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西双版纳尚勇亚洲象的食物组成与取食生态

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摘要:于 1998~2000 在西双版纳国家级自然保护区尚勇子保护区的自然生境中,通过对亚洲象取食植物调查和粪便分析,了解亚洲象的食物组成与取食习性。结果显示,野外跟踪调查共记录有 106 种植物被亚洲象所取食,其中有 83 种出现在象的粪便中,这些种类分别属于:禾本科 8 种(10.0%)、桑科 7 种(9.9%)、蝶形花科 4 种 (8.4%)、五加科 3 种(6.6%)、葡萄科 3 种(5.7%)、夹竹桃科 3 种(4.6%)、芭蕉科 1 种(4.2%)、姜科 3 种(3.7%)、紫金牛科 3 种(3.6%)、蔷薇科 3 种(3.6%)、大戟科 5 种(3.3%)、榆科 2 种(3.0%)、含羞草科 4 种(2.9%)13 个植物科。根据食物中所占的比率,桑科的榕属(*Ficus*)、禾本科的竹类(Bambusoideae)、小果野芭蕉(*Musa acuminate*)和莠竹(*Microstegium ciliatum*)是亚洲象的主要食物资源。在觅食过程中,亚洲象取食包括乔木、藤本灌木和草本等各种生活型的植物,其中先锋种所占比率(59%)高于后续种;选择性啃食枝条的植物种类(77 种)高于牧草式取食的种类(6 种)。亚洲象取食植物种类的月变化与月平均温度和月降雨量成负相关,旱季取食植物种类高于雨季。本研究对制定保护区野生动物管理策略,以及解决保护区周边日趋恶化的人象矛盾,具有一定的参考价值。

关键词:亚洲象;食物结构;粪便分析;取食方式;人象矛盾

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Diet composition and foraging ecology of Asian elephants in Shangyong, Xishuangbanna, China

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Abstract: Diet composition and foraging ecology of Asian elephant were studied in its natural habitat in Shangyong National Natural Reserve, Xishuangbanna, China, through field observation and dung analysis, from 1998 to 2000. A total of 106 species were recorded as being eaten by Asian elephants, among them 83 species were identified in elephant's dung. Plant families that contributed a major proportion of elephant's diet in the study area were: Gramineae (8 spp., 10.0%), Moraceae (7 spp., 9.9%), Papilionaceae (4 spp., 8.4%), Araliaceae (3 spp., 6.6%), Vitaceae (3 spp., 5.7%), Apocynaceae (3 spp., 4.6%), Musaceae (1 spp., 4.2%), Zingiberaceae (3 spp., 3.7%), Myrsinaceae (3 spp., 3.6%), Rosaceae (3 spp., 3.6%), Euphorbiaceae (5 spp., 3.3%), Ulmaceae (2 spp., 3.0%) and Mimosaceae (4 spp., 2.9%). The most important plants in elephants' diet are Ficus spp. (Moraceae, 9.0%), *Dendrocalamus* spp. (Gramineae, 4.5%), *Musa acuminata* (Musaceae, 4.2%), *Microstegium ciliatum* (Gramineae, 3.5%) and *Amalocalyx yunnanensis* (Apocynaceae, 3.1%). Asian

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elephants consumed a variety of plants in terms of life form, including tree, vine, shrub and herb. Early successional species comprise a higher proportion of diet than late successional plants (42 spp. taking 59% vs. 32 spp. taking 37%). Browse species contributed a larger proportion of diet compared to grazing species (77 spp. taking 91% *vs*. 6 spp. taking 9%). The number of plant taxa (species, genus, family) *in elephant's diet each month is negatively correlated with monthly rainfall and mean temperature*. The study may help to develop proper strategies for wildlife management especially referring to the human-elephant conflict, which is now a serious issue in the conservation of Asian elephants in this area.

