TREES AND LIANAS DIVERSITY IN SOME PRIMARY AND SECONDARY FORESTS IN PENANG, MALAYSIA

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ABSTRACT The richness and diversity of woody plants are important indices for maintaining and conserving tropical forests. This study evaluated the alpha diversity and richness indices of some ecologically important primary and old secondary forests in Penang, Malaysia. Plots of 2000 m^2 size, which were further divided into five subplots of 20 x 20 m^2 size, were established in each of the five forest reserves across Penang. A total of 1,161 individual trees and lianas belonging to 54 different families and 284 species were enumerated in all studied forests. Euphorbiaceae, Clusiaceae, and Dipterocarpaceae are the most prominent families with the highest number of species. *Vatica bella* is the most abundant plant with 127 individuals. Meanwhile, *Knema curtisii*, *Gluta elegans*, *Mangifera gracilipes*, and *Callerya atropurpurea* are more common to all forests. All forests could be described as highly rich in woody plant species and diverse due to the estimated high diversity indices. There is virtually no difference in the diversity indices between primary and old secondary forests, probably due to the recuperating nature of the old secondary forests after years of abandonment.

Keywords: Euphorbiaceae, *Knema curtisii*, Lianas, Penang, Trees.

1. INTRODUCTION

The world's tropical forests, which are the richest in terms of species among other terrestrial communities, are being threatened by several biotic intrusions related to over-exploitation, destruction of habitats, logging, and other forms of encroachment (Bheemalingappa et al., 2018; Mwavu & Witkowski, 2015). Most importantly, islands, which are rich in biodiversity, have been regarded as more prone to biodiversity loss and extinctions due to factors such as incessant natural disasters and invasive alien plants. The current geometrical rate of loss of forest plants worldwide has generated concerns among scientists and governments. Globally, the annual loss of forest lands has been estimated to be about 20 million hectares (Hansen et al., 2013). Trees and other woody plants dominate tropical forests. These plants form a vital component of the forests and serve as habitats for other organisms, including man (Armenteras et al., 2009). Tropical trees play a vital role in sustaining and conserving forest biodiversity, purifying the environment, and lock up carbon for photosynthesis (Attua & Pabi, 2013). Therefore, uncontrolled loss of these trees could adversely impact the forests, and the entire environment (Bheemalingappa et al., 2018).

Plant diversity in Penang, Malaysia, comprises both local plants and introduced ones by foreigners in the 1790s (Go et al.,

2011). Due to the recent rapid pace of development in Penang, many native and common plants are endangered, and some have already been lost. This scenario, combined with the forests' ecological significance, makes it essential to assess the distribution and diversity of woody plant species, which are critical indicators for assessing the ecological and conservation status of tropical forests (Buzas & Hayek, 1996; Ricotta et al., 2002). The quantitative data will then be useful for conserving the remaining plants in the forests (Castillo-Campos et al., 2008). Hence, it is deemed necessary to embark on a periodic inventory of forest trees to apprehend the current structure and possible threats. The biodiversity assessment will help researchers understand the forest structure, composition, and distribution patterns before implementing adequate management plans (Baraloto et al., 2013; Kacholi, 2014). This study aimed at assessing the diversity of trees and lianas of some primary and old secondary forests in Penang, Malaysia, after many years of post-logging activities. The data obtained from this study will improve the conservation and management strategies to be implemented for these forests in Penang. Besides, it will also improve the ecology of woody trees in these forests.

2. METHODOLOGY

2.1 Study Area

This study was carried out at five forests in Penang, Malaysia. Five forest areas were selected for this study comprising three old secondary/post-logging and two primary forests (Table 1). Penang, a state on the northwest of Peninsular Malaysia, is divided into the island and mainland. It is bordered on the north by Kedah and on the east by Perak. Penang has a total landmass of about 1048 km^2. Like other Malaysian states, Penang has tropical rainforest vegetation, and the climatic condition is often influenced by the sea surrounding it. This state has an annual average rainfall of 2670 mm, an average annual temperature range of 23.5–31.3 °C and relative humidity of 0%–50%.

2.2 Sampling Techniques

Plot sampling methods recommended for practical estimation of the richness and diversity of tropical tree species were used in this research (Condit et al., 1996). Plot sizes of 100 x 20 m^2 were established across the five forests in the study area. Each plot was divided into five subplots of 20 x 20 m^2 to allow for easier and accurate sampling of trees and lianas. This then produced a total of 25 subplots for the sampling. The abundance of woody plants, including trees and lianas, were enumerated in each subplot, and plants with the diameter at breast height (DBH) $\geq$ 2.0 cm were collected and identified. Some diagnostic features such as latex, fruits, flowers, leaves, and smell to identify unknown plants were collected and documented on the field. Voucher specimens were deposited at the Universiti Sains Malaysia herbarium for future reference. The identification of unknown specimens and confirmation of known ones were performed using taxonomic floras (Ridley, 1912; Whitmore, 1983). The species names were further regularized using the International Plant Name Index (http://www.ipni.org/).

2.3 Statistical Analyses

The species abundance data were normalized using log transformation in IBM SPSS version 24. Diversity indices such as the Shannon index, Simpson index, and species evenness were quantified using pairwise permutation test in PAST 3.0 software (Hammer et al., 2001). Non-parametric species richness evaluator called

rarefaction, and extrapolation analysis was done to avoid bias in species richness estimation on the field. This was achieved by employing 500 bootstrapping resampling methods using iNEXT software (Chao et al., 2016). The significant differences in the species richness between the plots were determined by the confidence intervals of the curves. An overlap in the curves indicates no significant difference in the species richness estimated. Meanwhile, to ascertain the plant species similarities among the plots, Ward linkage cluster analysis was used to plot a dendrogram in IBM SPSS 24.

