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SHORT COMMUNICATION

Diversity, distribution and resource values of woody climbers in tropical forests of southern Eastern Ghats, India

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Abstract: We investigated the distribution and resource values of liana species assessed in six hill complexes of southern Eastern Ghats, India. 143 liana species (DBH (diameter at breast height) ≥1.5 cm) and 32,033 liana individuals were recorded from 110 transects (0.5 ha each covering 55 ha area) in the study sites. The resource values of lianas were broadly categorized into ecological and economic importance. About 90% (129) of liana species and 96% (30,564) of liana individuals were established ecological/economic values. Fruit rewards provided by 76 species and 20,325 individuals constituted the major resource of ecological importance. 82 species and 21,457 liana individuals are of economic importance as medicine, edible fruits, edible and medicinal values, and yet others are used for different domestic purposes including furniture, fuel wood, rope making etc.. Ecologically, the prevalence of succulent diaspores in lianas of Indian Eastern Ghats indicates the animal dependence of many liana species for dispersal and underlines the need for a holistic and whole-forest conservation approach in maintaining forest biodiversity.

Keywords: animal dispersal; Eastern Ghats; India; liana diversity; resource values

Introduction

Lianas are an important structural component of most tropical forests, and typically they rely on trees. They comprise about 25% of species diversity (Gentry and Dodson 1987; Schnitzer and Bongers 2002) between 10%–45% of woody stem density (Gentry 1991a; Appanah et al. 1993; Nabe-Nielsen 2001; Perez-Salicrup et al. 2001; Schnitzer and Bongers 2002; Schnitzer et al. 2005; Senbeta et al. 2005; Addo-Fordjour et al. 2009; Schnitzer et al. 2011; Schnitzer and Bongers 2011). Liana abundance is a key physiognomic feature differentiating tropical forests from temperate forests (Putz and Mooney 1991; Schnitzer and Bongers 2002; Perez-Salicrup et al. 2004).

Lianas play a vital role in many aspects of forest functioning and dynamics, such as providing a valuable food resource for animals, physically linking trees together by providing canopy to canopy access for arboreal animals, tree regeneration and increasing tree mortality (Putz and Mooney 1991; Schnitzer and Bongers 2002). Lianas are widely used by people especially those living in rural areas (Phillips 1991; Liu et al. 2004; Bongers et al. 2002 and 2005; Muhwezi et al. 2009; Ewango 2010). Generally, lianas produce appealing, coloured flowers and profuse fruits attracting wide range of faunal community. They are also used by human community for several purposes in day life, such as food, medicine, constructions etc.. Our research deals with potential resource values of the 143 liana species inventoried from the forests of southern Eastern Ghats (Muthumperumal and Parthasarathy 2010). We addressed the following questions: (1) How many liana species in 143 liana species are of ecological importance and what are the resources provided by them to faunal communities? (2) What are the economic values of these liana species, and to suggest measures for sustainable resource use of biodiversity in the fragmented and human-impacted region in southern Eastern Ghats?

Materials and methods

Study sites

A large-scale liana inventory was carried out in six major hill complexes of southern Eastern Ghats, peninsular India, namely Bodamalais (BM), Chitteris (CH), Kalrayan (KA), Kolli hills (KO), Pachamalais (PM) and Shervarayans (SH) (Fig. 1). These hill complexes harbor five types of forests (tropical evergreen, semi-evergreen, mixed deciduous, dry deciduous and thorn forests). Among the forested area of southern Eastern Ghats, cover-

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ing 2,148 km^2, the elevation ranges from 180 m to 1,510 m. This region is subjected to various forest disturbances, such as cattle grazing, illegal timber extraction, collection of non-timber forest products, soil removal, ore mining, road construction, tourism, and *Lantana* invasion over a period of 40 years. Most forested areas were occupied by human settlement and for hill cultivation of tapioca, pepper, coffee, banana, pineapple and cereals etc..

