

Foraging Ecology of Semi-Free-Roaming Asian Elephants in Northern Thailand

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Abstract. We observed the foraging behaviour of five semi-free-roaming elephants in Thailand from December 2016 to October 2019 using all occurrence focal sampling. The elephants consumed 165 species of plants representing 56 families. *Dendrocalamus* sp. (bamboo), accounted for 40.3% of the elephants' foraging time. The elephants spent significantly more time browsing than grazing. A significant increase in grazing during the cold season may be attributed to increased access to cultivated fields. Despite this increase, bamboo remained the principle component of the elephants' diet across seasons. This study provides baseline information regarding foraging by semi-free ranging elephants in a previously undescribed area.

Introduction

Asian elephants (*Elephas maximus*) are one of the few extant megaherbivores. They spend between 12–18 hours per day feeding and consume 1.5–2.5% of their body weight in dry fodder daily (Sukumar 2003). Elephant diet is variable depending on habitat, geographic region, season, and availability (Sukumar 2003). They are known to switch between browse and graze depending on environmental conditions, especially in areas with strong seasonality (Sukumar 2006). Their dietary composition is also highly variable on a local scale within a geographic region (Himmelsbach *et al.* 2006). Although Asian elephants are generalized herbivores, their food selection is influenced by factors such as nutrient requirements and plant palatability, texture and phenophase (Sivaganesan & Johnsingh 1995; Sukumar 2003). Studies in India, China, Nepal, Sri Lanka and Myanmar have demonstrated that elephants consume a diverse array of fodder (Sukumar 1990; Chen *et al.* 2006; Himmelsbach *et al.* 2006; Samansiri & Weerakoon 2007; Roy & Chowdhury 2014; Koirala *et al.* 2016), and studies in Thailand have detailed the limited diet of captive elephants (Bansiddhi *et al.* 2018). However no comparable work has been done on free-foraging elephants in Thailand. Considering

the notable population of elephants in Thailand and the geo-spatial influences on elephant diet, it is important to address this knowledge deficit.

There are approximately 3100–3600 wild elephants in Thailand, and a captive population of over 3700 (AsERSM 2017). Of the captive population, 75% reside in 'Elephant Camps' established for tourism in the northern provinces (Kontogeorgopoulos 2009). These camp elephants are usually fed an insufficient variety of food and their staple fodder is of unbalanced nutritional composition, including supplements such as fruit (Kontogeorgopoulos 2009). Unnatural conditions of camps make them inadequate environments to study the foraging habits of Asian elephants, while low population density and poor visibility in forests makes studying foraging by wild elephants challenging in some areas (Campos-Arceiz *et al.* 2008). Knowledge of feeding behaviour and ecology is crucial to managing wild elephants, mitigating human-elephant conflict, and improving husbandry of captive elephants (Chen *et al.* 2006; Sukumar 2006; Campos-Arceiz *et al.* 2008; Koirala *et al.* 2016).

The objectives of this study were to document the main fodder species of semi-free-roaming

elephants in a mixed-use landscape in northern Thailand; and to identify seasonal changes in consumption. This study was part of ongoing research into Asian elephant behaviour and ecology in mountainous tropical rainforest ecosystems.

Materials and methods

Study site

Northern Thailand is characterized by mountain ranges and dense forests. Located 180 km southwest of Chiang Mai in the Mae Chaem district, Kindred Spirit Elephant Foundation and Sanctuary (KSES) is situated in a small Karen hill-tribe village called Ban Naklang with a population of about 500 people. The village was adjacent to approximately 4000 ha of land, comprised of mixed use agricultural fields (predominately rice and corn), old growth forests and various stages of successional forests (Fig. 1). The elevation ranges from 700–1100 m.

This mountain tropical ecosystem consists of a variety of habitats including sphagnum bog, moist and dense evergreen cloud-forest, dry evergreen, pine, mixed deciduous, teak and dipterocarp forests (Gale & Hammer 2018). The area is distinctly seasonal and can be divided into a cold dry season (November – February), a hot dry season (March – June), and a wet season (July – October) under the influence of the southwest monsoon.