3. RESULTS

A total of 1,157 individual trees and lianas belonging to 53 different families and 273 species were observed, collected, and identified in all studied plots (Tables 2 and 3). Detailed names of the species according to the abundance in each plot are listed in Appendix 1. Euphorbiaceae, Clusiaceae, and Dipterocarpaceae are the largest families with 25, 22, and 20 species. Families represented by only one species include Aquifoliaceae, Arecaceae, Bignoniaceae, Bombaceae, Crypteroniaceae, Icacinaceae, Ixonanthaceae, Loganaceae, Myrsinaceae, Myrsinaceae, Olacaceae, Polygalaceae, Proteaceae, Simaroubaceae, Smilacaceae, Sterculiaceae, and Ulmaceae (Table 2).

The highest number of species (78) is observed in plot 1 (Bukit Genting), while the lowest (55) is observed in plot 3 (Botanical Garden Water Catchment Area). However, plot 2 (Botanical Garden Forested Area A) with the lowest number of species has the highest number of individual plants (283; Table 3). *Vatica bella* could be described as the most abundant plant in plots 2 and 3, with 127 individuals. *Knema curtisii*, *Gluta elegans*, *Mangifera gracilipes*, and *Callerya atropurpurea* are found to be common in four of the studied plots. No species is found to be common in all five studied plots.

Similar trends were observed in the quantified diversity indices of plot 1 and plot 5. Both have similarly high Simpson index (0.974 and 0.973) and Shannon index (4.018 and 4.001) compared to the other plots. Meanwhile, plot 3 was identified as the least diverse plot having the lowest Simpson index (0.817) and Shannon index (2.768) significantly different from other plots. Plot 5 still had the significantly highest Margalef index (14.75) and Fisher's alpha (53.2). The evenness index of all the plots was not significantly different from each other except for plot 3. Plot 3 consistently showed the least in all the diversity indices measured, whereas plot 5 consistently showed the highest (Table 3). The rarefied and extrapolated estimator for species richness revealed that plots 1 and 5 have the highest species richness (Figure 1). The overlapped curves indicated that they are not significantly different from each other. However, plot 3 has the lowest and is significantly different from the others. The same trend was observed in the rarefied and extrapolated Shannon index and Simpson index curves, whereby plot 3 consistently showed significantly lower values than others, while plot 5 showed the highest (Figures 2 and 3). Based on the Ward linkage cluster analysis performed to understand the relationship between the sampled forests in similar species, plots 1 and 5 are the closest (Figure 4). Plot 3 is still observed to be far from the other plots but closer to plot 2.

4. DISCUSSION

The higher diversity indices consistently displayed by plot 5 (Bukit Kerajaan) in this study conforms with the reports of Zakaria et al. (2009), who also

recorded a similar trend in this forest. They attributed this to the less impact of human disturbances in the forest. On a similar note, plot 1 (Bukit Genting), a post-logging/old secondary forest, also exhibited high diversity indices in terms of number and evenness of species. This could result from forest plant regeneration after a long time restriction due to human activities. The Penang State government has restricted logging activities at these forests since 2006 (Chow, 2018). It means that the forest is undergoing the process of secondary regrowth, thereby increasing its plant diversity. Over the years, secondary forests could regain species composition and tend to increase in species richness and diversity if left undisturbed. It is very important to include woody plants with DBH ranging from 2–10 cm in the sampling of tropical forests because these categories of plants (non-trees) do enhance forest structure by increasing species richness and diversity (Gentry & Dodson, 1987; Nieder et al., 2000; Pitman et al., 2001). Hence, the addition of lianas (DBH ranging from 2–10 cm) in this study.

However, the lowest diversity indices recorded in plot 3 (Botanical Garden Water Catchment Area), the primary forest compared to the other forests, are of concern. This could be attributed to minimal unauthorized gradual encroachment of humans into the area, being a recreational forest. As a primary recreational forest, the prospect of any illegal disturbances by visitors may have endangered plant diversity. All the forests studied could still be defined as more diverse in terms of trees and lianas species due to their greater than 2 Shannon diversity index (Barbour et al., 1999). None of them has a Shannon index of less than 2, which implies that the forests are still stable and productive (Seabloom, 2007). All the rarefied and extrapolated curves nearly reached an asymptote, showing that the sampling size was almost adequate (Mwavu & Witkowski, 2015). This inevitably means that the sample size used has sufficiently revealed the variety of woody plants in these forests. Species richness of most continental tropical forests has been reported to be within 60–283 species per hectare (Phillips et al., 1994). The total number of species recorded per hectare in this study depicted the higher richness status of these island forests than some previous studies. For example, 54, 84, and 94 species per hectare were observed in some deciduous and evergreen forests in India (Chittibabu & Parthasarathy, 2000; Gupta & Prasad, 2013), whereas 255 species were reported in some forests in Peninsula Malaysia (Whitmore & Burnham, 1975). However, it is generally very difficult to compare the diversity of woody plants in forests of different climatic zones as a result of variations in factors that may affect species assemblages, such as soil, climate, human activities, nutrient distribution, and endemism (Pärtel et al., 2007; Primack & Corlett, 2005; Wilson et al., 2008).

Similarly, Euphorbiaceae and Dipterocarpaceae families, i.e., the richest families in this study, were also identified to be the richest families in previous studies in Malaysia (Ho et al., 1987; Zakaria et al., 2009). In this study, Lauraceae, represented by 17 species, was reported to be the most dominant canopy tree family in a wet forest in southwestern India (Parthasarathy, 1999). *K. curtisii*, *G. elegans*, *M. gracilipes*, and *C. atropurpurea*, which were found common to four plots, could be described as true representatives of both primary and old secondary forests. Some of the species recorded in this study, such as *Dipterocarpus spp.*, *Knema spp*., *Diospyros spp.*, and *Garcinia spp.* were also found to dominate some tropical evergreen and semi-deciduous forests in India (Bheemalingappa et al., 2018).

4. CONCLUSION

All the five studied forests are abundant in species of woody plants (mainly trees and lianas). Variations in species distribution and abundances have occurred in these forests. None of the forests could be identified as highly endangered by human disturbances. Efforts made so far by the government to limit human encroachments in these forests, most importantly in the Botanical Garden Water Catchment Area forest, should be encouraged and intensified.

