RAFFLES BULLETIN OF ZOOLOGY **67**: 352–362
Date of publication: 3 June 2019
DOI: 10.26107/RBZ-2019-0026
http://zoobank.org/urn:lsid:zoobank.org:pub:655AC04F-ABEB-4BCF-8403-39BAD8D16AEF

Diet of the Annamese langur (*Trachypithecus margarita*) (Elliot, 1909) at Takou Nature Reserve, Binh Thuan Province, Vietnam

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Abstract. The Annamese langur (*Trachypithecus margarita*) was described in 1909 but its ecology, including its feeding behaviour, is still largely unknown. Based on current knowledge of feeding ecology of many Asian langurs, *T. margarita* is expected to be a generalist herbivore, with seasonal variation in diet. Feeding behaviour of one habituated group of Annamese langurs at Takou Mountain was studied from October 2009 to September 2011. The dietary pattern of these langurs was found to be similar to other *Trachypithecus* species, which is characterised by a high amount of leaf consumption (54.4% immature leaves, 7.1% mature leaves) and complemented by fruits (29.9%). The Annamese langurs ate plant parts from 31 species belonging to 20 families on Takou Mountain where 689 plant species were known for the mountain. Moraceae is the most important family in the langur's diet with at least 10 species consumed and accounting for 41.1% of feeding time. Based on the current and previous feeding studies of *Trachypithecus* species, it could be concluded that the genus is a generalist folivore and the dietary pattern is similar among species.

Key words. diet pattern, folivorous species, food plant

INTRODUCTION

The diet of a number of colobine monkeys have been well studied providing crucial baseline information for scientists to develop conservation strategies. The diet of *Trachypithecus* genus is characterised by a high amount of leaf consumption (Kirkpatrick, 2007) but the proportion of mature and immature leaves and other food items differ among species. For example, while *Trachypithecus vetulus* and *T. pileatus* prefer mature leaves over immature leaves (Hladik, 1977; Solanki et al., 2008), *T. johnii* and *T. obscurus* prefer immature leaves (Curtin, 1980; Sunderraj, 2001). In the *Trachypithecus cristatus* group, to which *T. margarita* belongs, leaves are also the main food item, with fruits commonly contributing more than 25% of the total diet. However, leaves dominate the diets of langurs living in coastal forests: *T. cristatus* (Harding, 2010) and *T. germaini* (Le et al., 2015), while diets of langurs living in more inland forest are much less folivorous, for example *T. auratus* in Indonesia's rainforest (Kool, 1993). Moreover, the diet of *Trachypithecus* is also marked by seasonality and switching between mature leaves, young leaves and seed or fruits when they are available (Kirkpatrick, 2007). For example, *Trachypithecus francoisi* in China consumed higher mature leaves, fruit in dry season than in the wet season (Zhou et al., 2006); *T. delacouri* also consumed a higher amount of young leaves and flowers in the dry season compared to the wet season (Workman, 2010a).

The Annamese langur *Trachypithecus margarita* (Elliot, 1909) was described in 1909, and although the species is thought to be widely distributed throughout the area east of the Mekong River, with ranges including Cambodia (Moody et al., 2011), southern Lao PDR (Duckworth et al., 1999, Timmins et al., 2011) and Vietnam (Nadler et al., 2007), little is known about its status in these countries. In addition, the knowledge about its ecology is still limited, beyond general ideas about the habitats they are found in. This species inhabits lowland evergreen and semi-evergreen forest, mixed deciduous forest, and riverine and gallery forest (Nadler et al., 2007; Timmins et al., 2011). Until recently, *Trachypithecus margarita* was considered a subspecies of *Trachypithecus germaini* (Groves, 2001; Brandon-Jones et al., 2004), but through genetic and morphological studies, it has been elevated to species level (Roos et al., 2007; Roos et al., 2008; Hoang et al., 2012). Due to this new finding, the population status and ecology of *Trachypithecus margarita* as a species is poorly known, making conservation management challenging.

Here we present a 2-year study on the diet of *T. margarita* at Takou Mountain, Takou Nature Reserve, and the first for this species. As a species of *Trachypithecus*, we expected

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ISSN 2345-7600 (electronic) | ISSN 0217-2445 (print)