KSES was established in May 2016 and is currently home to five elephants, females Too

Meh (age 58) and Mae Doom (age 25), and males Gen Thong (age 7), Boon Rott (age 14) and Dodo (age 14). Too Meh, Mae Doom, Gen Thong, and Boon Rott have resided at KSES since it was established, and Dodo joined in September 2018. Before coming to KSES, these elephants were working in tourist camps in Northern Thailand, performing tricks, giving rides and serving as photo props. At KSES they are not worked but instead are free-roaming throughout the day. The elephants had access to approximately 4000 ha around Ban Naklang. They have free choice to forage, associate, and behave as they please with restrictions regarding use of agricultural fields, roads, and neighboring villages. The elephants all have mahouts (elephant caretakers) that ensure they stay away from restricted areas and in the forests with enough natural fodder. Mahouts followed the free roaming elephants for 12 hours a day on average, enforced land restrictions and prevented crop raiding via verbal commands. Land restrictions were relaxed after harvesting, allowing the elephants limited access to agricultural fields during the cold season. The elephants chose the plant species they consumed and the amount of time they spent foraging on the selected plants. The only exception to this was during the hot dry season when food was not abundant in the forests, when the mahouts provided grass to supplement the elephants' diets as needed. Throughout the day and during observational periods the elephants were not restricted to a location, allowing for a unique opportunity to study the foraging behaviour of semi-free-roaming elephants. The elephants were confined in place at night using long chains



Figure 1. Map of northern Thailand and study area.

in the forest to ensure their and the community's safety. Where they spent the night changed daily depending on where they roamed during the day.

Data collection

Data was collected from December 2016 through October 2019 on four elephants (Too Meh, Mae Doom, Gen Thong, and Boon Rott) with the addition of one elephant in October 2018 (Dodo). Observation periods lasted 1.5 hours and commenced between 9:00 and 10:00 am depending on the location of the elephants.

Data was collected via all-occurrence focal sampling, following Roy & Chowdhury (2014). In order to determine the amount of time the elephants spent foraging on plant species, the observer focused on one elephant at a time to record plant species consumed (identified by the mahout with the name in local language), the length of time the elephant fed on said plant species, functional group, and part(s) of the plant consumed. The functional groups identified were trees, shrubs, herbs, grasses, and climbers. Parts of the plants consumed were classified as bark, fruit, leaf, root, twig, stem or whole (plant eaten in entirety). Samples of all novel species the elephants consumed were collected, photographed, the common name recorded if known, and scientifically identified by a botanist in Chiang Mai, thus establishing a database of elephant food plants.

Data analysis

Trees, shrubs, herbs, climbers, and bamboo were classified as browse and grasses as graze. Despite being botanically classified as a grass, bamboo was categorized as browse because of its growth characteristics and following other feeding studies of elephants (i.e. Sukumar 1990; Himmelsbach *et al.* 2006; Chen *et al.* 2006).

A two-tailed Z-test with a significance level of $p = 0.05$ was used to test for seasonal differences in time spent grazing and browsing. Differences in time spent foraging on different functional groups between the three seasons, were tested for significance by One Way ANOVA. Tukey's

Honestly Significant Difference (HSD) post-hoc test was used to compare differences in the type of plants consumed between seasons. One elephant, Dodo, was excluded from the seasonal analysis because less than a year of data was collected on him.

Results

Dietary richness

The elephants were observed foraging for a total of 17,912 min. Of which, 4,546 minutes were in the cold season, 5,337 minutes in the hot season and 8,029 minutes in the wet season. A total of 165 identified plant species from 56 families were consumed. Of these, 155 were directly observed and 10 were observed by mahouts. Over 58% of the species were from 11 families, consisting of Fabaceae (30 species), Poaceae (19), Moraceae (10), Rubiaceae (6), Anacardiaceae (6), Fagaceae (5), Lythraceae (4), Apocynaceae (4), Phyllanthaceae (4), Euphorbiaceae (4), and Vitaceae (4) (See Appendix for species). Another 24 samples were not identified and consisted of one climber, two grasses, one shrub, 19 trees, and one herb.

