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Short Communication: Activity budget and diet in silvery lutung *Trachypithecus cristatus* at Gunung Padang, West Sumatra, Indonesia

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Abstract. *Akbar MA, Rizaldi, Novarino W, Perwitasari-Farajallah D, Tsuji Y. 2019. Activity budget and diet in silvery lutung* Trachypithecus cristatus *at Gunung Padang, West Sumatra, Indonesia. Biodiversitas 20: 719-724.* We studied the activity budget and diet of a group of wild silvery lutungs (*Trachypithecus cristatus*) in Gunung Padang, West Sumatra, Indonesia, with special attention to age-and sex-related differences. We conducted behavioral observations between July and October 2016, and found that resting constituted the greatest proportion of their daily activities (46%), followed by moving (38%), feeding (12%), and grooming (4%). Resting peaked between 11 am and 1 pm, while moving decreased in this period. The juveniles showed higher percentage of moving and lower percentage of feeding than the adults. The adult males showed higher percentage of grooming than the adult females. Finally, the nursing females showed lower percentage of resting and higher percentage of grooming than single females. During the study, we recorded 14 plant species consumed by the lutungs. Their dietary composition was composed of 63% foliage and 37% fruit. Both the foliage and fruits of *Ficus variegata*, a plant species belonging to the family Moraceae, was the most consumed. Foliage was frequently consumed by the nursing females and juveniles. The adult males were frequently observed to eat fruit during the study period. No fruit was consumed by the nursing females.

Keywords: Activity budget, age-and sex-related differences, colobines, dietary composition, behavioral observation

INTRODUCTION

Colobines, known as "leaf monkeys," are found throughout Asia and Africa (Fashing 2007; Kirkpatrick 2007). They are distinguished from the sub-family Cercopithecinae by an enlarged, ruminant-like stomach that has evolved to digest folivorous diets (Strasser and Delson 1987). Based on their gut physiology, the colobines have been shown to feed fundamentally on leaves, i.e., they are folivorous (Kay and Davies 1994). Previous studies have shown that colobines also feed on other plant parts, such as fruits, flowers, lichen, seeds, and buds (Kirkpatrick 2007; Matsuda et al. 2009; Kirkpatrick and Grueter 2010; Tsuji et al. 2013). The diet of the colobines is affected by moderate-alpine habitats, and this can be viewed as a feeding strategy in response to limited food resources (Tsuji et al. 2013).

Daily activity budgets are key information for evaluating the feeding strategies of primate species, that is, determine how they try to satisfy their nutritional requirements (Altmann 1980; Strier 1987). Feeding is the most necessary and major activity that provides sufficient nutrition and energy to maintain body condition, growth, and reproduction. Animals spend a lot of time feeding (Strier 1987; Zhou et al. 2007). Therefore, dietary habits are essential to understand the dietary composition (Yeager 1989; Hill and Lee 1998) of and food selection (Liu et al. 2013) by primates.

Colobines are primates that live in groups, and most of the species form one-male, multi-female groups (Wang et al. 2013). Both activity and diet composition vary among group members because the amount of nutrients required varies among animals belonging to different age-and sex classes. To the best of our knowledge, however, few studies have tried to address age-and sex-related differences in Asian colobines (e.g., Newton and Dunbar 1994; Boonratana 2003; Liu et al. 2013).

Information on this species under wild conditions is limited: Furuya (1961) studied the social structure of silvery lutungs in Rantau Panjang, north Klang, Malaysia. Harding (2010) documented their morphology, taxonomy, genetics, ethology, physiology, ontogeny, and ecology. Md-Zain and Ruslin (2012) reported the social system of silvery lutungs in Bukit Melawati, Kuala Selangor, Malaysia. To our knowledge, no studies have addressed the age-sex differences in the activities and dietary habits of silvery lutungs. In this study, we preliminary analyzed the fundamental ecology, in terms of activity and diet

composition, of wild silvery lutungs in Gunung Padang, West Sumatra, Indonesia, with emphasis on the age-sex differences in the activity budget and diet composition. Here, we have also discussed the similarities and differences between the silvery lutung and other Asian colobines in terms of their daily activities and diet composition.

