

THE VASCULAR PLANT FLORA OF ABANDONED PLANTATIONS IN SINGAPORE IV: WINDSOR FOREST

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ABSTRACT. — A checklist of vascular plant species was compiled for Windsor Forest, a patch of secondary regrowth forest bounded by Island Club Road, Venus Drive, Windsor Estate, and the Central Catchment Nature Reserve. We sampled five 20 × 20 m vegetation plots within the abandoned rubber plantation region of this forest. Within each plot, we recorded all vascular plant species and measured the diameter at breast height (DBH) of all woody stems with a DBH ≥ 5 cm. We conducted additional opportunistic surveys to supplement the plot data. A total of 311 species from 97 families was recorded, of which 276 are native, 30 are exotic, four are cryptogenic, and one has not yet been assessed. Of the native species, 57 are nationally critically endangered (three of which are likely to have persisted from cultivation rather than being from wild, native, genetic provenance), 49 are nationally endangered, and 75 are nationally vulnerable. Among the measured woody stems, Pará rubber (*Hevea brasiliensis*) was the species found to occur most frequently on average, but apart from this, all other species that were measured are native. Windsor Forest is likely important as a refuge for many nationally critically endangered species and as a buffer to the Central Catchment Nature Reserve.

KEY WORDS. — checklist, conservation, flora, Venus Drive, MacRitchie Reservoir Park, secondary forest

INTRODUCTION

Windsor Forest (01°21'20"N, 103°49'15"E) is a patch of secondary forest that has regenerated on land that was once used for cultivation. It is located in central Singapore, and is bounded by Island Club Road, Venus Drive, Windsor Estate, and the Central Catchment Nature Reserve (Figs. 1, 2A, and 2B). Based on Google Earth® satellite images, its current area is 57.4 ha. Windsor Forest is under the jurisdiction of the National Parks Board (NParks), Singapore, but lies just outside the boundary of the Central Catchment Nature Reserve as delineated in the Master Plan 2008 of the Urban Redevelopment Authority (URA), Singapore (URA, 2008a; SLA, 2014). It is separated from MacRitchie Reservoir Park by the MacRitchie Nature Trail (an approximately three man-wide dirt and gravel trail; Fig. 2C) and a narrow-strip buffer of old growth forest (mature secondary forest and primary forest). In the URA Parks and Waterbodies Plan (URA, 2008b), the forest patch is referred to by the name “Windsor Park Interim Green”.

Windsor Forest was part of a rubber estate from the 1920s to the 1970s (Fig. 2D; Surveyor-General, Federated Malay States and Straits Settlements, 1924; Survey Production Centre, South East Asia, 1945; URA, 1958; Chief Surveyor, Singapore, 1969). Following the subsequent abandonment of the rubber plantations (estimated to be during the 1970s), the area was classified as rubber dominated-vegetation, and considered to be part of a “green belt” outside of the boundary of the Central Catchment Nature Reserve (URA 1980; Singapore Mapping Unit, 1982, 1987, 1992). Windsor Forest was slated to be developed for residential use in the Master Plan 2008 (URA, 2008a), however it has since been classified as a “reserve” site instead, according to the proposed land use plan beyond 2030 (MND, 2013). A “reserve” site is land held in reserve for future planning, not to be confused with a nature reserve, and it can be used for residential, industrial, or other uses (MND, 2013).

Secondary forests that have regenerated on abandoned agricultural land, and which are often dominated by exotic species, have been shown to support the re-colonisation of native species (Lugo & Helmer, 2004). They are resource pools in which animals have been found to forage and transit (McShea et al., 2009), and may be the last refuges in which some primary forest species can persist (Turner & Corlett, 1996). In urban Singapore, secondary forests have been found to support populations of birds, butterflies, and frogs (Koh & Sodhi, 2004; Castelletta et al., 2005; Bickford et al., 2010; Chong et al., 2014). This paper aims to provide an accessible working checklist of the vascular plant species of Windsor Forest, which may be useful in the assessment of its value for conservation.



Fig. 1. Windsor Forest and nearby landmarks (Google, 2012). The red outline shows the extent of the forest at 13 Apr.2011 (date that the satellite image was acquired). The locations of the surveyed vegetation plots are represented by yellow dots labelled GA1–5.

MATERIAL AND METHODS

Five vegetation plots of 20×20 m each were surveyed within the abandoned rubber plantation region of Windsor Forest in 2012. We determined the extent of the rubber plantations by comparing topographic maps of Singapore against the latest Google Earth satellite image of the forest (Google, 2012). The fTools v. 0.6.1 plugin for the Quantum GIS software v. 1.6.0 (Quantum GIS Development Team, 2010) was used to derive a random location for each plot, but we also ensured a minimum distance of 60 m between plots, and that each plot was located at least 40 m from the forest edge, to ensure independence and avoid the edge effect, respectively. We recorded all species of vascular plants found within each plot. Where species could not be identified in the field, specimens were collected to be identified in the laboratory or in the Singapore Botanic Gardens Herbarium (SING). To estimate species dominance, we measured the stem diameter at breast height (DBH; measured at 1.3 m above the ground) of all woody stems with $\text{DBH} \geq 5$ cm (including lianas). Palms (Arecaceae) were not measured owing to the difficulty in measuring the true stems for some species. We conducted additional opportunistic surveys of the forest in the year 2014. The actual area of Windsor Forest was derived from OneMap (SLA, 2014), and saved on a Global Positioning System (GPS) receiver. We then recorded all species observed within the defined boundary, with some room allowed for satellite reception error.

A checklist of the recorded vascular plant species was compiled, with the nomenclature and national status category of each species following or updating those of Chong et al. (2009). The ‘specaccum’ function implemented in the vegan v. 2.0-2 package of the statistical software R v. 2.14.1 (R Development Core Team, 2011) was used to construct a species accumulation curve from the five sampled plots, to determine how the number of recorded vascular plant species increased with sampling effort. The approximate total number of species in the species pool, i.e., including unseen or undetected species, was calculated using the ‘specpool’ function in the vegan v. 2.0-2 package (R Development Core Team, 2011).

