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Foraging ecology of the Asian elephant (*Elephas maximus*) in northern west Bengal, north eastern India

Mukti Roy [1 &2], Tanmay Bhattacharya [1], Natarajan Baskaran [2], Raman Sukumar[2 & 3]

1) Department of Zoology, Vidyasagar University, Midnapore (west), West Bengal, India, 721102
2) Asian Elephant Research and Conservation Centre, C/o-Centre for Ecological Sciences, Indian Institute of Science, Bangalore -560012
3) Centre for Ecological Sciences, Indian Institute of Science, Bangalore-560012

Abstract:
The elephant habitat in northern West Bengal, India is part of the Eastern Himalayas biodiversity hotspot. The habitat is characterized by a high degree of fragmentation and severe human-elephant conflict. Foraging by Asian elephants was studied in this landscape during 2002-2004 as part of a larger study of elephant-human conflict. The study was carried out in the eastern parts of the landscape comprising the Buxa Tiger Reserve and Jaldapara Wildlife Sanctuary that together constitute a 1074 sq km area and harbour ~300 elephants. Systematic observations along feeding trails were made on a monthly basis following radio-collared elephant herds. Additionally, stable carbon isotope analysis of collagen from bone samples collected from dead elephants was also carried out.

In total, from 18,308 feeding scores, 108 plant species (that include 52 trees species, 20 shrubs, 8 herbs, 21 climbers, 6 grasses and 1 orchid) were recorded. Of the 108 plant species eaten by elephants, the top 15 species contributed to more than 85% of the annual diet. Elephants consumed more plant species in the dry season (91 *spp*.) compared to the wet season (59 *spp*.). *Acacia pennata*, a climber, was eaten more frequently (11%) in the dry season while in the wet season *Saccharum spontaneum*, a grass species, dominated (66%) the diet of the elephants.
In deciduous forest, the bulk of the elephant diet came from *Saccharum spontaneum* (55%), while in semi-evergreen forest and mixed vegetation, *Acacia pennata* (10%) and *Cephalostachym pergracile* (48%) contributed the highest proportions, respectively.
The feeding trail observation revealed that the annual diet of elephants is dominated by browse (58%). This is in keeping with the habitats in the study area being predominantly forested habitat. On a seasonal basis, browse constituted 93% of the elephant diet in dry season, while in the wet season, grass species formed the bulk (78%) of elephant diet. Results of bone collagen analysis revealed most of the samples to have $\delta^{13}C$ values more negative than –20 per mil, which correspond to contribution predominantly by C3 plants (browse species) to organic synthesis.

Introduction:

Foraging, the search for food is a major influencing factor in animal movement and habitat selection. For a mega-herbivore food, water and shelter are the principal factors that dictate the choice of areas used and their long and short-term movement patterns (Owen-Smith, 1988, Sukumar, 1989). Elephant is a megaherbivore requiring large amount of food (estimated variously at 1.5-2.5% of its body weight at dry fodder daily) for their maintenance (see Sukumar 2003 for a review). Though the elephant is a non-ruminant, it is still capable of utilizing microbial action for the digestion of cellulose in its ceacum and colon (Clemens and Maloiy, 1982). Due to this enormous food requirement, the elephant cannot afford to be a selective feeder like smaller herbivores and thus they consume large quantities of available forage, without spending much time and energy on selection. The trunk acts as an efficient screening and scooping instrument for distinguishing between palatable and non-palatable forage. The fast rate of passage enables consumption of large quantity of forage.
Most of the studies on elephant feeding habits have been in savanna habitats in Africa or tropical dry forest in Asia. The northern West Bengal landscape in northeastern India is primarily a tropical moist forest habitat with grasslands along the floodplains of rivers. Although there have been some studies on elephant habitats, and its population and human-elephant conflict (Lahiri Choudhury, 1975. Dey, 1991, Barua and

Bist, 1995, Choudhury *et a*l, 1997) in northern West Bengal, no detailed study on the foraging ecology of wild elephant has been done. The present study was carried out to document the plant species composition and its seasonal variation in the diet of elephants in this tropical moist forest and grassland habitat.