MATERIALS AND METHODS

Study site

Our study was conducted in Gunung Padang, Kampung Sebrang Pebayan, Batang Arau Village, Padang Selatan Sub-district, Padang City, West Sumatra, Indonesia (0°58′ S and 100°21′ E; Figure 1). The area of Gunung Padang is ca. 20 ha, and the maximum elevation is ca. 25 m. Gunung Padang is a cape and is surrounded by the Indian Ocean. This area is mainly covered by secondary forests dominated by trees of the families Moraceae (e.g., *Ficus* spp. and *Artocarpus* spp.) and Euphorbiaceae (e.g., *Mallotus* spp., *Macaranga* spp., and *Homalanthus* spp.) (Ilham et al. 2017). The average temperature in Padang City is about 22-33° C, and average rainfall is 405.58 mm, with 17 rainy days per month (Weatherbase 2016).

Study subjects

We observed one group of wild silvery lutungs. During the study period, the lutung population was comprised 22 individuals: one adult male (≥5 y, largest body size), five adult females (≥5 y, slightly smaller than the AM, with irregular white patches on the inside flanks) carrying five infants (<1.5 y, orange hair), six adult females without infants, and five juveniles (1.5-5 y, smaller body size than the adults). Classification of the age-and sex classes was based on Harding (2010).

Behavioral observation

We conducted the study in the months of July, August, and October of 2016. We observed the lutungs for a total of 15 days (five days of observation per month). We followed the lutungs for as long as possible each day: usually from 9 AM till 5 PM, when the group stopped moving and began to rest. We used instantaneous scan sampling (Martin and Batteson 1993) with 5-min intervals to record the daily activities of the lutungs. For each scan, we spent 10 seconds on each visible individual to record its behavior and age-sex class.

We classified lutung activities into five categories: (i) feeding—the target animals reached out, and obtained food or placed the food in the mouth; (ii) moving—the target animals walked, ran, and leaped; (iii) resting—the target animals remained motionless and did not perform any activity; (iv) grooming—the target animals searched for and removed ectoparasites from their own fur or that of another individual; and (v) others—playing, mating, aggression, and mothering.

When the lutungs were feeding, we recorded the food items consumed by them. On the basis of a previous study (Tsuji et al. 2013), the diet of the colobines was classified into five categories: (i) unripe fruit, (ii) ripe fruit, (iii) foliage (including leaves, buds, and petioles), (iv) flowers (including flower buds), and (v) others (including bark, stem, pith, and underground storage organs. When the lutungs fed on unknown species, we collected and identified them at the herbarium of Andalas University, Padang, Indonesia.

Statistical analyses

To compare age-sex differences in the activity budgets and diet composition, we conducted the chi-square test of independence on the pooled data. The statistical analyses were performed using R ver. 3.3.1 (R Development Core Team 2016). The significance level (α) was set at 0.05.

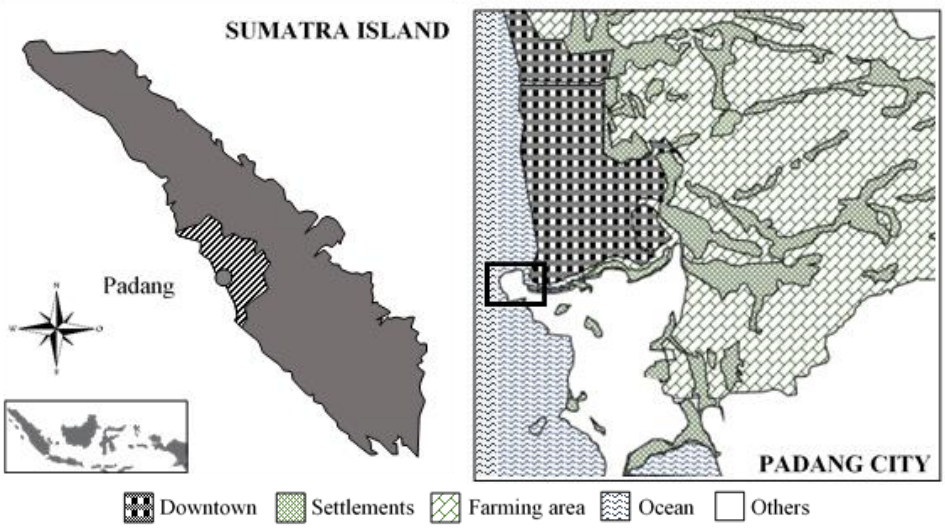

Figure 1. Study site map in Gunung Padang, West Sumatra, Indonesia (marked with rectangle sign)

RESULTS AND DISCUSSION

During the study, we observed the lutungs for a total of 61.7 h (July: 18.3 h; August: 20.1 h, and October: 23.3 h) with 740 number of scanning (n = 4271).