RESULTS

A total of 311 vascular plant species from 97 families was recorded. The species and their national conservation status categories are provided in Appendix 1. Based on Chong et al. (2009), 276 of the recorded species are native, 30 are exotic, four are cryptogenic [equivalent to the “Weed of Uncertain Origin” category in Chong et al., (2009)], and one has not been assessed. Of the native species, five are species once presumed to be nationally extinct, 57 are nationally critically endangered, 49 are nationally endangered, and 75 are nationally vulnerable (Table 1). Of the critically endangered species, three are likely to have persisted from cultivation: *Baccaurea motleyana* (rambai), *Gnetum gnemon* var. *gnemon* (belinjau), and *Nephelium lappaceum* (rambutan). The other critically endangered species include



Fig. 2. A, Windsor Forest as seen from the end of Gardenia Road; B, Windsor Forest, with part of Windsor Estate shown on the right; C, the MacRitchie Nature Trail, with Windsor Forest shown on the left; D, a *Hevea brasiliensis* tree with remnant tap marks on the trunk. (Photographs by: Louise Neo).

Byttneria maingayi, *Cryptocoryne griffithii*, and *Dipterocarpus kunstleri* (Figs. 3A–C, respectively). Of the species once presumed to be nationally extinct, *Grenacheria amentacea* and *Meliosma pinnata* subsp. *ridleyi* were re-collected after the publication of the 2nd Edition of the Singapore Red Data Book, while *Willughbeia coriacea* was erroneously listed as extinct (Chong et al., 2012). The other two species, *Trigoniastrum hypoleucum* and *Uvaria lobbiana*, were identified from non-fertile specimens and have not yet conclusively been “rediscovered”. Further collections will probably be required to confirm the identities of these two species.

Three species were not listed in the checklist by Chong et al. (2009), and have not been assessed for their national conservation statuses: *Desmos dunalii*, *Psydrax* sp. 10 of Wong (1989), and *Tectaria incisa*. The specimen of *Desmos dunalii* was non-fertile, and was identified from a likewise non-fertile specimen collected from Pulau Tekong in the year 2007 (SING 0096355; this species was not recorded from Singapore prior to this), noted to be a possible new record for Singapore. *Psydrax* sp. 10 is known to occur in the Bukit Timah and Central Catchment nature reserves (e.g., Wong et al., 1994; Tan et al., 1995; Turner & Chua, 2011), and was previously recorded from the Upper Thomson

Table 1. Summary of the national status categories of the vascular plants of Windsor Forest.

Nativeness	National Status Category	No. of Species	Percentage of All Species	Percentage of all Native Species
Exotic	Naturalised	14	4.50	–
	Casual	12	3.86	–
	Cultivated only	3	0.96	–
	Not assessed	1	0.32	–
	Total	30	9.65	–
Cryptogenic	Cryptogenic	4	1.29	–
	Total	4	1.29	–
Not assessed	Not assessed	1	0.32	–
	Total	1	0.32	–
Native	Critically endangered (persistence from cultivation)	3	0.96	1.09
	Critically endangered	54	17.36	19.27
	Endangered	49	15.76	17.82
	Vulnerable	75	24.12	27.27
	Common	89	28.62	32.36
	Not assessed	1	0.32	0.36
	Rediscovered	5	1.61	1.82
	Total	276	88.75	–

Forest (Neo et al., 2014). *Tectaria incisa* has been recorded from Bukit Batok Nature Park, Lentor Forest, and Upper Thomson Forest (Neo et al., 2013a; 2013b; 2014), and from the Singapore Botanic Gardens as an escapee of cultivation (SING 0044827 and SING 0155708).

When the number of species recorded from only the surveyed plots was plotted against sampling effort, it was found that the species accumulation curve did not approach an asymptote, suggesting that we would expect more species to be recorded with more survey effort (Fig. 4). Based on the most conservative estimates (Chao and Jackknife 2), the vegetation plots sampled 63% of the total number of species in the species pool of Windsor Forest. The total number of species is estimated to range from 186–252 (Table 2). In Appendix 2, we present the species for which we measured basal area, ordered by the mean number of stems measured per plot, except for species for which only a single individual occurred out of all the plots, which are ordered by basal area instead. The species found to occur most frequently was Pará rubber (*Hevea brasiliensis*), which averaged 18 stems per plot and made up 4.3% of the basal area measured in a plot on average. The most dominant species by basal area was *Syzygium filiforme*, of which a single individual was found to make up 9.26% of the basal area of one plot. Except for *Hevea brasiliensis*, all of the species measured are native. The next most frequently-occurring species was found to be *Rhodamnia cinerea*, which is characteristic of regenerating secondary forest in Singapore (Corlett 1991; Boo, 1996; Shono et al., 2006).

DISCUSSION

We observed a high occurrence of nationally critically endangered species, especially in the part of Windsor Forest that is closer to the MacRitchie Trail, and hence the old growth forest of MacRitchie Reservoir Park. For example, we found an abundance of dipterocarp saplings growing in the vicinity of their parent tree, within the boundary of Windsor Forest (Fig. 3C). Given more time, and its proximity to old growth forest, Windsor Forest may be able to further accumulate such nationally threatened species, and perhaps serve as an additional refuge for these species in Singapore. Thus, it may be necessary to relook at the delineation of the boundary between the Central Catchment Nature Reserve and Windsor Forest. Ideally, Windsor Forest should be left intact as a buffer area between the MacRitchie Reservoir Park old growth forest and the urban areas of Windsor Estate and beyond.

Table 2. Approximate true number of species calculated based on data from the five sampled plots, using four commonly used species richness estimators.

Estimator	Chao	Jackknife 1	Jackknife 2	Bootstrap
Predicted number of species	250.18	220.40	252.35	186.28
Proportion of the observed number of species out of the total predicted number of species	0.63	0.72	0.63	0.85



Fig. 3. A, The leaves and flowers of *Byttneria maingayi*, a critically endangered climber; B, *Cryptocoryne griffithii* growing in a freshwater stream in the forest; C, *Dipterocarpus kunstleri* saplings (indicated by red arrows) growing within the boundary of Windsor Forest. (Photographs by: Louise Neo).

CONCLUSIONS

The Pará rubber tree (*Hevea brasiliensis*), occurs at the highest frequency out of all the stems we measured in Windsor Forest, despite the abandonment of the rubber plantations about 40 years ago. Despite this, 89% of the plant species recorded from this forest patch are native, and 60% are nationally threatened. It is likely that Windsor Forest currently acts as a buffer to the Central Catchment Nature Reserve, and we recommend that it continue to be conserved as such.