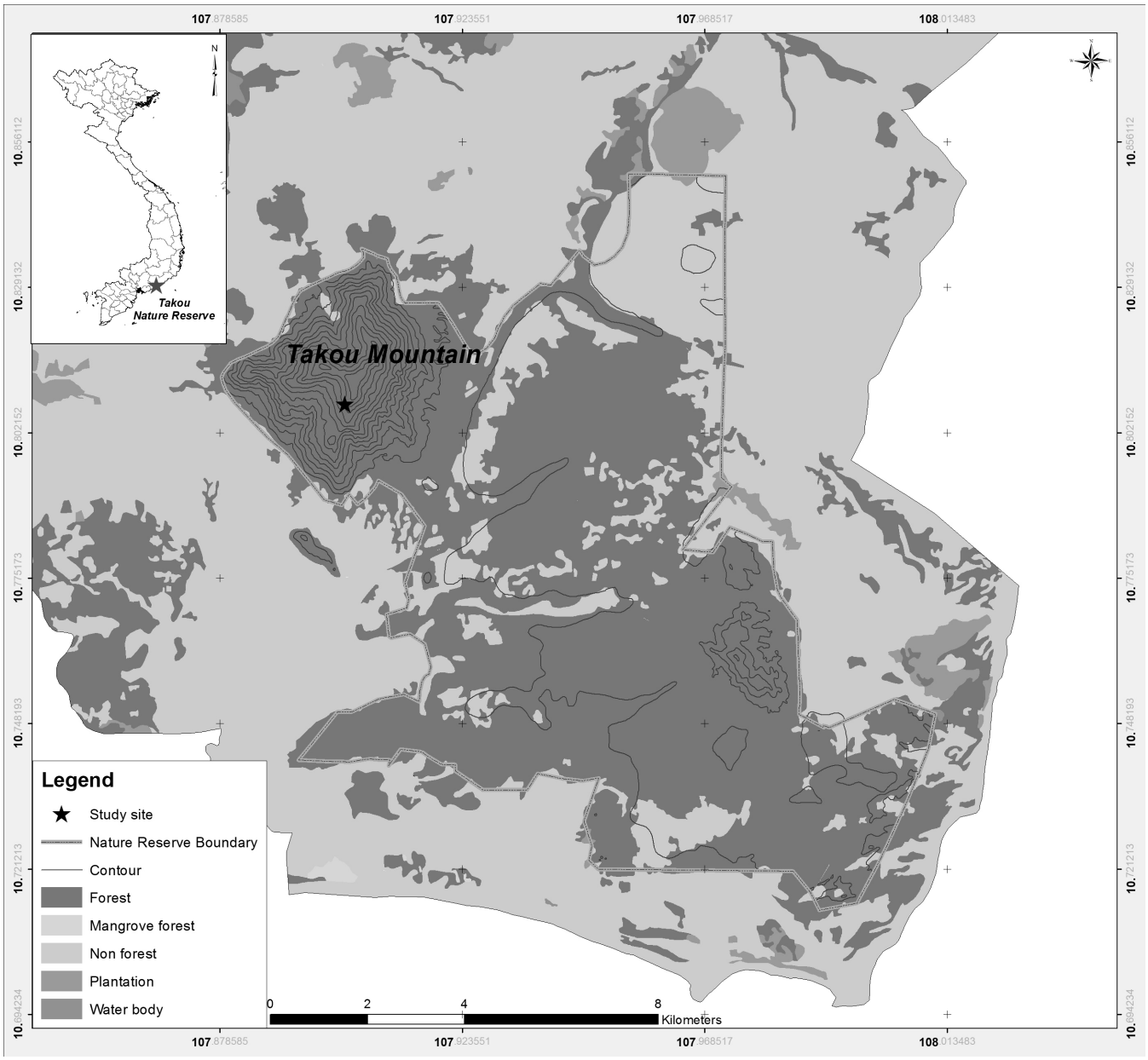

Fig. 1. Location of study site (star) on Takou Mountain in Takou Nature Reserve.

T. margarita to be a generalist herbivore. In addition, the dietary pattern of the species was expected to differ between seasons.

MATERIAL & METHODS

Study site. Takou Nature Reserve (NR) is a coastal nature reserve in Binh Thuan Province (10°41′ to 10°53 N and 107°52′ to 108°01′E) (Fig. 1). The topography of Takou NR is dominated by plains, which includes about 10,000 ha of coastal Dipterocarp forest and about 1,000 ha of Takou Mountain with the peak of 694 m above sea level. Takou NR experiences a tropical monsoon climate that is warm all year round with the average temperature of 26°C, an average rainfall of 1,115.7 mm, and an average humidity of 80.7%. There are two distinct seasons for the region: wet season from May to October, and dry season from November to April. During the two years of this study, the weather data for Takou region were obtained from Phan Thiet Meteorological Station, located about 20 km north of the nature reserve. The average temperature from 2009 to 2011 was 27.23°C. Rainfall for 2010 was 1,036 mm and the first nine months of 2011 had 1,150 mm of rainfall.

Takou Mountain accounts for about 1,000 ha of the reserve and is covered by forest that differs from other parts of the reserve. Six hundred and eighty-nine plant species have been recorded from Takou Mountain, with five families that include more than 20 species: Fabaceae, Rubiaceae, Euphorbiaceae, Orchidaceae, and Moraceae (Luu, 2000). The vegetation of Takou Mountain consists of three forest types: tropical evergreen seasonal sub-mountain forest, tropical semi-deciduous sub-mountain forest, and tropical drought-deciduous broad-leaved lowland forest. Of the evergreen species, many belonging to Fagaceae and Lauraceae families dominate the first vegetation type and are distributed from the top of the mountain (at 697 m) down to 450 m above

sea level. The second vegetation type is dominated by a mixture of deciduous and evergreen trees from 200 to 450 m above sea level. *Lagerstroemia calyculata* is the most dominant deciduous species and some evergreen species such as *Linociera sangda*, *Syzygium oblatum*, and *S. petelotii* are also found. The third vegetation type is dominated by deciduous species such as *Lannea coromandelina*, *Erythrina variegata*, and *Bombax ceiba* (Ly & Luu, 2007). *Trachypithecus margarita* lives mainly in the evergreen forest on the upper slopes of Takou Mountain (Tran et al., 2009; Hoang et al., 2010).

Feeding record. One group of 18 individuals (12 adults, 4 juveniles, and 2 infants) that had a range on Takou Mountain was habituated. We observed the behaviour of this group and feeding data were collected according to five categories of food items: mature leaves, immature leaves, fruits (including ripe and unripe fruits), flowers, and others. Mature leaves and immature leaves were distinguished by colour whereby immature leaves had a lighter colour compared to mature leaves or were reddish in colour in some plant species. Observations took place at an observation point from 0600 to 1800 hours during eight consecutive days of each month from October 2009 to September 2011. We collected feeding behaviour data opportunistically due to the complex topography of the area. We excluded feeding data from dependent infants. The animals were observed by using Nikon 10x42 binoculars and behaviour bouts were collected using focal animal sampling (Altmann, 1974). A behaviour bout was defined as the action that animal performed at the time the stopwatch sounded for recording data. The closest animal to the observer was chosen for data collection. After ten minutes, we switched to another individual, and continued for all members of the group, repeating until we lost sight of the group. If a langur moved away before the end of ten minutes, we switched to another animal. For the focal animal, we recorded activity, food plant and food items consumed every 15 seconds using a countdown stopwatch.

The topography of Takou Mountain is complex with steep slopes and large granite outcrops; therefore, it was difficult to follow the langurs in this area. In addition, *Trachypithecus margarita* is a shy species and often forages in middle and low canopies that are challenging to observe in their natural forested habitat. These conditions limited our data collection process and contact time with the animals to roughly 52 hours.