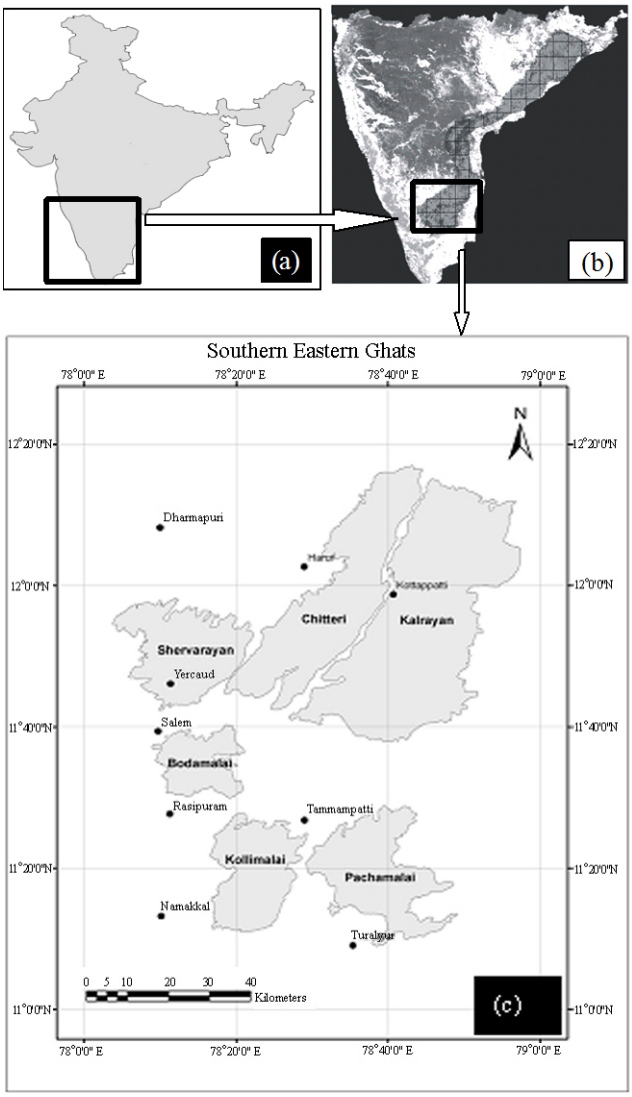


Fig. 1 Map of India, peninsular India indicated as a block (a), Eastern Ghats in peninsular India (b), six hill complexes of southern Eastern Ghats (c)

Materials

Assessing liana species distribution and resource value were conducted for the 143 liana species enumerated from 110 transects (0.5 ha, and each covering 55 ha area) of southern Eastern Ghats. The entire landscape of the southern Eastern Ghats (10° 93' N–12° 18' N) was divided into 6.25 km × 6.25 km grids, and a 0.5 ha belt transect (5 m × 1,000 m) was established within each grid. Each transect was subdivided into fifty 5 m × 20 m smaller units to facilitate the assessment. All lianas with DBH (diameter at breast height) ≥1.5 cm were enumerated in the whole transect. Voucher specimens were collected and identified using regional floras (Gamble and Fischer 1915–1935; Hooker 1872–1897; Matthew 1991), confirmed with the collections deposited in the Department of Ecology and Environmental Sciences (DEES), Pondicherry University, Botanical Survey of India, Coimbatore (MH) and online herbarium catalogue (Royal Botanical Garden, Kew). Voucher specimens were deposited in herbarium of DEES. The resource values of 143 liana species were categorized based on ecological (e.g., fruit, nectar and tuber) and economic importance (e.g., medicinal, edible and others which includes fire wood, ropes etc.), and such details were pooled from field observation and literature sources.

Results

Liana diversity and resource values

We recorded 143 liana species from 83 genera and 37 families in a 55 ha (110 transects) area of southern Eastern Ghats (Muthumperumal and Parthasarathy 2010). Among them about 90% (129) of liana species and 96% (30,564) of liana individuals possessed various resource values of ecological and economic importance (Table 1).

Ecological importance: Fruit resources and dispersal

Ecological importance of the enumerated liana species was categorized into fruit yielding (76 species and 20,325 individuals), e.g., *Ziziphus oenoplia*, *Jasminum angustifolium*, *Hugonia mystax*; nectar producing (16 species and 5645 individuals), e.g., *Combretum albidum*, *Argyreia elliptica*, *Argyreia cuneata*; tuber yielding (2 species and 10 individuals), e.g., *Dioscorea oppositifolia*, *Dioscorea pentaphylla*, and for 49 species (34.3%) resource values could not be ascertained (Table 2, Appendix 1 and Fig. 3). Of 143 liana species enumerated in southern Eastern Ghats, 84 liana species (58.7%) are fleshy-fruited, which chiefly includes berries (54 species, 37.8%; e.g., species of *Jasminum, Capparis, Carissa* and *Plecospermum spinosum* etc.), drupes (26 species, 18.1%; e.g., *Ziziphus oenoplia*, *Scutia myrtina* and *Lantana camara*) and capsule with arillate seeds (4 species, 2.8%; e.g., *Maytenus heyneana*, *Celastrus paniculatus* and *Maytenus royleanus*). These fleshy-fruited liana species depend on diverse vertebrate faunal communities such as birds and mammals etc., and thus make zoochory a predominant dispersal mode (Fig. 2).

Economic importance of lianas

Among 143 liana species, 82 species (57.3%) were established economic values, including 62 species (12,494 individuals) for medicinal purpose (e.g., *Aristolochia indica*, *Aristolochia tagala, Gymnema sylvestre, Piper nigrum* etc.), 6 species (506) for edible fruits (e.g., *Carissa spinarum,Coccinia grandis, Rubus ellipticus* etc.), 2 species (14) for edible & medicinal values (e.g.,

Carissa carandas, *Dioscorea oppositifolia*) and 12 species (8,443 individuals) for some domestic purposes such as fuel wood, rope making, furniture etc. (e.g., *Aganosma cymosa, Diploclisia glaucescens, Ipomoea staphylina, Lantana camara* etc.) (Table 2, Appendix 1 & Fig. 4).