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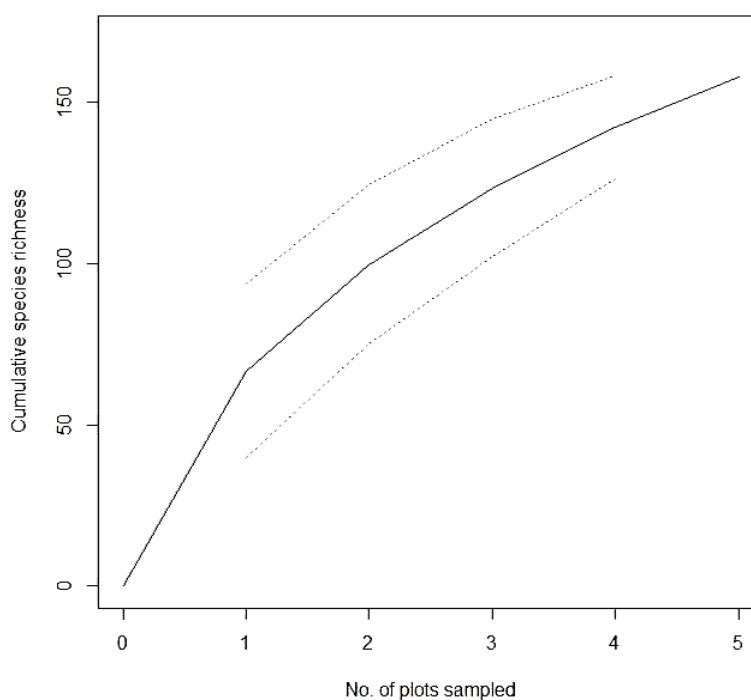


Fig. 4. Species accumulation curve showing the cumulative increase in the number of species recorded from the five sampled plots. The dotted lines represent 95% confidence intervals of the curve.

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APPENDIX 1

Checklist of the vascular plant flora of Windsor Forest. Nomenclature and conservation status categories follow those of Chong et al. (2009) with some updates based on our observations. "Weed of Uncertain Origin" of Chong et al. (2009) is "Cryptogenic" in this list. Species are grouped by family and arranged in alphabetical order.

S/No.	Species	Nativeness	National Status
ACANTHACEAE			
1.	<i>Asystasia gangetica</i> (L.) T.Anderson subsp. <i>micrantha</i> (Nees) Ensermu	Exotic	Naturalised
ANACARDIACEAE			
2.	<i>Buchanania sessifolia</i> Blume	Native	Vulnerable
3.	<i>Camposperma squamatum</i> Ridl.	Native	Common
4.	<i>Mangifera indica</i> L.	Exotic	Casual
ANISOPHYLLACEAE			
5.	<i>Anisophyllea disticha</i> (Jack) Baill.	Native	Common
ANNONACEAE			
6.	<i>Artabotrys suaveolens</i> (Blume) Blume	Native	Endangered
7.	<i>Cyathocalyx ramuliflorus</i> (Maingay ex Hook.f. & Thoms.) Scheff.	Native	Common
8.	<i>Cyathocalyx ridleyi</i> (King) Sinclair	Native	Vulnerable
9.	<i>Dasymaschalon dasymaschalum</i> (Blume) Turner	Native	Critically endangered
10.	<i>Desmos dunalii</i> (Wall.ex Hook.f. & Thoms.) Saff.	Not assessed	Not assessed (possible new record)
11.	<i>Fissistigma fulgens</i> (Hook.f. & Thoms.) Merr.	Native	Vulnerable
12.	<i>Fissistigma latifolium</i> (Dunal) Merr. var. <i>ovoideum</i> (King) Sinclair	Native	Vulnerable
13.	<i>Friesodielsia latifolia</i> (Hook.f. & Thoms.) Steenis	Native	Common
14.	<i>Mitrella kentii</i> (Blume) Miq.	Native	Common
15.	<i>Popowia tomentosa</i> Maing. ex Hook.f. & Thoms.	Native	Endangered
16.	<i>Uvaria lobbiana</i> Hook.f. & Thoms.	Native	Rediscovered
17.	<i>Xylopiia caudata</i> Hook.f. & Thoms.	Native	Vulnerable
18.	<i>Xylopiia malayana</i> Hook.f. & Thoms.	Native	Common
APOCYNACEAE			
19.	<i>Alstonia angustifolia</i> Wall. ex A.DC.	Native	Common
20.	<i>Alstonia angustiloba</i> Miq.	Native	Common
21.	<i>Anodendron candolleianum</i> Wight	Native	Critically endangered
22.	<i>Dyera costulata</i> (Miq.) Hook.f.	Native	Common
23.	<i>Parameria laevigata</i> (A.L.Juss.) Moldenke	Native	Critically endangered
24.	<i>Parameria polyneura</i> Hook.f.	Native	Critically endangered
25.	<i>Strophanthus caudatus</i> (L.) Kurz	Native	Critically endangered
26.	<i>Urceola torulosa</i> Hook. f.	Native	Endangered
27.	<i>Willughbeia coriacea</i> Wall.	Native	Rediscovered
AQUIFOLIACEAE			
28.	<i>Ilex cymosa</i> Blume	Native	Common
ARACEAE			
29.	<i>Aglaonema nebulosum</i> N.E.Br.	Native	Vulnerable
30.	<i>Alocasia macrorrhizos</i> (L.) G.Don	Exotic	Naturalised
31.	<i>Cryptocoryne griffithii</i> Schott	Native	Critically endangered
32.	<i>Dieffenbachia seguine</i> (Jacq.) Schott var. <i>seguine</i>	Exotic	Casual
33.	<i>Epipremnum aureum</i> (Linden ex André) Bunting	Exotic	Casual
34.	<i>Epipremnum pinnatum</i> (L.) Engl.	Native	Critically endangered
35.	<i>Scindapsus hederaceus</i> Schott	Native	Common
36.	<i>Syngonium podophyllum</i> Schott	Exotic	Naturalised
ARALIACEAE			
37.	<i>Arthrophyllum diversifolium</i> Blume	Native	Common