Study area:
The moist tropical and sub-tropical forests along the foothills of the Eastern Himalayan Region have six designated National Parks and Wildlife Sanctuaries. The study area comprised the Buxa Tiger Reserve and the adjoining Jaldapara Wildlife Sanctuary. The Buxa Tiger Reserve is the only reserve in the Dooars region designated as a Project Tiger Reserve in 1983. Subsequently in 1997, an area of 117 km^2 of the reserve was notified as a National Park. The Reserve is located between 89°25′ - 89°55′ N latitude and 26°30′ - 26°50′ E longitude encompassing an area of 761 km^2 that includes a core area of 385 km^2 and a buffer area of 376 km^2. The Jaldapara Wildlife Sanctuary lies to the west of Buxa Tiger Reserve, between 89° 15' - 89° 35' N latitude and 26° 30' – 26° 48' E longitude covering an area of 217 km^2. The entire forest range along the foothills of northern Bengal, from the Mechi River in the west along the Indo-Nepal border to Sankosh River in the east along the border with Assam, is also believed to be a contiguous elephant range. The population is the western most extension of the North East population (~11000), particularly North bank of Brahmaputra landscape (~3250) contiguous with Myanmar in the east, Bhutan in the North and Nepal in the west. From an ecological point of view, this population is a Trans-boundary elephant population and the conservation of the entire landscape is essential to conserve the biodiversity of the region.

Buxa Tiger Reserve and Jaldapara Wildlife Sanctuary together constitute a 1074 sq km area and harbour ~300 elephants (Sukumar *et al*, 2003). The forest types are Sub Himalayan semi-evergreen, Moist mixed deciduous, Eastern Himalayan upper and lower bhabar sal, Sub Himalayan terai, moist temperate, grassland and savannah (Champion, et al., 1968). Rainfall varies from 360 cm to 600 cm and temperature varies from 11^0C to 31^0C. Dry season is from November to April and wet season is from May to October.

Methodology:

Feeding trail observation:
Data on feeding behavior of elephants were collected mostly by following fresh feeding trails, as direct observation (scan and focal sampling) was not possible due to extremely poor visibility in the forested habitat. Feeding trails of elephant herds fitted with radio-collars were used for recording food species eaten, by following the trails left by the collared elephants from the preceding day location. From each feeding trail, information such as plant species eaten, plant parts consumed and discarded were recorded. Unidentified food plant were collected, preserved and identified later. One feeding trail per month per animal was targeted to do the feeding trail and three radio-collared herds were followed from 2002 to 2004. Additionally, fresh elephant dung piles were examined in order to know the fruit species consumed.

Bone Collagen analysis:
Stable carbon isotope analysis was carried out to determine the relative proportions of C3 plants (browse or most trees, shrubs and herbs) and C4 plants (tropical grasses) (Sukumar and Ramesh, 1992). Bone samples were collected from 12 elephants, which died during the study period in the study area. The collected bone samples were cleaned and air-dried and powdered using a screw holder. About 50-150 mg of bone powder was mixed with 50ml of 1M HCl. After 15-20 minutes the supernatant was filtered through glass fiber filter. Residues were transferred to a beaker containing 50ml of 10^{-3} HCl and the beaker was heated for 10 hours at 95^0 C and again filtered using glass micro filter. Residues were discarded and filtrate was lyophilized to extract bone collagen (DeNiro and Epstein, 1978; Sukumar and Ramesh 1992).

Observations and Results:

Food plants eaten by elephants (Overall and seasonal):
In total 18,308 feeding signs of elephants were recorded from 68 feeding trail (Dry season 39, Wet season 29) observations between 2002 and 2004; from these 108 plant species consumed by elephants were

identified (Appendix-I). Additionally, five more species eaten by elephants were identified from 529 elephant dung piles examined. Overall, the 111 plant species eaten by elephants belonged to 54 families and the common families eaten are *Moraceae* (8%), *Mimosaceae (7%), Euphorbiaceae* (7%), *Fagaceae* (7%), *Poaceae (6%), Palmaceae (5%) and Zingiberaceae (4%).* Seasonal analysis carried out using feeding trail data revealed that more number of plant species (91 *spp*.) were eaten by elephants in dry season compared to wet season (59 *spp*.)