Activity budget and hourly activity rhythm resting was the most frequent activity (46.3%), followed by moving (37.8%), feeding (12.1%), and grooming (3.8%). The hourly activity rhythm of the lutungs is shown in Figure 2. Resting peaked between 11.00 am and 13.00. At the same time, the proportion of time spent on moving and feeding decreased. Moving and feeding peaked after 13.00 until 17.00. At the same time, the proportion of time spent on feeding decreased. The proportions of time spent grooming and performing other activities were stable throughout the day.

Age-sex differences in activity budgets

The proportions of activity budgets were significantly different among the age-and sex classes (chi-square test of independence: $\chi^2 = 43.55$, $df = 9$, $p < 0.001$). The juveniles showed higher percentage of moving and lower percentage of feeding than the adults. The adult male showed higher percentage of grooming than the adult females. Finally, the adult females with infants showed lesser percentage of resting and greater percentage of grooming than the ones without infants (Figure 3).

Dietary profile

The total number of plant species consumed by the lutungs in Gunung Padang during the study was 14, belonging to 11 genera and 10 families. The animals' diet during the study was composed of only foliage (63.0%) and fruits (37.0%). The main food species was *Ficus variegata* (foliage and fruits together constituted 63.2% of the diet). We combined ripe and unripe fruits. During this study, we did not find lutung fed on flower or other parts.

Age-sex difference in dietary composition

The percentage of food parts eaten by the lutungs was significantly different among the age-and sex classes ($\chi^2 = 38.95$, $df = 3$, $p < 0.001$; ; Figure 4). Compared with the other age-and sex classes, the nursing females (no fruit in their diet composition) and the juveniles consumed foliage mostly. A greater percentage of fruit comprised the diet of the adult male.

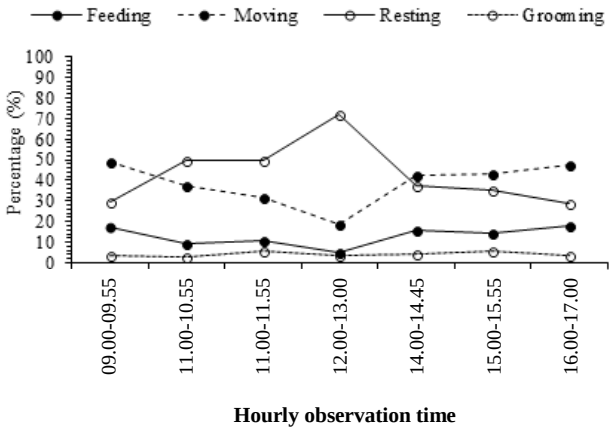

Figure 2. Hourly activity rhythm of T. cristatus at Gunung Padang, Padang City, West Sumatra, Indonesia

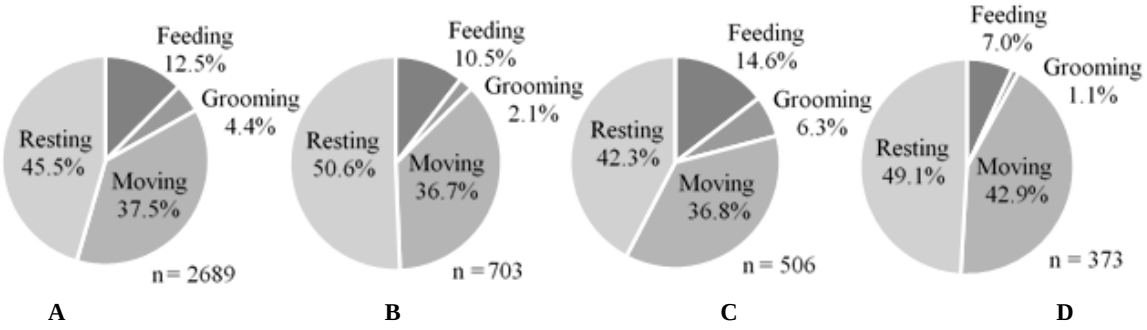

Figure 3. Age-and sex-related differences in activity budget of the silvery lutungs: A. Nursing females, B. Single females, C. Adult male, D. Juveniles. "n" represents number of scanned animals