Table 1. Description of Sapling Plots in Penang, Malaysia

S/N	NAME OF FOREST	LATITUDE (N)	LONGITUDE (E)	ALTITUDE (m)	FOREST TYPE
1	Bukit Genting	05° 18.473'	100° 13.151'	313	Old Secondary Forest/ Post-logging
2	Botanical Garden Forested Area	5° 26.572'	100° 17.542'	220	Old Secondary Forest/ Post-logging
3	Botanical Garden Water Catchment Area	5° 26.337' N	100° 16.981'	230	Primary Forest
4	Bukit Penara	5° 24.347'	100° 13.236'	331	Old Secondary Forest/ Post-logging
5	Bukit Kerajaan	5° 25.474'	100° 15.336'	650	Primary Forest

Table 2. Families of plants identified and the respective number of species

S/N	Family	Number of Species
1	Anacardiaceae	14
2	Anisophyllaceae	4
3	Annonaceae	11
4	Apocynaceae	4
5	Aquifoliaceae	1
6	Arecaceae	1
7	Bignoniaceae	1

8	Bombaceae	1
9	Burseraceae	9
10	Celastraceae	3
11	Chrysobalanaceae	3
12	Clusiaceae	22
13	Coniferae	2
14	Connaraceae	3
15	Crypteroniaceae	1
16	Dilleniaceae	2
17	Dipterocarpaceae	20
18	Ebenaceae	8
19	Elaeocarpaceae	2
20	Euphorbiaceae	25
21	Fabaceae	12
22	Fagaceae	4
23	Flacourtiaceae	3
24	Gnetaceae	2
25	Icacinaceae	1
26	Ixonanthaceae	1
27	Lauraceae	16
28	Lecythidaceae	2
29	Loganaceae	1
30	Melastomataceae	3
31	Meliaceae	7
32	Moraceae	8
33	Myristicaceae	9
34	Myrsinaceae	1
35	Myrtaceae	16
36	Olacaceae	1
37	Polygalaceae	1
38	Proteaceae	1
39	Rhamnaceae	2
40	Rhizophoraceae	2
41	Rosaceae	5
42	Rubiaceae	13
43	Rutaceae	2
44	Sapindaceae	3
45	Sapotaceae	6
46	Simaroubaceae	1
47	Smilacaceae	1
48	Sterculiaceae	1
49	Theaceae	3
50	Thymelaeaceae	2
51	Tiliaceae	3
52	Ulmaceae	1
53	Verbenaceae	2

Table 3. Plant community characteristics of sampling locations

Community characteristics	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5
Observed Species Richness	78	74	55	69	77
Number of Individuals	195	283	267	239	173
Simpson index*	0.974[a]	0.959[a]	0.817[b]	0.971[a]	0.973[a]
Shannon index*	4.018[a]	3.71[b]	2.768[c]	3.834[b]	4.001[a]
Evenness index*	0.713[a]	0.547[a]	0.289[b]	0.670[a]	0.751[a]
Margalef index*	14.60[a]	12.93[b]	9.67[c]	12.42[d]	14.75[a]
Fisher's alpha*	48.18[a]	32.59[b]	21.01[c]	32.51[b]	53.20[d]

*Significant difference was determined using pairwise permutation test in PAST

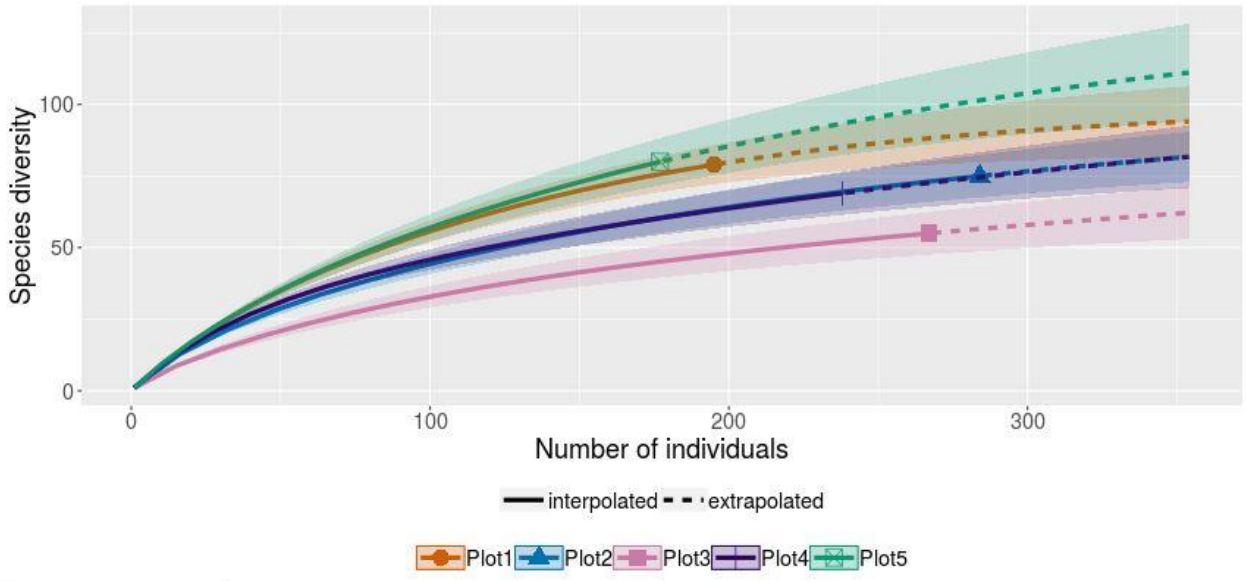

Figure 1. Individual-based rarefaction and extrapolation curve for species richness of the sampling plots. Solid lines represent the rarefied curves while dotted lines represent extrapolated curves. The shadows represent confidence intervals while the shaped dots represent the number of individual plants for each plot.

