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Diversity of Climbing Plants in Degraded Forest of Andaman and Nicobar Islands, India

Asutosh Ghsosh
Taxonomy and Biosystematics Lab, Department of Botany,
University of Calcutta, Kolkata, (WB) - India

Abstract

The present study examined the floristic diversity, dominance, abundance and IVI of climbers and lianas species in the degraded vegetation in North Andaman forest. A total of 1098 climbing plants belonging to 65 species, 51 genera, and 23 families were identified. These consisted of 16 liana and 49 herbaceous climber species. Stem twinning was the most predominant (70.76%) climbing mechanism. The dominant species recorded from this forest were *Tylophora capparidifolia* (IVI-37.3), *Argyreia wallichii* (IVI-20.47) and *Hibiscus scandens* (IVI-10.37) respectively. Most of the species were randomly distributed whereas some showed clumped distribution.

Key-Words: Diversity, Climbing plants, Degraded, Andaman

Introduction

Degraded landscapes are expanding in area as forests are converted to unsustainable pasture or cultivation and then abandoned (Nepstad *et al.* 1991, Brown and Lugo 1994). Habitat loss and climate change pose increasing threats for biological communities worldwide (Thomas *et al.* 2004; Ewers and Didham 2006). In some cases, disturbance may cause significant changes in size and structure of plant populations, by influencing the regeneration of adult plants.

Deforestation or degradation affects biological forest communities in various ways. Cutting forest reduces the amount of habitat, isolates the remaining patches (habitat fragmentation) and alters the local or regional microclimate (Lawton *et al*. 2001; Fahrig 2003). In remaining forest fragments, selective logging (Berry *et al*. 2008; Ruger *et al.* 2008) and the subsequent invasion of alien or early-successional species (Devlaeminck *et al.* 2005; Heckmann *et al.* 2008) further degrade habitat quality. Consequently, biological communities in fragmented forests are expected to differ from the original, pre-fragmentation situation (temporal effect). They are also expected to vary between and within remaining forest patches. Abiotic site conditions are responsible for natural variation of vegetation patterns.

*** Corresponding Author**
E.Mail: ghoshasutosh@yahoo.in
Mob. +91-9432241496

In disturbed ecosystems, processes such as soil erosion may affect abiotic site conditions, for instance through nutrient losses (de Koff *et al*. 2006). Differences in size, shape and degree of disturbance may have additional effects on the vegetation (spatial effect). Species in the altered communities may facilitate, tolerate or inhibit the recruitment of the original climax species. Ecological restoration must therefore acknowledge the present site potential and the remaining vegetation, because both may pose constraints for restoring plant communities.

In spite of the numerous roles climbers play in ecosystems, little attention has been given to them; they are scanty treated in literature (Bongers *et al.*, 2005) almost all work on forest plant communities have over relied heavily on tree (Turner *et al*, 1996) probably due to commercial value of many trees among other reasons (Bongers *et al*., 2005)

A few quantitative ecological studies on lianas are available from the forests of Sarawak (Proctor *et al.*, 1983; Putz & Chai, 1987), Sabah, East Malaysia (Campbell & Newbery, 1993), Queensland, Australia (Hegarty, 1989, 1990), Hunter Valley, New South Wales (Chalmers & Turner, 1994), Knysna, South Africa (Balfour & Bond 1993), Itu-ri, Congo (Makana *et al.*, 1998), Costa Rica (Lie-berman *et al.*, 1996), Barro Colorado island, Pa-nama (Putz, 1984) and in the subtropical humid forest of Bolivia (Pinard *et al.*, 1999). Such studies are lacking from Indian forests, except for the two recent works in the forest of Anamalais, Western Ghats (Muthuramkumar & Parthasarathy, 2000; Srinivas & Parthasarathy, 2000) and from the Ka-lrayan hills, Eastern Ghats (Kadavul & Partha-sarathy, 1999), North Andaman Islands (Ghosh and Mukherjee, 2006; Prasad *et al*., 2009; Ghosh *et al.*, 2013; Ghosh, 2013a, b; Ghosh, 2014, Ghosh and Pandey, 2014; Ghosh, 2014a, b, c, d).