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S/No.	Species	Nativeness	National Status
ARECACEAE			
38.	<i>Caryota mitis</i> Lour.	Native	Common
39.	<i>Cocos nucifera</i> L.	Exotic	Naturalised
40.	<i>Elaeis guineensis</i> Jacq.	Exotic	Casual
41.	<i>Licuala ferruginea</i> Becc.	Native	Endangered
42.	<i>Oncosperma tigillarum</i> (Jack) Ridl.	Native	Vulnerable
43.	<i>Plectocomia elongata</i> Mart. ex Blume	Native	Vulnerable
44.	<i>Ptychosperma macarthurii</i> (H.Wendl. ex anon.) H.Wendl. ex Hook.f.	Exotic	Naturalised
ARISTOLOCHIACEAE			
45.	<i>Thottea grandiflora</i> Rottb.	Native	Vulnerable
ASPARAGACEAE			
46.	<i>Dracaena fragrans</i> (L.) Ker Gawl.	Exotic	Casual
47.	<i>Dracaena porteri</i> Baker	Native	Common
ASPLENIACEAE			
48.	<i>Asplenium longissimum</i> Blume	Native	Common
49.	<i>Asplenium nidus</i> L.	Native	Common
ASTERACEAE			
50.	<i>Mikania micrantha</i> Kunth	Exotic	Naturalised
BIGNONIACEAE			
51.	<i>Spathodea campanulata</i> P.Beauv.	Exotic	Naturalised
BLECHNACEAE			
52.	<i>Blechnum finlaysonianum</i> Wall. ex Hook. & Grev.	Native	Vulnerable
BURSERACEAE			
53.	<i>Canarium pilosum</i> Benn.	Native	Endangered
54.	<i>Santiria apiculata</i> Benn.	Native	Common
55.	<i>Santiria griffithii</i> (Hook.f.) Engl.	Native	Common
56.	<i>Santiria laevigata</i> Blume	Native	Vulnerable
CALOPHYLLACEAE			
57.	<i>Calophyllum ferrugineum</i> Ridl.	Native	Common
58.	<i>Calophyllum pulcherrimum</i> Wall. ex Choisy	Native	Common
59.	<i>Calophyllum rubiginosum</i> Hend. & Wyatt-Smith	Native	Endangered
60.	<i>Calophyllum teysmannii</i> Miq.	Native	Vulnerable
61.	<i>Calophyllum wallichianum</i> Planch. & Tr. var. <i>incrassatum</i> (Hend. & Wyatt-Smith) P.F.Stevens	Native	Vulnerable
CANNABACEAE			
62.	<i>Gironniera nervosa</i> Planch.	Native	Common
63.	<i>Gironniera subaequalis</i> Planch.	Native	Endangered
64.	<i>Trema tomentosa</i> (Roxb.) H.Hara	Native	Common
CELASTRACEAE			
65.	<i>Kokoona reflexa</i> (Laws.) Ding Hou	Native	Critically endangered
66.	<i>Lophopetalum wightianum</i> Arn.	Native	Vulnerable
CENTROPLACACEAE			
67.	<i>Bhesa paniculata</i> Arn.	Native	Common
CHRYSOBALANACEAE			
68.	<i>Licania splendens</i> (Korth.) Prance	Native	Common

S/No.	Species	Nativeness	National Status
CLUSIACEAE			
69.	<i>Garcinia forbesii</i> King	Native	Critically endangered
70.	<i>Garcinia griffithii</i> T.Anderson	Native	Endangered
71.	<i>Garcinia parvifolia</i> Miq.	Native	Common
72.	<i>Garcinia rostrata</i> (Hassk.) Miq.	Native	Critically endangered
COMMELINACEAE			
73.	<i>Amischotolype gracilis</i> (Ridl.) I.M.Turner	Native	Common
CONNARACEAE			
74.	<i>Agelaea macrophylla</i> (Zoll.) Leenh.	Native	Critically endangered
75.	<i>Agelaea borneensis</i> (Hook.f.) Merr.	Native	Vulnerable
76.	<i>Cnestis palala</i> (Lour.) Merr.	Native	Common
77.	<i>Rourea asplenifolia</i> (Schellenb.) Jongkind.	Native	Critically endangered
78.	<i>Rourea fulgens</i> Planch.	Native	Vulnerable
79.	<i>Rourea mimosoides</i> (Vahl) Planch.	Native	Endangered
80.	<i>Rourea minor</i> (Gaertn.) Leenh.	Native	Critically endangered
CONVOLVULACEAE			
81.	<i>Erycibe leucoxyloides</i> King ex Prain	Cryptogenic	Cryptogenic
82.	<i>Erycibe tomentosa</i> Blume	Native	Common
83.	<i>Ipomoea cairica</i> (L.) Sweet	Exotic	Naturalised
COSTACEAE			
84.	<i>Cheilocostus speciosus</i> (J.Koenig) C.D.Specht	Native	Common
CYATHEACEAE			
85.	<i>Cyathea squamulata</i> (Blume) Copel.	Native	Endangered
DENNSTAEDTIACEAE			
86.	<i>Lindsaea ensifolia</i> Sw.	Native	Common
DILLENIAEAE			
87.	<i>Dillenia suffruticosa</i> (Griff. ex Hook.f. & Thomson) Martelli	Native	Common
88.	<i>Tetracera akara</i> (Burm.f.) Merr.	Native	Vulnerable
89.	<i>Tetracera fagifolia</i> Blume	Native	Vulnerable
90.	<i>Tetracera indica</i> (Christm. & Panz.) Merr.	Native	Common
91.	<i>Tetracera macrophylla</i> Wall. ex Hook.f. & Thoms.	Native	Vulnerable
DIOSCOREACEAE			
92.	<i>Dioscorea laurifolia</i> Wall. ex Hook.f.	Native	Common
93.	<i>Dioscorea pyrifolia</i> Kunth	Native	Common
94.	<i>Dioscorea sansibarensis</i> Pax	Exotic	Naturalised
95.	<i>Tacca integrifolia</i> Ker Gawl.	Native	Vulnerable
DIPTEROCARPACEAE			
96.	<i>Dipterocarpus kunstleri</i> King	Native	Critically endangered
97.	<i>Hopea griffithii</i> Kurz	Native	Critically endangered
98.	<i>Hopea mengarawan</i> Miq.	Native	Endangered
99.	<i>Shorea macroptera</i> Dyer subsp. <i>macroptera</i>	Native	Vulnerable
100.	<i>Shorea ovalis</i> Blume subsp. <i>ovalis</i>	Native	Critically endangered
101.	<i>Shorea pauciflora</i> King	Native	Vulnerable
DRYOPTERIDACEAE			
102.	<i>Tectaria incisa</i> Cav.	Exotic	Not assessed
EBENACEAE			
103.	<i>Diospyros pilosanthera</i> Blanco var. <i>oblonga</i> (Wall. ex G.Don) Ng	Native	Vulnerable

