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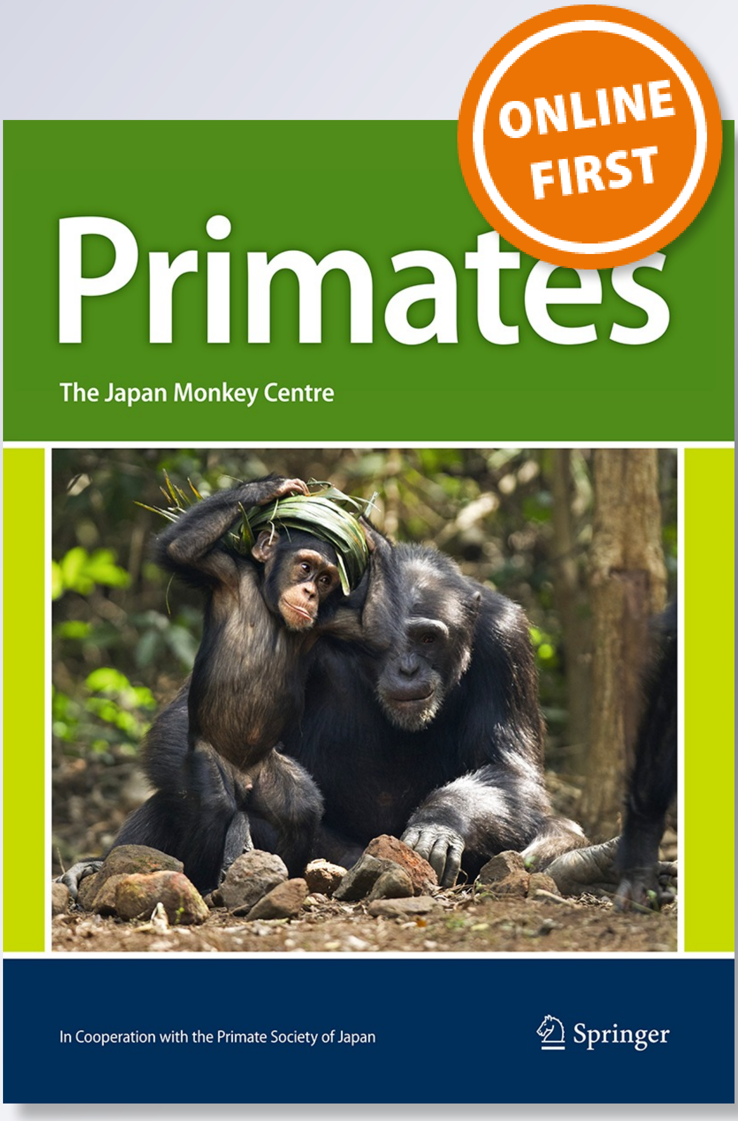

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ORIGINAL ARTICLE

Status of urban populations of the long-tailed macaque (*Macaca fascicularis*) in West Sumatra, Indonesia

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Abstract We studied long-tailed macaque (*Macaca fascicularis*) populations in Padang, West Sumatra, Indonesia, focusing on the effect of human provisioning on their demography and dietary composition. We conducted a field survey at three sites in the city: Gunung Meru, Gunung Padang, and Gunung Panggilun. Mean troop size (range 28–68) and infant ratio (range 0.38–1.00) were greater in Gunung Meru, where the macaques have been highly provisioned, than at the other two study sites (troop size 10–15; infant ratio 0.00–0.33). The macaques at all sites consumed both natural and human foods, but dependence on the latter differed among sites: three-quarters of the diet of macaques in Gunung Meru consisted of human foods, while human foods comprised less than 5% of the macaque diet at the other sites. The ability of macaques to modify the proportion of human food is a behavioral flexibility that facilitates the survival of the long-tailed macaque in urban habitats. Without restrictions on provisioning, the degree of dependence of macaques on human foods and population size could increase, especially in Gunung Meru, and human–macaque conflict could escalate. In order to create an effective management policy for urbanized monkeys, long-term quantitative data on macaque behavior and monitoring of population parameters are required.

Keywords Demographic profiles · Diet · Long-tailed macaque · Provisioning · Urban habitat

Introduction

The long-tailed macaque (*Macaca fascicularis*) is a primate species that is among the most tolerant of habitat disturbance by humans (Richard et al. 1989; Fooden 1995). These monkeys are predominantly found in evergreen forests, mangrove forests, swamp forests, riparian forests, and forest edges (Ong and Richardson 2008; Gumert 2011). Habitat loss due to logging, farming, and human housing have resulted in long-tailed macaques living in close proximity to humans in rural and urban environments (Hadi 2005; Gumert 2011; Aggimarangsee 2013). The ability of macaques to thrive in various habitat conditions or survive in a highly anthropogenic landscape depends on their ecological flexibility—their ability to adjust their diet, troop size, habitat use, and activity budgets (Hanya et al. 2003; Jaman and Huffman 2013; Tsuji et al. 2013).