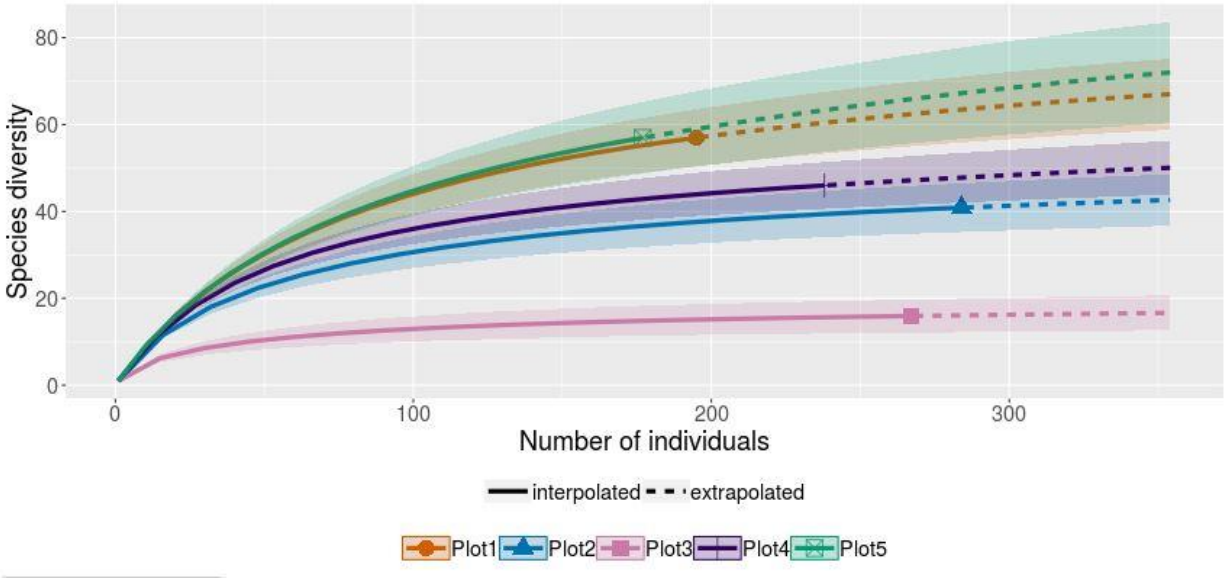

Figure 2. Individual-based rarefaction and extrapolation curve for Shannon index of the sampling plots. Solid lines represent the rarefied curves while dotted lines represent extrapolated curves. The shadows represent confidence intervals while the shaped dots represent the number of individual plants for each plot.

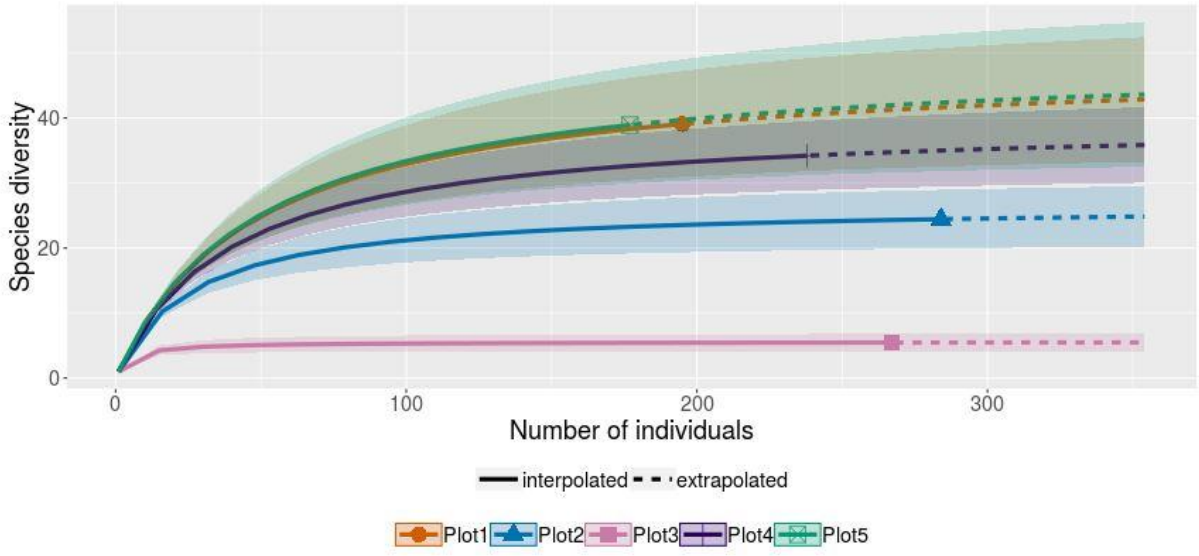

Figure 3. Individual-based rarefaction and extrapolation curve for Simpson index of the sampling plots. Solid lines represent the rarefied curves while dotted lines represent extrapolated curves. The shadows represent confidence intervals while the shaped dots represent the number of individual plants for each plot.