North Andaman, a major group of islands, is rich in species diversity. But very little information exists on the ecological aspects of the degraded forest climbing communities these Islands. The specific objectives of the present study was to determine the diversity and distribution of climbing plants in the degraded forest of North Andaman as a way of contributing to the understanding of the general floristic composition, abundance and diversity.

Material and Methods

The North Andaman is the northernmost island of the Andaman region and includes about 70 other smaller islands. It is located between 13°41′ N to 12°50′ N latitudes and 92°11′ E to 93°07′ E longitudes, covering an area of 1458 km^2, and is separated from the Middle Andaman by Austin Strait.

The phytosociological study in this region was carried out during the years 2002-2004 through nested quadrate sampling method. Eight quadrate plots (32 x 32 m) were studied for recording ground covers (Mishra, 1966; Malhotra, 1973; Das & Lahiri, 1997; Rai *et al.*, 2011).

In each quadrate the climbing plants were enumerated and measured for girth (GBH >0.5 cm) at breast height. The collected voucher specimens were processed into mounted herbarium sheets following the conventional methodology (Jain & Rao, 1977) and were identified and deposited at CUH Herbarium. Climbing mechanisms were also studied for each species and classified them based on observations in the field and reliable references (Putz, 1984).

The collected field-data were analyzed for Species structure (frequency, density, abundance, basal area, importance value index (IVI), using the formula as suggested by Mishra (1966), Phillips (1959), Das & Lahiri (1997) and Ghosh (2012). The species diversity was determined using Shannon-Weiner''s Index (1963).

Results and Discussion

Diversity of climbing plants

In the study area, 65 species of climbing plants were found, of which all are angiosperms, of which 56 species are from the dicotyledons (45 genera in 19 families) and 9 species are from the monocotyledons (6 genera in 4 families) (Table: 1).

The most specious families investigated in the present study include Convolvulaceae (11 species), Papilionaceae (8 species), Asclepiadaceae (5 species). In the open degraded forest, 46 species (70.76%) are stem twiners, 9 (13.84%) tendril climbers, 4 (6.15%) branch twiners, 3 (4.61%) hook climbers, 2 (3.07%) root climbers, and 2 spiny twiners (Fig.44). In these forests, 49 species (75.38%) are climbers and 16 species (24.61%) are lianas (Fig: 1).

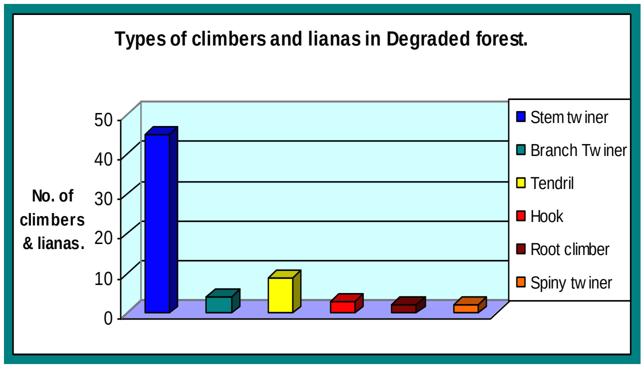

Fig. 1: Types of climbers and lianas in degraded forest

In the study area, 49 species are herbaceous climber and 16 species are lianas or woody climbers.

Amongst the herbaceous climbers, 41 species are from the dicotyledons, 8 species from the monocotyledons. Within the climbers, 38 species (77.55%) are stem twiners; 8 tendril climbers, 2 root climbers, and one is a branch twiner (Fig: 2).