In general, food availability is the most important factor affecting the behavior of macaques (Fuentes et al. 2005; Tsuji et al. 2006; Jaman and Huffman 2013). Long-tailed macaques are predominantly frugivorous, but they also consume a wide variety of plant and animal foods, including young and mature leaves, flowers, seeds, barks, fungi, insects, and small invertebrates—especially crustaceans in mangroves (Fooden 1995; Yeager 1996). In anthropogenic habitats, they often shift their diet from natural foods to human foods (Hadi et al. 2007; Fuentes et al. 2011; Sha and Hanya 2013). Human foods are more palatable, energy-rich, easily digestible, spatially clumped, and abundant, offering energetic advantages over natural ones (Forthman-Quick and Demment 1988; Iwamoto 1988).

The provisioning of human food to macaques can significantly affect their behavior: feeding time (including foraging) occupies most of the day in undisturbed

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environments or natural habitats, while time spent resting is more important in habitats with human foods (Asquith 1989; Saj et al. 1999; El Alami et al. 2012; Sha and Hanya 2013). Since human foods possess higher nutritional value, which is essential for basic health and breeding, females that feed on human food grow faster and mature earlier than females that do not consume such food (Wong 1994; Iwamoto 1988). The utilization of human foods often increases the birth and survival rates of macaque infants and decreases their primiparous age (Sugiyama and Ohsawa 1982; Watanabe et al. 1992; Brotcorne 2014). Thus, the sizes of the troops with access to human foods are larger than those without access to human foods (Wheatley et al. 1996; Wong and Ni 2000; Malaivijitnond and Hamada 2008). This extended macaque troop size often causes potential conflicts between human and macaques (Sha et al. 2009). From a social point of view, the presence of human food increases the degree of intragroup competition over food, resulting in higher levels of social tension and anxiety (Maréchal et al. 2011; Sussman et al. 2011). Furthermore, human foods sometimes cause health issues and diseases in macaques (Aggimarangsee 1992; Malaivijitnond et al. 2011).

In Padang, West Sumatra, Indonesia, long-tailed macaque habitats have been fragmented by human habitation and farming. We identified three urban populations of long-tailed macaques in Gunung Meru, Gunung Padang, and Gunung Panggilun. The macaques in Gunung Meru seem to have been provisioned by humans for more than 200 years (Koyama 1984). Information on the macaque populations in Gunung Padang and Gunung Panggilun is scarce, and the degree of provisioning there is unclear. The aim of the study reported in the present paper was therefore was to assess the behavioral ecology of long-tailed macaques in Padang. As ecobehavioral parameters, we focused on the demographic profiles and diet compositions of these three populations of long-tailed macaques. Such quantitative data should lead to a better understanding of the dietary plasticity and the population parameters of the long-tailed macaques living in urban areas. Demographic studies play a paramount role in primate conservation biology, particularly given the need to estimate the status and trends of populations in order to develop appropriate conservation and management action.

Methods

Study site

The study was conducted in Padang, West Sumatra, Indonesia (Fig. 1). We conducted a field survey at three sites: Gunung Meru (hereafter GM, 01°00′24.75″S and 100°23′14.0″E), Gunung Padang (GP, 0°57′56.6″S and 100°20′56.5″E), and Gunung Panggilun (GPG, 0°54′35.9″S and 100°22′9.4″E). These three sites are located on small mountains (altitude range 76–200 m). Each site encompasses ca. 2 ha of secondary forest surrounded by roads and human settlements. Dominant plants at these sites include *Ficus elastica*, *F. benjamina* (Moraceae), *Alstonia scholaris* (Apocynaceae), *Cocos nucifera*, *Arenga obtusifolia* (Arecaceae), and *Eurya acuminate* (Theaceae), but a detailed vegetation survey of these sites has not been conducted.

Data collection

There were three macaque troops (troops A, B, and C) at GM, one troop (X) at GP, and two troops (G and P) at GPG. During the observation period, we attempted to count the number of animals in each troop. We classified each animal into one of six age classes based on morphological characteristics such as body size, developmental stage of sexual organs, and skin color (Poirier and Smith 1974). Male long-tailed macaques reach sexual maturity at approximately 6 years of age, whereas female maturity occurs at about 4 years of age (Fooden 1995). We classified the macaques into adult males (>5 years), adult females (>4 years), subadult males and females (3.5–4 years), juveniles (1–3 years), and infants (<1 year). We summed the troop sizes for each study site to obtain the overall population size. We calculated (1) socionomic sex ratio (adult male/adult female), an indicator of sex ratio skewness, and (2) infant ratio (infant/adult female), an indicator of crude birth rate (Kyes 1993), for each troop. During the study period (October 2015 to February 2016), we counted the number of animals 20 times for troop A, 18 times for troop B, 30 times for troop C, 30 times for troop X, 30 times for troop G, and 15 times for troop P, and employed the maximum number as the size of the given troop. Due to the short study duration, we may have underestimated the birth rate: we could not detect infants born in January 2015 but died before October 2015.