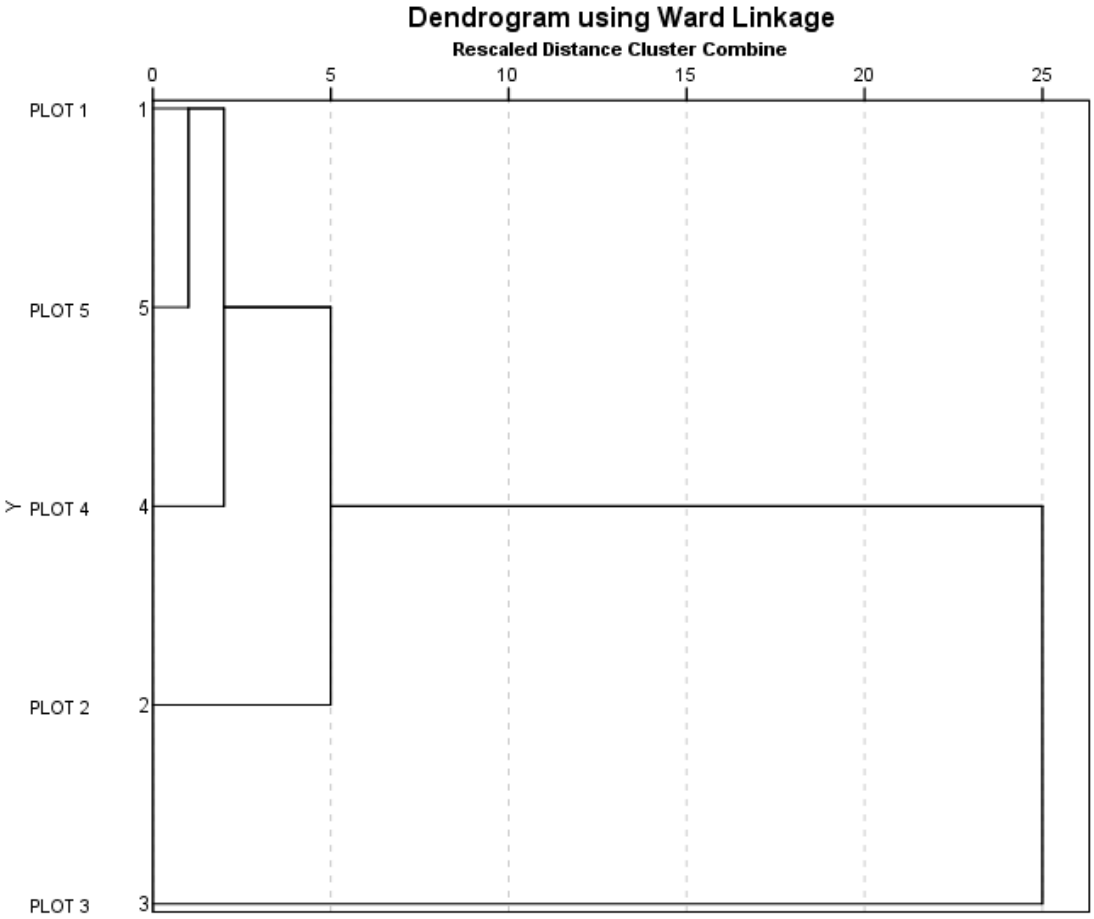

Figure 4. Dendrogram showing the relationship between the plots in terms of similar species

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APPENDIX 1. List of woody plant species observed at different plots in Penang, Malaysia

S/N	FAMILY	SPECIES	PLOT 1	PLOT 2	PLOT 3	PLOT 4	PLOT 5
1	Anacardiaceae	*Bouea oppositifolia*	0	0	1	0	0
2	Anacardiaceae	*Buchanania arborescens*	0	1	0	0	0
3	Anacardiaceae	*Buchanania sessifolia*	0	0	0	1	0
4	Anacardiaceae	*Gluta aptera*	0	3	6	0	2
5	Anacardiaceae	*Gluta beccarii*	0	18	0	0	0
6	Anacardiaceae	*Gluta elegans*	0	29	1	2	4
7	Anacardiaceae	*Gluta reghas*	0	0	0	0	2
8	Anacardiaceae	*Gluta wallichii*	0	0	0	0	1
9	Anacardiaceae	*Mangifera gracilipes*	0	8	8	1	1
10	Anacardiaceae	*Melanochyla spp*	7	0	0	0	0
11	Anacardiaceae	*Parishia insignis*	0	1	3	0	0
12	Anacardiaceae	*Swintonia floribunda*	0	1	5	0	1
13	Anacardiaceae	*Swintonia schwenkii*	0	2	0	0	0
14	Anacardiaceae	*Swintonia spicifera*	0	0	18	0	0
15	Anisophyllaceae	*Anisophyllea corneri*	0	0	0	0	2
16	Anisophyllaceae	*Anisophylla globulosa*	0	0	0	0	3
17	Anisophyllaceae	*Anisophyllea griffithii*	0	0	0	0	2

18	Anisophyllaceae	*Anisophyllea grandis*	2	0	0	0	0
19	Annonaceae	*Alphonsea curtisii*	2	0	0	0	0
20	Annonaceae	*Bouea oppositifolia*	0	0	0	1	0
21	Annonaceae	*Cyathostemma excelsum*	2	0	0	0	0
22	Annonaceae	*Cyathostemma hookeri*	2	0	0	0	0
23	Annonaceae	*Fissistigma manubriatum*	2	0	0	0	0
24	Annonaceae	*Goniothalamus malayanus*	0	0	0	6	0
25	Annonaceae	*Mezzettia parviflora*	0	0	2	0	0
26	Annonaceae	*Mitrella kentii*	0	7	2	0	0
27	Annonaceae	*Polyalthia cauliflora*	2	0	0	0	1
28	Annonaceae	*Polyalthia jenkensii*	0	0	0	0	3
29	Annonaceae	*Polyalthia rumphii*	0	0	2	0	0
30	Apocynaceae	*Alstonia angustiloba*	0	1	0	0	0
31	Apocynaceae	*Ancistrocladus tectorius*	2	0	0	0	0
32	Apocynaceae	*Willughbeia edulis*	0	0	2	0	0
33	Apocynaceae	*Willughbeia oblonga*	12	3	5	0	0
34	Aquifoliaceae	*Ilex cymosa*	0	0	1	0	0
35	Arecaceae	*Pinanga malaiana*	0	0	0	0	4

36	Bignoniaceae	*Radermachera spp*	0	0	0	0	1
37	Bombaceae	*Durio griffithii*	0	0	0	0	3
38	Burseraceae	*Canarium littorale*	1	0	0	0	0
39	Burseraceae	*Canarium patentinervum*	3	0	0	0	0
40	Burseraceae	*Dacryodes costrata*	0	0	1	0	0
41	Burseraceae	*Dacryodes incurvata*	0	0	0	1	0
42	Burseraceae	*Dacryodes longifolia*	0	0	0	1	0
43	Burseraceae	*Dacryodes rubiginosa*	0	1	0	0	0
44	Burseraceae	*Dacryodes rugosa*	0	0	2	0	0
45	Burseraceae	*Santiria griffithii*	2	0	0	0	0
46	Burseraceae	*Santiria oblongifolia*	0	0	1	0	0
47	Celastraceae	*kokoona littoralis*	0	0	0	1	0
48	Celastraceae	*Kokoona reflexa*	7	0	0	0	0
49	Celastraceae	*Salacia macrophylla*	0	0	1	0	0
50	Chrysobalanaceae	*Atuna penangiana*	0	1	0	0	0
51	Chrysobalanaceae	*Maranthes corymbosa*	0	0	0	5	0
52	Chrysobalanaceae	*Parinari costata*	0	3	0	5	0
53	Clusiaceae	*Calophyllum calaba*	1	0	0	0	0