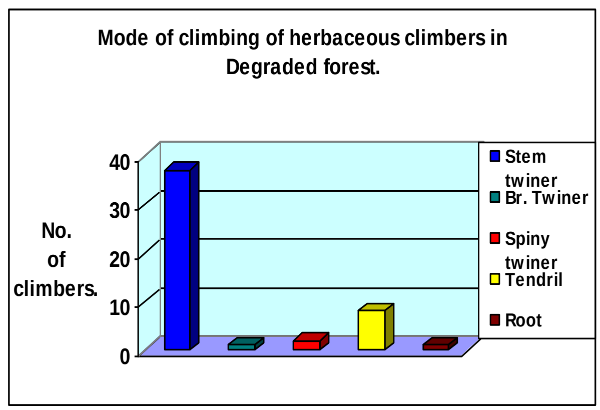

Fig. 2: Mode of climbing of herbaceous climbers in degraded forest

Amongst the woody lianas, 15 species are from the dicotyledons and one species is from the monocotyledons. Within the lianas, 7 species (43.75%) are stem twiners; 4 species are branch twiners, 3 species are hook climbers, one tendril climber and another is a root climber (Fig. 3).

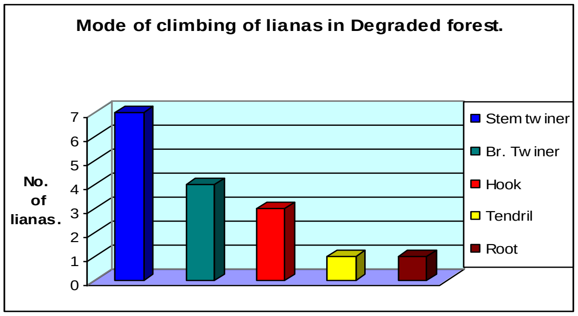

Fig. 3: Mode of climbing of lianas in degraded forest

Frequency and density of species

It has been observed that *Tylophora capparidifolia* shows the highest frequency (100%) with density of 16.25/hec. in the forest; followed by *Dioscorea esculenta* (frequency: 87.5%, and density: 18.75/hec.); *Cardiospermum halicacabum* and *Colubrina asiatica* (frequency: 50%, and density: 13.75/hec.). *Argyreia wallichii* shows the highest density (47.5/hec.) with very low frequency (75%); followed by *Ipomoea eriocarpa (*density: 25/hec., frequency: 62.5%). Expect *Argyreia wallichii*, showing highest density, all other species show exponential progression of density and frequency with regression value (R^2) =0.7421. (Fig: 4)

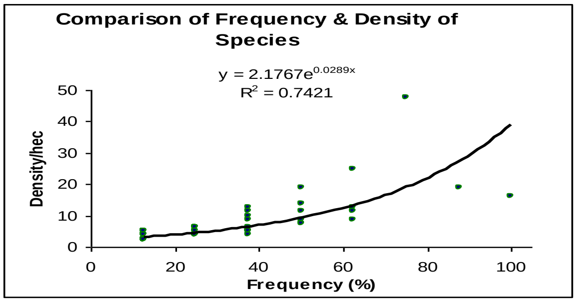

Fig. 4: Comparison of frequency and density of degraded forest species

Relative abundance and relative frequency of species

Argyreia wallichii shows highest relative abundance (4.3537) with high frequency of 75 % in the forest followed by *Gymnopetalum cochinchinense, Hibiscus scandens, Thunbergia alata* and *Tylophora zeylanica (*rel. abund.- 2.7497, with frequency- 12.5%). In the degraded forest the lowest abundance is found in *Strophanthus wallichii*. (rel. abundance-0.6874, with 37.5% frequency). Expect *Argyreia wallichii*, the frequency of the entire species group found in the Mangrove forest with their respective relative abundance (Fig: 5) show linear progression of distribution with regression value (R^2) =0.9328.

