pabean* group occupied an area around the Pabean Temple, close to the beach.

Food consumption data of *M. fascicularis* in the Pulaki Temple area were categorized into natural and non-natural sources. Natural food refers to items readily available in nature, whereas non-natural food includes items not naturally occurring. Non-natural food sources recorded included offerings from visitors, pilferage of personal belongings, and scavenging from trash. Researchers' observation results indicated that the consumption of natural food by *M. fascicularis* in the Pulaki Temple area was lower (12.82%) than non-natural food (87.18%). Detailed data on food consumption by *M. fascicularis* are presented in Table 5.

Table 4. Comparison of the percentage of food consumed by *M. fascicularis* in the Pulaki Temple area

Type	Frequency (n)	Percentage (%)
Natural food	1.523	12.82
Non-natural food	10.352	87.18
Total (N)	11.875	100

Table 5. Food consumed by *M. fascicularis* in the Pulaki Temple area from August to October 2023

No	Type of Food	Frequency in each group												Total
		<i>Madya</i>			<i>Medal</i>			<i>Pabean</i>			<i>Parkiran</i>			
		August	September	October	August	September	October	August	September	October	August	September	October	
Non-natural food														
1	Banana	187	106	154	134	102	110	93	87	75	108	112	102	1370
2	Grapes	68	23	76	47	38	27	26	20	15	28	17	18	403
3	Papaya	57	46	58	48	46	48	24	23	34	23	45	32	484
4	Snake fruit	23	31	34	23	17	19	32	27	31	19	20	19	295
5	Orange	52	41	50	48	26	38	24	23	37	23	41	32	435
6	Mango	54	42	43	41	28	32	25	28	31	24	32	31	411
7	Melon	31	24	15	23	14	7	20	8	4	23	11	8	188
8	Rice	12	3	5	4	1	0	0	0	0	2	0	3	37
9	Noodles	2	0	3	0	4	1	0	0	0	7	3	2	22
10	Gemitir (Marigold) flower	458	511	387	121	111	87	65	89	76	213	56	125	2299
11	Egg	225	206	227	98	81	64	76	65	87	130	106	98	1463
12	Candy	12	3	21	0	7	3	0	0	0	5	1	3	55
13	Biscuits	154	176	268	234	165	173	76	34	42	41	25	27	1415
14	Peanut shells	153	124	120	108	126	118	108	98	78	124	153	143	1453
14	Sukro (Oven Coated Peanut)	7	1	0	1	0	0	0	0	0	0	0	0	9
15	Shrimp crisp	3	0	0	0	0	0	0	0	0	11	0	2	16
16	Milk pie	1	0	2	0	0	0	0	0	0	2	0	0	5
TOTAL		1499	1337	1462	930	766	727	569	502	510	783	622	645	10352
Natural food														
1	Bekul (<i>Ziziphus</i>)	46	28	23	0	0	0	0	0	0	0	0	0	97

	<i>jujuba</i> Mill.) fruit													
2	<i>Ental</i> (<i>Borassus</i> <i>flabellifer</i>) fruit	5	9	4	3	0	0	4	6	3	9	8	5	56
3	Tamarind leaves	0	0	0	0	0	0	32	65	46	0	0	0	143
4	Puzzle grass	32	24	26	67	71	87	89	93	76	42	52	42	701
5	<i>Intaran</i> (<i>Azadirachta</i> <i>indica</i>) fruit	12	15	9	3	2	0	0	0	0	0	0	0	41
6	<i>Ketapang</i> (<i>Terminalia</i> <i>catappa</i>) fruit	3	4	1	0	0	0	0	0	0	0	0	0	8
7	<i>Buni</i> (Blueberry) fruit	3	2	4	0	0	0	0	0	0	0	0	0	9
8	Cherry fruit	23	21	43	27	32	24	0	0	0	0	0	0	170
9	<i>Kesambi</i> (<i>Schleichera</i> <i>oleosa</i>) fruit	5	4	0	0	0	0	0	0	0	0	0	0	9
10	Cactus	3	2	4	0	0	0	0	0	0	0	0	0	9
5	Crab	2	0	0	5	8	11	45	32	37	0	0	0	140
TOTAL		134	109	114	105	112	122	170	196	162	51	60	47	1523

Discussion

The behavior of *Macaca fascicularis* in the Pulaki Temple area had undergone noticeable changes. Research findings indicated a shift in the preferred food sources of the long-tailed monkeys in this region, now favoring non-natural food items procured from visitors, plundered items used in rituals, and leftovers from rubbish bins. This aligns with previous studies by Nila et al. (2014) and Nugraheni (2016), which observed similar trends among *M. fascicularis* in Telaga Warna, Bogor, and Bangi Permanent Forest Reserve, Selangor, Malaysia respectively (Ruslin et al., 2019).

In the Pulaki Temple area, the *Gemitir* (Marigold) flower was the most preferred food item among *M. fascicularis*. This flower is traditionally included in Hindu offerings during prayers. Groups of *M. fascicularis* tracked visitors carrying luggage, seizing bags containing some flowers used in offerings. Additionally, they frequently scavenged for leftover offerings in the trash. This behavior distinguished the feeding habits of *M. fascicularis* in the Pulaki Temple area from those of other populations. Quinda et al. (2013) noted that *M. fascicularis* typically favors fruits due to their superior taste to other plant parts. However, eggs and peanut shells were also consumed by *M. fascicularis* in the Pulaki Temple area, likely due to regular offerings of these items by temple officials and volunteers, who consider them sacred.

Despite regulations prohibiting the feeding of animals, enforcement remained lax, leading to frequent violations by visitors. Interviews with officials revealed that at Pulaki Temple, a ritual known as "*wanaralaba*" involves offering fruits, *Gemitir* (Marigold) flowers, and eggs to *M. fascicularis* as a sacred tradition to express gratitude to the long-tailed monkeys for their presence in the

temple area. However, this practice indirectly contributed to the altered foraging behavior of *M. fascicularis*, driven by anthropogenic disturbances that disrupted their natural habitat. Similar disruptions have been observed globally, such as in Southern Thailand, where *M. fascicularis* has adapted to exploit oil palm fruit due to habitat loss (Luncz et al., 2017).

Another factor that contributed to changes in the feeding preferences of *M. fascicularis* in the Pulaki temple area was the limited availability of natural food sources in their habitat. Given the significance of this species in ecosystem balance, it is crucial to consider the conservation status of *M. fascicularis* in the Pulaki Temple area. Thus, concerted efforts are necessary to maintain their natural behavior and ecosystem equilibrium. These efforts may entail augmenting the abundance of natural food sources for *M. fascicularis* in the Pulaki Temple area while minimizing the provision of non-natural food by visitors. Reinegger et al. (2023) highlighted that *M. fascicularis*, which consumes fruit, plays an ecological role in seed dispersal from the fruits they consume.

Accurate identification of natural food sources is essential for estimating the amount required for all *M. fascicularis* populations at the Pulaki Temple. Besides, the temple authorities must intensify efforts to protect and conserve this animal, which holds sacred significance.

Conclusion

The high consumption of non-natural food by *M. fascicularis* in the Pulaki Temple area could be attributed to several factors, including the scarcity of natural food sources and the lack of human awareness in refraining from providing non-natural food, thereby altering the species' natural behavior. This behavioral change could disrupt the ecological

niche, consequently diminishing the balance of the ecosystem.

Acknowledgment

The authors express gratitude to the management of Pulaki Temple for

facilitating this research funded by the DIPA (Budget Implementation List) grant provided by Ganesha University of Education in 2023.

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