S/No.	Species	Nativeness	National Status
ELAEOCARPACEAE			
104.	<i>Elaeocarpus ferrugineus</i> (Jack) Steud.	Native	Common
105.	<i>Elaeocarpus mastersii</i> King	Native	Common
106.	<i>Elaeocarpus petiolatus</i> (Jack) Wall	Native	Common
107.	<i>Elaeocarpus salicifolius</i> King	Native	Vulnerable
108.	<i>Elaeocarpus stipularis</i> Blume	Native	Vulnerable
EUPHORBIACEAE			
109.	<i>Agrostistachys borneensis</i> Becc.	Native	Common
110.	<i>Alchornea villosa</i> (Benth.) Müll.Arg.	Native	Critically endangered
111.	<i>Blumeodendron tokbrai</i> (Blume) Kurz	Native	Vulnerable
112.	<i>Claoxylon indicum</i> (Reinw. ex Blume) Hassk.	Native	Common
113.	<i>Croton oblongus</i> Burm.f.	Native	Endangered
114.	<i>Hevea brasiliensis</i> (Willd. ex A.Juss.) Müll.Arg.	Exotic	Naturalised
115.	<i>Koilodepas longifolium</i> Hook.f.	Native	Vulnerable
116.	<i>Macaranga bancana</i> (Miq.) Müll.Arg.	Native	Common
117.	<i>Macaranga conifera</i> (Zoll.) Müll.Arg.	Native	Common
118.	<i>Macaranga gigantea</i> (Rchb.f. & Zoll.) Müll.Arg.	Native	Common
119.	<i>Macaranga heynei</i> I.M.Johnst.	Native	Common
120.	<i>Macaranga hullettii</i> King ex Hook.f.	Native	Critically endangered
121.	<i>Macaranga recurvata</i> Gage	Native	Critically endangered
122.	<i>Macaranga trichocarpa</i> (Rchb.f. & Zoll.) Müll.Arg.	Native	Endangered
123.	<i>Manihot esculenta</i> Crantz	Exotic	Naturalised
FABACEAE			
124.	<i>Andira inermis</i> (W.Wright) Kunth ex DC.	Exotic	Casual
125.	<i>Archidendron clypearia</i> (Jack) I.C.Nielsen	Native	Common
126.	<i>Baphia nitida</i> Lodd. et al.	Exotic	Casual
127.	<i>Bauhinia semibifida</i> Roxb. var. <i>semibifida</i>	Native	Vulnerable
128.	<i>Dialium platysepalum</i> Baker	Native	Critically endangered
129.	<i>Koompassia malaccensis</i> Maingay ex Benth.	Native	Endangered
130.	<i>Kunstleria ridleyi</i> Prain	Native	Endangered
131.	<i>Mimosa pudica</i> L.	Exotic	Naturalised
132.	<i>Parkia speciosa</i> Hassk.	Native	Vulnerable
133.	<i>Spatholobus ferrugineus</i> (Zoll. & Moritzi) Benth.	Native	Common
FAGACEAE			
134.	<i>Lithocarpus conocarpus</i> (Oudem.) Rehd.	Native	Critically endangered
135.	<i>Lithocarpus ewyckii</i> (Korth.) Rehd.	Native	Endangered
FLAGELLARIACEAE			
136.	<i>Flagellaria indica</i> L.	Native	Common
GENTIANACEAE			
137.	<i>Cyrtophyllum fragrans</i> (Roxb.) DC.	Native	Common
GLEICHENIACEAE			
138.	<i>Dicranopteris curranii</i> Copel.	Native	Common
GNETACEAE			
139.	<i>Gnetum gnemon</i> L. var. <i>gnemon</i>	Native	Critically endangered (persistence from cultivation)
140.	<i>Gnetum macrostachyum</i> Hook.f.	Native	Critically endangered
141.	<i>Gnetum microcarpum</i> Blume	Native	Critically endangered
HYPERICACEAE			
142.	<i>Cratoxylum cochinchinense</i> (Lour.) Blume	Native	Endangered
143.	<i>Cratoxylum maingayi</i> Dyer	Native	Critically endangered

S/No.	Species	Nativeness	National Status
HYPOXIDACEAE			
144.	<i>Molineria latifolia</i> (Dryand. ex W.T.Aiton) Herb. ex Kurz var. <i>latifolia</i>	Native	Vulnerable
ICACINACEAE			
145.	<i>Phytocrene bracteata</i> Wall.	Native	Vulnerable
IRVINGIACEAE			
146.	<i>Irvingia malayana</i> Oliv. ex A.W.Benn.	Native	Critically endangered
IXONANTHACEAE			
147.	<i>Ixonanthes icosandra</i> Jack	Native	Vulnerable
148.	<i>Ixonanthes reticulata</i> Jack	Native	Common
LAMIACEAE			
149.	<i>Clerodendrum deflexum</i> Wall.	Native	Vulnerable
150.	<i>Clerodendrum laevifolium</i> Blume	Native	Common
151.	<i>Clerodendrum paniculatum</i> L.	Exotic	Casual
152.	<i>Clerodendrum villosum</i> Blume	Native	Vulnerable
153.	<i>Vitex pinnata</i> L.	Native	Common
LAURACEAE			
154.	<i>Beilschmiedia madang</i> Blume	Native	Endangered
155.	<i>Cinnamomum iners</i> Reinw.	Native	Common
156.	<i>Dehaasia incrassata</i> (Jack) Kosterm.	Native	Critically endangered
157.	<i>Lindera lucida</i> (Blume) Boerl.	Native	Vulnerable
158.	<i>Litsea accedens</i> (Blume) Boerl.	Native	Endangered
159.	<i>Litsea castanea</i> Hook.f.	Native	Endangered
160.	<i>Litsea elliptica</i> (Blume) Nees	Native	Common
161.	<i>Litsea firma</i> Hook.f.	Native	Vulnerable
162.	<i>Nothaphoebe umbelliflora</i> (Blume) Blume	Native	Common
LINACEAE			
163.	<i>Indorouchera griffithiana</i> (Planch.) Hallier f.	Native	Common
LOGANIACEAE			
164.	<i>Strychnos ignatii</i> P.J.Bergius	Native	Vulnerable
165.	<i>Strychnos maingayi</i> C.B.Clarke	Native	Critically endangered
LYGODIACEAE			
166.	<i>Lygodium longifolium</i> (Willd.) Sw.	Native	Vulnerable
167.	<i>Lygodium microphyllum</i> (Cav.) R.Br.	Native	Common
MAESACEAE			
168.	<i>Maesa ramentacea</i> Wall.ex Roxb.	Native	Common
MAGNOLIACEAE			
169.	<i>Magnolia elegans</i> (Blume) H.Keng	Native	Critically endangered
MALPIGHIACEAE			
170.	<i>Malpighia coccigera</i> L.	Exotic	Casual
MALVACEAE			
171.	<i>Byttneria maingayi</i> Mast.	Native	Critically endangered
172.	<i>Durio zibethinus</i> L.	Exotic	Casual
173.	<i>Heritiera elata</i> Ridl.	Native	Endangered
174.	<i>Pentace triptera</i> Mast.	Native	Endangered
175.	<i>Scaphium macropodium</i> (Miq.) Beumée ex K.Heyne	Native	Endangered