Plant samples and species identification. Any plant used by langurs was recorded. In cases where the common or scientific name of food plants was known, we recorded it directly on the data sheet. For unknown species, we recorded the plant location and obtained samples for species identification after the langurs left the feeding site. The number of food plants sampled in a feeding site included food items collected on the ground including fruits, leaves or flowers that were not directly observed, which was more than the number of plant species recorded during focal observations. This information was used to compile a complete food item list but was not used for analysis. Scientific names of the plants used in this study basically followed "An Illustrated Flora of Vietnam" volumes I, II, and III (Pham, 1999, 2000a, 2000b).

Data analysis. The proportion of food item *a* (*Pa*) consumed by langurs was calculated monthly based on the total number of feeding bouts recorded with item *a* (N_a) and the total number of feeding behavioural bouts (*N*) as in the following equation:

$$Pa = \frac{Na}{N}$$

The statistical difference between morning (before 1200 hours) versus afternoon (after 1200 hours inclusive) and rainy season versus dry season were tested using one-way ANOVA after the proportions of each food items in the langur diet was normalised by arcsine (square root) transformation (Poulsen et al., 2001). To obtain the total number of plant species that may be used by the langurs, the number of plant species used by *T. margarita* each month was treated as sample and then using Jackknife estimator to estimate the total of food plant may consumed by the langur. The monthly data of food plant species eaten by *T. margarita* at Takou Mountain was used to construct the species accumulation curve. Jackknife estimator was applied. The estimator was done by using Vegan package and performed in R. We also used Spearman rank correlation coefficient test to identify significant correlations between examined variables. To understand if the diet of *T. margarita* at Takou Mountain is similar or different compared to other *Trachypithecus* species and to other genera of Asian colobine monkeys, we compiled the average consumption of food items for all selected species of the genera based on this and other studies (Newton, 1992; Kool, 1993; Sunderraj, 2001; Zhou et al., 2006; Le et al., 2007; Sayer & Norconk, 2008; Grueter et al., 2009; Ha et al., 2009; Matsuda et al., 2009; Rawson, 2009; Workman, 2010a; Hanya & Bernard, 2012; Le et al., 2015) into a contingency table before applying a Chi-square test. All statistical tests was done using R Version 3.4.1 for Windows.

RESULTS

Dietary composition. We recorded a total of 47.2 hours of behaviour (n = 11,321 behavioural bouts) during the two-years study period, of which 4,046 behavioural bouts (35.7%) were feeding behaviours. The diet of *Trachypithecus margarita* was dominated by immature leaves (54.87%), followed by fruits (29.54%), flowers (7.74%), mature leaves (7.08%), and other food items (0.72%) (Fig. 2). Other food items include buds, stems, and plant parts that we could not identify. We did not observe langurs eating non-plant material.

Trachypithecus margarita ate plant parts from 31 species belonging to 20 families. However, the data for feeding time is only available for 22 of these species; nine other species were identified based on partially eaten items dropped by langurs

Table 1. Plant part used of each species and the amount of time spent feeding on it by *Trachypithecus margarita* at Takou Mountain (Plant part used: YL = Young leaves, ML = mature leaves, FR = fruits, FL = Flowers, O = others)

Species	Family	# month used	FL	YL	ML	FR	O	Total
Ficus elastica Roxb. ex Hornem.	Moraceae	16		11.53	2.00	10.46	0.25	24.24
Ficus tinctoria subsp *gibbosa* (Blume) Corner	Moraceae	3		9.40	2.52	1.01		12.94
*Sphenodesme pentandr*a Jack	Lamiaceae	*1*	0.84	9.84	0.54	0.02		11.25
Radermachera hainanensis Merr.	Bignonaceae	*4*	6.90	3.02	0.67		0.10	10.69
Ventilago cristata Pierre	Rhamnaceae	1		0.35		7.94		8.29
Beilshmiedia sp.	Lauraceae	2		0.57		4.16	0.02	4.75
Parameria laevigata (Juss.) Moldenke	Apocynaceae	1		3.31	0.10	0.07		3.49
Schefflera elliptica (Blume) Harms	Araliaceae	2		3.39				3.39
Chrysophyllum roxburghii G.Don.	Sapotaceae	1		1.68	0.35	0.05		2.08
Vitex pinnata L.	Verbenaceae	2		1.48	0.59			2.08
Ficus variegata Blume	Moraceae	3				1.63		1.63
*Sphenodesme griffithia*na Wight	Lamiaceae	1		1.41	0.12			1.53
Ficus spathulifolia Corner var. *annamensis* Corner	Moraceae	3		1.14			0.35	1.48
*Erycibe cf. elliptilim*ba Merr. & Chun	Convolvulaceae	2		1.36	0.07			1.43
Aglaia sp.	Meliaceae	1		1.43				1.43
Lagerstroemia calyculata Kurz	Lythraceae	3		0.02		0.87		0.89
Artocarpus lacucha Buch. Ham.	Moraceae	1		0.07		0.32		0.40
Anamirta cocculus (L.) Wight & Arn.	Menispermaceae	1		0.32				0.32
Ficus depressa Blume	Moraceae	1		0.22				0.22
Ficus benjamina L.	Moraceae	1				0.22		0.22
Drypetes hoaensis Gagnep.	Putranjivaceae	1				0.17		0.17
Melia azedarach L.	Meliaceae	1				0.12		0.12
spp.				4.33	0.12	2.50		6.95
Diospyros cf. rhodocalyx Kurz	Ebenaceae	N/a		+	+	+		N/a
Casearia membranacea Hance	Salicaceae	*N/a*	+					N/a
Mammea siamensis T.Anderson	Calophyllaceae	N/a				+		N/a
Gonocaryum lobbianum (Miers) Kurz	Cardiopteridaceae	N/a		+		+		N/a
Ficus callophyla Bl. *var. callop*hyla	Moraceae	N/a				+		N/a
Ficus racemosa L.	Moraceae	N/a		+	+			N/a
Ficus superba Miq. var. *superba*	Moraceae	N/a		+				N/a
Ixora sp.	Rubiaceae	*N/a*		+				N/a
Macclurodendron oligophlebia (Merr.) Hartl	Rutaceae	*N/a*		+				N/a