54	Clusiaceae	*Calophyllum macrocarpum*	0	0	1	0	0
55	Clusiaceae	*Calophyllum molle*	0	0	0	1	0
56	Clusiaceae	*Calophyllum rubiginosum*	1	0	0	0	0
57	Clusiaceae	*Calophyllum rupicola*	0	0	0	7	0
58	Clusiaceae	*Calophyllum wallichianum*	2	6	0	0	0
59	Clusiaceae	*Calophyllum wallichianum v incrassatum*	0	0	0	11	0
60	Clusiaceae	*Cratoxylum arborescens*	2	2	0	0	0
61	Clusiaceae	*Garcinia atroviridis*	0	0	1	0	0
62	Clusiaceae	*Garcinia bancana*	2	0	0	0	0
63	Clusiaceae	*Garcinia griffithii*	0	0	2	0	0
64	Clusiaceae	*Garcinia hombroniana*	0	0	0	1	0
65	Clusiaceae	*Garcinia opaca v dumosa*	0	0	0	1	0
66	Clusiaceae	*Garcinia parvifolia*	2	0	0	5	0
67	Clusiaceae	*Garcinia penangiana*	0	0	1	6	0
68	Clusiaceae	*Calophyllum canum*	0	1	0	0	0
69	Clusiaceae	*Calophyllum tetrapterum*	0	3	0	0	0
70	Clusiaceae	*Cratoxylum formosum*	0	4	0	0	0
71	Clusiaceae	*Garcinia dulcis*	0	1	0	0	0

72	Clusiaceae	*Garcinia eugenifolia*	3	2	0	1	0
73	Clusiaceae	*Mesua ferrea*	1	0	2	0	0
74	Clusiaceae	*Mesua kunstleri*	0	1	0	0	0
75	Coniferae	*Agathis alba*	0	0	0	0	2
76	Coniferae	*Dacrydium elatum*	0	0	0	0	2
77	Connaraceae	*Agelaea borneensis*	0	0	3	0	0
78	Connaraceae	*Connarus grandis*	0	0	7	0	0
79	Connaraceae	*Connarus planchonianus*	0	0	1	0	0
80	Crypteroniaceae	*Crypteronia paniculata*	0	0	0	2	0
81	Dilleniaceae	*Tetracera akara*	3	0	0	0	0
82	Dilleniaceae	*Tetracera macrophylla*	5	1	0	0	0
83	Dipterocarpaceae	*Anisoptera curtisii*	0	1	0	0	0
84	Dipterocarpaceae	*Dipterocarpus fagineus*	0	0	3	0	0
85	Dipterocarpaceae	*Dipterocarpus grandiflorus*	0	0	4	0	0
86	Dipterocarpaceae	*Dipterocarpus oblongifolius*	0	0	1	0	0
87	Dipterocarpaceae	*Hopea beccariana*	0	2	6	0	1
88	Dipterocarpaceae	*Hopea sangal*	0	0	0	0	1
89	Dipterocarpaceae	*Shorea ciliata*	0	0	0	0	2

90	Dipterocarpaceae	*Shorea curtisii*	0	28	3	0	1
91	Dipterocarpaceae	*Shorea dasyphylla*	1	0	0	0	0
92	Dipterocarpaceae	*Shorea glauca*	0	1	1	0	0
93	Dipterocarpaceae	*Shorea guiiso*	0	0	0	0	1
94	Dipterocarpaceae	*Shorea leprosula*	0	0	0	0	1
95	Dipterocarpaceae	*Shorea longisperma*	0	0	3	0	0
96	Dipterocarpaceae	*Shorea macroptera*	0	0	0	0	3
97	Dipterocarpaceae	*Shorea multiflora*	0	5	20	0	1
98	Dipterocarpaceae	*Shorea ovata*	0	1	0	0	0
99	Dipterocarpaceae	*Shorea pauciflora*	0	1	0	0	0
100	Dipterocarpaceae	*Vatica bella*	0	18	109	0	0
101	Dipterocarpaceae	*Vatica odorata*	0	2	0	0	0
102	Dipterocarpaceae	*Vatica pauciflora*	4	1	1	0	0
103	Ebenaceae	*Diospyros andamanica*	1	0	0	0	0
104	Ebenaceae	*Diospyros buxifolia*	0	0	0	0	1
105	Ebenaceae	*Diospyros kurzii*	0	0	0	0	1
106	Ebenaceae	*Diospyros lucida*	0	0	0	0	2
107	Ebenaceae	*Diospyros scortechinii*	0	1	1	0	0

108	Ebenaceae	*Diospyros singaporensis*	1	0	0	0	0
109	Ebenaceae	*Diospyros sumatrana*	1	0	0	0	0
110	Ebenaceae	*Diospyros tritis*	1	0	0	0	0
111	Elaeocarpaceae	*Elaeocarpus pedunculatus*	0	2	0	0	0
112	Elaeocarpaceae	*Elaeocarpus spp*	0	0	0	0	2
113	Euphorbiaceae	*Antidesma montanum*	0	0	0	0	1
114	Euphorbiaceae	*Antidesma velutinosum*	0	0	0	5	0
115	Euphorbiaceae	*Aporosa aurea*	0	0	0	1	0
116	Euphorbiaceae	*Aporosa benthamiana*	0	0	0	8	0
117	Euphorbiaceae	*Aporosa nervosa*	6	0	0	0	0
118	Euphorbiaceae	*Aporosa nigropunctata*	0	0	0	12	0
119	Euphorbiaceae	*Aporosa prainiana*	0	0	0	1	0
120	Euphorbiaceae	*Aporosa spp*	0	0	1	0	0
121	Euphorbiaceae	*Aporosa symplocoides*	0	0	0	0	1
122	Euphorbiaceae	*Baccaurea brevipes*	0	0	0	0	2
123	Euphorbiaceae	*Baccaurea parvifolia*	3	0	0	0	0
124	Euphorbiaceae	*Baccaurea sumatrana*	0	0	0	1	0
125	Euphorbiaceae	*Cleistanthus glaber*	1	0	0	0	0