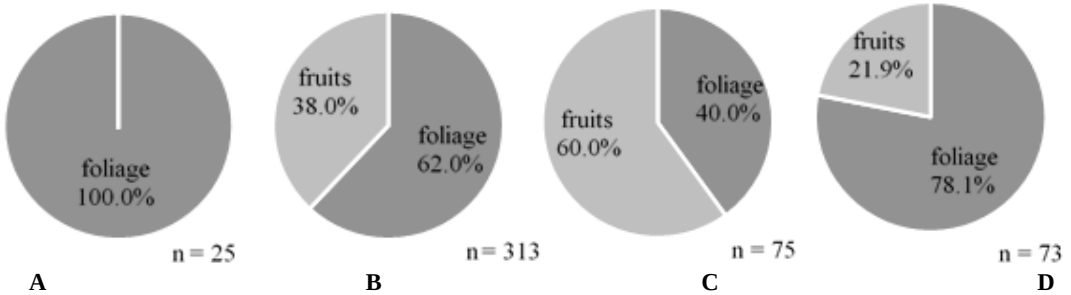

Figure 4. Food part eaten among age-and sex classes: A. Nursing females, B. Single females, C. Adult male, D. Juveniles. "n" represents number of scanned animals

Table 1. Food plant species and food part eaten by silvery lutung in Gunung Padang, Padang City, West Sumatra, Indonesia

Plant species	Family	% Foliage	% Fruits
Arenga pinnata	Arecaceae	-	0.6
Cassia esculenta	Fabaceae	0.6	-
Commersonia bartramia	Malvaceae	0.8	-
Cyclea barbata	Menispermaceae	4.5	0.0
Eugenia cumini	Myrthaceae	2.7	0.4
Eugenia polyantha	Myrthaceae	11.7	2.7
Eurya acuminata	Theaceae	0.8	-
Ficus benjamina	Moraceae	1.9	0.6
Ficus fulva	Moraceae	1.9	2.9
Ficus variegata	Moraceae	35.0	28.2
Homalanthus populneus	Euphorbiaceae	0.8	-
Mallotus floribundus	Euphorbiaceae	0.8	0.2
Mangifera indica	Anacardiaceae	0.6	1.4
Terminalia catappa	Combretaceae	0.8	-

Discussion

The lutungs showed a higher proportion of time spent resting (46.3%), which is similar to the other colobine species (Table 2). Colobines have a multi-chambered stomach, similar to that of the ruminants, and devote a high proportion of their activity budget for resting to digest foods containing fibers, such as cellulose (Chivers 1994). Under captive conditions, the proportion of time spent resting by the silvery lutungs is decreased (34.1%) (Prayogo 2006); restriction of movement due to small cages and higher food quality than that obtained in the wild are possibly responsible for this change observed in the animal's captive condition. Resting in silvery lutungs peaked at noon, while, at the same time, the proportion of time spent moving decreased, and vice versa. Such relationships have been reported in other Indonesian colobines; *Presbytis thomasi* (Gurmaya 1986), *P. aygula* (Ruhiyat 1983) and *P. potenziani* (Fuentes 1996). Previous studies also have shown that Asian colobines spend larger proportions of time resting (Stanford 1991; Davies and Oates 1994; Huang et al. 2003; Li and Rogers 2004; Zhou et al. 2007). For example, the white-headed langurs (*Trachypithecus leucocephalus*) and capped langurs (*T. pileatus*) spent 50% and 53% of their day resting, respectively (Li et al. 2003; Solanki et al. 2008). The activity patterns of primates can be affected by the seasonal changes in food availability (Oates 1987). energy intake and body heat regulation (Oates 1977), and space usage (Hadi et al. 2012).