In order to study feeding behavior, we selected one troop from each site (troop C at GM, troop X at GP, and troop G at GPG) and followed them from dawn to dusk (range 06:00–17:00 h). We observed the macaques at GM (by IK and RZ) from October 20, 2015 to December 6, 2015 (observation time: 30 d or 370 h), at GP (by IK and RZ) from December 7, 2015 to January 17, 2016 (30 d or 308 h), and at GPG (by IK, RZ, and JN) from January 18, 2016 to February 29, 2016 (30 d or 353 h). We studied each site on weekdays and holidays to examine the effect of number of tourists on the macaques' feeding behavior. Mean (±SD) daily observation times for GM, GP, and

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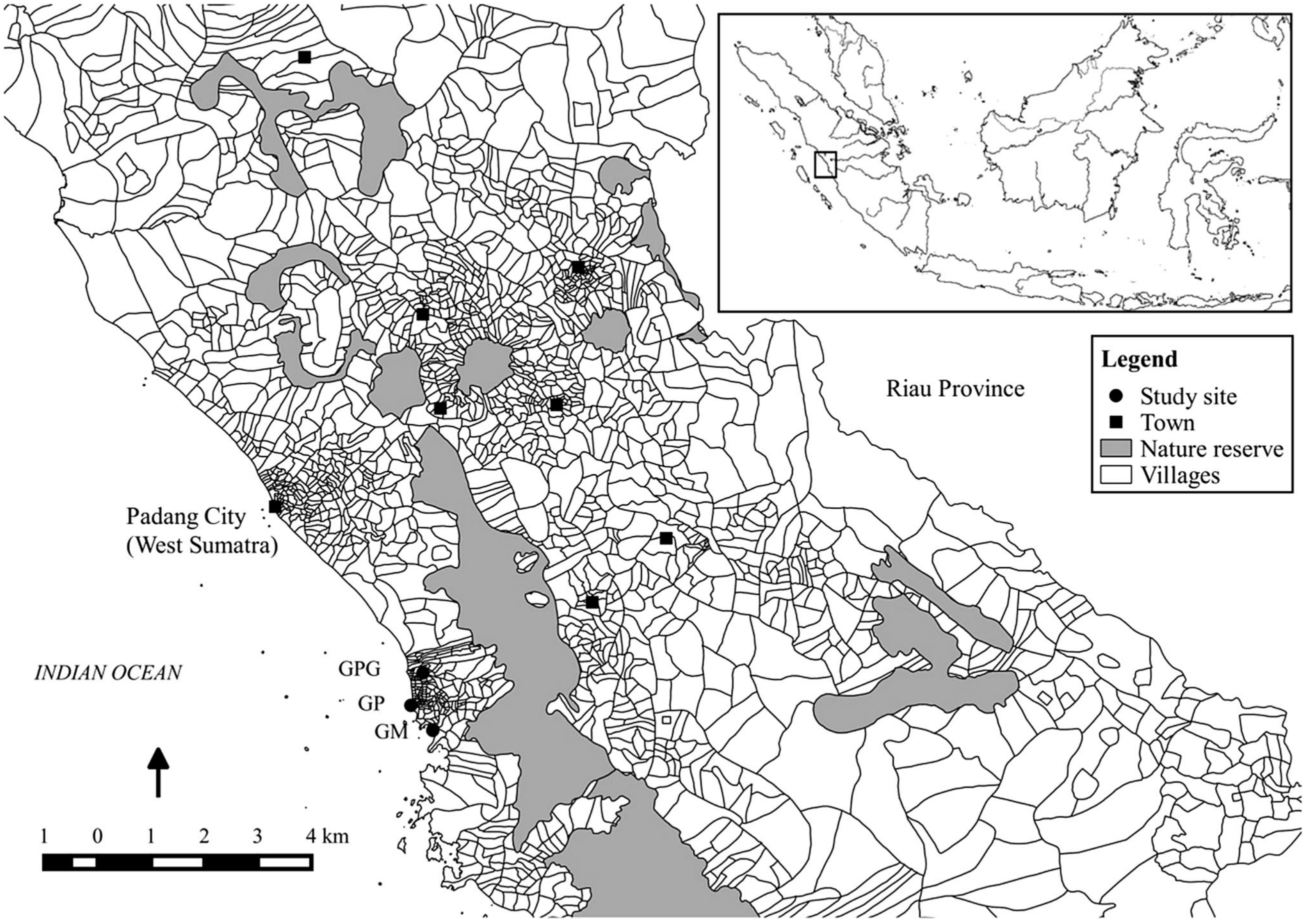

Fig. 1 Map of the study sites. *GM* Gunung Meru, *GP* Gunung Padang, *GPG* Gunung Panggilun

GPG were 9.3 ± 0.6, 8.5 ± 0.6, and 9.2 ± 1.1 h, respectively.