Important food plants:
Fifteen species comprised 87% of the overall diet of elephants in the study area. The higher contributions of *S. spontaenium* (48%) to the overall diet of elephants indicated the importance of this species as food for elephants. On the seasonal basis, the top 15 species formed a less proportion (79%) of the dry season diet of elephants as compared to the wet season diet (97%). *A. pennata* (11%) and *L. crenulata* 10% were the most commonly eaten food plants in dry season while in wet season *S. spontaneum* alone contributed to 66% of the elephant's diet (Table 1)

Table 1: List of top 15 species eaten in dry and wet season observed from feeding trails of wild elephants from 2002 to 2004

S. No.	Scientific Name	%Dry n =4819	%Wet n =13489	% Overall n =18308
1	*Acacia catechu*	~	1.06	0.98
2	*Acacia pennata*	10.77	3.79	5.63
3	*Acacia sp.*	~	2.37	1.75
4	*Albizzia lucidor*	7.57	2.14	3.57
5	*Atrocarpus lakoocha*	2.80	~	~
6	*Butea parviflora*	2.84	~	~
7	*Cephalostachyum pergracile*	~	11.65	8.58
8	*Commelina benghlensis*	7.47	~	1.97
9	*Cucurma sp.*	~	3.10	2.28
10	*Dendrobium sp.*	~	0.42	~
11	*Ficus hispida*	~	0.37	~
12	*Icynocarpus frutescens*	~	0.67	~
13	*Laportia crenulata*	9.55	0.91	3.18
14	*Lasia spinosa*	3.82	~	1.01
15	*Leea indica*	7.91	~	2.28
16	*Litsea monopetala*	~	0.47	~
17	*Mallotus philippinensis*	3.71	0.59	1.41
18	*Mallotus sp.*	2.26	~	~
19	*Phonix acaulis*	1.99	~	~
20	*Phyrinum pubinerve*	7.20	~	1.90
21	*Saccharum spontaneum*	~	65.67	48.38
22	*Saccharum arundinaceum*	6.00	~	1.63
23	*Shorea robusta*	2.26	~	~
24	*Sterblus asper*	~	0.84	~
25	*Tectona grandis*	~	2.60	2.09
26	*Zingiber rubens*	3.34	~	~
	Top 15 species	**79.49**	**96.65**	**86.64**
27	***Others species***	**76 *sp*=20.51**	**44*sp*=3.35**	**93*sp* =13.36**

Food plants in different habitats:
Feeding trail data were analyzed separately for each habitat to document the important food plants in different vegetation types. Food plant composition varied considerably between habitats. For example, *S. spontaneum* a tall grass found in the deciduous forests (55%) and flood plains (99%) habitats was being eaten by the elephants more often than any other species (Table 2). But in the case of mixed vegetation, elephants depended on 47 Species and C. *pergracile,* a bamboo found on the hill slopes formed 48% of the elephant's diet. In mixed plantations, *Acacia sp.* a shrub (30%) was the major diet of the elephants followed by *A. lucidor* 20%, *A. pennata* 17%, *Cucurma sp*, 11%, *and T. grandis*, 11%. In semi evergreen habitat, it depended on 89 species, in which *A. pennata* (9.7%) was followed by *L. crenulata (*9.15%), *C. benghalensis (9%), L. indic*a (8.8%) and *P. pubinerve* (8.5%). In teak plantation, *A. pennata* was most commonly used species (56%), followed by *T. grandis* 38%. (Table 2)

Table 2: List of top 5 species eaten by elephants in various habitats in the study area during 2002-2004