Of the 165 identified species, trees accounted for 49.1% of the species consumed, climbers 21.2%, grasses 12.1%, shrubs 10.3%, herbs 6.1% and bamboo 1.2%. Although bamboo represented 1.2% of the species, the elephants spent 44.0% of their time consuming bamboo. The remaining time was spent feeding on trees (29.1%), grasses (12.4%), climbers (12.4%), shrubs (1.4%) and herbs (0.8%). The elephants spent significantly more time browsing than grazing (browse 87.6%, graze 12.4%, $z = 142.257$, Fig. 2).

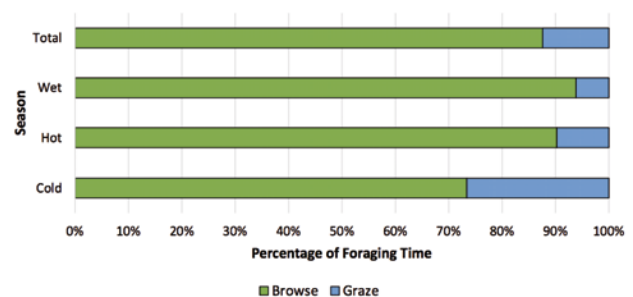


Figure 2. Time elephants spent browsing and grazing during the year and seasonally.

In assessing feeding time by species, *Dendrocalamus* sp. (bamboo), accounted for 40.3%, *Zea mays* (grass) 7.9%, *Sphatolobus* sp. 1 (climber) 6.2%, *Bambusa* sp. (bamboo) 3.7%, *Radermachera* sp. 1 (tree) 3.6%, and *Pachyrhizus* sp. 1 (climber) 2.3%. Other species accounted for less than 2.0% each (see Appendix).

Four crop species were consumed, *Zea mays* (corn), *Pennisetum purpureum* (Napier grass), *Mussa* sp. (banana) and *Oryza sativa* (rice). Crop consumption was from leftover harvest and diet supplementation and not crop raiding. The elephants had limited access to corn and rice fields post-harvest, aligning with the cold season. All four crops were used for diet supplementation when needed.

The parts of plants consumed varied by functional groups. For trees, leaves were the most commonly consumed (80.0% of species), followed by stems (49.0%), bark (47.0%), and twigs (41.0%). To a lesser extent the roots (16.0%), shoots (7.0%), and fruits (5.0%) were eaten, and some trees were eaten whole (12.0%). Mainly leaves (80.0%) and stems (74.0%) of climbers were consumed. Some climbers were consumed whole (26.0%), or the twigs (11.0%), bark (9.0%), and one fruit (3.0%). Leaves were also the most consumed portions of shrubs (53.0%), while many were also consumed whole (35.0%). Additionally, the twigs and stems were consumed (24.0% each), as well as the roots (18.0%), and one fruit (6.0%). Bamboo was consumed whole (100.0%), although the leaves, twigs, stems, and shoots were also selected for (100.0% each). Herbs were most commonly consumed whole (70.0%), but leaves (50.0%) and stems (30.0%) were also consumed. Grasses were also dominantly consumed whole (100.0%), while the fruit, leaves, and stems of one species (*Zea mays*) were also selected for.

When feeding on trees, in 31.0% of species only one part was consumed, in 22.0% two parts, in 11.0% three, and in 36.0% four or more parts. When only one plant part was consumed, the elephants most commonly chose the leaves (68.0% of species), and to a lesser extent bark (three species), roots (two), and stems, twigs, or fruit (one each). When feeding on climbers,

in 20.0% of species only one plant part was consumed, in 46.0% two parts, in 20.0% three, and 14.0% four or more parts. From the shrubs, 47.0% were fed on selectively for one part, 12.0% for two parts, 12.0% for three, and 29.0% for four or more parts.

Seasonal comparison

The elephants spent significantly more time consuming bamboo in the wet season than in the cold season ($F = 4.790$, $p = 0.038$). Differences in bamboo consumption between wet and hot seasons and between cold and hot seasons were not significant ($F = 1.06$, $p = 0.342$, $F = 3.120$, $p = 0.128$, respectively). The elephants spent significantly more time consuming grasses in the cold season than in hot and wet seasons ($F = 20.067$, $p = 4.818 \times 10^{-4}$). There were no significant differences in time spent consuming climbers ($F = 0.134$, $p = 0.871$), herbs ($F = 0.088$, $p = 0.916$), shrubs ($F = 3.190$, $p = 0.897$), or trees ($F = 0.789$, $p = 0.483$) between the cold, hot, and wet seasons (Fig. 3).