The climate (in terms of temperature and monthly rainfall) in Padang during this study was stable (range of maximum temperature 32.3–33.9, minimum temperature 23.3–24.0, rainfall 104–510 mm, www.accuweather.com, accessed on 07/02/2016), so we did not consider seasonal changes in diet availability and number of visitors.

During the observation period, we conducted 5-min scan sampling at 10-min intervals and recorded the activities of all visible animals (except for infants). If the scanned animals were foraging, we recorded the type of food (natural or human) and parts eaten. The parts were classified as young leaves, mature leaves, young fruits, mature fruits, flower, bark, or seeds.

We recorded the number of tourists during the observations. We also recorded provisioning events (defined as events in which a tourist fed a monkey manually) by ad libitum sampling for 15 min. We treated two provisioning events occurring >15 min apart as different events. Provisioned foods were classified as processed (boiled, baked, or fried) or unprocessed foods. Whenever we observed a provisioning event, we took photographs to identify the item, from which we estimated the weight of the provisioned food. If possible, we asked the feeders directly about the type of food. The amount of provisioned foods during the observation was estimated by multiplying the weight of each food item by the number of provisioning events. We estimated foods provisioned per capita by dividing the total amount of human food by the total number of monkeys at a given site during the study period.

Statistical analyses

In order to assess the differences in the number of visitors per day among the study sites, we conducted the Kruskal–Wallis test and post-hoc tests with Bonferroni adjustment. In order to compare the degree of provisioning (no. of feeders/no. of visitors) and dietary composition among the study sites, we conducted a chi-square test of independence for the pooled data over the 30-day survey. Statistical analyses were performed using R ver. 3.2.3 (R Development Core Team 2016). The statistical significance level (α) was set as 0.05.

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Results

Population structure and age-sex ratios

The three population studies of long-tailed macaques comprised 172 individuals (Table 1). The largest population was found at GM, with 132 individuals in three troops (A, B, and C). The mean ± SD troop size at GM was 44.0 ± 21.1. In GP, the troop (X) was composed of 15 individuals. In GPG, we counted 25 individuals in two troops (G and P), and the mean troop size was 12.5 ± 2.1. Overall, the age structure of the populations was 35% adults, 25% subadults, 30% juveniles, and 10% infants. The mean socionomic sex ratios of the population at GM, GP, and GPG were 0.57, 0.67, and 0.59, respectively, and all were skewed towards females. The infant ratio ranged from 0.00 to 1.00 and was highest at GM. There were no infants in troops X and G (Table 1).

Intensity of human provisioning

The number of visitors significantly differed among the study sites (Kruskal–Wallis test: $\chi^2 = 78$, $df = 2$, $p < 0.001$, Fig. 2a). Post-hoc tests revealed that the number of visitors at GM was significantly greater than those at the other two sites ($p < 0.001$). The number of tourists at GM was greater during holidays, whereas such differences were not observed at GP and GPG. The number of feeders also differed significantly among the sites ($\chi^2 = 66$, $df = 2$, $p < 0.001$), and was significantly higher at GM ($p < 0.001$, Fig. 2b). In addition, there were significant differences in the degree of human provisioning among the three study sites, with the highest degree occurring at GM ($\chi^2 = 152$, $df = 2$, $p < 0.001$). At GM, both the number of visitors and the number of feeders peaked during weekends and holidays (Fig. 2).

At GM, the total amount of food provisioned during the study was approximately 519.6 kg (mean ± SD: 129.8 ± 10.4 kg/week; ca. 0.98 kg per capita). In GP, the total amount of food provisioned was 47.5 kg (8.3 ± 1.9 kg/week; ca. 0.53 kg per capita). In GPG, the total amount of food provisioned was approximately 13.2 kg (3.5 ± 1.3 kg/week; ca. 0.14 kg per capita). The quantity and type of food provided to the macaques at each study site are shown in Table 3 in Appendix 1.

Food selection and diet composition

During the study period, the macaques consumed both natural and human foods (Fig. 3; Table 2). At GM, the percentage of human food in the macaque diet was 70.19%, while the corresponding values at GP and GPG were 4.85 and 2.66%, respectively. The percentage of human food differed significantly among sites ($\chi^2 = 3394$, $df = 2$, $p < 0.001$). The macaques' natural food consisted only of plant species. We recorded 45 plant species eaten by the macaques at the three study sites. The numbers of plant species eaten by the macaques at GM, GP, and GPG were 26, 28, and 24, respectively (Table 4 in Appendix 2). Most plant species consumed by the macaques at the three study sites were wild plants (Table 4 in Appendix 2). The composition of natural food items consumed by the macaques significantly differed among the study sites ($\chi^2 = 509$, $df = 8$, $p < 0.001$). The dietary percentages of leaves and fruits at GPG and GP were higher than those at GM (Table 2). In terms of human foods, the dietary percentages of boiled peanuts, peanuts, and foods taken from garbage bins at GM were much higher than those at the other sites (Table 2).