S/No.	Species	Nativeness	National Status
MELASTOMATACEAE			
176.	<i>Clidemia hirta</i> (L.) D.Don	Exotic	Naturalised
177.	<i>Dissochaeta monticola</i> Blume	Native	Vulnerable
178.	<i>Melastoma malabathricum</i> L.	Native	Common
179.	<i>Memecylon lilacinum</i> Z. & M.	Native	Critically endangered
180.	<i>Pternandra caerulescens</i> Jack	Native	Vulnerable
181.	<i>Pternandra echinata</i> Jack	Native	Vulnerable
MELIACEAE			
182.	<i>Aphanamixis polystachya</i> (Wall.) Parker	Native	Endangered
183.	<i>Dysoxylum cauliflorum</i> Hiern	Native	Vulnerable
184.	<i>Lansium domesticum</i> Corrêa	Exotic	Cultivated only
MENISPERMACEAE			
185.	<i>Fibraurea tinctoria</i> Lour.	Native	Common
186.	<i>Limacia scandens</i> Lour.	Native	Vulnerable
MORACEAE			
187.	<i>Artocarpus anisophyllus</i> Miq.	Native	Endangered
188.	<i>Artocarpus elasticus</i> Reinw. ex Blume	Native	Common
189.	<i>Ficus benjamina</i> L.	Cryptogenic	Cryptogenic
190.	<i>Ficus chartacea</i> Wall. ex King	Native	Vulnerable
191.	<i>Ficus fistulosa</i> Reinw. ex Blume	Native	Common
192.	<i>Ficus punctata</i> Lam.	Exotic	Cultivated only
193.	<i>Ficus sagittata</i> Vahl	Native	Critically endangered
194.	<i>Ficus variegata</i> Blume	Native	Common
MUSACEAE			
195.	<i>Musa</i> cultivar	Exotic	Cultivated only
MYRICACEAE			
196.	<i>Myrica esculenta</i> Buch.-Ham. ex D.Don	Native	Common
MYRISTICACEAE			
197.	<i>Gymnacranthera forbesii</i> (King) Warb.	Native	Critically endangered
198.	<i>Horsfieldia polyspherula</i> (Hook.f. emend. King) J.Sinclair var. <i>polyspherula</i>	Native	Vulnerable
199.	<i>Knema hookeriana</i> (Wall. ex Hook.f. & Thoms.) Warb.	Native	Critically endangered
200.	<i>Knema latericia</i> Elm. subsp. <i>ridleyi</i> (Gandoger) de Wilde	Native	Endangered
201.	<i>Knema laurina</i> (Blume) Warb.	Native	Endangered
MYRTACEAE			
202.	<i>Rhodammia cinerea</i> Jack	Native	Common
203.	<i>Syzygium borneense</i> (Miq.) Miq.	Native	Common
204.	<i>Syzygium filiforme</i> (Wall. ex Duthie) Chantaran. & J.Parn. var. <i>filiforme</i>	Native	Endangered
205.	<i>Syzygium grande</i> (Wight) Walp.	Native	Common
206.	<i>Syzygium incarnatum</i> (Elmer) Merr. & L.M.Perry	Native	Endangered
207.	<i>Syzygium lineatum</i> (DC.) Merr. & L.M.Perry	Native	Common
208.	<i>Syzygium nigricans</i> (King) Merr. & L.M.Perry	Native	Endangered
209.	<i>Syzygium polyanthum</i> (Wight) Walp.	Native	Vulnerable
210.	<i>Syzygium ridleyi</i> (King) P.Chantaran. & J.Parn.	Native	Endangered
OLACACEAE			
211.	<i>Erythralum scandens</i> Blume	Native	Vulnerable
212.	<i>Ochanostachys amentacea</i> Mast.	Native	Vulnerable
213.	<i>Strombosia ceylanica</i> Gardn.	Native	Vulnerable
214.	<i>Strombosia javanica</i> Blume	Native	Vulnerable