The elephants spent significantly more time feeding on browse than graze species year-round. The elephants spent the largest percentage of time consuming browse species during the wet season at 94.0% ($z = 111.159$), compared to 90.0% browse in hot season ($z = 83.189$) and 73.0% in cold season ($z = 44.548$, Fig. 2).

Discussion

The total of 165 plant species from 56 families consumed by the elephants in our study exceeds that recorded for Asian elephants in other

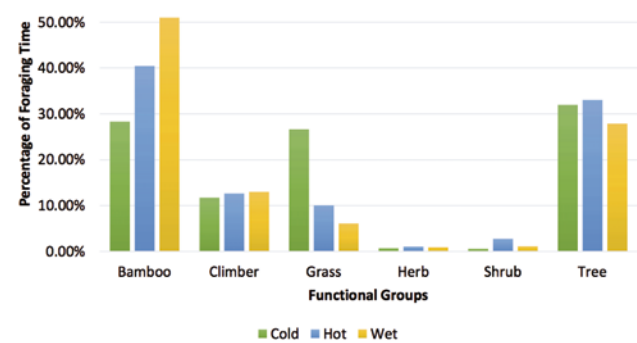


Figure 3. Foraging times on different functional groups of plants by elephants by season.

geographic areas. For example 57 species from 25 families in Nepal (Koirala *et al.* 2016), 67 species from 28 families in West Bengal, India (Roy & Chowdhury 2014), 106 species from 27 families in China (Chen *et al.* 2006), 112 species in India (Sukumar 1990), 116 species from 35 families in Sri Lanka (Samansiri & Weerakoon 2007), and 124 species from 27 families in Myanmar (Himmelsbach *et al.* 2006).

Of the 165 plant species consumed, six species accounted for 64% of the elephants' foraging time. This selective feeding behaviour with a few species comprising the main portion of their diet is consistent with studies done in India and Myanmar (Sukumar 1990; Himmelsbach *et al.* 2006). Elephants may use easily consumable fodder such as bamboo to fulfil their high intake requirements of up to 10% of bodyweight in fresh biomass, while a diverse diet is required to ensure elephants still obtain essential nutrients found in time-intensive species, such as trees (Sukumar 1989; Karunaratne & Ranawana 1999). For example, bark contains important minerals including calcium (Sukumar 2006). Our elephants selectively fed on the bark of 47% of observed tree species (see Appendix). Thus, despite access to an abundance of easily consumable fodder, the elephants spent time and energy consuming selected plant parts.

In southern India, Sukumar (1990) found 85% of the elephants diet consisted of species from the families Leguminosae (Fabaceae), Arecaceae, Cyperaceae and Poaceae (formerly Gramineae). With the exception of Cyperaceae, all these families were represented in the diet of elephants in our study. The elephants in this study spent about 56% of their time consuming plants of the family Poaceae. However as grasses encompassed only about 12% of their foraging time, the majority of this was due to consumption of bamboo. Notably, almost 44% of their time was spent consuming two species of bamboo (Fig. 4). Our findings are similar to that of a study in Myanmar, where bamboo comprised 57% and 85% of elephants' diet at two sites (Himmelsbach *et al.* 2006). In contrast, bamboo formed a much smaller portion of the diet, and was only consumed by elephants at three of five

study sites in southern India (Sukumar 1990). A study in China found elephants consumed mostly browse species, however bamboo accounted for only about 4.5% of their diet (Chen *et al.* 2006). Bamboo comprising a variable proportion of elephants' diet in different locations may be due to its natural absence or rarity in some geographic areas. Availability may also differ due to overfeeding, decreased regeneration and extraction by people (Joshi & Singh 2008).