Table 1 Demographic structure and socionomic sex ratio of the long-tailed macaque population at each of the three sites considered during the study period

Population	Troop size	Adult		Subadult		Juvenile		Infant	Socionomic sex ratio	Infant ratio
		M	F	M	F	M	F			
GM										
Troop A	36	3	8	4	7	6	5	3	0.38	0.38
Troop B	28	2	6	3	3	5	3	6	0.33	1.00
Troop C	68	12	16	6	8	11	7	8	0.75	0.50
Total	132	17	30	13	18	22	15	17	0.57	0.57
GP										
Troop X	15	2	3	1	3	2	4	0	0.67	0.00
GPG										
Troop G	10	1	2	1	3	1	2	0	0.50	0.00
Troop P	15	2	3	2	2	4	1	1	0.67	0.33
Total	25	3	5	3	5	5	3	1	0.59	0.17

The table presents the number of individuals in each age-sex category within each troop during the observation period

M males, *F* females

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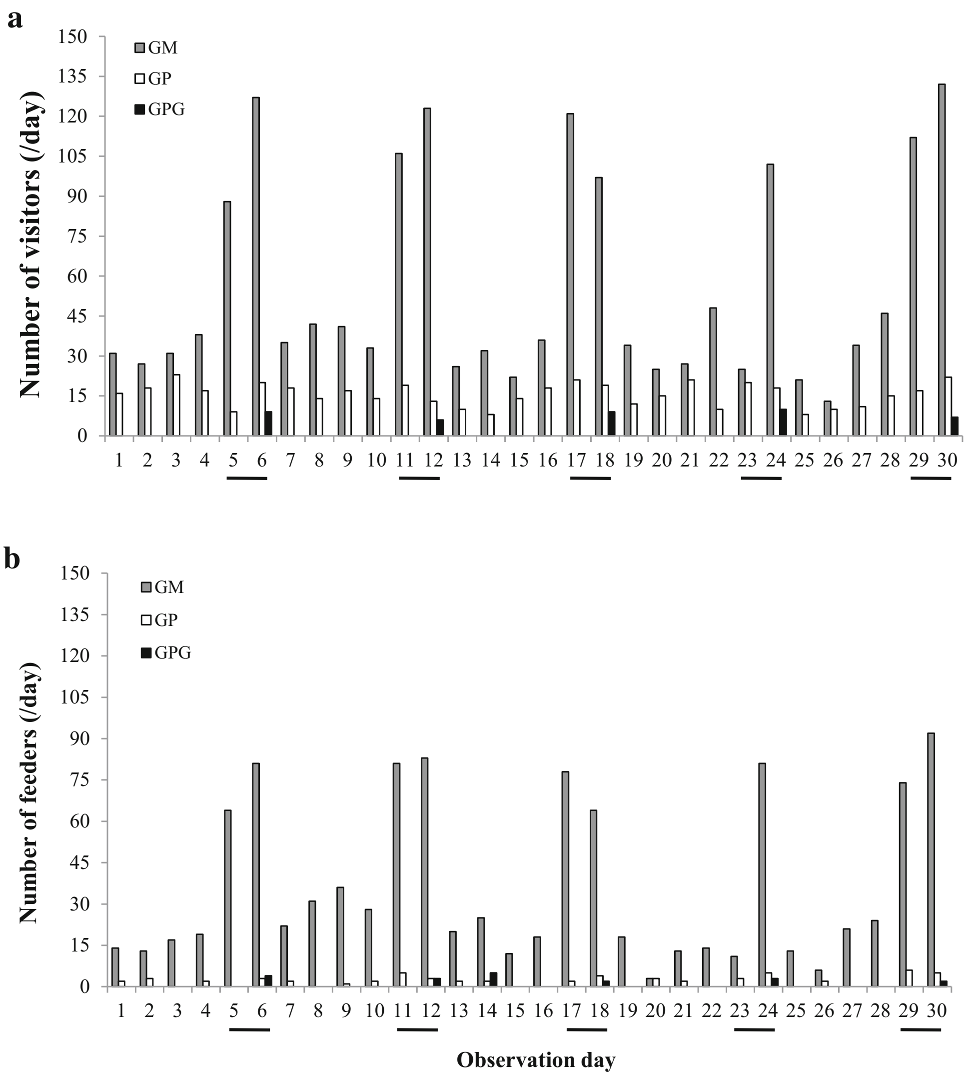

Fig. 2 **a** Number of visitors per day at each study site. **b** Number of feeders per day at each study site. *Gray bars* Gunung Meru, *open bars* Gunung Padang, *filled bars* Gunung Panggilun. Observation days marked with a *bar* represent weekends and holidays