Sl.no.	Plant species	Deciduous	Mixed plantation	Mixed vegetation	Semi evergreen	Teak plantation	Flood plain
		n=2520	n=1052	n=2948	n=3998	n=295	n=7495
1	*Acacia catechu*	~	~	~	~	~	0.25
2	*Acacia pennata*	~	17.02	6.51	9.68	55.59	~
3	*Acacia sp.*	~	30.42	~	~	~	~
4	*Albizzia lucidor*	4.88	19.49	~	~	~	~
5	*Atrocarpus lakoocha*	4.80	~	~	~	~	~
6	*Butea parviflora*	5.44	~	~	~	~	~
7	*Cephalostachyum pergracile*	~	~	47.86	~	~	~
8	*Clerodendron sp.*	~	~	~	~	0.68	~
9	*Commelina benghalensis*	~	~	~	9.00	~	~
10	*Cucurma sp.*	~	11.12	7.43	~	~	~
11	*Dalbergia sissoo*	~	~	`	~	~	0.01
12	*Ficus hispida*	~	~	`	~	5.42	~
13	*Garuga pinnata*	~	~	~	~	0.34	~
14	*Ichynocarpus fruttescens*	~	~	~	~	~	0.09
15	*Laportia crenulata*	4.29	~	~	9.15	~	~
16	*Leea indica*	~	`	~	8.83	~	~
17	*Phrynium pubinerve*	~	~	~	8.50	~	~
18	*Saccharum arundinaceum*	~	~	8.24	~	~	~
19	*Saccharum spontaneum*	55.16	~	~	~	~	99.64
20	*Shorea robusta*	~	~	3.93	~	~	~
21	*Tectona grandis*	~	10.93	~	~	37.97	~
	Top 5 species	**74.57**	**88.98**	**73.97**	**45.16**	**100.00**	**99.99**
22	**Others species**	**25.43**	**11.02**	**26.03**	**54.84**	**0.00**	
	Number of other species	**28 sp**	**11sp**	**42sp**	**84sp**		

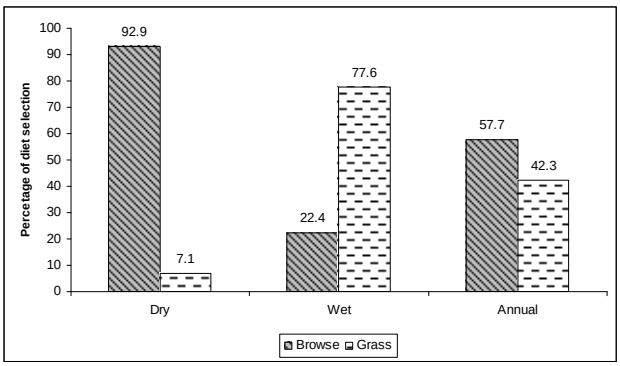
When the elephant feeds on trees and shrubs, both twigs and leaves are taken. In species like *Acacia sp, Ficus sp, etc.*, only twigs with leaves are selected. In case of *Mallotus and Albizia*, they discard the leaves and eat only twigs, and in case of *Laportea* it discards the leaves and eats only roots. In case of *Dillenia indica*, fruits are taken and in *Tectona* only bark is eaten. In dry season, after the grass has withered, the elephants turn to eat browse species like *Laportea* root, *Leea* twigs, *Acacia* twigs, *Dillenia* fruit, *Cayratia* stem, *Zingiber* stem frequently and in wet season *S. spontaenium* stem, *C. pergracile* twigs, *Cucurma sp.* stem and *Tectona* bark are frequently eaten. *Cepahlostachym, Bambosa*, *Musa* and *Acacia* are eaten frequently in the hills slope (Titi and Raimatang, Adma, Bhtanghat, Jayanti).

Elephants feed on bark of certain species in the study area like *Albizzia lucidor, Tectona grandis, Shorea robusta, Lagestromea speciosa, Artocarpus lakuoocha, Ficus sp, Ficus hispida, Dalberzia sissoo, Bombax ceiba, Sterculia villosa, Acacia catechu, Grewia sp, Mallotus philippinensis,* and *Litsea monopetala. Bridelia retusa, Terminalia crenulata, Dillenia pentagyna.*

Fruit is commonly consumed by the elephants here. Among the five fruit species (*Dillenia indica, Dillenia pentagyna, Ficus sp., Mangifera indica, Careya arborea*) recorded from (n=529) dung pile examination about 50% dung pile had *D. indica* remains in the dung pile of elephant during dry season (n=396, November to April). *D. indica* is one of the important food plants found mainly in semi evergreen undisturbed forest. *D. pentagyna* fruit is eaten in wet season.

Browse and graze ratio in the diet of elephants:
Evaluation of grass and browse consumption by elephants based on the feeding sign (n = 18,308) revealed that browse (58%) formed a marginally higher ratio of the elephant's diet compared to grass (42%). However, on seasonal basis, significant differences in browse and grass ratio was observed with the major part of the diet being browse (93%) during dry season and grass (78%) in wet season (Figure 1).