Key words: asian elephants; diet composition; dung analysis; foraging type; human-elephant conflict; Southwest China

Introduction

Asian elephant Elephas maximus L. is number about 45 000 in the wild and is distributed over South and Southeast Asia[1]. As a mega-herbivore, Asian elephant consumes more than 110 plant species and the daily mass of an elephant's diet may be as much as 1.5% ~ 1.9% of its body weight in dry weight fodder[2~4]. Previous studies have suggested that Asian elephants' feeding preferences might be related to plants' palatability, phenophase[3], texture and protein content[5]. Sukumar has also suggested that elephants' feeding selection were due to certain nutrients requirement, such as crude protein, calcium and sodium[4]. Several studies indicate the Asian elephants' food selection behavior are highly spatial-dependent and vary among different seasons[2~4]. The investigation in different areas may enrich our knowledge on feeding preference and forging ecology of Asian elephant.

Asian elephant are often considered as the flagship species in their habitats, and efforts have been putting into its conservation[6]. However, increasing conflicts between human and elephant occur in many areas in Asian countries[7, 8]. Elephants come out of the protective habitats, destroy farming lands and even injury people. Elephant-human conflicts become an important issue to the conservation of elephants in many areas[8], as well as in Xishuangbanna, Southwest of China, where most wild elephants of China distributed[14]. Understanding of the diet composition and forging ecology of Asian elephants in our study area may help to develop proper strategies concerning the human-elephant conflict.

Our study addressed the following questions. What kinds of plants do Asian elephant feed on in the study area? What is the seasonal change in their diet patterns? Whether the diet composition correlates to certain nutritional items?

1 Study area

This study was conducted in Shangyong protected forest (21°15′ ~ 21°25′N, 101°20′ ~ 101°37′E) of Xishuangbanna National Natural Reserve, Yunnan Province of China[9]. Average rainfall is about 1500 mm per year. With the influence of the southwest monsoon, the wet season starts in early May and ends in early October, so that the climate in the study area can be characterized by two distinct seasons, the wet season (May-October) and the dry season (November-April). Annual average temperature is 15.1 ~ 21.7℃. The total area is about 321.85 sq. km and elevation ranges from 630 m to 1300 m above sea level. The floristic composition and structure of the forest have been described by Cao & Zhang[10]. The forest is linked with Nam Ha National Biodiversity Conservation Area (20°33′ ~ 21°13N′, 100°08′ ~ 101°30′E, 2224 km^2) *in* Luang Namtha province of Lao People' Democratic Republic.

The exact number of the wild Asian elephants in the forest is not yet known. Local villagers estimate there are about 60 individuals in the forest in Shangyong while the largest number implied by villagers' witness was 33 individuals. The estimate of 130 ~ 150 elephants in that forest by Zhu & Santiapillai is more optimistic. Differences may be related to the fact that wild elephants frequently across the China-Laos border[9].

2 Methods

2.1 Field observation

We followed fresh elephant trace on 5 ~ 8 January, 4 ~ 6 May and 27 ~ 28 August in 2000 respectively, and each

time walked more than 3 km. During the walks, we recorded all plants eaten by elephants, identifying foraging type (grazing vs. browsing), life form of the plants. The classification of life history was based on our field experiences. Voucher specimens were collected and brought to laboratory for identification and references of plant tissues in elephant dung that each species were consumed by elephants in the same area.

2.2 Dung analysis

We collected fresh elephant dung samples from the field every month from September 1998 to December 1999, and every two months during 2000. All together we collected 22 samples. Dung was sampled from > 10 different places each time, and the nearest distance between each sites was > 30 m, so that a good representative sample is obtained. Fresh dung samples were brought back to laboratory and dried at 40℃ in an oven and were stored under dry condition for subsequent analysis. A small part of each dung sample was randomly picked and then placed in a dish with distilled water, and analyzed under a microscopy (25 times) work, with 30 views being taken per sample. We identified and counted the appearance of each plant species by using known plants vouchers as a reference. Microscopic characters, such as epidermal pattern, trichomes, cellular inclusions, and starch grains, as well as shape, texture, and color of particles were used as characters for identification. We excluded the views with unidentifiable plant tissues. Each dung sample require about 2 hours of microscope work.