Discussion

The troop size of GM (range 28–68) was much larger than those of GP (15) or GPG (10–15). Due to their higher nutritional value and higher digestibility, human foods are high-quality foods for primates (Wong 1994; Iwamoto 1988). Thus, an abundance of human food provided to macaques is likely to increase their carrying capacity in a given habitat (Dobson and Lees 1989; Crockett et al. 1996), and long-term provisioning causes an increase in troop size. Troop sizes of long-tailed macaques in urban areas sometimes exceed 100 individuals (Aggimarangsee 1992; Brotcorne 2009), while those in forested habitats range from 12 to 30 (van Schaik and van Noordwijk 1985; Wheatley et al. 1996). The larger numbers at GM can be attributed to the long-term provisioning there. On the other hand, the troop sizes of GP and GPG are comparable to those of the wild population, and the degree of provisioning at those sites at present is slight.

Effects of provisioning are often reflected in the socionomic sex ratio and/or birth ratio. Fooden (1995) reported the range of socionomic sex ratios in the wild population to be 0.22–0.90. At the troop level, the corresponding values range from 0.15 to 0.6 (Wheatley et al. 1996). Socionomic sex ratios of long-tailed macaques at our study sites (range: 0.33-0.75) were within the range of the wild populations mentioned above (Wheatley et al. 1996), indicating that the socionomic sex ratio of these macaques is a relatively conservative feature related to female philopatry and male emigration from natal troops (van Noordwijk and van

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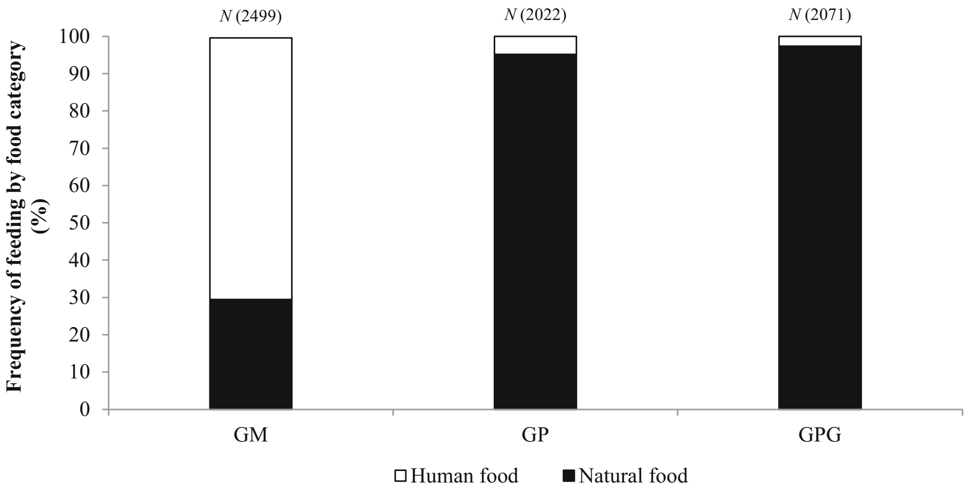

Fig. 3 Frequencies of feeding on human food (*open area*) and natural food (*filled area*) at the study sites. *GM* Gunung Meru, *GP* Gunung Padang, *GPG* Gunung Panggilun. The *figures at the top of the bars* represent the total number of animals scanned while feeding

Schaik 1999). Among our study sites, the infant ratio of the macaques was particularly high at GM (0.57). This ratio is similar to that of long-tailed macaques in Ubud, Bali: when highly provisioned, their infant ratio was 0.53, indicating that half of the adult females had infants (Brotcorne 2009). The stability of the human food provided to the macaques can explain the high birth rate at GM. It has been documented that provisioned females grow faster, mature earlier, and have shorter interbirth intervals than those in nonprovisioned populations (Sugiyama and Ohsawa 1982; Asquith 1989; Watanabe et al. 1992; van Noordwijk and van Schaik 1999; Altman and Albert 2005). The infant ratio at GM indicates that provisioning affected the reproductive performance of the macaques.

Our study showed that the number of feeders greatly differed among the sites: at GM, the number of feeders per month was more than 1000, and the per capita food was 0.98 kg; this is comparable to the highly provisioned population of rhesus macaques (*Macaca mulatta*) in Kowloon Hills, Hong Kong (3066 casual feeders per month, per capita provisioned food: 1.1 kg) (Wong 1994). On the other hand, provisioning at GP and GPG was occasional, and the per capita provisioned food was lower (0.14–0.55 kg). This implies that artificial effects are much greater at GM. Koyama (1984) mentioned that the reason for provisioning at GM was related to the religious context: there were graves of mythical Muslim warriors nearby, and people treat the monkeys as incarnations of the warriors and therefore feed them. GM has become a famous tourist site in Padang, and tourists feed the monkeys not only as a traditional offering but also for entertainment. Koyama (1984) showed no quantitative data on provisioning in GM, but our results implied that provisioning at this site has been done regularly. These macaques receive food directly from humans or from garbage.