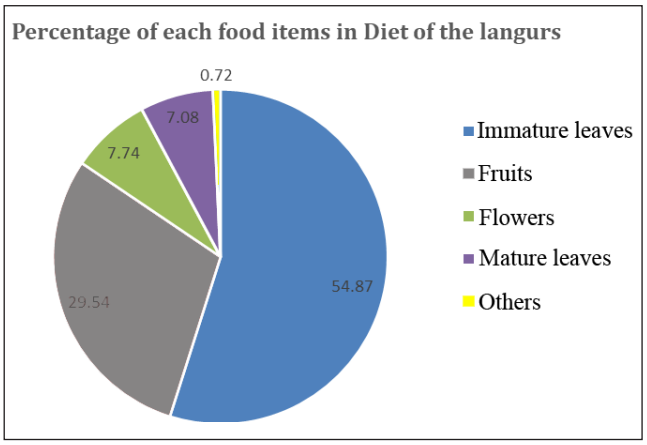

Fig. 2. Percentage of each food item consumed by *Trachypithecus margarita* at Takou Mountain from October 2009 – September 2011 (n = 4046).

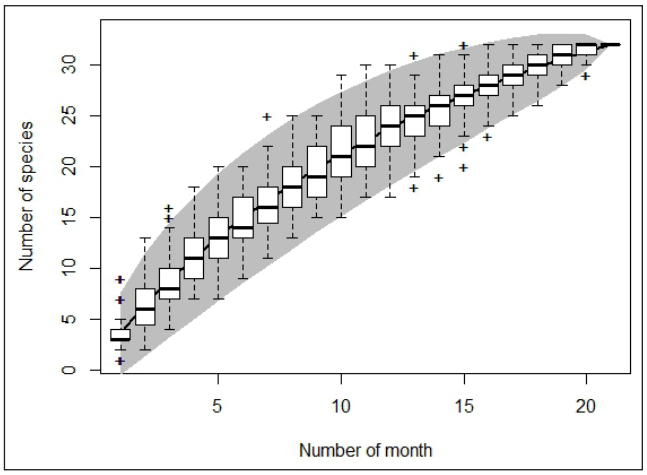

Fig. 3. Species accumulation curve of plant species eaten by *Trachypithecus margarita* at Takou Mountain based on monthly observation data. Boxplots mark standard deviations and light blue color represents confidence intervals of total species accumulation.

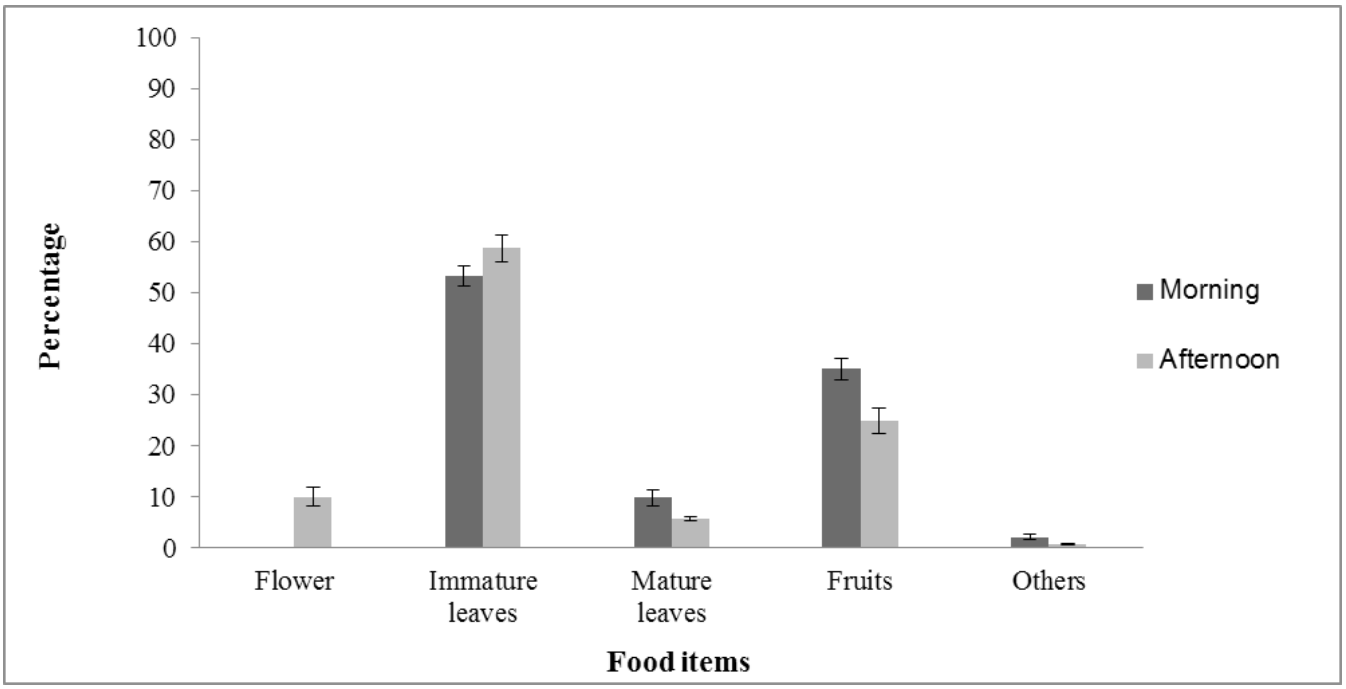

Fig. 4. Food items consumed by *Trachypithecus margarita* at Takou Mountain in the morning (n = 1478) and afternoon (n = 2568).

at feeding sites. The species accumulation curve for food plant species consumed monthly by *T. margarita* at Takou Mountain followed an upward trend (Fig. 3) so we anticipate that the number of food plant species would be more than 31 species if we had more observations. Therefore, the number of potential species that could be used by *T. margarita* at Takou Mountain was estimated range from 46 to 53 species. At the plant family level, Moraceae was the family with the largest number of species consumed (10 species), followed by Lamiaceae and Meliaceae with two species each. For the rest of the list, each family had only one species represented in the diet. Moraceae and Lamiaceae are two of the five most important families in the langur diet, accounting for 41.13% and 12.78% of feeding time, respectively. The other two important families that accounted for more than 5% of feeding time, were Bignoniaceae (10.69%) and Rhamnaceae (8.29%), even though the langurs only ingested one species from these families (Table 1).