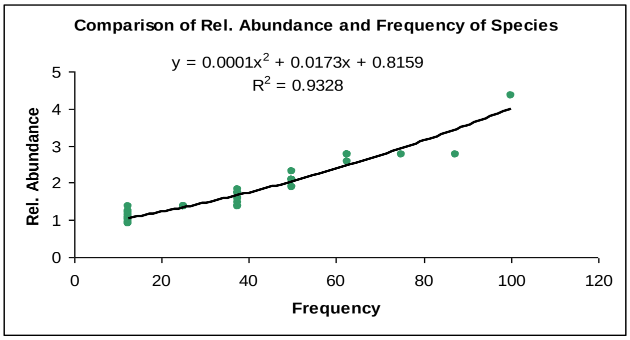

Fig. 5: Comparison of Relative Abundance and frequency of degraded forest

Density-rank relation of species

It shows that *Argyreia wallichii* has density (47.50/ha) with first rank, followed by *Ipomoea eriocarpa* (25/ha, rank-2), *Argyreia mollis*, and *Dioscorea esculenta* (18.75/ha, rank-3), *Tylophora capparidifolia* (16.25/ha, rank-4), *Cardiospermum halicacabum*, and *Colubrina asiatica* (13.75/ha, rank-5). Except of species of higher density (>20), all the others show logarithmic pattern of curve with regression value (R^2) =0.9208. (Fig: 6).

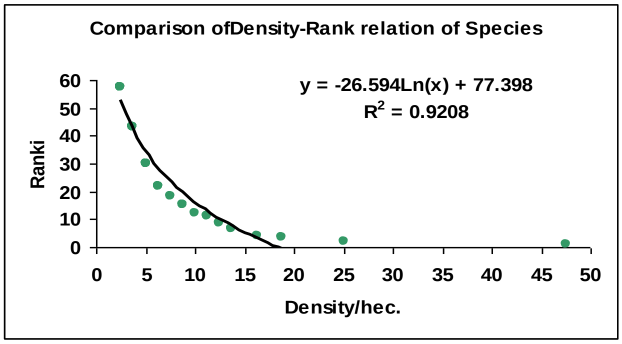

Fig. 6: Comparison of density-rank relation of degraded forest species

Mean and variance analyses of species

Values of mean and variance of the species of degraded forest (Fig: 7), show that species having values ranging from 0.375-4.75 and 1.125-13.0714 respectively are generally aggregated. The common aggregated species are: *Argyreia mollis, Argyreia wallichii, Dioscorea hispida, Hoya globulosa, Ipomoea nil, Operculina riedeliana*. Species with values ranging from 0.25-2.5 and 0.2679-5.7143 mean and variance respectively are generally random in distribution in the habitat. The common randomly distributed species are: *Dioscorea* *esculenta, Hewittia malabarica, Ipomoea eriocarpa, Sphenodesme involucrate, Thunbergia grandiflora, Tylophora capparidifolia* etc.

Degree of freedom is 7. The species are aggregated in distribution show 0.000256 to 0.018913 probabilities with chi square values ranging from 16.7778 to 28, whereas species of random distribution show probability of 0.025066 to 0.935054 with chi square values ranging from 2.3846 to 16.

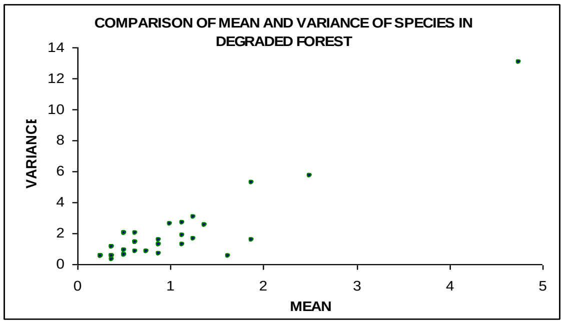

Fig. 7: Comparison of mean and variance of degraded forest species

Importance value indices (IVI) of species

Tylophora capparidifolia, shows the highest IVI (37.3), followed by *Argyreia wallichii* (20.47), *Hibiscus scandens* (10.37), *Argyreia mollis* (10.26), *Strophanthus wallichii* (8.97), *Ipomoea eriocarpa* (8.8) etc. In 6 species the IVI is more than 5; in 9 it is more than 4; in 8 it is more than 3 and in 12 species it is more than 2. The minimum IVI (1.18) is found in *Tetrastigma lanceolarium.* Except the *Tylophora capparidifolia* and *Argyreia wallichii,* other species show exponential pattern with regression value (R^2) =0.9341 (Fig: 8).