The macaques at our study sites fed on both human and natural foods, but the percentages differed greatly among sites, with the highest dietary percentage of human food found at GM. The dietary percentage of human foods depends on their availability, which is proportional to the number of tourists (feeders) (Brotcorne 2014). In the case of long-tailed macaques in Singapore, 49% of the food consumed by the high-anthropogenic troop was human food, whereas this percentage was less than 26% for the low-anthropogenic troop (Sha and Hanya 2013). Our results supported that finding. The ability to adjust their dependence on human food resources seems to be a behavioral flexibility of long-tailed macaques living in urban habitats.

The natural diet of macaques consists mainly of fruits, leaves, seeds, flowers, and bark. However, dietary composition differed among the sites. The macaques at GM and GP fed primarily on fruits, while the macaques at GPG consumed more leaves. Intraspecific variation in the proportions of different plant parts in the diet can be attributed to natural food availability (Hill 1997; Hanya 2004; Tsuji et al. 2013). For example, *Muntingia calabura*, *Ficus benjamina*, and *Arenga obtusifolia* trees grow rapidly and produce fruit throughout the year. Therefore, the macaques at GM and GP may have relied more on their fruit. On the other hand, at GPG, the forest was dominated by bamboo trees and there were fewer fruit trees, which may have caused the macaques to be more folivorous. To test this hypothesis, a detailed vegetation survey should be conducted in the future.

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Table 2 Comparison of plant parts and human food items consumed by macaques at three study sites in West Sumatra: Gunung Meru (GM), Gunung Padang (GP), and Gunung Panggilun (GPG)

Food items	GM		GP		GPG	
	No. of animals	%	No. of animals	%	No. of animals	%
Natural food items						
Young leaves	192	7.68	343	16.96	760	36.70
Mature leaves	36	1.44	65	3.21	264	12.75
All leaves	228	9.12	408	20.18	1024	49.44
Young fruits	223	8.92	690	34.12	332	16.03
Mature fruits	161	6.44	627	31.01	483	23.32
All fruits	384	15.37	1317	65.13	815	39.35
Flowers	98	3.92	157	7.76	74	3.57
Seeds	27	1.08	26	1.29	96	4.64
Bark	8	0.32	16	0.79	7	0.34
Human food items						
Boiled peanuts	628	25.13	–	–	–	–
Peanuts	232	9.28	36	1.78	5	0.24
Bread	125	5.00	–	–	–	–
Papaya	123	4.92	–	–	2	0.1
Watermelon	106	4.24	3	0.15	–	–
Rambutan	87	3.48	–	–	3	0.14
Banana	78	3.12	2	0.1	–	–
Cake	67	2.68	12	0.59	2	0.1
Biscuit	46	1.84	–	–	4	0.19
Vegetables	32	1.28	23	1.14	3	0.14
Snack	27	1.08	–	–	–	–
Potato chips	25	1.00	5	0.25	2	0.1
Rice	18	0.72	–	–	–	–
Chocolate chips	17	0.68	–	–	10	0.48
Sweetcorn	5	0.20	–	–	–	–
Orange	4	0.16	3	0.15	–	–
Durian	2	0.08	–	–	–	–
Apple	2	0.08	–	–	–	–
Garbage	130	5.20	14	0.69	24	1.16

Numbers of animals scanned and their percentages are shown

Our results confirmed that a dietary shift to human food is one of the adaptive mechanisms of macaques in urban environments. Our results indicate that if the present situation continues, the population of long-tailed macaques at GM will continue to grow. If a restriction on feeding is not initiated by the local government, serious human–macaque conflicts such as crop raiding and aggressive behavior toward visitors will likely occur in the near future. Furthermore, human foods cause health issues and diseases in macaques (Aggimarangsee 1992; Malaivijitnond et al. 2011; Wheatley et al. 1996), which can have a serious impact on their survival. Continuous monitoring of long-tailed macaque behavior and regular population surveys are necessary to fully understand their population status, and would provide the scientific data required to create an efficient management plan for the macaques in Padang.

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Appendix 1

See Table 3.

Table 3 Quantity of provisioned foods from October 2015 to February 2016 at three study sites in West Sumatra: Gunung Meru (GM), Gunung Padang (GP), and Gunung Panggilun (GPG)