Among 31 recorded food plant species, the langurs ate immature leaves of 24 species, mature leaves of 11 species, fruits of 17 species, and flowers of three species (Table 1). The more parts of a plant species consumed reflects the importance of that species in the langurs' diet ($R = 0.753$, $t = 5.248$, $df = 21$, $p<0.05$). In fact, the four most important species in the diet of the langurs (*Ficus elastica*, *Ficus tinctoria* subsp *gibbosa*, *Radermachera hainanensis* and *Sphenodesme pentandra*) provided flowers, immature leaves, mature leaves, fruits and other parts to the diet of the species and these comprised 59.12% of total feeding time. There were eleven species from which the langurs consumed both immature leaves and mature leaves. However, there were no

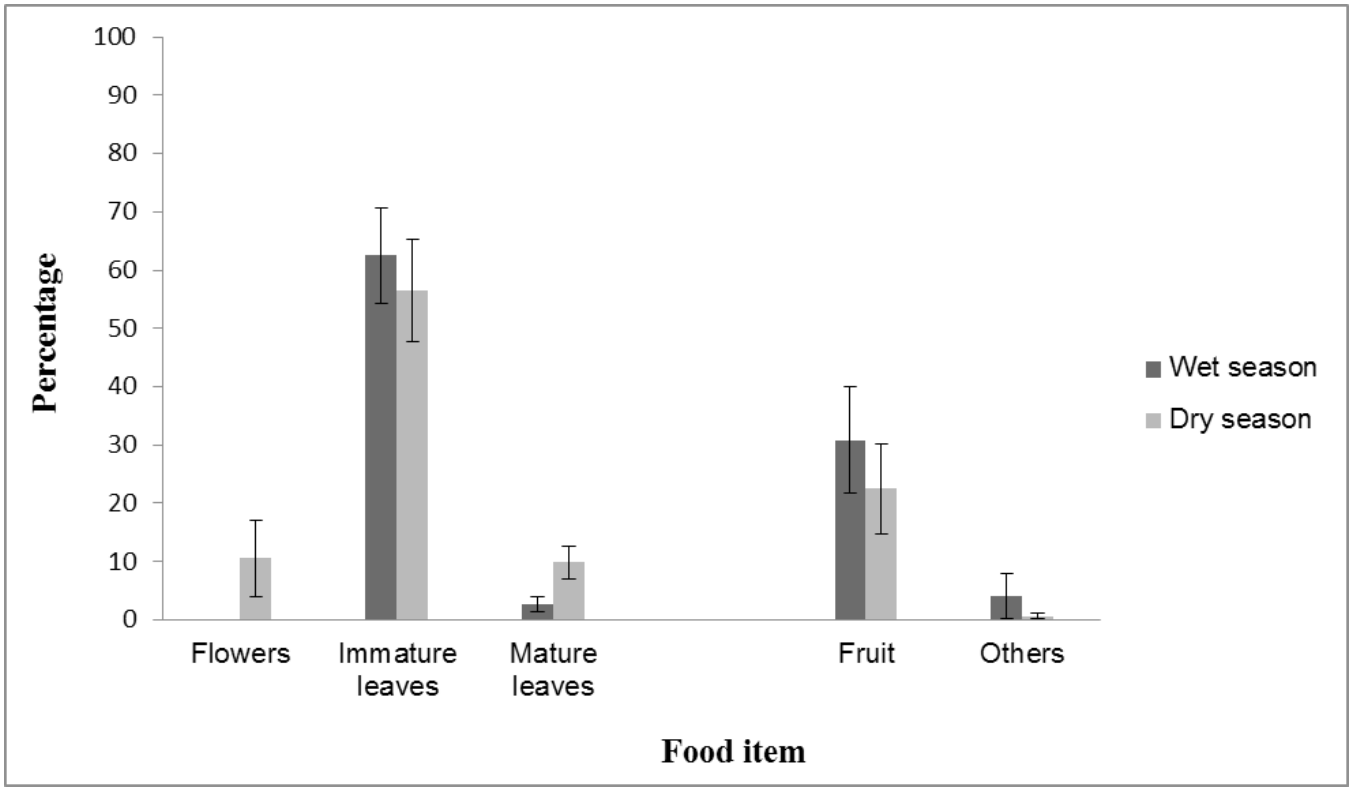

Fig. 5. Food items consumed by *Trachypithecus margarita* at Takou Mountain in the wet season (n = 1932) and dry season (n = 2114).