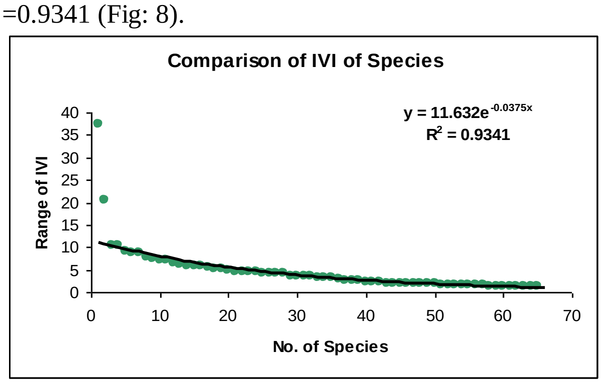

Fig. 8: Comparison of IVI of degraded forest species

Species diversity of the studied plots

In these analysis it was found that Plot number 6 (Fig: 9) shows the highest species diversity (H'= 3.011105204); followed by plot no. 1 (H'= 2.986968099); plot number 5 (H'= 2.880593852); plot no. 7 (H'= 2.872691571). Plot no.3rd and 4th have diversity (H'=2.809994351, 2.804149966), slightly higher than the plot no. 2nd (H'= 2.701393687).

Lowest species diversity is found in 8th plot (H'= 2.700978279)

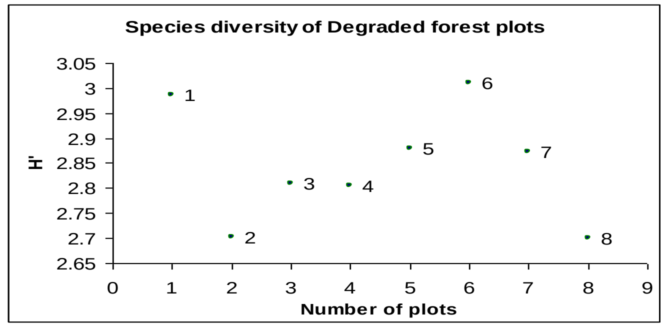

Fig. 9: Species richness (S) of degraded forest plots

Species richness (S) and diversity of plots

It was found that plot number 6 shows high species richness (S = 52), the diversity is relatively high (*N1*=20.3) in comparison to plot numbers 2, 3 and 4 where species richness is high (S =<46) but the diversity is relatively low (*N1* = <14.9). It is also found that the plot numbers 1, 5, and 7 show high diversity (*N1*=<17.68), but species richness is low (S=<43). Plot like 8 show more or less proportionate S and *N1* values. (Fig: 10)

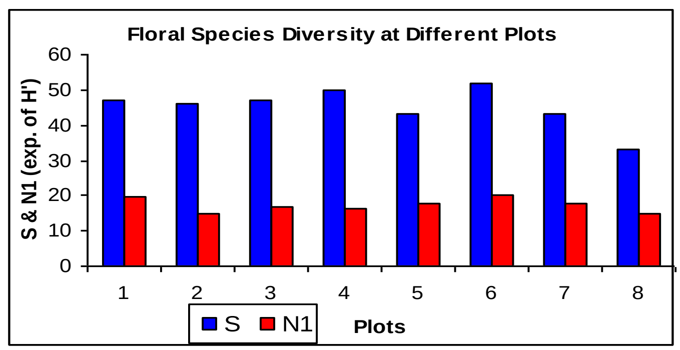

Fig. 10: Comparison of species richness (S) and diversity (*N1*) of degraded forest plots

Similarity measures of Taxonomic Diversity by Cluster Analysis

From the dendogram of degraded plots (Fig: 11) it has been observed that the plots 4th and 8th, situated in Krishorinagar region, show high taxonomic similarity (48.06061). These two plots cluster with the plot number 1, which is present in the Radhanagar adjacent to the previous region. Plots, 2 and 5 cluster together with similarity value of 43.27603. Plots 3rd and 6th, though situated at the same region, show different species composition with low similarity. Plot 7th is entirely of different composition and is found as a separate cluster form the rest.