When analyzing seasonal patterns in foraging, we found that more time was spent consuming bamboo in the wet season than the cold season. In the cold season, there is an increase in grass consumption time. This may be due to seasonal differences in agricultural field access, including rice (*Oryza sativa*) and corn (*Zea mays*), that are restricted during hot and wet seasons while the fields are in use. Grass is considered an important component of elephants' diet because it has a high protein content, especially while young, and few toxic secondary compounds (McKay 1973; Sukumar 1989). We found that the proportion of grass in the elephants' diet decreased as the seasons shifted from cold to hot, then wet. This is likely due to the increased access to fields during the cold season, the lack of available grasses in the hot season, followed by restricted access to the fields in the wet season. A study in Sri



Figure 4. Elephant consuming bamboo.

Lanka found a similar pattern, where fields were cultivated seasonally and wild elephants were able to feed on grass only for a brief period of time (Pastorini *et al.* 2013). This indicates that graze may be a significant but transitory fodder in the diet of some elephants (Pastorini *et al.* 2013).

The elephants in this study demonstrated a year round preference for browse over graze. Our results differ from findings in India where grasses comprised the majority of the elephants' diet in the wet season (Sukumar 1989) and dominated the diet in deciduous forests (Baskaran *et al.* 2010; Sivaganesan & Johnsingh 1995). Our findings are consistent with a study in China that showed browsing species accounted for a larger proportion of the elephants' diet (77 spp. taking 91% vs. 6 spp. taking 9%; Chen *et al.* 2006). These findings may indicate that grasses contribute a smaller portion to Asian elephant diet in Southeast Asia than in the Indian subcontinent (Chen *et al.* 2006; Himmelsbach *et al.* 2006; Campos-Arceiz *et al.* 2008). However a study from West Bengal, India reported 56% of elephants' bite counts were browse species (Roy & Chowdhury 2014). Therefore elephants may vary in their use of grass and browse geographically, possibly due to differences in availability.

Frequency and foraging time are not the only indicators of importance in the elephants' diet, and even rarely used plants may have important roles (Himmelsbach *et al.* 2006). In fact, elephants might be very particular about how much they consume of specific plant types or parts in order to balance nutritional requirements while limiting consumption of potentially toxic plant compounds (Campos-Arceiz *et al.* 2008). Large herbivores such as elephants may require a more diverse diet than smaller herbivores due to slower metabolic processes and detoxification rates (Freeland 1991).

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Appendix. List of all plants recorded in this study organized by family, including number of species documented in each family (N), percentage of time the elephants spent foraging on each species out of the total of 17,912 minutes (% Time), the plant type and parts consumed (B = bark, F = fruit, L = leaf, R = root, T = twig, St = stem, Sh = shoot, WP = whole plant).

Family	N	Latin name	Type	% Time	Plant part(s) consumed								
					B	F	L	R	T	St	Sh	WP	
Adoxaceae	1	<i>Viburnum</i> sp.	Tree	0.01	X						X		
Amaranthaceae	1	<i>Amaranthus viridis</i>	Herb	0.04									X
Anacardiaceae	6	<i>Buchanania lanzan</i>	Tree	1.19	X		X	X	X	X			
		<i>Gluta obovata</i>	Tree	0.40	X						X		
		<i>Gluta usitata</i>	Tree	1.40	X		X	X	X	X			
		<i>Mangifera</i> sp.	Tree	0.51	X	X	X						
		<i>Spondias pinnata</i>	Tree	0.82			X						
		Anacardiaceae sp.	Tree	0.03	X								