The juveniles spent less time feeding than the adults.Juveniles may probably not spend much time for eating (Rose 1994; Agetsuma 2001). We also found that the adult females with infants showed more time feeding than the females without infants. This finding is similar to that observed by Smith (1977), who demonstrated that nursing females of howler monkeys (*Alouatta palliata*) fed longer, at 59 percent than single females, possibly to meet the increased energy demands of lactation and infant care. Altmann (1980) also showed that nursing females of yellow baboons (*Papio cynocephalus*) spent higher amounts of time feeding, at 43 percent. In the case of females, reproductive status also affects nutritional requirement (Coelho et al. 1976; Clutton-Brock and Harvey 1977; McNab 1978, 1980; Richard 1985; Strier 1987; Dunbar 1988). In general, adult females spend a considerable amount of time feeding to accumulate body fat necessary for reproduction, nursing, or both, as well as socializing; while the adult males spent most of their time moving (Clutton-Brock 1977).

Table 2. Comparison between activity categories among several Indonesian colobine species

Species	Percentage (%)					Reference
	Feeding	Moving	Resting	Grooming	Others*	
Nasalis larvatus	19.5	3.5	76.5	-	0.5	Matsuda et al. (2009)
Presbytis rubicunda	29.3	14.2	48	0.4	8.1	Smith et al. (2013)
P. thomasi	24.7	8.5	66.8	-	-	Gurmaya (1986)
Simias concolor	44	7	46	-	3	Paciulli and Holmes (2008)
Trachypithecus auratus	36.9	15.0	37.7	10.4	-	Heru and Djuwantoko (2010)
T. cristatus	12.0	37.8	46.3	4.0	-	This study

Note: *including nursing, defecating, urinating and conflict.

Table 3. Comparison in dietary composition on feeding behaviour of Indonesian colobines

Species	Percentage (%)				Reference
	Foliage[a]	Fruit[b]	Flower[c]	Others[d]	
Nasalis larvatus	65.9	25.9	7.7	0.5	Matsuda et al. 2009
P. rubicunda	37.6	49.3	11.1	-	Davies 1991
P. thomasi	23.4	66.8	6.9	2.9	Gurmaya 1986
Trachypithecus auratus	64	17	16	3	Beckwtih 1995
T. cristatus	63.0	37.0	-	-	This study

Note: [a] including mature and young leaves, [b] including unripe fruits, ripe fruits and seeds, [c] including flower buds, [d]including bark, stem, pith, and underground storage

Adult males spent significantly greater proportions of time grooming than did the other age-and sex classes. This may be because the silvery lutung is polygynous (single male-multi-female society), and the adult male has to maintain strong relationships and socialize with the other members of the group (Wang et al. 2013). Newton and Dunbar (1994) summarized that in the red colobus monkeys (*Piliocolobus rufomitratus*), adult males groomed adult females more frequently than did the adult females. The juveniles spent less time grooming. We speculate that the juveniles prefer to stay with their mothers than groom other females, which leads to a higher percentage of their time spent resting. We need to confirm this possibility with more observational data.

In our study, the group of lutungs ate foliage mostly (63%). This tendency was similar to that of the other Asian colobines (Table 3). The adult females with infants and juveniles showed a higher preference for foliage. Similar tendencies have been reported in other Asian colobines. Boonratana (2003) reported that nursing females of proboscis monkeys (*Nasalis larvatus*) tended to eat more foliage than the other age-and sex classes, at 50-70 percent because of an increased need for protein following the nutritional stress of lactation. A previous study on golden snub-nosed monkeys (*Rhinopithecus roxellana*) showed that the juveniles ate foliage more frequently for growth (Liu et al. 2013). Since foliage contains a higher amount of protein, feeding on more leaves would be beneficial for their nursing and growth. The adult male lutung was frequently observed to eat fruit during the study period. This may be because fruits are an efficient source of energy (Oates 1977).

We conducted the first systematic comparison of the activity budget and feeding behavior of the age-and sex classes of wild silvery lutungs. Because of the short duration (three months) of the study, our findings should be interpreted with caution. Further studies are required to collect supplemental information on the activity and dietary habits of the silvery lutungs, in addition to information on their ranging patterns and seasonal variation in food availability, by conducting vegetation and phenological surveys to address the effects of environmental fluctuations on their food preferences (Garber 1987) and socio-ecology (O'Brien 2014).

The habitat conditions of silvery lutungs are of concern because construction and road development have disturbed their habitat. Information on the daily activity and feeding behavior of wild lutungs is very limited in West Sumatra, necessitating the collection and presentation of raw field data to the government authorities and stakeholders to conserve lutungs and their habitats.

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