S/No.	Species	Nativeness	National Status
OLEANDRACEAE			
215.	<i>Nephrolepis auriculata</i> (L.) Trimen	Cryptogenic	Cryptogenic
OPILIACEAE			
216.	<i>Champereia manillana</i> (Blume) Merr.	Native	Common
ORCHIDACEAE			
217.	<i>Bromheadia finlaysoniana</i> (Lindl.) Miq.	Native	Common
PANDACEAE			
218.	<i>Galearia fulva</i> (Tul.) Miq.	Native	Vulnerable
PANDANACEAE			
219.	<i>Pandanus parvus</i> Ridl.	Native	Critically endangered
PENTAPHYLACACEAE			
220.	<i>Adinandra dumosa</i> Jack	Native	Common
PHYLLANTHACEAE			
221.	<i>Antidesma cuspidatum</i> Müll.Arg.	Native	Common
222.	<i>Antidesma velutinosum</i> Blume	Native	Endangered
223.	<i>Aporosa benthamiana</i> Hook.f.	Native	Vulnerable
224.	<i>Aporosa frutescens</i> Blume	Native	Common
225.	<i>Aporosa lucida</i> (Miq.) Airy Shaw var. <i>lucida</i>	Native	Critically endangered
226.	<i>Aporosa nervosa</i> Hook.f.	Native	Vulnerable
227.	<i>Aporosa symplocoides</i> (Hook.f.) Gage	Native	Common
228.	<i>Baccaurea motleyana</i> (Müll.Arg.) Müll.Arg.	Native	Critically endangered (persistence from cultivation)
229.	<i>Baccaurea parviflora</i> (Müll.Arg.) Müll.Arg.	Native	Common
230.	<i>Baccaurea polyneura</i> Hook.f.	Native	Endangered
231.	<i>Bridelia pustulata</i> Hook.f.	Native	Critically endangered
232.	<i>Bridelia stipularis</i> (L.) Blume	Native	Vulnerable
233.	<i>Bridelia tomentosa</i> Blume	Native	Common
PIPERACEAE			
234.	<i>Piper betle</i> L.	Exotic	Casual
235.	<i>Piper caninum</i> Blume	Native	Common
236.	<i>Piper flavimarginatum</i> C.DC.	Native	Critically endangered
237.	<i>Piper porphyrophyllum</i> (Lindl.) N.E.Br.	Native	Endangered
238.	<i>Piper sarmentosum</i> Roxb.	Native	Common
POACEAE			
239.	<i>Centotheca lappacea</i> (L.) Desv.	Native	Critically endangered
POLYGALACEAE			
240.	<i>Xanthophyllum discolor</i> Chodat	Native	Endangered
241.	<i>Xanthophyllum ellipticum</i> Korth.	Native	Critically endangered
242.	<i>Xanthophyllum eurhynchum</i> Miq.	Native	Vulnerable
243.	<i>Xanthophyllum flavescens</i> Roxb.	Native	Endangered
244.	<i>Xanthophyllum vitellinum</i> (Blume) Dietr.	Native	Vulnerable
POLYPODIACEAE			
245.	<i>Goniophlebium percussum</i> (Cav.) Wagner & Grether	Native	Vulnerable
PRIMULACEAE			
246.	<i>Ardisia sanguinolenta</i> Blume	Native	Common
247.	<i>Grenacheria amentacea</i> (C.B.Clarke) Mez	Native	Rediscovered
248.	<i>Labisia pumila</i> (Blume) F.-Vill.	Native	Vulnerable

S/No.	Species	Nativeness	National Status
PTERIDACEAE			
249.	<i>Adiantum latifolium</i> Lam.	Exotic	Naturalised
250.	<i>Taenitis blechnoides</i> (Willd.) Sw.	Native	Common
251.	<i>Taenitis interrupta</i> Hook. & Grev.	Native	Common
RHAMNACEAE			
252.	<i>Ziziphus elegans</i> Wall.	Native	Critically endangered
RHIZOPHORACEAE			
253.	<i>Carallia brachiata</i> (Lour.) Merr.	Native	Endangered
254.	<i>Gynotroches axillaris</i> Blume	Native	Common
255.	<i>Pellacalyx axillaris</i> Korth.	Native	Endangered
ROSACEAE			
256.	<i>Prunus polystachya</i> (Hook.f.) Kalkm.	Native	Common
RUBIACEAE			
257.	<i>Aidia auriculata</i> (Wall.) Ridsdale	Native	Critically endangered
258.	<i>Aidia densiflora</i> (Wall.) Masam.	Native	Vulnerable
259.	<i>Chassalia chartacea</i> Craib	Native	Vulnerable
260.	<i>Diplospora malaccensis</i> Hook.f.	Native	Critically endangered
261.	<i>Gaertnera obesa</i> Hook.f. ex C.B.Clarke	Native	Endangered
262.	<i>Gynochthodes coriacea</i> Blume	Native	Vulnerable
263.	<i>Gynochthodes sublanceolata</i> Miq.	Native	Common
264.	<i>Ixora congesta</i> Roxb.	Native	Common
265.	<i>Ixora lobbii</i> Loudon	Native	Endangered
266.	<i>Morinda citrifolia</i> L.	Cryptogenic	Cryptogenic
267.	<i>Mussaenda glabra</i> Vahl	Native	Endangered
268.	<i>Nauclea officinalis</i> (Pierre ex Pitard) Merr. & Chun.	Native	Critically endangered
269.	<i>Oxyceros bispinosus</i> (Griff.) Tirveng.	Native	Endangered
270.	<i>Oxyceros longiflorus</i> (Lam.) T.Yamazaki	Native	Vulnerable
271.	<i>Porterandia anisophylla</i> (Jack ex Roxb.) Ridl.	Native	Vulnerable
272.	<i>Psychotria ovoidea</i> Wall.	Native	Vulnerable
273.	<i>Psychotria penangensis</i> Hook.f.	Native	Vulnerable
274.	<i>Psydrax</i> sp. 10	Native	Not Assessed
275.	<i>Rothmannia macrophylla</i> (R.Br. ex Hook.f.) Bremek.	Native	Vulnerable
276.	<i>Tarenna mollis</i> (Wall. ex Hook.f.) B.L.Robinson	Native	Critically endangered
277.	<i>Timonius wallichianus</i> (Korth.) Valetton	Native	Common
278.	<i>Uncaria cordata</i> (Lour.) Merr.	Native	Endangered
279.	<i>Uncaria longiflora</i> (Poir.) Merr. var. <i>pteropoda</i> (Miq.) Ridsdale	Native	Critically endangered
280.	<i>Urophyllum blumeianum</i> (Wight) Hook.f.	Native	Critically endangered
281.	<i>Urophyllum griffithianum</i> (Wight) Hook.f.	Native	Vulnerable
282.	<i>Urophyllum hirsutum</i> (Wight) Hook.f.	Native	Endangered
RUTACEAE			
283.	<i>Glycosmis chlorosperma</i> (Blume) Spreng. var. <i>chlorosperma</i>	Native	Vulnerable
284.	<i>Maclurodendron porteri</i> (Hook.f.) T.G.Hartley	Native	Vulnerable
285.	<i>Paramignya scandens</i> (Griff.) Craib var. <i>ridleyi</i> (Burkill) Swingle	Native	Critically endangered
SABIACEAE			
286.	<i>Meliosma pinnata</i> (Roxb.) Maxim. subsp. <i>ridleyi</i> (King) Beus.	Native	Rediscovered
SANTALACEAE			
287.	<i>Scleropyrum pentandrum</i> (Dennst.) Mabb.	Native	Critically endangered