The proportion of plant species i (P_i) in each month was calculated by the following formula:

$$P_i = S_i \Big/ \sum_{i=1}^{n} S_i$$

Where S_i denotes the sum of occurrences of species i that appeared in the 30 views, and n means the total number of species recorded in the sample.

The proportion of species i in different seasons was calculated by the average of P_i over the months in a given season. The average proportion of species i was calculated using the average of P_i of 21 months.

2.3 Measurement of nutrients

Representative parts of plants foraged by Asian elephant were collected. The determination of sampling parts from the plants was based on authors' field observation. Samples were sealed in plastic bag and brought back to laboratory within two days for chemical analysis. The following nutritional parameters were determined: (1) Energy content per unit of dry mass was calculated using the sum of energy from protein (4 × 4186 kJ/g), carbohydrate (4 × 4186 kJ/g) and fat (9 × 4186 kJ/g)[11]. (2) Water content was measured by drying in an oven 40 ℃ until constant mass reached over a period of about one week. (3) Content of protein was calculated by 6.25 × (nitrogen content). (4) Crude fatty acid was determined by using the Soxhlet-extraction method. (5) Carbohydrate was calculated using the following formula: Carbon hydrogen = 1 − (water content) − (ash) − (protein) − (crude fatty acid) − (crude fiber). (6) Crude fiber: the cellulose content was qualified by determining the ash-free dry weight of the residues after treating the samples with 1.25% (W/V) of H_2SO_4 and 1.25% (W/V) of NaOH. (7) Ash was measured by firing under 525℃. (8) Mineral element contents: For analysis of nitrogen (N), samples were digested with H_2SO_4-H_2O_2, and for phosphorus (P), potassium (K), sodium (Na), calcium (Ca), magnesium (Mg), zinc (Zn), copper (Cu) and iron (Fe), samples were digested with HNO_3-$HClO_4$. Total-N was determined by diffusion, total-P by molybdenum-blue colorimetric method. K, Na, Ca, Mg, Zn, Cu and Fe were determined by Inductively Coupled Plasma Atomic-Emission Spectrometry (Thermo Jarrell Ash Corporation, USA, 1999. Type: IRIS Advantage-ER).

3 Results

3.1 Plant species eaten by Asian elephants

Asian elephants consumed a wide range of plant species. In totally 106 species were recorded by field observation and

83 species by dung identification (see Appendix 1 A listof the plant species of > 1% in average diet proportion). Plant families that contributed a major proportion of elephant's diet in the study area were: Gramineae (8 spp., 10.0%), Moraceae (7 spp., 9.9%), Papilionaceae (4 spp., 8.4%), Araliaceae (3 spp., 6.6%), Vitaceae (3 spp., 5.7%), Apocynaceae (3 spp., 4.6%), Musaceae (1 spp., 4.2%), Zingiberaceae (3 spp., 3.7%), Myrsinaceae (3 spp., 3.6%), Rosaceae (3 spp., 3.6%), Euphorbiaceae (5 spp., 3.3%), Ulmaceae (2 spp., 3.0%) and Mimosaceae (4 spp., 2.9%). The most important plants in elephants' diet are *Ficus* spp. (Moraceae, 9.0%), *Dendrocalamus* spp. (Gramineae, 4.5%), *Musa acuminata* (Musaceae, 4.2%), *Microstegium ciliatum* (Gramineae, 3.5%) and *Amalocalyx yunnanensis* (Apocynaceae, 3.1%) (Appendix 1).

Asian elephants consumed a variety of plants in terms of life form, including tree, vine, shrub and herb (Table 1). Early successional species contain a higher proportion of diet than late successional plants. Forty-two early successional species that accounted for 59% in diet were recorded by dung analysis, while 32 species of late successional plants accounted for 37% of the diet (Table 1). Asian elephants often visit secondary forest habitats or forest gaps where pioneer plant species are more abundant. Browse species contributed a larger proportion of diet compared to grazing species (Table 1). We also observed that elephants did not obviously avoid feeding on plants that have defense traits against herbivores, such as thorns on leaves and twigs.