Figure 1: Browse and graze ratio found from feeding trail of elephant in the study area during study period



Stable carbon isotopic composition of Asian elephant bone collagen:
The $\delta^{13}C$ value of bone collagen of an animal is representative of the diet composition. Generally, $\delta^{13}C$ of C3 plants (browse) varies between –20 and -35 per mil and C4 plants (grass) -7 and -15 per mil. During metabolism the values are enriched by about +4.5 per mil in collagen relative to the diet (see Sukumar and Ramesh 1992). The collagen analysis of 12 bone samples showed the $\delta^{13}C$ value (Table 3) of all the samples closer to C3 plants as their values fall between –21 to –32 per mil indicating browse-dominated diet. Although, the bone collagen results show that all elephants have browse-dominated diet, difference in the ratio of browse and grass could still be very marginal as $\delta^{13}C$ values of 11 (out of 12) samples (–21 to –27) fall on the lower side of mid value (-27.5) of C3 plants (Table 3).

Table 3: Stable carbon isotopic composition of Asian elephant bone collagen

Sl.no.	Sex	Age	$\delta^{13}C$
1	Adult Male	15-20	-32.83
2	Juvenile	2-3	-27.38
3	Sub adult Male	5-10	-26.36
4	Adult Male	15-20	-25.69
5	Sub Adult Male	12-15'	-25.25
6	Juvenile	5	-24.87
7	Adult Male	30-35	-24.31
8	Sub adult female	10-15'	-24.12
9	Adult Female	45-50	-24.10
10	Adult Female	20-25	-23.67
11	Adult Male	40-45	-22.01
12	Adult Male	40-45	-21.00

Discussion:

Analysis of forage selection by elephants shows exploitation of large variety of species in the study area. Overall 150 species (including 39 additional species by captive elephants in the same) are being eaten by elephants in the region. Moreover it is likely that some herbs, shrubs and grasses could have been overlooked in the feeding trail observation due to the size of some plant species coupled with indirect method used by the study. The reason for elephants feeding on diverse food plants in the region as compared to elsewhere in India (Sukumar, 1985 recorded 112 plants in southern India in deciduous and thorn forest; Baskaran, 1998 recorded 83 plant species in Nilgiri Biosphere Reserve, Daniel *et al*, 1995 recorded central India 54 species) could be due to predomination of habitat by browse species (64% by Sukumar *et al*., 2003). Studies on foraging by elephants from primary forest of Asia (Olivier, 1978) and Africa (Ruggiero, 1992 recorded 45 species; White *et al*, 1993 recorded, 307 species) reported higher number of food plants being eaten than in the secondary forest (Tchamba *et al*, 1993 recorded 35 species, Kabigumela, 1993 recorded 36 species). From the present result and published literature it appears that elephants in the primary forest depend on diverse food plants. Sukumar *et al*, 2003, reported 307 plant species >1 cm dbh in the study area, of which elephants have eaten 34% of the species, which mean remaining 66 % of the species are not palatable to elephants. Therefore availability of palatable species could also be another reason for diverse food plants being eaten by elephants in the browse dominated habitats. In the study area, elephants consumed more species in dry season (91 *spp*.) compare to wet season (59 *spp.*) due to the abundance of grass species.

A few studies have mentioned that toxic plant secondary compounds influence elephant to take diversity of food plant species (Olivier, 1978; McNaughton, 1981; Jackman and Bell, 1985).

Analysis of grass and browse ratio in the annual diet of elephants from observations along feeding trails showed browse (58%) marginally higher compared to grass (42%). But on the seasonal basis, grass formed the major bulk of diet (77%) during wet season, a trend similar to earlier findings (Barnes, 1982; Sukumar, 1989; Buss, 1961). As discussed by Olivier (1978) the elephant's body size and dental structure have specialized towards grass feeding, but because of the seasonal variation in grass availability in wet and dry season he believed that they must be able to switch to alternative foods of browse during dry season. However, the carbon isotope analysis clearly indicates that browse (C3 plants) contributes over 90% of the carbon for protein synthesis. This could be due to the higher nitrogen (protein) content of the browse plants as compared to the tall, perennial grasses that provide bulk but not much protein. These results are consistent with the expectation that elephants move from a diet of an equal mixture of grass and browse in tropical savannas and dry forest to a pure browse diet as one proceeds along an increasing rainfall gradient to tropical moist forest (Merwe *et a,*. 1988, Sukumar 2003).