Table 1. Resource values of liana species (DBH≥1.5 cm) sampled in 110 transects (55 ha) of tropical forests in six hill complexes of southern Eastern Ghats, India

Variable	BM (5 ha)	CH (10 ha)	KA (12 ha)	KO (9 ha)	PM (12 ha)	SH (7 ha)	Total for 55 ha
Total liana species richness	43	75	85	86	77	78	143
Number of families	18	26	30	32	29	30	37
Total abundance of lianas	2947	7073	5828	5027	6706	4452	32,033
Richness of fleshy-fruited (zoochorous) species	28	42	51	50	51	51	85
Abundance of fleshy-fruited (zoochorous) species	1903	4385	3458	3492	4290	2971	20,499
Liana species with resource values	41	67	78	78	72	71	129
Abundance of lianas with resource values (%)	2894 (9)	6935 (22)	5487 (17)	4548 (14)	6345 (20)	4355 (14)	30,564 (96)

Six hill complexes and hectares sampled: BM-Bodamalais, CH-Chitteris, KA-Kalrayans, KO-Kolli hills, PM-Pachamalais and SH- Shervarayans

Table 2. Resources values of liana species and abundance categorized by ecological and economic importance in six hill complexes of southern Eastern Ghats, India

Study sites	Species richness							Abundance						
	BM	CH	KA	KO	PM	SH	Total species	BM	CH	KA	KO	PM	SH	Total abundance
Ecological importance														
Fruits	28	39	47	45	47	46	76	1,919	4,371	3,447	3,367	4,278	2,943	20,325
Nectar	4	8	8	6	7	7	16	557	1,285	1,224	670	1,283	626	5,645
Tuber	0	2	2	0	0	1	2	0	3	2	0	0	5	10
Economic importance														
Edible	1	2	3	4	2	3	6	7	12	74	24	267	122	506
Edible & Medicine	0	2	2	0	0	0	2	0	10	4	0	0	0	14
Medicine	24	34	42	46	36	37	62	1,416	3,255	2,312	1,529	2,716	1,266	12,494
Other domestic purposes	3	8	6	9	9	9	12	673	1,923	1,083	1,804	782	2,178	8,443

Six hill complexes and hectares sampled: BM-Bodamalais, CH-Chitteris, KA-Kalrayans, KO-Kolli hills, PM-Pachamalais and SH- Shervarayans

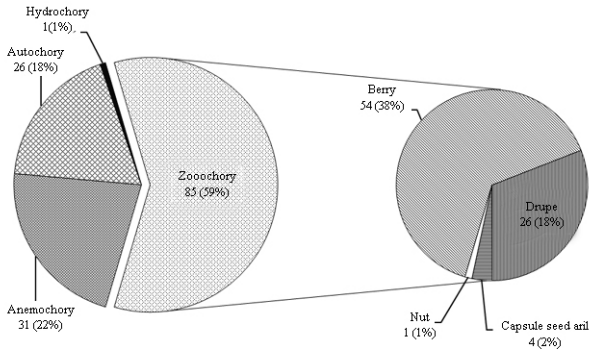
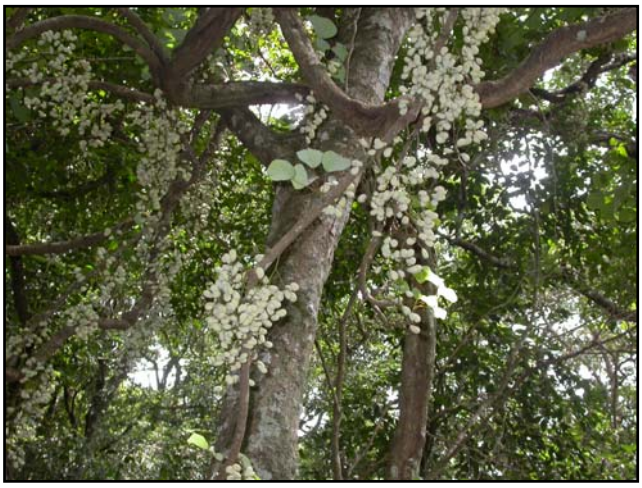


Fig. 2 Liana dispersal modes and the contribution of zoochory and fleshy-fruited species in tropical forests of southern Eastern Ghats, India

Discussion

In the past three decades, liana inventories were conducted in different parts of the world with varied objectives: developing protocols, considering additional ecological variables etc., but few studies are available on resource values of lianas (Phillips 1991; Vidal et al. 1997; Kuzee 2002; Bongers et al. 2002; Tra bi et al. 2005; Bongers et al. 2005; Muhwezi et al. 2009; Ewango 2010). Various liana species constitute a very important group of non-timber forest produce (Abbiw 1990; Malaisse 1997; Tra bi 1997; Van valkenburg 1997; Van andel 2000).