Table 1 The number of species (N) and proportion in diet (%) of different kinds of plants consumed by Asian elephants (The data is based on dung analysis and numbers in parentheses are the number of species identified by field observation)

Life form								Life history*						Foraging type			
Herb		Vine		Shrub		Tree		ES		LS		Unidentified		Graze		Browse	
N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
14	18	19	24	10	12	37	46	42	59	32	37	9	4	6	9	77	91
(26)		(24)		(12)		(41)		(55)		(41)		(9)		(7)		(99)	

* ES: Early successional plants, LS: Late successional plants

3.2 Seasonal change of plants consumed

The number of plants consumed by Asian elephants differed among seasons. During the cold dry season, elephants consume more plant taxa at family, genus and species levels compared with those consumed in hot rainy season. The number of plant species in diet was negatively correlated with the monthly mean temperature and precipitation (Fig. 1).

Some species, such as *Spondias pinnata* (Anacardiaceae), *Microstegium ciliatum* (Gramineae), *Curculigo*

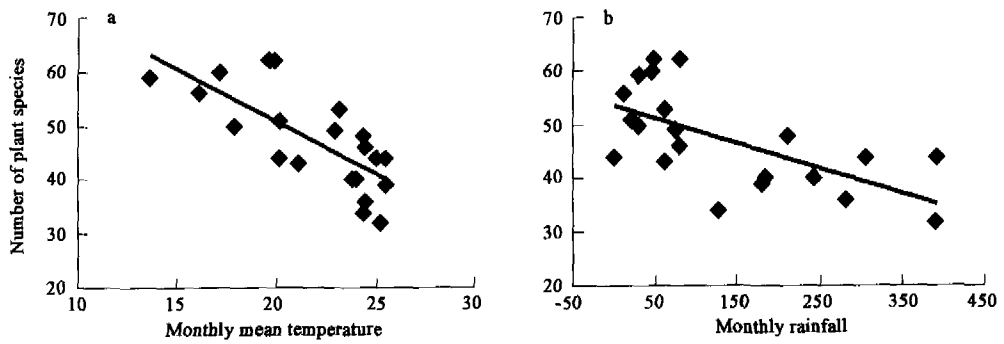

Fig. 1 The number of plant species consumed by Asian elephant in the diet of each month as identified through dung analysis was negatively related with the monthly rainfall(mm), monthly mean temperature(℃); $n = 21$

Number of plant taxa in genus and family are also negatively relate to the monthly mean temperature (a), ($R^2 = 0.4942, p < 0.001$; $R^2 = 0.4136, p < 0.01$) and monthly rainfall (b). ($R^2 = 0.3597, p < 0.01$; $R^2 = 0.4118, p < 0.01$)

capitatum (Hypoxidaceae), and *Amomum glabrum* (Zingiberaceae) were consumed more in the wet season. While, other plants such as *Castanopsis mekongensis* root (Fagaceae), *Acacia* sp. stem (Mimosaceae), *Leea indica* (Vitaceae) were more consumed in the dry season(Appendix 1).

3.3 Plant selection in relation to nutrients

The nutrient contents of 29 most important species consumed by elephants are given in Appendix 2. Iron content in plant parts was highly correlated with the plant species proportion in the diet ($R^2 = 0.4199$, $p = 0.0006$, $N = 25$). No relationships were found between the proportion and other nutrient items, such as energy, protein, protein to fiber ratio, protein plus ash, the contents of phosphorus, potassium, sodium, calcium, magnesium, zinc and copper, etc.