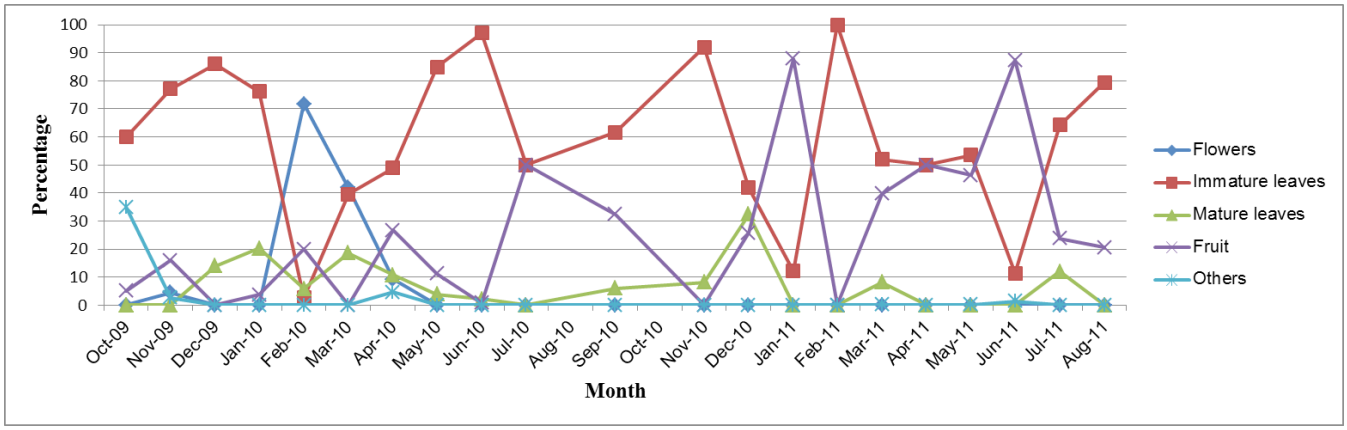

Fig. 6. Percentage of each plant part consumed by *Trachypithecus margarita* at Takou Mountain in each month.

species from which the langurs ate only mature leaves. The general plant types in the langurs' diet are trees (25 species; 63.33% feeding time), followed by vines (5 species; 25.24% feeding time), and herbs (2 species, 3.73% feeding time).

The dietary pattern of *Trachypithecus margarita* was not statistically different from other species that belonging to *Trachypithecus* ($\chi^2 = 6.399$, df = 4, p = 0.17), to *Pygathrix* ($\chi^2 = 7.973$, df = 4, p = 0.09), and to *Nasalis* ($\chi^2 = 9.1820$, df = 4, p = 0.057). However, it was statically different between the dietary pattern of *T. margarita* and *Semnopithecus* sp. ($\chi^2 = 39.173$, df = 4, p<0.05), *Rhinopithecus* sp. ($\chi^2 = 59.941$, df = 4, p<0.05), and *Presbytis* sp. ($\chi^2 = 16.833$, df = 4, p<0.05).

Temporal variation of feeding behaviour. While there are differences in percentage of food items consumed in the morning (n = 1478) and afternoon (n = 2568) and during the dry (n = 2114) and wet season (n = 1932) (Figs. 4, 5), none of these differences are statistically significant. Immature leaves were a major food source throughout the day, comprising 53.1% of feeding bouts in the morning and 58.6% in the afternoon; no significant difference (F = 0.503, df = 1, p = 0.483). There was no statistical significance in temporal variation of feeding behaviour for other food items (fruits: F = 0.005, df = 1, p = 0.942; mature leaves: F = 0.86, df = 1, p = 0.36; others food items: F = 0.686, df = 1, p = 0.414). Although we did not see langurs eating flowers in the morning and they spent 10.0% of their feeding time on flowers in the afternoon, the difference was not statistically significant (F = 2.778, df = 1, p = 0.105).

In both seasons, immature leaves were the langurs' main food item, followed by fruits with a slight difference in percentage of each food item between two seasons; and there was no

significant difference in time spent consuming these items (immature leaves: F = 0.206, df = 1, p = 0.655, fruits: F = 0.11, df = 1, p = 0.744). In the dry season, the langurs spent more time feeding on flowers (10.7%) than during the wet season (0.0%) but it was also not significantly different (F = 1.982, df = 1, p = 0.175).

Over the study duration, *T. margarita* typically used one dominant plant part for its diet in each month (Fig. 6) which differed between the two years. For example, in February 2010, langurs spent 71.8% (n = 224) of feeding time consuming flowers from a single species, *Radermachera hainanensis*. In February 2011, langurs were only observed to consume immature leaves. Similarly, about 97.1% (n = 539) in the diet of this species in June 2010 was immature leaves but fruits accounted for 87.4% (n = 263) in the diet in June 2011. Most of the fruits consumed in this month came from *Beilschmiedia* sp.

DISCUSSION

Is the dietary pattern of *T. margarita* similar to other Asian colobine monkeys? Most Asian colobine species are folivorous with leaves accounting for more than 50% of their diet (Chapman & Chapman, 1990; Kirkpatrick, 2007). The diet of Annamese langurs in Takou Mountain is similar to most other species of *Trachypithecus*, where leaves comprise the majority of their diet followed by fruits, flowers and other food items (Table 2). For example, *T. francoisi* in the Nonggang Nature Reserve, China consumed 52.8% leaves, 31.4% fruits/seeds and 7.5% flowers (Zhou et al., 2006) and *T. johnii* on Mundanthurai plateau, India spent 48.3% of its feeding time exploiting leaves, followed by fruits/seeds (34.2%) and flowers (8.4%) (Sunderraj, 2001). Like other species of *Trachypithecus*, the Annamese langurs consume mainly immature leaves. In the diet of *T. germaini*, *T. francoisi*, *T. delacouri* and *T. johnii*, immature leaves account for 87.4%, 73.7%, 75%, and 91.3% of total leaf consumption, respectively (Sunderraj, 2001; Zhou et al., 2006; Workman, 2010a; Le et al., 2015). These species have similar dietary patterns even though they are distributed across a wide range of habitats, from semi-evergreen forest to forested limestone karsts. Dietary similarities between these species might be explained by their close evolutionary relationship. Studies so far indicate that the diet of *Trachypithecus* species is characterised by leaves (with immature leaves dominating mature leaves) followed by fruits/seeds, flowers and other kinds of food items.