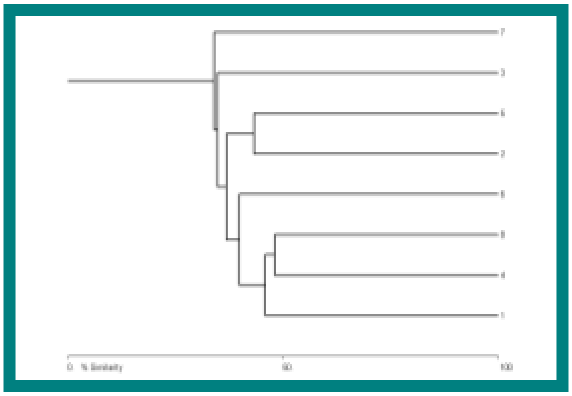

Fig. 11: Dendogram of taxic similarity of degraded plots

The variation amongst the plots may be due to their continued human interference and physical limitations to new incursions. There are divergent views whether disturbance maintain species diversity (Denslow, 1987) or not (Brokaw & Busing, 2000; Hubbel *et al*., 1999). The age of the forest also affects diversity (Dewalt *et al*., 2000). Sfair & Martins (2011) proposed the biotic interaction hypothesis, whereby coexistence of heterogeneity of tree traits and greater number of their combinations influences positively the speciation rate and maintenance of climber richness. The species richness decreases with dominance and reduction of common species during past pressure contributes to higher richness.

The results presented here, it may be iterated, are in respect of forests that in most represent secondarily regenerated ones and are in still in a flux at different stages of succession. The diversity that is seen is factored mainly by fragmentation and the resulting gaps in the landscape. Anthropogenic disturbances, including logging and changes in land use pattern, are still operating in various degrees. Phytodiversity, especially diversity of climbers and lianas, an important constituent for the perpetuation of ecosystem integrity, is in stake. The social, political and economical goodwill can only change the balance.

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Table 1: Phytosociological analysis of the recorded species [F=Frequency; D=Density; RF = Relative Frequency; RD = Relative Density; RA = Relative Abundance; Rel. Dom=Relative Dominance; IVI = Importance Value Index]