4 Discussion

The diets of elephants in our study were very different from those previously reported in India. Among the most important plant families of elephant diets in our study, only Gramineae, Papilionaceae and Mimosaceae have been recognized as important in India[4]. Comparing the two studies, among 39 plant genera of the elephants fodder recorded in Sir Lanka, 29 genera occurred in our study, but only 6 of the genus (21%) were fed by elephants. These were *Capparis*, *Cordia*, *Croton*, *Mallotus*, *Phyllanthus* and *Sysigium*[2]. Also, among 17 plant genera of the elephants' diets in India[3], 14 genera exist in our study area, but only 4 of them (29%) recorded as elephants' food plants (*Acacia*, *Albizia*, *Capparis* and *Dendrocalamus*). Janzen has pointed out that diet breadth cannot be defined usefully in terms of plant taxa, as herbivores are unlikely to select food on the basis of Latin binomials[12]. Plant resources are spatially-dependent, Asian elephants may eat contemporary plants to meet their nutritional requirements. Elephants need such large quantities of food it is to be expected that availability of plant species will be an important factor in their diet.

Asian elephants are mixed feeders eating both graze and browse. Early studies by direct field observation suggested that food plants by grazing makes up a major part of elephants' diet[3]. Later Sukumar & Ramesh reported that intake of plants by browsing constitutes a major part of diet as indicated by analysis of stable carbon isotope ratios in dung[13]. Our study showed that 91% of food plants were consumed by browsing.

A total of seven species were recorded as consumed by grazing, of which six species appeared in dung. Comparing nutrients of grazed species with browsed species did not reveal any significant difference.

The minimal amount of different nutritional components to maintain elephants' body is unknown. Sukumar discussed elephants' requirements for protein, calcium and sodium, and suggested that the minimal daily amounts for an adult elephant (supposed body weight 3 t) were 900g of digestible protein, and 60 g and 75 ~ 100 g of calcium and sodium respectively. Supposed an elephant consumed plants amounting to 1.5% in dry weight of its own body weight and that 40% of crude protein are digestible[3], the minimal amount of average content of the consumed plants would be 5%, 0.13% and 0.17% ~ 0.22% for protein, calcium and sodium respectively. The average amount of nutritive items in 29 plants identified in our study suggested that the plant materials in the study habitat were easily sufficient to supply enough protein and calcium, while there is some difficulty in meeting elephant's requirements for sodium. This might be the reason why elephants often seek sodium from salt pond.

Some plants were only consumed during certain seasons. This may be interpreted in term of their nutrient content. *Acacia* spp. got intensively consumed in dry season compare that in wet season in our study (4.1% vs. 1.2% in diet). This is also reported by several studies in other regions, and, the selection of *Acacia* is explained to be high protein content[3~5]. Our study indicated that the consumed part of Acacia species did not show a relatively high protein content (3.2% ~ 3.5%) but had a relatively high fiber content (40.4% ~ 51.3%). Elephants need to lose their body weight during the dry season so as to avoid excessive fat deposits that inhibit efficient thermoregulation[3]. During the dry season, excessive protein intake is also undesirable, because nitrogen excretion requires more water which may be in short

supply[3]. Seeking for *Acacia* and *Leea indica* as fiber rich plants may be critical for elephants to achieve a proper ratio of protein to fiber and to avoid constipation during dry and hot season.

The present study had showed the iron content in consumed plants positively related to the composition percentage in dung. The reasons for this pattern require further study. It might be that elephant prefer iron rich plants, or by chance those intensive consumed plants have higher iron contents.

Understanding the diet composition and forging ecology may help conservationists and protective reserve managers to develop proper strategies for a better wildlife management in this area, especially referring to the conflict between human and elephants. The National Natural Reserve is strictly protected and all villagers have been excluded from the reserve. Secondary and early successional forests which were often created by villagers' shifting cultivation in the past time, now become less and less in Natural Reserve. This may cause the decrease of biomass of many important elephant food plants in the forest, *e. g.*, *Dendrocalamus* spp. (Gramineae), *Musa acuminata* (Musaceae), *Microstegium ciliatum* (Gramineae), etc. With the help of the research team, forest managers are trying to reestablish some patches of early successional forests and plant some elephant food plants in the protect area so as to solve the human elephant conflict. Certainly the effects of such practice need careful assessment.