Compared to other genera of colobines in Southeast Asia, the dietary pattern of *T. margarita* in Takou Mountain is most like *Pygathrix* spp. In Vietnam's Phuoc Binh and Nui Chua National Parks, *Pygathrix nigripes* also has a highly folivorous diet, followed by fruits/seeds and flowers (Hoang et al., 2009). *Trachypithecus margarita* and the Vietnamese *Pygathrix nigripes* differ from *Pygathrix nigripes* in Cambodia, where langurs ate fruits and seeds as their primary food source (Rawson, 2009). The dietary pattern of *T. margarita* at Takou Mountain is also similar to *Pygathrix cinerea* in Kon Ka Kinh National Park, Vietnam with a high proportion of immature leaves (Ha, 2009). *Trachypithecus margarita* and *Pygathrix nigripes* are sympatric on Takou Mountain and our observations of *Pygathrix nigripes* at Takou Mountain indicate that fruits (especially the fruits of figs species) are important in their diet. However, more comprehensive comparisons of food consumption by these sympatric colobines at Takou Mountain is needed to better understand their dietary pattern. Diet similarities between *T. margarita* and *Pygathrix* spp. may be a result of their habitat. These species inhabit semi-evergreen to evergreen habitats that have immature leaves throughout the year and a high diversity of plant species. In such habitats, they tend to choose leaves, especially immature leaves, because they are readily available. *Semnopithecus entellus* in the evergreen forest of Nepal is somewhat similar to *T. margarita* at Takou Mountain in the amount of leaves consumed but *Semnopithecus entellus* prefers mature leaves (25.2%) over immature leaves (10.2%) (Sayers & Norconk, 2008). In addition, the similarity in dietary pattern between *T. margarita* with genus *Semnopithecus* is not significant. And the selection of immature leaves over mature leaves in the diets of Asian colobines is also influenced by its digestibility and nutritional content. A number of researchers have noted that immature leaves were easier to digest than mature leaves (Kool, 1992; Yeager & Kool, 2000). Moreover, immature leaves have a higher quality of nutrients than mature leaves including a lower amount of fiber and higher amounts of protein (Kool, 1992; Workman, 2010b).

The dietary pattern of *T. margarita* differs statistically from other colobine monkeys in Asia such as *Rhinopithecus* sp. (Le et al., 2007; Grueter et al., 2009), and *Presbytis* sp. (Hanya & Bernard, 2012) but somewhat similar to *Nasalis* sp. (Matsuda et al., 2009). These differences are likely related in part to their different habitats and possibly due to phylogenetic differences. *Rhinopithecus avunculus* is found in limestone forests and fruits is a preferred food (Le et al., 2007), while *R. bieti* in sub-tropical forests ingest large amounts of moss and lichen seasonally (Grueter et al., 2009). Two other species distributed in different habitats from that of *T. margarita* are *N. larvatus* in mangrove and riverine forests, and *Presbytis rubicunda* in dipterocarp forest; they also prefer fruits over leaves (although it should be noted that all these colobines have diets that consist of at least 30% leaves).

The range of food plant species in the diet of *T. margarita.* The number of plant food species consumed by *T. margarita* at Takou is lower than that reported for most other Asian colobines (Table 2). From this study, *T. margarita* fed on only 31 plant species belonging to 20 families. Even though increasing the observation time could increase the number of food plant species identified in the diet, the estimated range from 46 to 53 species is less diverse than most Asian colobines, whether they inhabit similar or different habitats. In the same genus, the closest congenic *T. germaini* on limestone forest consumed at least 53 species (Le et al., 2015) while evergreen forest langurs such as *T. pileatus* and *T. johnii* exploited more plant species than *T. margarita* at

Table 2. Diet comparison of *Trachypithecus margarita* at Takou Mountain and other Asian colobines.

Species	Habitat	# food species	Leaves	Immature leaves	Mature Leaves	Flowers	Fruits/ Seeds	Others	References
Trachypithecus margarita	Evergreen forest	31	61.95	54.87	7.08	7.74	29.54	0.72	This study
T. germaini	Limestone forest	53	67.3	58.8	8.5	2.8	23.6	6.4	(Le et al. 2015)
T. pileatus	Evergreen forest, Semi-evergreen forest	52	68	–	–	16	16	–	(Solanki et al., 2008)
T. poliocephalus leucocephalus	Limestone forest	50	89	–	–	2.7	5.7	0.4	(Li & Rogers, 2006)
T. francoisi	Limestone forest	90	52.8	38.9	13.9	7.5	31.4	7.4	(Zhou et al., 2006)
T. delacouri	Limestone forest	42	80	60	20	5	9	6	(Workman, 2010a)
T. cristatus	Mangrove forest	94	91	–	–	–	9	–	(Harding, 2010)
T. auratus	Secondary forest	88	47		< 1	12.5	32	8	(Kool, 1993)
T. johnii	Evergreen forest	102	48.27	44.06	4.21	8.44	34.17	9.57	(Sunderraj, 2001)
Semnopithecus entellus	Evergreen forest	43	54.7	29.5	25.2	6.9	18.7	19.7	(Sayers & Norconk, 2008)
S. entellus	Deciduous forest	60-67	49.1	14.2	34.9	9.5	24.4	4	(Newton, 1992)
Rhinopithecus bieti	Sub-tropical forest	94	21	16	5	–	11	68	(Grueter et al., 2009)
R. avunculus	Limestone forest	31	33.21	11.11	–	8.33	52.76	2.78	(Le et al., 2007)
Pygathrix nigripes	Evergreen forest, semi-evergreen forest	152	54.6	–	–	14.56	29.34	1.51	(Hoang et al., 2009)
P. nigripes	Semi-evergreen forest, Deciduous forest	35	39.96	24	5.9	8.78	51.08	0.18	(Rawson, 2009)
P. cinerea	Evergreen forest, Semi-evergreen forest	166	55.87	46.55	9.32	–	41.02	0.11	(Ha, 2009)
Nasalis larvatus	Riverine forests	188		65.9		7.7	25.9		(Matsuda et al., 2009)
Presbytis rubicunda	Dipterocarpus forest	122	–	46	–	2	50	2	(Hanya & Bernard, 2012)

Takou (Sunderraj, 2001; Solanki et al., 2008). In addition, limestone forest langurs also consumed plant parts from more species than the langurs at Takou (Li & Rogers, 2006; Zhou et al., 2006; Workman, 2010a). The number of plant food species was also fewer than that ingested by *Pygathrix nigripes* in semi-evergreen forest of Nui Chua and evergreen forest of Phuoc Binh NP in Vietnam (Hoang et al., 2009); *Semnopithecus entellus* in deciduous forest in India (Newton, 1992) and *Presbytis rubicunda* in dipterocarp forest of Borneo (Hanya & Bernard, 2012). However, the number of food species consumed by *R. avunculus* in limestone forests in Vietnam (Le et al., 2007) and *Pygathrix nigripes* in the semi-evergreen forest in Cambodia (Rawson, 2009) is similar to *T. margarita* at Takou Mountain with 31 and 35 species, respectively.