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Appendix I: Food plant eaten by elephants during dry season, wet season and overall identified from feeding trail observation between 2002 and 2004 in the study area

Sl. No.	Scientific Name	%Dry	Rank Dry	%Wet	Rank wet	%Overall	Rank overall
1	*Saccharum spontaneum*	0.00	106	65.67	1	48.38	1
2	*Cephalostachym pergracile*	0.00	96	11.65	2	8.58	2
3	*Acacia pennata*	10.77	1	3.79	3	5.63	3
4	*Albizia lucidor*	7.57	4	2.14	7	3.57	4
5	*Laportia crenulata*	9.55	2	0.91	9	3.18	5
6	*Cucurma sp.*	0.00	98	3.10	4	2.28	6
7	*Leea indica*	7.91	3	0.27	17	2.28	7
8	*Tectona grandis*	0.64	30	2.60	5	2.09	8
9	*Commelaena benghlensis*	7.47	5	0.00	60	1.97	9
10	*Phyrinum pubinerve*	7.20	6	0.00	61	1.90	10
11	*Acacia sp.*	0.00	91	2.37	6	1.75	11
12	*Saccarum arundanicium*	6.00	7	0.07	32	1.63	12
13	*Mallotus philippinensis*	3.71	9	0.59	12	1.41	13
14	*Lasia spinosa*	3.82	8	0.00	62	1.01	14
15	*Acacia catechu*	0.77	22	1.06	8	0.98	15
16	*Zinziber sp.*	3.34	10	0.01	51	0.88	16
17	*Butea parviflora*	2.84	11	0.07	33	0.80	17
18	*Sterblus asper*	0.66	26	0.84	10	0.79	18
19	*Atrocarpus lakoocha*	2.80	12	0.00	63	0.74	19
20	*Mallotus sp.*	2.26	13	0.19	19	0.73	20
21	*Shorea robusta*	2.26	14	0.18	21	0.73	21
22	*Phonix sp.*	1.99	15	0.00	64	0.52	22
23	*Icynocarpus frutescens*	0.04	69	0.67	11	0.50	23
24	*Meliosma simplicifolia*	1.89	16	0.00	65	0.50	24
25	*Ficus glomeruta*	1.33	17	0.17	23	0.48	25
26	*Litsea monopetala*	0.42	34	0.47	13	0.46	26
27	*Cayratia japonica*	0.91	20	0.20	18	0.39	27
28	*Daemonorps jenkinensis*	0.73	24	0.19	20	0.33	28
29	*Ficus cunia*	0.93	19	0.10	30	0.32	29

30	*Dendrobium sp.*	0.00	99	0.42	14	0.31	30
31	*Ficus hispida*	0.04	68	0.37	15	0.28	31
32	*Tinospora cordifolia*	0.06	64	0.36	16	0.28	32
33	*Seteria palmifolia*	1.08	18	0.00	66	0.28	33
34	*Sterculia villosa*	0.85	21	0.00	67	0.22	34
35	*Castonopsis tribuloides*	0.66	25	0.04	35	0.20	35
36	*Ficus sp.*	0.75	23	0.00	68	0.20	36
37	*Smilax perfoliata*	0.64	29	0.01	52	0.17	37
38	*Pentapenax lesohenaultii*	0.44	33	0.07	31	0.17	38
39	*Leea sp (Bhui Galeni)*	0.64	27	0.00	69	0.17	39
40	*Pandanus sp.*	0.64	28	0.00	70	0.17	40
41	*Mucunia microcarpa*	0.25	42	0.11	29	0.15	41
42	*Atrocarpus chaplasa*	0.56	31	0.00	71	0.15	42
43	*Bombax ceiba*	0.06	59	0.16	24	0.14	43
44	*Thysolaena maxima*	0.00	108	0.18	22	0.13	44
45	*Oroxylum indicum*	0.15	47	0.13	27	0.13	45
46	*Bridelia scandens*	0.44	32	0.01	53	0.12	46
47	*Microstegium sp.*	0.06	63	0.13	25	0.11	47
48	*Bridelia stipularis*	0.08	55	0.13	28	0.11	48
49	*Lagostromia speciosa*	0.02	80	0.13	26	0.10	49
50	*Boehmeria macrophylla*	0.39	35	0.00	72	0.10	50
51	*Rhus sp.*	0.39	36	0.00	73	0.10	51
52	*Cissus repanda*	0.29	40	0.01	44	0.09	52
53	*Caesalpinea cuculata*	0.29	38	0.01	54	0.08	53
54	*Albizzia sp.*	0.15	46	0.05	34	0.08	55
55	*Calamus flaggelum*	0.29	39	0.00	75	0.08	56
56	*Herdycium gracile*	0.27	41	0.00	76	0.07	57
57	*Clematis sp.*	0.19	45	0.02	43	0.07	58
58	*Dalbargia sissoo*	0.10	51	0.03	38	0.05	60
59	*Castonopsis sp.*	0.19	44	0.00	78	0.05	61
60	*Piper sp.*	0.08	58	0.03	39	0.04	62
61	*Morinda citrifolia*	0.08	57	0.01	45	0.03	64
62	*Alpania sp.*	0.12	49	0.00	80	0.03	65
63	*Castonopsis indica*	0.00	95	0.04	36	0.03	66
64	*Grewia sp.*	0.00	101	0.04	37	0.03	67
65	*Syzygium cumini*	0.02	85	0.03	40	0.03	68
66	*Bahunia purpurea*	0.10	50	0.00	81	0.03	69