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Appendix 1 Information on plant species consumed by Asian elephants and their proportions in the diet in different seasons as identified through dung analysis (Only those species which constitute at least 1% of diet have been included)

Scientific name	Proportion in different seasons(%)		Average proportion (%) (Mean ± 1SD)	LF	AR	LH	FT
	Dry	Rainy					
Anacardiaceae							
Spondias pinnata	1.3	2.1	1.8 ± 1.1	Tree	no	LS	Br
Apocynaceae							
Amalocalyx yunnanensis	2.8	3.1	3.1 ± 0.7	*Vine*	*yes*	*LS*	*Br*
Chonemorpha eriostylis	1.4	0.9	1.2 ± 0.9	Vine	yes	LS	Br
Araliaceae							
Heteropanax fragrans	1.6	1.8	1.8 ± 0.9	Tree	yes	LS	Br
Macropanax dispelmus	2.2	2.2	2.3 ± 0.7	Tree	no	LS	Br
Trevesia palmata	1.9	2.9	2.5 ± 1.0	Tree	yes	LS	Br
Bignoniaceae							
Oroxylum indicum	2.0	2.1	2.0 ± 1.3	Tree	yes	ES	Br
Boraginaceae							
Cordia furcans	1.6	1.1	1.5 ± 0.8	Tree	no	ES	Br
Combretaceae							
Combretum punctatum	1.0	1.1	1.0 ± 0.8	Vine	yes	ES	Br
Cyperaceae							
Carex baccans	1.6	1.6	1.7 ± 0.7	Herb	yes	ES	Br
Euphorbiaceae							
Bridelia tomentosa	1.2	1.0	1.1 ± 0.9	Tree	no	ES	Br
Croton argyratus	1.0	1.3	1.2 ± 1.1	Tree	no	ES	Br
Fagaceae							
Castanopsis fleuryi	2.4	2.1	2.3 ± 1.1	Tree	yes	ES	Br
C. mekongensis	1.6	0.6	1.1 ± 1.2	Tree	no	ES	Br
Gramineae							
Bamboo*	3.9	4.5	4.5 ± 1.1	Herb	yes	ES	Br
Microstegium ciliatum	2.3	4.2	3.5 ± 1.7	Herb	yes	ES	Gr
Thysanolaena maxima	1.6	1.9	1.8 ± 1.1	Herb	yes	ES	Gr
Hypoxidaceae							
Curculigo capitulata	0.7	2.1	1.6 ± 1.1	Herb	yes	ES	Gr
Marantaceae							
Phrynium capitatum	1.3	1.6	1.5 ± 0.7	Herb	yes	ES	Br
Menispermaceae							
Parabaena sagittata	2.5	1.9	2.3 ± 1.1	Vine	yes	LS	Br
Mimosaceae							
Acacia megaladena	2.4	0.5	1.4 ± 1.7	Vine	yes	ES	Br
Acacia pennata	1.7	0.7	1.1 ± 1.2	Vine	yes	ES	Br
Moraceae							
Ficus auriculata	2.1	2.6	2.4 ± 1.0	*Tree*	*no*	*ES*	*Br*
F. fistulosa	2.2	2.5	2.5 ± 0.6	*Tree*	*no*	*ES*	*Br*
F. racemosa	2.3	2.2	2.4 ± 0.6	*Tree*	*no*	*ES*	*Br*
F. semicordata	1.5	1.6	1.7 ± 0.8	Tree	no	ES	Br
Musaceae							
Musa acuminata	4.0	3.8	4.2 ± 1.3	Herb	yes	ES	Br
Myrsinaceae							
Measa indica	2.1	2.1	2.1 ± 1.0	Shrub	no	ES	Br
Papilionaceae							
Derris caudatilimba	2.1	2.1	2.2 ± 0.6	Vine	yes	ES	Br
Millettia leptobotrya	1.1	1.2	1.1 ± 1.0	Tree	yes	ES	Br
Shuteria hirsuta	2.5	2.7	2.8 ± 0.6	Vine	yes	ES	Br
Rosaceae							
Rubus ellipticus var. *obcordatus*	1.8	1.8	1.9 ± 0.7	Shrub	yes	ES	Br
R. pyrifolius var. *cordatus*	0.7	1.3	1.1 ± 0.9	Shrub	yes	ES	Br
Rubiaceae							
Uncaria laevigata	1.9	0.8	1.3 ± 1.1	Vine	yes	ES	Br
U. scandens	1.5	0.9	1.3 ± 1.0	Vine	yes	ES	Br
Solanaceae							
Solanum torvum	2.2	2.2	2.3 ± 0.7	Shrub	yes	ES	Br
Staphyleaceae							
Turpinia pomifera	1.5	0.4	1.0 ± 0.8	Tree	no	LS	Br
Sterculiaceae							