Family	N	Latin name	Type	%	Plant part(s) consumed								
					Time	B	F	L	R	T	St	Sh	WP
Annonaceae	1	Annonaceae sp.	Tree	0.32	X		X						
Apocynaceae	4	<i>Horrharena pubescen</i>	Tree	0.10	X		X		X	X			
		<i>Wrightia arborea</i>	Tree	0.12	X	X	X		X				
		Apocynaceae sp. 1	Climber	0.01			X			X			
		Apocynaceae sp. 2	Tree	0.94	X		X		X	X			X
Araliaceae	1	<i>Radermachera</i> sp.	Tree	3.63	X		X	X	X	X	X		
Arecaceae	1	<i>Phoenix loureiroi</i>	Tree	0.47	X		X		X	X			X
Asparagaceae	1	<i>Asparagus filicinus</i>	Herb	0.01			X			X			
Asteraceae	3	<i>Ageratum conyzoides</i>	Herb	0.02									X
		<i>Crassocephalum crepidioides</i>	Herb	0.21			X						X
		Asteraceae sp.	Climber	0.01			X			X			
Capparaceae	1	<i>Capparis</i> sp.	Tree	0.08			X						
Celastraceae	1	<i>Celastrus paniculatus</i>	Climber	0.12			X		X	X			
Clusiaceae	1	<i>Cratoxylum formosum</i>	Tree	0.44	X		X	X	X				
Commelinaceae	2	<i>Commelina paludosa</i>	Herb	0.01									X
		Commelinaceae sp.	Grass	0.01									
Convolvulaceae	2	<i>Ipomea hederifolia</i>	Climber	0.02			X			X			
		Convolvulaceae sp.	Climber	0.15									
Costaceae	1	<i>Cheilocostus speciosus</i>	Herb	0.01			X			X			
Cucurbitaceae	1	<i>Cucurbita maxima</i>	Climber	0.02			X	X		X			
Dilleniaceae	1	<i>Dillenia</i> sp.	Tree	0.63	X	X							
Dioscoreaceae	3	<i>Dioscorea</i> sp. 1	Climber	0.01			X			X			
		<i>Dioscorea</i> sp. 2	Climber	0.01			X			X			
		<i>Dioscorea</i> sp. 3	Climber	0.25			X			X			X
Dipterocarpaceae	3	<i>Dipterocarpus tuberculatus</i>	Tree	0.05			X						
		<i>Pentacme siamensis</i>	Tree	0.13	X		X	X		X			
		<i>Shorea obtusa</i>	Tree	1.70	X		X	X	X	X			
Equisetaceae	1	<i>Equisetum ramosissimum</i>	Herb	0.10									X
Euphorbiaceae	3	<i>Macaranga denticulata</i>	Tree	0.11					X				
		<i>Mallotus philippensis</i>	Tree	0.59	X		X		X	X			
		Euphorbiaceae sp.	Climber	0.01							X		
Fabaceae	28	<i>Acacia megaladena</i>	Climber	0.15	X		X						
		<i>Acacia</i> sp.	Tree	0.88			X		X	X			
		<i>Albizia odoratissima</i>	Tree	0.03			X		X				
		<i>Albizia</i> sp.	Tree	0.83			X		X	X			X
		<i>Archidendron</i> sp.	Tree	0.37			X		X	X			
		<i>Bauhinia</i> sp.	Tree	0.09			X						
		<i>Cassia fistula</i>	Tree	0.01			X		X				
		<i>Dalbergia</i> sp. 1	Tree	0.01			X			X	X		
		<i>Dalbergia</i> sp. 2	Tree	0.41	X		X			X			