S/No.	Species	Nativeness	National Status
SAPINDACEAE			
288.	<i>Dimocarpus longan</i> Lour.	Exotic	Casual
289.	<i>Guioa pubescens</i> (Z. & M.) Radlk.	Native	Vulnerable
290.	<i>Nephelium lappaceum</i> L.	Native	Critically endangered (persistence from cultivation)
291.	<i>Pometia pinnata</i> J.R.Forst & G.Forst.	Native	Endangered
SAPOTACEAE			
292.	<i>Palaquium obovatum</i> (Griff.) Engl.	Native	Vulnerable
293.	<i>Palaquium rostratum</i> (Miq.) Burck	Native	Critically endangered
294.	<i>Pouteria malaccensis</i> (C.B.Clarke) Baehni	Native	Vulnerable
SELAGINELLACEAE			
295.	<i>Selaginella intermedia</i> (Bl.) Spring	Native	Vulnerable
SIMAROUBACEAE			
296.	<i>Eurycoma longifolia</i> Jack	Native	Critically endangered
SMILACACEAE			
297.	<i>Smilax setosa</i> Miq.	Native	Common
SYMPLOCACEAE			
298.	<i>Symplocos fasciculata</i> Zoll.	Native	Vulnerable
THEACEAE			
299.	<i>Gordonia singaporeana</i> Wall. ex Ridl.	Native	Endangered
THELYPTERIDACEAE			
300.	<i>Pronephrium triphyllum</i> (Sw.) Holttum	Native	Common
THYMELAEACEAE			
301.	<i>Aquilaria malaccensis</i> Lamk.	Native	Vulnerable
302.	<i>Enkleia malaccensis</i> Griff.	Native	Critically endangered
303.	<i>Gonystylus confusus</i> Airy Shaw	Native	Endangered
TRIGONIACEAE			
304.	<i>Trigonostrium hypoleucum</i> Miq.	Native	Rediscovered
VITACEAE			
305.	<i>Ampelocissus ascendiflora</i> Latiff	Native	Critically endangered
306.	<i>Ampelocissus elegans</i> (Kurz) Gegnep.	Native	Endangered
307.	<i>Ampelocissus gracilis</i> (Wall.) Planch.	Native	Endangered
308.	<i>Leea indica</i> (Burm.f.) Merr.	Native	Common
309.	<i>Nothocissus spicifera</i> (Griff.) Latiff	Native	Critically endangered
VITTARIACEAE			
310.	<i>Vittaria elongata</i> Sw.	Native	Common
ZINGIBERACEAE			
311.	<i>Hornstedtia leonurus</i> (J.König) Retz.	Native	Critically endangered

APPENDIX 2

Mean percentage basal area per plot of sub-canopy and canopy species sampled from Windsor Forest. Species are arranged in descending order of the mean number of stems per plot, except for species with only one individual found out of all the plots, which are arranged in decreasing order of stem size.

S/No.	Species	Mean Percentage Basal Area per Plot \pm Standard Error of the Mean	Mean No. Of Stems per Plot \pm Standard Error of the Mean
1.	<i>Hevea brasiliensis</i>	4.28 \pm 0.64	18.00 \pm 3.58
2.	<i>Rhodammia cinerea</i>	0.59 \pm 0.05	12.60 \pm 0.98
3.	<i>Elaeocarpus mastersii</i>	0.34 \pm 0.05	2.40 \pm 1.36
4.	<i>Syzygium ridleyi</i>	0.63 \pm 0.10	2.20 \pm 2.20
5.	<i>Gironniera nervosa</i>	0.45 \pm 0.10	1.40 \pm 0.51
6.	<i>Syzygium lineatum</i>	3.20 \pm 1.49	1.20 \pm 0.49
7.	<i>Elaeocarpus ferrugineus</i>	2.15 \pm 0.76	1.00 \pm 0.55
8.	<i>Cyathocalyx ridleyi</i>	1.05 \pm 0.36	0.80 \pm 0.58
9.	<i>Licania splendens</i>	0.74 \pm 0.52	0.60 \pm 0.25
10.	<i>Macaranga bancana</i>	0.40 \pm 0.07	0.60 \pm 0.25
11.	<i>Garcinia forbesii</i>	0.32 \pm 0.11	0.40 \pm 0.40
12.	<i>Maclurodendron porteri</i>	0.34 \pm 0.05	0.40 \pm 0.40
13.	<i>Pellacalyx axillaris</i>	0.54 \pm 0.29	0.40 \pm 0.40
14.	<i>Xanthophyllum vitellinum</i>	1.00 \pm 0.64	0.40 \pm 0.40
15.	<i>Adinandra dumosa</i>	1.61 \pm 1.06	0.40 \pm 0.24
16.	<i>Aporosa symplocoides</i>	0.29 \pm 0.05	0.40 \pm 0.24
17.	<i>Aidia densiflora</i>	0.24	0.20 \pm 0.20
18.	<i>Alstonia angustifolia</i>	0.24	0.20 \pm 0.20
19.	<i>Aporosa benthamiana</i>	0.29	0.20 \pm 0.20
20.	<i>Aporosa frutescens</i>	0.35	0.20 \pm 0.20
21.	<i>Aquilaria malaccensis</i>	0.73	0.20 \pm 0.20
22.	<i>Ficus variegata</i>	0.24	0.20 \pm 0.20
23.	<i>Garcinia rostrata</i>	0.41	0.20 \pm 0.20
24.	<i>Hopea mengarawan</i>	0.49	0.20 \pm 0.20
25.	<i>Lindera lucida</i>	0.32	0.20 \pm 0.20
26.	<i>Macaranga conifera</i>	1.44	0.20 \pm 0.20
27.	<i>Ochanostachys amentacea</i>	0.31	0.20 \pm 0.20
28.	<i>Prunus polystachya</i>	1.00	0.20 \pm 0.20
29.	<i>Shorea pauciflora</i>	0.22	0.20 \pm 0.20
30.	<i>Strombosia ceylanica</i>	0.40	0.20 \pm 0.20
31.	<i>Strychnos ignatii</i>	0.32	0.20 \pm 0.20
32.	<i>Syzygium borneense</i>	0.66	0.20 \pm 0.20
33.	<i>Syzygium filiforme</i>	9.26	0.20 \pm 0.20
34.	<i>Syzygium grande</i>	0.37	0.20 \pm 0.20
35.	<i>Timonius wallichianus</i>	0.54	0.20 \pm 0.20