Continue

Byttneria grandifolia	1.5	0.7	1.1 ± 0.9	Vine	yes	LS	Br
Ulmaceae							
Celtis timorensis	2.6	2.8	2.8 ± 0.6	Tree	no	LS	Br
Urticaceae							
Boehmeria clidemioides	2.0	1.6	1.9 ± 0.8	Shrub	no	ES	Gr
Vitaceae							
Leea indica	2.3	2.5	2.4 ± 1.0	Shrub	yes	LS	Br
Tetrastigma planicaulum	2.6	1.9	2.4 ± 1.0	Vine	yes	LS	Br
Zingiberaceae							
Amomum glabrum	1.0	2.3	1.8 ± 1.2	Herb	yes	LS	Br
Costus speciosus	1.1	1.1	1.2 ± 0.8	Herb	yes	LS	Br

LF life form; AR ability of regrowth, if the plant have ability for asexual propagation and re-grow after being eaten is 'yes', otherwise it is 'no'; LH life history, LS Late successional plants, ES Early successional plants; FT foraging type, Br browse, Gr graze; Dry season: November ~ April, Rainy season: May—October; * Bamboo here includes *Dinochloa bannaensis*, *Gigantochloa nigrociliata* and *Dendrocalamus membranaceus*

Appendix 2 Nutrient contents of 29 commonly consumed plants (The data are in dry weight)