Family	N	Latin name	Type	%	Plant part(s) consumed							
					Time	B	F	L	R	T	St	Sh
		<i>Entada rheedii</i>	Climber	1.33			X		X	X		X
		<i>Erythrina variegata</i>	Tree	0.03			X			X		
		<i>Mimosa pigra</i>	Shrub	0.23			X		X			X
		<i>Mimosa pudica</i>	Herb	0.11								X
		<i>Mucuna</i> sp.	Climber	0.15			X			X		X
		<i>Pachyrhizus</i> sp.	Climber	2.28	X		X			X		X
		<i>Phylacium majus</i>	Climber	0.05						X		
		<i>Pueraria</i> sp. 1	Climber	0.02	X					X		
		<i>Pueraria</i> sp. 2	Climber	0.12			X					
		<i>Sphatolobus</i> sp.	Climber	6.20			X			X		X
		<i>Tamarindus indica</i>	Tree	0.12			X		X			
		<i>Xylia xylocarpa</i>	Tree	0.22	X		X			X		X
		Fabaceae sp. 1	Climber	0.06			X			X		
		Fabaceae sp. 2	Climber	0.08			X			X		
		Fabaceae sp. 3	Climber	0.01			X					
		Fabaceae sp. 4	Climber	0.04			X			X		
		Fabaceae sp. 5	Tree	0.06			X					
		Fabaceae sp. 6	Climber	0.09			X			X		
		Fabaceae sp. 7	Shrub	0.07			X	X	X			
Fagaceae	4	<i>Lithocarpus</i> sp.	Tree	0.01			X			X		
		<i>Quercus kerrii</i>	Tree	0.56	X		X	X	X	X		X
		<i>Quercus</i> sp. 1	Tree	0.09			X					
		<i>Quercus</i> sp. 2	Tree	0.03			X					
Lamiaceae	3	<i>Tectona grandis</i>	Tree	1.01	X		X		X	X		
		<i>Vitex</i> sp. 1	Tree	0.01						X		
		<i>Vitex</i> sp. 2	Tree	0.03			X			X		
Lecythidaceae	1	<i>Careya arborea</i>	Tree	0.11		X						
Loganiaceae	1	<i>Strychnos nux-blanda</i>	Tree	0.03			X			X		
Lythraceae	4	<i>Lagerstroemia</i> sp. 1	Shrub	0.02			X					
		<i>Lagerstroemia</i> sp. 2	Tree	0.07			X		X			
		<i>Lagerstroemia speciosa</i>	Tree	0.11	X					X		
		<i>Lagerstroemia villosa</i>	Tree	0.01			X					
Malvaceae	3	<i>Grewia laevigata</i>	Tree	0.03	X							
		<i>Grewia</i> sp.	Tree	0.37	X		X			X		
		<i>Sterculia foetida</i>	Tree	0.35	X					X		
Menispermaceae	3	<i>Tinospora crispa</i>	Climber	0.17			X			X		
		<i>Tinospora</i> sp.	Climber	0.05			X			X		
		Menispermaceae sp.	Climber	0.03			X					
Moraceae	9	<i>Broussonetia papyrifera</i>	Tree	0.03			X					
		<i>Ficus hispida</i>	Tree	0.13			X					

Family	N	Latin name	Type	% Time	Plant part(s) consumed							
					B	F	L	R	T	St	Sh	WP
		<i>Ficus racemosa/fistulosa</i>	Tree	1.35	X		X	X	X	X		X
		<i>Ficus religiosa</i>	Climber	0.12			X		X			
		<i>Ficus semicordata</i>	Tree	0.03			X		X			
		<i>Ficus</i> sp. 1	Tree	0.27			X		X	X	X	
		<i>Ficus</i> sp. 2	Tree	0.02			X					
		<i>Ficus</i> sp. 3	Tree	0.01			X					
		<i>Ficus</i> sp. 4	Tree	0.01			X		X			
Musaceae	1	<i>Musa</i> spp.	Tree	1.32			X			X	X	X
Myrsinaceae	2	<i>Ardisia</i> sp.	Tree	0.34			X	X	X	X		
		<i>Embelia</i> sp.	Tree	0.01			X					
Myrtaceae	1	<i>Syzygium</i> sp.	Tree	0.17	X		X		X		X	
Oleaceae	1	<i>Olea salicifolia</i>	Tree	0.01			X			X		
Orchidaceae	2	<i>Dendrobium</i> sp.	Shrub	0.06								X
		Orchidaceae sp.	Shrub	0.01			X					
Pandanaceae	1	<i>Pandanus</i> sp.	Shrub	0.02			X					
Passifloraceae	1	<i>Passiflora edulis</i>	Climber	0.16			X			X		X
Phyllanthaceae	4	<i>Antidesma</i> sp.	Tree	0.01			X					
		<i>Aporosa</i> sp.	Tree	0.11	X		X	X	X	X		
		<i>Aporosa villosa</i>	Tree	0.03				X				
		<i>Phyllanthus emblica</i>	Tree	0.01								X
Piperaceae	1	<i>Piper</i> sp.	Climber	0.01			X			X		
Poaceae	16	<i>Apluda mutica</i>	Grass	0.06								X
		<i>Arundinella setosa</i>	Grass	0.01								X
		<i>Bambusa</i> sp.	Bamboo	3.68			X		X	X	X	X
		<i>Cyrtococcum accrescens</i>	Grass	0.07								X
		<i>Dendrocalamus</i> sp.	Bamboo	40.27			X		X	X	X	X
		<i>Imperata cylindrica</i>	Grass	0.10								X
		<i>Microstegium vagans</i>	Grass	0.15								X
		<i>Oryza sativa</i>	Grass	0.27								X
		<i>Panicum notatum</i>	Grass	0.03								X
		<i>Pennisetum purpureum</i>	Grass	1.34								X
		<i>Thysanolaena latifolia</i>	Grass	0.03								X
		<i>Zea mays</i>	Grass	7.93		X	X			X		X
		Poaceae sp. 1	Grass	0.24								X
		Poaceae sp. 2	Grass	0.03								X
		Poaceae sp. 3	Grass	0.74								X
		Poaceae sp. 4	Grass	1.14								X
Polygalaceae	1	<i>Xanthophyllum</i> sp.	Tree	0.01			X					
Primulaceae	2	<i>Ardisia crenata</i>	Shrub	0.03			X					
		<i>Embelia</i> sp.	Tree	0.41	X		X		X	X		