In our study, among 143 liana species of southern Eastern Ghats, zoochory is the predominant dispersal mode (59.4%, 85 species; Table 1, Fig. 2) and this conforms with the results of other sites in peninsular India (Coromandel coast, Agumbe, Varagalaiar, Kalrayan and Kolli hills; Parthasarathy et al. 2004) confirming the prevalence of animal dispersal guild in forests of peninsular India. According to Gentry (1982, 1991b), liana species were mostly wind dispersed, although he noted that the species number decreased as rainfall increased, changing the prevalence to animal-dispersed species in wetter localities. In our work, the same trend also prevailed in terms of liana abundance. In subtropical mountainous forest of South West China, Yuan et al. (2009) reported that 75.8% (25) of liana species with 1,542 individuals displayed zoochory, contrary to the observation by Cai et al. (2009) who found that 61.5% of lianas as wind-dispersed in tropical-temperate transition area in Xishuangbanna, South West China.



Diploclisia glaucescens (Menispermaceae) – Profuse drupes for animals

Cansjera rheedii (Opiliaceae) – Ripe drupes edible for animals

Grewia rhamnifolia (Tiliaceae) – Fruits with mealy mesocarp for frugivores

Ziziphus oenoplia (Rhamnaceae) – Black drupes for vertebrate frugivores

Lantana camara (Verbenaceae) –Floral nectar and pyrenes as rewards to fauna

Pachygone ovata (Menispermaceae) – Ripe drupes for animals

Plecospermum spinosum (Moraceae) – Fleshy anthocarp for animals

Fig. 3 Ecologically important selected liana species

Aristolochia indica (Aristolochiaceae) – Root medicinal

Aristolochia tagala (Aristolochiaceae) – Root for snake bite

Piper nigrum (Piperaceae) – Fruit as medicine and condiment

Aganosma cymosa (Apocynaceae) – Stem for making ropes

Gymnema sylvestre (Asclepiadaceae) – Leaves medicinal for diabetes

Carissa carandas (Apocynaceae) – Plant medicinal & fruit edible

Entada pursaetha (Mimosaceae) – Seed medicinal

Fig. 4 Economically important selected liana species

Among 143 liana species enumerated in our study, 82 species possessed economic values (Table 2 and Appendix 1) including 62 species used for medicinal purpose, 6 species yield edible fruits, 2 of them for edible and medicinal values and 12 species

for some domestic purpose such as fuel wood, rope making and furniture etc. Whereas, in Ivory coast forests of Africa, 114 liana species were reported to have potential resource values: 83 species for medicine, 30 species for food, 25 species for craft work, 19 species for construction for traditional houses, 16 species as aphrodisiac, species for mouth and teeth hygiene and 5 species for hunting (Tra bi 1997; Tra bi et al. 2005). Such resource assessment analyses reveal the importance of liana taxa for local people, particularly, for medicinal purposes. Some liana species have extreme importance, for example: the Cameroonian liana *Ancistocaldus korupensis* which yields alkaloids that have anti-HIV activity (Thomas 1994; Foster and Sork 1997).

Conclusion

The prevalence of succulent diaspores in lianas of Indian Eastern Ghats shows the animal dependence of many liana species for dispersal, thus indicating the importance of a holistic, whole-forest conservation approach to maintain forest biodiversity. The liana life-form is dependent on host tree species for mechanical support and further on animals for dispersal, underlines the inter-system coupling of forest functional ecology in maintenance of biodiversity.

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Appendix

Appendix 1. Resource rewards [Fruit type and Dispersal mode (AU- Autochory, AN- Anemochory, HC-Hydochory & ZO- Zoochory)] of liana species and abundance enumerated in 110 transects of 0.5 ha (totaling 55 ha), in six hill complexes of southern Eastern Ghats, India. Ecol. Imp. (Ecological importance): Ft-Fruits, Ne-Nectar, Tu-Tuber; Econ. Imp. (Economic importance): E- Edible, E & M- Edible & Medicine, M- Medicine, O- Other domestic purposes