SL.	Species	Family	F	D	RF	RD	RA	Rel. Dom.	IVI
1	*Argyreia mollis* (N. L. Burman) Choisy	Convolvulaceae	50	187.5	2.5	4.155	2.58	3.609	10.26
2	*Argyreia wallichii* Choisy	Convolvulaceae	75	475	3.75	10.53	4.35	6.2	20.48
3	*Asparagus racemosus* Willd.	Liliaceae	50	112.5	2.5	2.493	1.55	0.058	5.051
4	*Cajanus crassus* (Prain & King) van der Maesen	Papilionaceae	12.5	25	0.63	0.554	1.37	4.895	6.074
5	*Cardiospermum halicacabum* L.	Sapindaceae	37.5	50	1.88	1.108	0.92	4.066	7.049
6	*Cayratia pedata* (Lam.) Juss. Ex Gagnep.	Vitaceae	50	75	2.5	1.662	1.03	0.039	4.201
7	*Cissampelos pareira* L.	Menispermaceae	37.5	50	1.88	1.108	0.92	0.744	3.727
8	*Cissus pentagona* Roxb.	Vitaceae	50	137.5	2.5	3.047	1.89	0.092	5.639
9	*Clitoria ternate* L.	Papilionaceae	37.5	62.5	1.88	1.385	1.15	0.293	3.553
10	*Coccinia grandis* (L.) J. Voigt.	Cucurbitaceae	50	87.5	2.5	1.939	1.2	0.104	4.543
11	*Colubrina asiatica* (L.) Brongn.	Rhamnaceae	37.5	50	1.88	1.108	0.92	0.253	3.236
12	*Cucumis melo* L.	Cucurbitaceae	12.5	37.5	0.63	0.831	2.06	0.019	1.475
13	*Dioclea hexandra* (Ralph) Mabberley	Papilionaceae	50	87.5	2.5	1.939	1.2	0.058	4.497
14	*Dioscorea esculenta* (Loureiro) Burkill	Dioscoreaceae	37.5	87.5	1.88	1.939	1.6	0.427	4.241
15	*Dioscorea hispida* Dennstedt	Dioscoreaceae	50	137.5	2.5	3.047	1.89	2.296	7.843
16	*Dioscorea oppositifolia* L.	Dioscoreaceae	25	37.5	1.25	0.831	1.03	3.745	5.826
17	*Dioscorea wallichii* Hook.	Dioscoreaceae	25	37.5	1.25	0.831	1.03	2.84	4.921
18	*Gloriosa superba* L.	Liliaceae	12.5	25	0.63	0.554	1.37	0.06	1.239
19	*Gymnema latifolium* Wall. ex Wight	Asclepiadaceae	25	37.5	1.25	0.831	1.03	0.032	2.113
20	*Gymnopetalum cochinchinense* Kurz	Cucurbitaceae	87.5	187.5	4.38	4.155	1.47	0.125	8.655
21	*Hewittia malabarica* (L.) Suresh	Convolvulaceae	25	62.5	1.25	1.385	1.72	0.049	2.684
22	*Ipomoea alba* L.	Convolvulaceae	25	62.5	1.25	1.385	1.72	0.048	2.683
23	*Ipomoea eriocarpa* R. Brown	Convolvulaceae	12.5	25	0.63	0.554	1.37	0.015	1.194
24	*Ipomoea nil* (L.) Roth	Convolvulaceae	12.5	25	0.63	0.554	1.37	0.038	1.217
25	*Ipomoea sepiaria* Roxb.	Convolvulaceae	25	62.5	1.25	1.385	1.72	4.922	7.557

26	*Jacquemontia paniculata* (N. L. Burman) H. Hallier	Convolvulaceae	37.5	50	1.88	1.108	0.92	0.679	3.662
27	*Jasminum cordifolium* Wall.	Oleaceae	12.5	50	0.63	1.108	2.75	0.428	2.161
28	*Jasminum lanceolaria* Roxb.	Oleaceae	62.5	87.5	3.13	1.939	0.96	0.051	5.115
29	*Lablab purpureus* (L.) Sweet	Papilionaceae	12.5	50	0.63	1.108	2.75	8.642	10.38
30	*Momordica cochinchinensis* Spreng.	Cucurbitaceae	12.5	25	0.63	0.554	1.37	2.547	3.726
31	*Myxopyrum smilacifolium* Bl.	Oleaceae	37.5	125	1.88	2.77	2.29	0.069	4.715
32	*Operculina riedeliana* (Oliv.) Oost	Convolvulaceae	12.5	25	0.63	0.554	1.37	0.453	1.632
33	*Paederia scandens* (Lour.) Merr.	Rubiaceae	25	50	1.25	1.108	1.37	0.9	3.259
34	*Pycnarrhena longifolia* (Decne ex Miq.) Bece.	Menispermaceae	12.5	25	0.63	0.554	1.37	0.013	1.192
35	*Stictocardia tiliifolia* (Desrousseaux) H. Hallier	Convolvulaceae	62.5	250	3.13	5.54	2.75	0.139	8.804
36	*Strongylodon lucidus* (Frost.) Seemann	Papilionaceae	37.5	112.5	1.88	2.493	2.06	0.06	4.428
37	*Strophanthus wallichii* A. de Candolle	Apocynaceae	25	37.5	1.25	0.831	1.03	0.021	2.102
38	*Thunbergia alata* Bojer ex Sims	Thunbergiaceae	25	37.5	1.25	0.831	1.03	0.045	2.126
39	*Thunbergia coccinea* Wall. ex Don.		25	50	1.25	1.108	1.37	0.7	3.058
40	*Thunbergia grandiflora* (Rottler) Roxb.	Thunbergiaceae	12.5	25	0.63	0.554	1.37	0.369	1.548
41	*Thunbergia mysorensis* (Wight) Anderson ex Bedd.	Thunbergiaceae	50	75	2.5	1.662	1.03	0.04	4.202
42	*Tournefortia ovata* Wall. ex G. Don	Thunbergiaceae	25	37.5	1.25	0.831	1.03	0.025	2.106
43	*Toxocarpus himalensis* Falconer ex Hook. f.	Boraginaceae	12.5	25	0.63	0.554	1.37	0.526	1.705
44	Tridynamia megalantha (Merr.) Staples	Asclepiadaceae	37.5	100	1.88	2.216	1.83	0.214	4.305
45	*Tylophora capparidifolia* Wight & Arn.	Convolvulaceae	12.5	25	0.63	0.554	1.37	0.122	1.301
46	*Tylophora zeylanica* Dene.	Asclepiadaceae	12.5	37.5	0.63	0.831	2.06	0.09	1.546
47	*Vigna adenantha* (G. F. Meyer) Marechal & Stainier	Asclepiadaceae	25	62.5	1.25	1.385	1.72	3.135	5.77