Family	N	Latin name	Type	%	Plant part(s) consumed								
					B	F	L	R	T	St	Sh	WP	
Rosaceae	2	<i>Rubus</i> sp. 1	Shrub	0.08									X
		<i>Rubus</i> sp. 2	Shrub	0.01									X
Rubiaceae	6	<i>Gardenia sootepensis</i>	Tree	1.11	X		X	X	X	X	X		
		<i>Hymenodictyon orixense</i>	Tree	0.07	X		X		X				
		<i>Paederia foetida</i>	Climber	0.51			X		X	X			
		Rubiaceae sp. 1	Tree	0.14	X		X			X			
		Rubiaceae sp. 2	Tree	0.24	X		X		X	X			
		Rubiaceae sp. 3	Tree	0.08	X								
Rutaceae	3	<i>Clausena</i> sp.	Tree	0.01			X						
		<i>Toddalia asiatica</i>	Climber	0.04									X
		Rutaceae sp.	Shrub	0.03				X	X				
Sapindaceae	1	<i>Dimocarpus longan</i>	Tree	0.47	X		X		X	X			
Smilacaceae	1	<i>Smilax ovalifolia</i>	Climber	0.03			X			X			
Solanaceae	2	<i>Solanum erianthum</i>	Shrub	0.09									X
		<i>Solanum torvum</i>	Shrub	0.70		X	X		X	X			X
Tectariaceae	1	<i>Tectaria</i> sp.	Shrub	0.04						X			
Tiliaceae	2	<i>Grewia eriocarpa</i>	Tree	1.22	X		X			X			
		Tiliaceae sp.	Tree	0.53	X		X		X	X			
Ulmaceae	1	<i>Holoptelea integrifolia</i>	Tree	0.02									X
Urticaceae	1	<i>Boehmeria</i> sp.	Herb	0.01			X			X			
Vitaceae	4	<i>Cayratia</i> sp.	Shrub	0.01			X						
		<i>Cissus</i> sp.	Climber	0.04									X
		Vitaceae sp. 1	Shrub	0.01				X					
		Vitaceae sp. 2	Shrub	0.02			X			X			
Zingiberaceae	3	Zingiberaceae sp. 1	Grass	0.03									X
		Zingiberaceae sp. 2	Grass	0.01									X
		Zingiberaceae sp. 3	Herb	0.32			X						X
Identified by Mahouts													
Euphorbiaceae	1	<i>Manihot esculenta</i>	Shrub								X		
Fabaceae	2	<i>Albizia chinensis</i>	Tree				X						
		Fabaceae sp. 8	Climber				X						
Fagaceae	1	<i>Castanopsis</i> sp.	Tree					X					
Gnetaceae	1	<i>Gnetum</i> sp.	Climber							X			
Hypoxidaceae	1	<i>Curculigo</i> sp.	Tree										X
Moraceae	1	<i>Ficus</i> sp. 5	Tree		X		X						
Poaceae	3	<i>Pennisetum polystachyon</i>	Grass										X
		<i>Saccharum</i> sp.	Grass										X
		Poaceae sp. 5	Grass										X
Unidentified	24	unknown species		1.58									
Total	189			100									