Sl. No.	Species	BM (5 ha)	CH (10 ha)	KA (12 ha)	KO (9 ha)	PM (12 ha)	SH (7 ha)	Total abundance	Fruit type	Dispersal mode	Ecol. Imp.	Econ. Imp.
1	*Lantana camara* L. (Verbenaceae)	616	1840	944	1587	634	2082	7703	Drupe	ZO	Ft	O
2	*Pterolobium hexapetalum* (Roth) Sant. & Wagh (Caesalpiniaceae)	539	1237	1178	626	1203	598	5381	Samara	AN	Ne	
3	*Ziziphus oenoplia* (L.) Miller (Rhamnaceae)	281	522	365	115	310	179	1772	Drupe	ZO	Ft	M
4	*Jasminum angustifolium* (L.) Willd. (Oleaceae)	11	652	192	341	195	55	1446	Berry	ZO	Ft	M
5	*Acacia torta* (Roxb.) Craib (Mimosaceae)	30	563	245	96	3	458	1395	Pod	AU		M
6	*Hugonia mystax* L. (Linaceae)	279	102	128	190	434	15	1148	Drupe	ZO	Ft	M
7	*Acacia caesia* (L.) Willd. (Mimosaceae)	52	122	209	268	204	18	873	Pod	AU		
8	*Ventilago maderaspatana* Gaertner (Rhamnaceae)	61	290	121	100	216	33	821	Samara	AN		M
9	*Grewia opposistifolia* Buch-Ham. (Tiliaceae)	79	103	240	100	199	4	725	Drupe	ZO	Ft	
10	*Secamone emetica* (Roxb.) R. Br. ex Schultes (Asclepiadaceae)	78	244	182	33	72	54	663	Follicle	AN		M
11	*Scutia myrtina* (Burm.f.) Kurz (Rhamnaceae)	39	239	129	2	197	4	610	Drupe	ZO	Ft	M
12	*Cissus quadrangularis* L. (Vitaceae)	146	65	45	123	177	49	605	Berry	ZO	Ft	M
13	*Cansjera rheedii* J. Gmelin (Opiliaceae)	96	72	135	37	114	47	501	Drupe	ZO	Ft	
14	*Maytenus heyneana* (Roth) Raju & Babu (Celastraceae)	0	0	28	42	405	14	489	Capsule-Aril	ZO	Ft	
15	*Capparis sepiaria* L. var. *Sepiaria* (Capparaceae)	62	79	66	78	160	41	486	Berry	ZO	Ft	M
16	*Toddalia asiatica* (L.) Lam. (Rutaceae)	151	104	140	7	27	7	436	Berry	ZO	Ft	M
17	*Jasminum auriculatum* Vahl (Oleaceae)	32	110	120	36	50	42	390	Berry	ZO	Ft	M
18	*Carissa spinarum* L. (Apocynaceae)	7	11	63	7	260	4	352	Berry	ZO	Ft	E
19	*Grewia rhamnifolia* Heyne ex Roth, Nov. (Tiliaceae)	20	64	95	40	76	38	333	Drupe	ZO	Ft	
20	*Premna villosa* Clark (Verbenaceae)	7	45	33	132	85	5	307	Drupe	ZO	Ft	
21	*Jasminum malabaricum* Wight (Oleaceae)	2	48	43	12	182	14	301	Berry	ZO	Ft	M
22	*Acacia pennata* (L.) Willd.ex Del. (Mimosaceae)	135	3	1	14	111	0	264	Pod	AU		M
23	*Hiptage benghalensis* (L.) Kurz (Malpighiaceae)	0	13	36	21	55	90	215	Samara	AN		M