126	Euphorbiaceae	*Drypetes indica*	0	0	0	1	0
127	Euphorbiaceae	*Drypetes pendula*	2	0	0	0	0
128	Euphorbiaceae	*Drypetes perakensis*	0	0	0	1	0
129	Euphorbiaceae	*Baccaurea minor*	0	3	1	0	0
130	Euphorbiaceae	*Glochidion hypoleucum*	0	1	0	3	0
131	Euphorbiaceae	*Glochidion superbum*	0	1	0	0	0
132	Euphorbiaceae	*Glochidion wallichianum*	2	0	0	0	0
133	Euphorbiaceae	*Macaranga amissa*	0	1	0	0	0
134	Euphorbiaceae	*Macaranga conifera*	1	0	0	2	0
135	Euphorbiaceae	*Macaranga lowii*	0	0	4	0	0
136	Euphorbiaceae	*Mallotus dispar*	0	0	0	0	2
137	Euphorbiaceae	*Pimelodendron griffithianum*	0	0	1	0	0
138	Fabaceae	*Acasia auriculiformis*	0	0	0	0	1
139	Fabaceae	*Agelaea macrophylla*	1	0	0	0	0
140	Fabaceae	*Bauhinia bidentata*	1	0	3	0	0
141	Fabaceae	*Callerya atropurpurea*	2	1	2	6	0
142	Fabaceae	*Cynometra malaccensis*	2	0	0	0	0
143	Fabaceae	*Dalbergia junghuhnii*	0	1	1	0	0

144	Fabaceae	*Dalbergia pubinervis*	4	0	0	0	0
145	Fabaceae	*Dalbergia rostrata*	0	0	2	0	0
146	Fabaceae	*Fordia unifoliata*	0	2	0	1	0
147	Fabaceae	*Milletia sericea*	1	0	0	0	0
148	Fabaceae	*Sindora coriacea*	3	0	0	0	0
149	Fabaceae	*Spatholobus ferrugineus*	3	0	0	0	0
150	Fagaceae	*Castanopis inermis*	0	0	0	0	2
151	Fagaceae	*Lithocarpus ewyckii*	0	12	0	0	4
152	Fagaceae	*Lithocarpus lucidus*	0	0	1	0	0
153	Fagaceae	*Lithocarpus sundaica*	0	0	0	0	7
154	Flacourtiaceae	*Homalium longifolium*	2	0	0	0	0
155	Flacourtiaceae	*Ryparosa kunstleri*	1	0	0	0	0
156	Flacourtiaceae	*Scolopia spinosa*	0	0	0	1	0
157	Gnetaceae	*Gnetum latifolium*	0	5	1	0	0
158	Gnetaceae	*Gnetum macrostachyum*	1	0	0	0	0
159	Icacinaceae	*Gonocaryum gracile*	0	0	1	2	0
160	Ixonanthaceae	*Ixonanthes reticulata*	0	0	0	2	0
161	Lauraceae	*Actinodaphne pruinosa*	0	0	0	0	1

162	Lauraceae	*Actinodaphne sesquipedalis*	0	0	0	8	0
163	Lauraceae	*Beilschmiedia insignus*	0	0	0	7	0
164	Lauraceae	*Beilschmiedia kunstleri*	0	2	0	0	0
165	Lauraceae	*Beilschmiedia maingayi*	0	2	0	0	0
166	Lauraceae	*Beilschmiedia penangiana*	0	0	0	0	1
167	Lauraceae	*Cinnamomum cuspidatum*	0	0	0	0	1
168	Lauraceae	*Cinnamomum kunstleri*	0	0	0	0	5
169	Lauraceae	*Cinnamomum parthenoxyllum*	0	0	0	0	4
170	Lauraceae	*Cinnamomum porectum*	0	0	0	3	1
171	Lauraceae	*Cryptocarya infectoria*	1	1	0	0	0
172	Lauraceae	*Deehasia longipetiolata*	1	0	0	0	0
173	Lauraceae	*Litsea castanea*	0	0	0	0	1
174	Lauraceae	*Litsea firma*	1	0	0	0	0
175	Lauraceae	*Litsea wrayi*	0	0	0	2	0
176	Lauraceae	*Neolitsea zeylanica*	0	0	0	0	1
177	Lecythidaceae	*Baringtonia fusiformis*	0	0	0	0	3
178	Lecythidaceae	*Barringtonia macrostaychya*	0	0	0	3	0
179	Loganaceae	*Fragraea racemosa*	0	0	0	1	0

180	Melastomataceae	*Melastoma sanguineum*	0	1	0	4	0
181	Melastomataceae	*Pternandra coerulescens*	0	3	0	0	1
182	Melastomataceae	*Pternandra echinata*	0	4	0	0	0
183	Meliaceae	*Aglaia aspera*	0	0	0	1	0
184	Meliaceae	*Aglaia leptantha*	4	0	0	0	0
185	Meliaceae	*Aglaia rubescens*	0	0	0	1	0
186	Meliaceae	*Azadirachta excelsa*	0	0	1	0	0
187	Meliaceae	*Chisocheton tomentosum*	2	0	0	0	0
188	Meliaceae	*Dysoxylum cauliflorum*	0	0	0	1	0
189	Meliaceae	*Langsium spp*	1	0	0	0	0
190	Moraceae	*Artocarpus gameziana*	0	0	0	0	1
191	Moraceae	*Artocarpus integer*	0	0	0	0	1
192	Moraceae	*Artocarpus lanceifolius*	1	0	1	0	0
193	Moraceae	*Artocarpus nitidus*	0	2	2	0	0
194	Moraceae	*Artocarpus scortechinii*	0	0	0	0	1
195	Moraceae	*Artocarpus rigidus*	2	0	0	0	0
196	Moraceae	*Prainea limpato*	4	0	0	0	0
197	Moraceae	*Streblus elongatus*	17	0	3	0	4