Scientific name	Content (%)	Energy (×4.18 kJ/g)	Protein (%)	fat (%)	hydrogen (%)	Fiber (%)	Ash (%)	Protein/ fiber	N (%)	P (%)	K (%)	Na (μg/g)	Ca (%)	Mg (μg/g)	Fe (μg/g)	Zn (μg/g)	Cu (μg/g)
Acacia megaladena	61.6	28.0	3.5	0.9	1.6	40.4	3.6	0.1	0.56	0.06	0.38	52.0	0.53	0.04	168	20	10
Acacia pennata	50.3	17.4	3.2	0.2	0.8	51.3	4.2	0.1	0.51	0.04	0.59	15	1.19	0.23	76	0	9
Boehmeria sp.	35.3	111.4	17.1	2.3	5.6	26.3	13.4	0.7	2.74	0.22	1.43	55	2.88	0.36	365	32	6
Calamus sp.	78.3	42.3	8.0	0.9	0.7	40.0	6.4	0.2	1.27	0.14	1.46	47	0.26	0.15	151	18	19
Carex baccans	44.4	67.7	7.7	2.1	4.5	27.7	13.6	0.3	1.23	0.14	1.58	55	0.23	0.13	87	20	8
Castanopsis calathiformis	55.9	29.5	3.7	0.7	2.1	33.5	4.1	0.1	0.6	0.04	0.25	51	0.11	0.08	651	10	3
Castanopsis fleuryi	57.1	23.6	3.2	0.6	1.4	44.4	4.8	0.1	0.51	0.04	0.24	47	0.08	0.10	499	15	2
Celtis timorensis	35.7	123.2	19.5	1.6	7.7	21.2	14.2	0.9	3.12	0.26	1.16	62	5.61	0.27	179	25	7
Costus speciosus	61.2	69.2	9.2	3.3	0.6	18.8	13.8	0.5	1.47	0.15	2.36	51	1.07	0.44	154	139	6
Curculigo capitullata	33.1	99.7	8.0	1.8	13.0	34.5	9.7	0.2	1.27	0.12	2.18	60	1.47	0.54	103	30	10
Dendrocalamus barbatus	45.8	48.1	10.0	0.8	0.1	40.1	6.8	0.3	1.61	0.16	1.07	80	0.48	0.19	529	25	5
Dinochloa dannaenlis	65.9	49.9	8.9	1.2	0.7	34.2	8.1	0.3	1.43	0.23	1.51	76	0.35	0.10	497	20	2
Ficus auriculata	82.0	76.3	11.4	3.1	0.8	26.4	14.5	0.4	1.82	0.50	4.10	45	1.57	0.44	127	15	11
Ficus racemosa	75.3	113.9	20.7	2.7	0.9	14.6	11.4	1.4	3.30	0.47	2.24	29	1.92	0.57	166	35	16
Harpullia cupanioides	40.1	89.4	10.9	1.3	8.6	27.7	11.5	0.4	1.7	0.18	1.01	62	3.20	0.72	125	56	5
Heteropanax fragrans	76.3	57.1	9.3	1.7	1.2	43.8	8.5	0.2	1.5	0.29	2.99	30	0.81	0.26	135	33	23
Mallotus barbatus	42.7	157.0	15.9	5.5	10.9	18.4	6.6	0.9	2.6	0.24	1.44	43	2.19	0.13	224	33	7
Microstegium ciliatum	50.2	58.1	7.7	1.2	4.1	27.4	9.4	0.3	1.2	0.20	1.40	59	0.47	0.22	210	63	5
Musa acuminata	43.5	108.5	10.7	2.6	10.6	23.6	9.0	0.5	1.7	0.35	18.39	47	0.41	0.33	600	103	33
Parabaena sagittata	47.3	101.3	11.2	3.8	5.6	20.0	12.1	0.6	1.8	0.15	1.28	59	3.05	0.35	282	63	3
Phrynium capitatum	32.4	102.5	9.7	0.7	14.5	33.8	9.0	0.3	1.5	0.17	2.58	55	0.63	0.32	311	22	6
Pleioblastus amarus	51.6	71.0	12.2	1.9	1.3	26.5	14.9	0.5	1.9	0.13	1.16	56	0.33	0.17	298	30	6
Rubus ellipticus var. *obcordatus*	61.8	57.5	10.1	1.7	0.4	35.1	7.1	0.3	1.6	0.20	1.66	48	1.78	0.39	110	109	9
Shuteria hirsuta	47.2	77.2	13.9	2.2	0.4	29.4	9.5	0.5	2.2	0.20	2.02	69	2.32	0.21	371	32	7
Tetrastigma planicaulum	26.9	160.6	9.1	2.7	24.9	22.9	13.5	0.4	1.5	0.16	2.05	69	1.60	0.52	199	28	8
Thysanolaena maxima	33.8	105.1	7.6	1.3	15.8	34.0	7.6	0.2	1.2	0.19	2.20	47	0.31	0.21	111	38	5
Trevesia palmata	21.7	141.9	12.0	2.1	18.7	33.5	12.0	0.4	1.9	0.26	3.32	77	1.20	0.61	377	57	10
Turpinia pomifera	39.3	94.8	7.4	2.5	10.7	28.2	11.9	0.3	1.2	0.17	1.69	51	3.16	0.56	59	25	5
Zingiber orbiculatum	89.0	73.9	10.7	2.7	1.7	30.4	12.9	0.4	1.7	0.41	4.25	39	0.87	0.35	149	31	12
Mean ± 1SD	51.2	81.2	10.1	1.9	5.9	30.6	9.8	0.4	1.6	0.20	2.34	53	1.38	0.31	252	39	9
	± 17.3	± 38.2	± 4.4	± 1.1	± 6.6	± 8.7	± 3.4	± 0.3	± 0.7	± 0.16	± 3.24	± 14	± 1.27	± 0.18	± 168	± 31	± 7