Continued Appendix 1

Sl. No.	Species	BM (5 ha)	CH (10 ha)	KA (12 ha)	KO (9 ha)	PM (12 ha)	SH (7 ha)	Total abundance	Fruit type	Dispersal mode	Ecol. Imp.	Econ. Imp.
24	*Gymnema sylvestre* (Retz.) R.Br.ex Roemer & Schultes (Asclepiadaceae)	48	85	27	12	14	20	206	Follicle	AN		M
25	*Carissa salicina* Lam. (Apocynaceae)	0	1	6	0	176	6	189	Berry	ZO	Ft	
26	*Sageretia filiformis* (Schultes) Don (Rhamnaceae)	0	68	4	17	79	17	185	Drupe	ZO	Ft	
27	*Reissantia indica* (Willd.) Halle (Hippocrataceae)	0	0	27	0	156	0	183	Samara	AN		M
28	*Plecospermum spinosum* Trecul. (Moraceae)	0	14	25	72	58	7	176	Berry	ZO	Ft	O
29	*Embelia basaal* (Roemer ex Schultes) A. DC. (Myrsinaceae)	0	0	50	89	3	33	175	Drupe	ZO		M
30	*Loeseneriella obtusifolia* (Roxb.) A.C. Smith (Hippocrataceae)	0	5	3	123	43	0	174	Samara	AN		
31	*Rivea hypocrateriformis* (Desr.) Choisy (Convolvulaceae)	8	2	78	7	72	2	169	Capsule	ZO	Ft	M
32	*Pachygone ovata* (Poir.) Miers ex Hook. (Menispermaceae)	27	27	58	29	1	14	156	Drupe	ZO	Ft	O
33	*Sarcostemma acidum* (Roxb.) Voigt (Asclepiadaceae)	30	15	13	10	81	4	153	Follicle	AN		M
34	*Dalbergia rubiginosa* Roxb. (Papilionaceae)	0	1	18	15	111	1	146	Pod	AU		
35	*Jasminum sessiliflorum* vahl (Oleaceae)	8	4	20	22	80	5	139	Berry	ZO	Ft	
36	*Elaeagnus indica* Servattaz (Elaeagnaceae)	0	0	7	13	7	111	138	Nut	ZO	Ft	E
37	*Tinospora cordifolia* (Willd.) Hook.f. & Thomson (Menispermaceae)	2	5	63	1	6	44	121	Drupe	ZO	Ft	M
38	*Combretum albidum* G. Don (Combretaceae)	11	30	26	31	16	1	115	Samara	AN	Ne	
39	*Derris scandens* (Roxb.)Benth. (Papilionaceae)	17	16	52	9	7	13	114	Pod	AU	Ft	
40	*Gnetum ula* Brongn. (Gnetaceae)	0	0	0	58	28	26	112	Drupe	ZO	Ft	O
41	*Mimosa intsia* L. (Mimosaceae)	0	0	75	1	0	35	111	Pod	AU		
42	*Cissus vitiginea* L. (Vitaceae)	2	11	63	2	22	4	104	Berry	ZO	Ft	M
43	*Ipomoea staphylina* Romer & Schultes (Convolvulaceae)	30	6	45	2	12	8	103	Capsule	AU		O
44	*Capparis shevaroyensis* Sun.-Ragh. (Capparaceae)	0	0	100	0	0	0	100	Berry	ZO	Ft	
45	*Jasminum azoricum* L. var.*azoricum* (Oleaceae)	0	0	5	65	27	2	99	Berry	ZO	Ft	M
46	*Morinda umbellata* L. (Rubiaceae)	0	24	8	38	13	6	89	Berry	ZO		O
47	*Zanthoxylum ovalifolium* Wight (Rutaceae)	0	0	0	31	20	37	88	Capsule	AU		M
48	*Capparis zeylanica* L. (Capparaceae)	5	13	28	7	20	3	76	Berry	ZO	Ft	M
49	*Ziziphus horrida* Roth, Nov. (Rhamnaceae)	0	48	6	9	8	3	74	Drupe	ZO	Ft	
50	*Aganosma cymosa* (Roxb.) G. Don var. *cymosa* Hook. f. (Apocynaceae)	0	22	41	6	0	0	69	Follicle	AN		M
51	*Cissus heyneana* (Wall. ex Lawson) Planch. (Vitaceae)	7	16	30	7	0	1	61	Berry	ZO	Ft	
52	*Premna corymbosa* (Burm.f.) Rottler & Willd. (Verbenaceae)	1	29	17	0	12	0	59	Drupe	ZO	Ft	M
53	*Zanthoxylum tetraspermum* Wight & Arn. (Rutaceae)	0	0	0	50	0	0	50	Capsule	AU		
54	*Pseudaida speciosa* (Bedd.) Tirveng. (Rubiaceae)	0	0	0	48	0	0	48	Berry	ZO	Ft	
55	*Capparis divaricata* Lam. (Capparaceae)	3	0	0	0	44	0	47	Berry	ZO	Ft	
56	*Uvaria narum* (Dunal) Wall. ex Wight & Arn. (Annonaceae)	0	0	46	0	0	0	46	Berry	ZO	Ft	M
57	*Celastrus paniculatus* Willd. (Celastraceae)	5	5	15	6	0	13	44	Capsule-Aril	ZO	Ft	M
58	*Acacia columnaris* Craib (Mimosaceae)	0	0	11	0	0	29	40	Pod	AU		
59	*Jasminum multiflorum* (Burm. f.) Andr. (Oleaceae)	0	0	1	18	17	3	39	Berry	ZO	Ft	M
60	*Cocculus hirsutus* (L.) Diels (Menispermaceae)	0	0	0	9	29	0	38	Drupe	ZO	Ft	M
61	*Neonotonia wightii* (Wight & Arn.) Lackey (Papilionaceae)	1	0	14	20	1	0	36	Pod	AU		
62	*Maytenus royleanus* (Wallich ex M. Lawson) M.A. Rau (Celastraceae)	0	19	2	0	10	0	31	Capsule-Aril	ZO	Ft	M
63	*Grewia flavescens* Juss. (Celastraceae)	4	0	1	11	6	8	30	Drupe	ZO	Ft	
64	*Aganosma cymosa* (Roxb.) G. Don var. *lanceolata* Hook. f. (Apocynaceae)	0	1	0	0	28	0	29	Follicle	AN	Ne	O
65	*Butea parviflora* Roxb. (Papilionaceae)	0	0	0	0	0	29	29	Pod	AU	Ft	O
66	*Canavalia virosa* (Roxb.) Wight & Arn. (Papilionaceae)	6	0	11	7	3	2	29	Pod	AU	Ne	
67	*Cayratia roxburghii* (Wight & Arn.) Gagnep. (Vitaceae)	0	0	0	25	0	1	26	Berry	ZO	Ft	M
68	*Carissa paucinervia* A. DC. (Apocynaceae)	0	0	14	0	11	0	25	Berry	ZO	Ft	