198	Myristicaceae	*Gymnochanthera forbesii*	0	0	0	0	3
199	Myristicaceae	*Horsfieldia polyspherula*	1	0	0	0	0
200	Myristicaceae	*Horsfieldia polyspherula var.sumatrana*	0	0	0	2	0
201	Myristicaceae	*Knema conferta*	0	0	0	2	0
202	Myristicaceae	*Knema curtisii*	9	1	0	4	1
203	Myristicaceae	*Knema hookeriana*	4	0	0	0	1
204	Myristicaceae	*Knema laurina*	2	0	0	0	0
205	Myristicaceae	*Knema stenophylla*	1	0	0	0	0
206	Myristicaceae	*Myristica fragrans*	0	0	0	0	1
207	Myrsinaceae	*Embelia lampani*	0	5	0	0	0
208	Myrtaceae	*Leptospermum flavescens*	0	0	0	0	2
209	Myrtaceae	*Rhodamnia cinerea*	0	3	0	18	1
210	Myrtaceae	*Syzygium bernardi*	0	0	0	0	13
211	Myrtaceae	*Syzygium chlorantha*	0	1	0	0	0
212	Myrtaceae	*Syzygium filiforme*	0	0	0	1	0
213	Myrtaceae	*Syzygium gracile*	0	0	0	1	0
214	Myrtaceae	*Syzygium kunstleri*	0	0	0	0	1
215	Myrtaceae	*Syzygium napiformis*	0	0	0	7	6

216	Myrtaceae	*Syzygium nigricans*	0	0	0	1	0
217	Myrtaceae	*Syzygium politum*	0	1	0	1	0
218	Myrtaceae	*Syzygium scortechinii*	0	0	0	0	1
219	Myrtaceae	*Syzygium zeylanicum*	0	0	0	0	13
220	Myrtaceae	*Syzygium spp*	2	8	0	0	0
221	Myrtaceae	*Syzygium subrufa*	0	0	0	0	1
222	Myrtaceae	*Syzygium syzygioides*	0	0	0	5	0
223	Myrtaceae	*Tristaniopsis merguensis*	0	0	0	0	1
224	Olacaceae	*Ochanostachys amnetacea*	1	0	0	0	0
225	Polygalaceae	*Xanthophyllum griffithii*	1	0	0	0	0
226	Proteaceae	*Heliciopsis whitmore*	0	0	0	1	0
227	Rhamnaceae	*Luvunga scandens*	1	0	0	0	0
228	Rhamnaceae	*Ziziphus calophylla*	6	0	0	0	0
229	Rhizophoraceae	*Pellacalyx saccardianus*	1	0	0	0	0
230	Rhizophoraceae	*Pellacalyx axillaris*	0	1	0	0	0
231	Rosaceae	*Atuna penangiana*	0	0	0	0	1
232	Rosaceae	*Parinari costata*	0	0	0	0	1
233	Rosaceae	*Parinari griffithianum*	0	0	0	0	1

234	Rosaceae	*Prunus arborea*	0	2	0	0	0
235	Rosaceae	*Prunus arborea*	0	1	0	0	0
236	Rubiaceae	*Aidia densiflora*	1	0	0	0	0
237	Rubiaceae	*Canthium aciculatum*	0	0	0	2	0
238	Rubiaceae	*Diplospora malaccensis*	1	0	0	0	0
239	Rubiaceae	*Eurya acuminata*	0	0	0	0	3
240	Rubiaceae	*Hypobathrium racemosum*	0	0	0	1	0
241	Rubiaceae	*Mussaendopsis beccariana*	0	0	0	1	0
242	Rubiaceae	*Pertusadina euryhncha*	1	16	0	7	0
243	Rubiaceae	*Porterandia anisophyllea*	0	5	0	5	3
244	Rubiaceae	*Psydrax spp*	0	9	0	5	2
245	Rubiaceae	*Randia densiflora*	0	0	0	0	9
246	Rubiaceae	*Timonius wallichianus*	1	0	0	1	0
247	Rubiaceae	*Urophyllum glabrum*	1	0	0	1	4
248	Rubiaceae	*Urophyllum umbellatum*	0	0	0	0	2
249	Rutaceae	*Acronychia pedunculata*	0	1	0	0	0
250	Rutaceae	*Luvunga crassifolia*	0	1	0	0	0
251	Sapindaceae	*Guioa pleuropteris*	0	2	0	0	0

252	Sapindaceae	*Nephelium cuspidatum*	1	0	0	0	0
253	Sapindaceae	*Nephelium costatum*	0	0	1	0	0
254	Sapotaceae	*Madhuca kingiana*	2	0	0	0	0
255	Sapotaceae	*Madhuca utilis*	0	0	0	11	0
256	Sapotaceae	*Palaquium gutta*	0	0	0	2	0
257	Sapotaceae	*Palaquium hexandrum*	0	3	1	13	0
258	Sapotaceae	*Palaquium obovatum*	0	0	0	2	0
259	Sapotaceae	*Palaquium rostratum*	0	2	0	0	0
260	Simaroubaceae	*Eurycoma longifolia*	0	2	0	2	1
261	Smilacaceae	*Smilax setosa*	2	0	0	0	0
262	Sterculiaceae	*Byttneria maingayi*	2	0	0	0	0
263	Theaceae	*Adinandra dumosa*	0	0	0	0	1
264	Theaceae	*Gordonia singaporiana*	0	2	0	0	0
265	Theaceae	*Schima wallichii*	0	3	0	0	0
266	Thymelaeaceae	*Aquilaria malaccensis*	0	0	0	6	0
267	Thymelaeaceae	*Gonystylus affinis*	0	2	0	0	0
268	Tiliaceae	*Grewia antidesmaefolia*	0	0	0	0	1
269	Tiliaceae	*Pentace curtisii*	5	0	0	0	0

270	Tiliaceae	*Schoutenia acrescens*	2	0	0	0	1
271	Ulmaceae	*Gironniera parvifolia*	0	3	4	0	0
272	Verbenaceae	*Clerodendron spp*	0	0	0	0	1
273	Verbenaceae	*Teijsmanniodendron coriaceum*	0	4	5	0	0