Regarding the range of food species of Asian colobines, habitat quality may be the main factor determining the number of food plant species. The quality of colobine habitat has been assessed previously by evaluating three features (Bennett & Davies, 1994): (1) the plant species diversity, and hence the range of plants and plant parts which can be selected as foods; (2) the seasonal availability of preferred food items; and (3) the chemical composition of plant parts. At first glance, langurs tend to exploit a wide range of food species when they live in habitats that have a high diversity of plants (Ha, 2009; Rawson, 2009). However, Takou Mountain has at least 689 plant species (Luu, 2000) and therefore it is striking that we only observed langurs eat 31 species or an estimate of 53 species. In this case, the availability of preferred food items and chemical composition, especially secondary compound, are likely key factors affecting the range of food species.

How does *T. margarita* on Takou Mountain select food through the day and throughout the year? Even though our analysis failed to demonstrate significant differences in time used for consuming each kind of food item in the morning and afternoon or during the wet and dry seasons, our data indicate that the diet of *T. margarita* at Takou Mountain is consistently dominated by immature leaves throughout the day, while they fed on more fruits and mature leaves in the morning and more flowers in the afternoon. This dietary pattern was not previously recorded for other *Trachypithecus* species. There are however some similarities to that observed for *Pygathrix nigripes* in Nui Chua and Phuoc Binh NP (Vietnam) and in Mondulkiri Province (Cambodia). In Nui Chua and Phuoc Binh NP, *Pygathrix nigripes* spend more time of eating fruits and flowers in the morning than in the afternoon (Hoang et al., 2009). In Mondulkiri, Rawson (2009) found *Pygathrix nigripes* consumed significantly more fruits in early mornings compared to early afternoons using a method that divided daytime into four periods.

Chapman & Chapman (1991) argued that most primate species spend more time feeding on fruits in the morning because it is high in nutrients, is easily digested and provides more energy (Garber, 1987; Milton, 1993) to restore energy that has been used over the night. However, colobine monkeys appear to differ from this generalisation; for example, *Colobus guereza,* had a peak in fruits consumption in the afternoon as noted by Chapman & Chapman (1991). In addition, the amount of leaves consumed in the morning in diet of *T. margarita* and *Pygathrix nigripes* were higher than 50% and more than fruits. Therefore, the diurnal diet pattern of *T. margarita* at Takou Mountain and *Pygathrix nigripes* in Vietnam could be considered as characteristic diurnal feeding pattern of Asian colobine monkeys. Further studies of foraging behaviour on Asian colobines are needed to better understand such feeding patterns.

Throughout the year, *T. margarita* at Takou often preferred one food item per month, consuming one kind of food item predominantly over other in term of feeding time. For example, in February 2010, langurs spent 71.8% (n = 224) of feeding time consuming flowers, from only one species (*Radermachera hainanensis*). Immature leaves accounted for 97.1% (n = 539) in the diet of this species in June 2010 with fruits only 0.7% in the diet. The amount of fruits consumed in June 2011 was 87.4% (n = 263) and immature leaves was 11.3% (n = 34). Most of the fruits consumed in this month came from *Beilschmiedia* sp. The preferred food item in each month may relate to the preferred species and its abundance in the habitat. In addition, concentrating on eating one kind of plant part of an abundant species can reduce travel distance and hence reduce the cost of travel.

Although seasonal change in weather conditions affect the availability of plant parts in the forest and can therefore influence the availability of food resources, leading to changes in primate feeding behaviour (Newton, 1992; Hanya, 2004; Zhou et al., 2006), there were no significant correlation of time spent for consuming each type of food item by *T. margarita* at Takou Mountain with between the wet and dry seasons. The habitat of *T. margarita* on Takou Mountain is an evergreen forest with few deciduous trees; therefore, seasonal changes in habitat may be less obvious and reflected in the diet of *T. margarita* found in this study. Immature leaves, mature leaves, and fruits (especially figs) are usually available in this habitat throughout the year. However, we also need additional studies on the phenology of plants to understanding the food selection by the langurs in term of food availability in their habitat. Because of the slight difference in potential food resources between the two seasons, the langurs adjusted their food consumption only to some extent.

CONCLUSION

This study provides the first data on the diet of the Annamese langur, one of the least studied primate species in Vietnam. Based on our study and comparisons to previous studies, the Annamese langur is a generalist folivore, showing similar dietary patterns with other *Trachypithecus* species. However, this study does not show daily or seasonal variation in food item consumed by the langurs. Future studies should analyse nutrient ecology and monitor plant phenology to better understand food selection and food plant exploitation by this species.

ACKNOWLEDGEMENTS

We thank the Wenner-Gren Foundation for Anthropological Research, Inc. for financial support to conduct fieldwork via the project title "Behavioral Ecology of Sympatric Colobines: Niche Partitioning at Takou and Nui Ong Nature Reserves". We also thank the Denver Zoo for additional financial support to expand the study time. We thank the Ta Kou Nature Reserve management board and the director Mr. Mai Van Quynh for permission to conduct the project. We sincerely thank technical staff of Takou Nature Reserve, and especially our late friends Vo Thanh Liem and Nguyen Van Hung, for help in fieldwork. We also thank Nguyen Quoc Dat and the late botanist Ly Tho for additional help in plant species identification.

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