Continued Appendix 1

Sl. No.	Species	BM (5 ha)	CH (10 ha)	KA (12 ha)	KO (9 ha)	PM (12 ha)	SH (7 ha)	Total abundance	Fruit type	Dispersal mode	Ecol. Imp.	Econ. Imp.
69	*Ziziphus rugosa* Lam. (Rhamnaceae)	0	0	0	8	9	8	25	Drupe	ZO	Ft	M
70	*Cayratia japonica* (Thunb.) Gagnep. (Vitaceae)	0	0	0	23	0	0	23	Berry	ZO	Ft	
71	*Mussaenda hirsutissima* (Hook.f.) Hutch. ex Gamble (Rubiaceae)	0	0	0	4	0	19	23	Berry	ZO	Ne	
72	*Diploclisia glaucescens* (Blume) Diels (Menispermaceae)	0	0	0	12	5	4	21	Drupe	ZO	Ft	O
73	*Cayratia pedata* (Lour.) A.L. Juss. ex Gagnep. (Vitaceae)	0	0	0	16	0	2	18	Berry	ZO	Ft	
74	*Cissus gigantea* (Bedd.) Planch. (Vitaceae)	0	0	0	0	18	0	18	Berry	ZO	Ft	
75	*Mucuna atropurpurea* DC. (Papilionaceae)	0	0	0	0	18	0	18	Pod	AU	Ne	
76	*Pisonia aculeata* L. (Nyctaginaceae)	0	0	0	5	12	0	17	Capsule	AU		M
77	*Clematis gouriana* Roxb. ex DC. (Ranunculaceae)	0	0	1	0	0	15	16	Follicle	AN		M
78	*Marsdenia brunoniana* Wt. & Arn. (Asclepiadaceae)	0	0	11	1	2	2	16	Follicle	AN		
79	*Naravelia zeylanica* (L.) DC. (Ranunculaceae)	0	2	1	12	1	0	16	Follicle	AN		M
80	*Wattakaka volubilis* (L.f.) T. Cooke (Asclepiadaceae)	0	1	3	4	8	0	16	Follicle	AN		M
81	*Abrus precatorius* L. (Papilionaceae)	4	3	6	0	0	1	14	Pod	AU		M
82	*Caesalpinia cucullata* Roxb. (Caesalpiniaceae)	0	0	0	0	14	0	14	Pod	AU	Ne	
83	*Maerua oblongifolia* (Forsk.) A.Rich. (Capparaceae)	0	6	0	5	3	0	14	Berry	ZO	Ft	O
84	*Premna wightiana* Schauer (Verbenaceae)	0	2	12	0	0	0	14	Drupe	ZO	Ft	
85	*Jasminum cuspidatum* Rottl. (Oleaceae)	0	1	9	0	3	0	13	Berry	ZO	Ft	
86	*Ampelocissus arnottiana* Planch. (Vitaceae)	0	0	7	0	5	0	12	Berry	ZO	Ft	
87	*Carissa carandas* L. (Apocynaceae)	0	8	3	0	0	0	11	Berry	ZO	Ft	E, M
88	*Combretum acuminatum* Roxb. (Combretaceae)	0	9	2	0	0	0	11	Samara	AN	Ne	
89	*Cosmostigma racemosum* (Roxb.) Wight (Asclepiadaceae)	0	1	2	8	0	0	11	Follicle	AN		M
90	*Ventilago goughii* Gamble (Rhamnaceae)	0	0	0	0	0	11	11	Samara	AN		
91	*Capparis brevispina* DC. (Capparaceae)	0	10	0	0	0	0	10	Berry	ZO	Ft	
92	*Capparis sepiaria* L. var. *retusella* Thwaites (Capparaceae)	0	0	0	10	0	0	10	Berry	ZO	Ft	
93	*Cryptolepis buchanani* Roemer & Schultes (Asclepiadaceae)	0	0	0	3	0	7	10	Follicle	AN		M
94	*Anodendron paniculatum* A. DC. (Apocynaceae)	0	0	0	8	0	0	8	Follicle	AN		M
95	*Piper nigrum* L. (Piperaceae)	0	0	0	1	1	6	8	Berry	ZO		M
96	*Acacia sinuata* (Lour.) Merr. (Mimosaceae)	0	0	0	2	0	5	7	Pod	AU		M
97	*Ampelocissus tomentosa* (Heyne ex Roth) Planch (Vitaceae)	2	2	1	0	0	2	7	Berry	ZO	Ft	M
98	*Argyreia elliptica* (Roth) Choisy (Convolvulaceae)	0	4	0	1	0	2	7	Berry	ZO	Ne	O
99	*Coccinia grandis* (L.) J. Voigt (Cucurbitaceae)	0	0	4	3	0	0	7	Berry	ZO	Ft	E
100	*Dioscorea pentaphylla* L. (Dioscoreaceae)	0	1	1	0	0	5	7	Samara	AN	Tu	M
101	*Rubus niveus* Thunb. (Rosaceae)	0	0	0	0	0	7	7	Drupe	ZO	Ft	E
102	*Decalepis hamiltonii* Wight & Arn. (Asclepiadaceae)	0	2	2	2	0	0	6	Follicle	AN		M
103	*Tylophora subramanii* Henry (Asclepiadaceae)	0	0	0	6	0	0	6	Follicle	AN		
104	*Marsdenia tenacissima* (Roxb.) Moon (Asclepiadaceae)	0	5	0	0	0	1	6	Follicle	AN		M
105	*Acacia canescens* Grah. (Mimosaceae)	0	0	0	0	5	0	5	Pod	AU		M
106	*Carissa gangetica* Stapf (Apocynaceae)	0	0	0	0	5	0	5	Berry	ZO	Ft	
107	*Mucuna pruriens* (L.) DC. (Papilionaceae)	0	0	2	1	0	2	5	Pod	AU	Ne	M
108	*Smilax zeylanica* L. (Smilacaceae)	0	0	0	5	0	0	5	Berry	ZO	Ft	M
109	*Anamirta cocculus* (L.) Wight & Arn. (Menispermaceae)	0	0	0	0	0	4	4	Drupe	ZO	Ft	M
110	*Argyreia cuneata* (Willd.) ker-Gawl. (Convolvulaceae)	0	1	3	0	0	0	4	Berry	ZO	Ne	O
111	*Desmos viridiflorus* (Bedome) Safford. (Annonaceae)	0	4	0	0	0	0	4	Berry	ZO	Ft	
112	*Ichnocarpus frutescens* (L.) R. Br. (Apocynaceae)	2	1	1	0	0	0	4	Follicle	AN		M
113	*Argyreia pilosa* Arn. (Convolvulaceae)	0	1	1	0	1	0	3	Berry	ZO	Ne	
114	*Dioscorea oppositifolia* L. (Dioscoreaceae)	0	2	1	0	0	0	3	Samara	AN	Tu	E, M
115	*Embelia ribes* Burm.f. (Myrsinaceae)	0	0	0	1	0	2	3	Drupe	ZO		M
116	*Entada pursaetha* DC. (Mimosaceae)	0	0	0	3	0	0	3	Pod	HC		M
117	*Grewia heterotricha* Mast. (Tiliaceae)	0	0	0	0	3	0	3	Drupe	ZO	Ft	
118	*Gymnema hirsutum* Wight & Arn. (Asclepiadaceae)	0	0	0	1	0	2	3	Follicle	AN		M
119	*Paramignya beddomei* Tanaka (Rutaceae)	0	3	0	0	0	0	3	Berry	ZO	Ft	