Human food items	Estimated weight (kg/item)	GM		GP		GPG	
		Frequency given	Total weight (kg)	Frequency given	Total weight (kg)	Frequency given	Total weight (kg)
Unprocessed foods							
Banana	0.2	29	5.8	–	–	–	–
Papaya	0.3	192	57.6	–	–	–	–
Watermelon	0.2	127	25.4	4	0.8	–	–
Rambutan	1.0	9	9.0	5	5	–	–
Durian	1.5	2	3.0	–	–	–	–
Sweetcorn	0.5	7	3.5	–	–	–	–
Apple	0.2	2	0.4	–	–	–	–
Orange	0.2	4	0.8	–	–	–	–
Vegetables	0.5	11	5.5	2	1.0	2	1.0
Processed foods							
Bread	0.5	42	21.0	5	2.5	2	1.0
Biscuit	0.1	57	5.7	12	1.2	11	1.1
Chocolate chips	0.02	24	0.5	20	0.4	2	0.0
Potato chips	0.03	36	0.9	2	0.1	–	–
Cooked rice	2.0	5	10.0	4	8.0	2	4.0
Snack	0.02	25	0.5	26	0.5	5	0.1
Cake	0.5	29	14.5	7	3.5	6	3.0
Roasted peanuts	0.5	232	116.0	49	24.5	6	3.0
Boiled peanuts	0.5	497	239.5	–	–	–	–
Total		1330	519.6	136	47.5	36	13.2

The frequency of provisioning was recorded by 15-min ad libitum sampling. Total weight of provisioned foods was estimated by multiplying the estimated weight by the number of provisioning events

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Appendix 2

See Table 4.

Table 4 List of natural foods consumed by long-tailed macaques between October 2015 and February 2016 at three study sites in West Sumatra: Gunung Meru (GM), Gunung Padang (GP), and Gunung Panggilun (GPG)

No.	Species	Family	Feeding record (%)		
			GM	GP	GPG
	Wild plants				
1	*Artocarpus elasticus*	Moraceae	–	0.59	–
2	*Artocarpus integra*	Moraceae	1.25	1.24	0.68
3	*Adinandra* sp.	Theaceae	–	0.79	–
4	*Areca catechu*	Arecaceae	0.36	–	–
5	*Arenga obtusifolia*	Arecaceae	3.37	0.94	4.06
6	*Baccaurea* sp.	Phyllanthaceae	1.73	–	–
7	*Bamboo* sp.	Poaceae	–	–	41.48
8	*Calamus* sp.	Arecaceae	1.29	–	–
9	*Cassia esculenta*	Fabaceae	1.88	1.04	1.45
10	*Clausena excavata*	Rutaceae	0.32	–	1.11
11	*Commersonia bartramia*	Malvaceae	0.6	0.79	–
12	*Cyclea barbata*	Menispermaceae	0.84	1.63	1.59
13	*Dolichos lablab*	Fabaceae	0.56	–	–
14	*Eugenia cumini*	Myrtaceae	0.84	1.48	0.77
15	*Eugenia polyantha*	Myrthaceae	–	1.34	–
16	*Eurya acuminata*	Theaceae	1.00	1.19	1.69
17	*Ficus amplas*	Moraceae	–	–	9.32
18	*Ficus benjamina*	Moraceae	–	21.56	12.17
19	*Ficus fulva*	Moraceae	–	2.42	1.88
20	*Ficus variegata*	Moraceae	0.40	2.23	2.17
21	*Hibiscus tilliaceus*	Malvaceae	–	7.27	–
22	*Homalanthus populneus*	Euphorbiaceae	1.45	2.08	2.03
23	*Ixora blumei*	Rubiaceae	–	4.70	1.98
24	*Leea indica*	Vitaceae	2.01	1.38	1.64
25	*Macaranga indica*	Euphorbiaceae	–	1.07	0.82
26	*Mallotus floribundus*	Euphorbiaceae	0.64	1.43	–
27	*Malottus* sp.	Euphorbiaceae	–	0.74	1.26
28	*Melastoma malabathricum*	Melastomataceae	–	0.40	–
29	*Mikania micrantha*	Asteraceae	0.84	1.68	–
30	*Millettia sericea*	Fabaceae	–	–	4.20
31	*Nephelium lappaceum*	Sapindaceae	0.44	–	–
32	*Piper aduncum*	Piperaceae	–	0.30	–
33	*Pithecellobium jiringa*	Fabaceae	0.44	1.24	1.21
34	*Poaceae* sp.	Poaceae	0.32	–	–
35	*Rubus moluccanus*	Rosaceae	0.56	–	0.77
36	*Terminalia catappa*	Combretaceae	–	8.61	–
37	*Villebrunea rubescens*	Urticaceae	0.32	–	–
38	*Vitex pubescens*	Verbenaceae	–	0.89	–
39	*Voacanga foetida*	Apocynaceae	–	–	1.88
	Agricultural plants				
40	*Carica papaya*	Caricaceae	–	–	1.73
41	*Cocos nucifera*	Arecaceae	0.52	1.14	0.92
42	*Durio zyberthinus*	Malvaceae	0.60	–	–
43	*Mangifera indica*	Anacardiaceae	6.27	–	–
44	*Musa acuminata*	Musaceae	–	–	0.53
45	*Muntingia calabura*	Muntingiaceae	0.96	24.98	–
	Total (%)		29.81	95.15	97.34
	Number of speceis consumed		$N = 26$	$N = 28$	$N = 24$

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