67	*Dillenia indica*	0.10	52	0.00	82	0.03	70
68	*Ficus sp (Timilo)*	0.10	53	0.00	83	0.03	71
69	*Crataeva unilcularia*	0.00	97	0.03	41	0.02	72
70	*Garuga pinnata*	0.00	100	0.03	42	0.02	73
71	*Clerodendron viscosum*	0.04	66	0.01	46	0.02	74
72	*Dillenia penta gyna*	0.06	60	0.01	55	0.02	75
73	*Bouhinia anguina*	0.08	54	0.00	84	0.02	76
74	*Lasia sp.*	0.08	56	0.00	85	0.02	77
75	*Entada scandens*	0.02	78	0.01	47	0.02	78
76	*Phylocanthus thyrsiflorus*	0.02	82	0.01	48	0.02	79
77	*Erythrina sp.*	0.06	61	0.00	86	0.02	80
78	*Macaranaga denticulata*	0.06	62	0.00	87	0.02	81
79	*Milletia auriculata*	0.00	103	0.01	49	0.01	82
80	*Wrighitia tomentosa*	0.00	109	0.01	50	0.01	83
81	*Citrus decumana*	0.04	65	0.00	88	0.01	84
82	*Elaeocarpus lanceefolius*	0.04	67	0.00	89	0.01	85
83	*Premana sp.*	0.04	70	0.00	90	0.01	86
84	*Bridelia retusa*	0.00	93	0.01	56	0.01	88
85	*Paedaria foetida*	0.00	104	0.01	57	0.01	89
86	*Polyalthia cimiarium*	0.00	105	0.01	58	0.01	90
87	*Teerminilia chebula*	0.00	107	0.01	59	0.01	91
88	*Amoora wallchi*	0.02	72	0.00	92	0.01	92
89	*Amora rohitika*	0.02	73	0.00	93	0.01	93
90	*Baccurea sp.*	0.02	74	0.00	94	0.01	94
91	*Castonopsis sp (katus)*	0.02	75	0.00	95	0.01	95
92	*Cinnamonum sp.*	0.02	76	0.00	96	0.01	96
93	*Comretum decandrum*	0.02	77	0.00	97	0.01	97
94	*Ficus sp 4*	0.02	79	0.00	98	0.01	98
95	*Machilus sp.*	0.02	81	0.00	99	0.01	99
96	*Smilax sp*	0.02	83	0.00	100	0.01	100
97	*Spondias pinnata*	0.02	84	0.00	101	0.01	101
98	*Viburnum erubescens*	0.02	86	0.00	102	0.01	102
99	*Albizzia procera*	0.00	92	0.00	107	0.00	107
100	*Calamus tennuis*	0.00	94	0.00	108	0.00	108
	Unidentified (8species together)	0.79		0.00		0.21	
	Total	100.00		100.00		100.00	

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