Continued Appendix 1

Sl. No.	Species	BM (5 ha)	CH (10 ha)	KA (12 ha)	KO (9 ha)	PM (12 ha)	SH (7 ha)	Total abun-dance	Fruit type	Dis-persal mode	Ecol. Imp.	Econ. Imp.
120	*Argyreia kleiniana* (Roem. & Schultes) Raizada (Convolvulaceae)	0	0	0	0	0	2	2	Berry	ZO	Ne	
121	*Caesalpinia crista* Linn. (Caesalpiniaceae)	0	1	1	0	0	0	2	Pod	AU	Ne	M
122	*Dolichos trilobus* L. (Papilionaceae)	0	2	0	0	0	0	2	Pod	AU		
123	*Gymnema elegans* Wight & Arn. (Asclepiadaceae)	0	1	0	1	0	0	2	Follicle	AN		
124	*Gymnema tingens* (Roxb.) Wight & Arn. (Asclepiadaceae)	0	0	0	2	0	0	2	Follicle	AN		M
125	*Jasminum trichotomum* Heyne ex Roth (Oleaceae)	0	0	2	0	0	0	2	Berry	ZO	Ft	
126	*Salacia chinensis* L. (Hippocrataceae)	0	0	1	0	1	0	2	Berry	ZO		M
127	*Ampelocissus araneosa* (Dalz. & Gibs.) Planch (Vitaceae)	0	0	0	0	0	1	1	Berry	ZO	Ft	
128	*Argyreia sericea* Dalz. (Convolvulaceae)	1	0	0	0	0	0	1	Berry	ZO	Ne	
129	*Aristolochia indica* L. (Aristolochiaceae)	0	0	1	0	0	0	1	Capsule	AU		M
130	*Aristolochia tagala* Cham. (Aristolochiaceae)	0	0	0	1	0	0	1	Capsule	AU		M
131	*Basella alba* L. (Basellaceae)	0	1	0	0	0	0	1	Berry	ZO	Ft	E
132	*Dalbergia congesta* Graham ex Wight & Arn. (Papilionaceae)	0	1	0	0	0	0	1	Pod	AU		
133	*Ellertonia rheedii* Wight (Apocynaceae)	0	1	0	0	0	0	1	Follicle	AN		M
134	*Gymnopetalum cochinchinense* Kurz (Cucurbitaceae)	0	0	1	0	0	0	1	Berry	ZO	Ft	
135	*Icnocarpus pubiflorus* Hook. f. (Apocynaceae)	0	1	0	0	0	0	1	Follicle	AN		
136	*Ipomoea asarifolia* (Desr.) Roemer & Shultes (Convolvulaceae)	0	1	0	0	0	0	1	Capsule	AU	Ne	
137	*Kedrostis courtallensis* (Arn.) Jeffrey (Cucurbitaceae)	0	0	0	0	1	0	1	Berry	ZO	Ft	
138	*Phyllanthus reticulatus* Poir. (Euphorbiaceae)	0	0	1	0	0	0	1	Berry	ZO	Ft	
139	*Premna* sp. (Verbenaceae)	0	0	0	0	0	1	1	Drupe	ZO	Ft	
140	*Rubus ellipticus* Smith (Rosaceae)	0	0	0	1	0	0	1	Drupe	ZO	Ft	E
141	*Salacia oblonga* Wal. ex Wight & Arn. (Hippocrataceae)	0	0	0	0	1	0	1	Berry	ZO	Ft	M
142	*Solanum seaforthianum* Andr. Bot. (Solanaceae)	0	0	0	0	0	1	1	Berry	ZO	Ft	
143	*Trichosanthes anaimalaiensis* Bedd. (Cucurbitaceae)	0	0	0	0	0	1	1	Berry	ZO	Ft	