48	*Vigna unguiculata* (L.) Walp. ssp. *cylindrical* (L.) van Eseltine	Papilionaceae	12.5	25	0.63	0.554	1.37	0.5	1.679
49	*Hoya globulosa* Hook.f.	Papilionaceae	12.5	37.5	0.63	0.831	2.06	1.119	2.575
50	*Bougainvillea spectabilis* Willd.	Asclepiadaceae	12.5	25	0.63	0.554	1.37	0.06	1.239
51	*Caesalpinia cucullata* Roxb.	Nyctaginaceae	62.5	112.5	3.13	2.493	1.24	0.333	5.951
52	*Calycopteris floribunda* (Roxb.) Lam	Caesalpiniaceae	12.5	25	0.63	0.554	1.37	0.533	1.712
53	*Cocculus pendulus* (J.R. & G. Forst.) Diels	Combretaceae	25	37.5	1.25	0.831	1.03	5.045	7.126
54	*Combretum punctatum* Bl. ssp. *squamossum* (Roxb. ex G. Don.) Excell.	Menispermaceae	37.5	37.5	1.88	0.831	0.69	6.271	8.977
55	*Combretum roxburghii* Spreng.	Combretaceae	12.5	50	0.63	1.108	2.75	0.28	2.013
56	*Gouania leptostachya* DC.	Combretaceae	37.5	50	1.88	1.108	0.92	0.283	3.266
57	*Hibiscus scandens* Roxb.	Rhamnaceae	62.5	125	3.13	2.77	1.37	0.594	6.489
58	*Hippocratea grahamii* Wight	Malvaceae	25	37.5	1.25	0.831	1.03	0.225	2.306
59	*Ichnocarpus frutescens* (L.) W. T. Aiton	Celastraceae	12.5	25	0.63	0.554	1.37	0.673	1.852
60	*Illigera appendiculata* Bl.	Apocynaceae	12.5	37.5	0.63	0.831	2.06	0.583	2.039
61	*Parabaena sagittata* Miers ex Hook. F. & Thomson	Hernandiaceae	12.5	25	0.63	0.554	1.37	0.231	1.41
62	*Pisonia aculeata* L.	Menispermaceae	100	162.5	5	3.601	1.12	28.7	37.3
63	*Spatholobus acuminatus* Benth.	Nyctaginaceae	12.5	50	0.63	1.108	2.75	0.234	1.967
64	*Sphenodesme involucrata* (Presl) Robinson	Papilionaceae	12.5	25	0.63	0.554	1.37	0.015	1.194
65	*Raphidophora pertusa* (Roxb.) Schott	Verbenaceae	25	37.5	1.25	0.831	1.03	0.022	2.104

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