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THE VASCULAR PLANT FLORA OF DOVER FOREST

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ABSTRACT. — A checklist of vascular plant species was compiled for Dover Forest, a secondary forest located at the junction of Clementi Road and Commonwealth Avenue West on Singapore Island. We use "Dover Forest" to refer collectively to two adjacent forest patches that are separated by a mowed lawn. In the year 2011, we sampled five 20 × 20 m plots within the patch closer to Clementi Road. 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. The resultant species list was supplemented with information from other surveys conducted in the years 2010–2011. We recorded a total of 136 species from 55 families. Sixty-nine of the recorded species are native, 57 are exotic, and 10 are cryptogenic. Of the native species, one was presumed nationally extinct, eight are nationally critically endangered, five are nationally endangered, and seven are nationally vulnerable. Among the measured woody stems, *Dillenia suffruticosa* was the species found to occur most frequently on average. The fact that exotic species comprise almost half of the recorded species can be attributed to the land use history of Dover Forest.

KEY WORDS. — checklist, flora, Clementi Road, Commonwealth Avenue West, secondary forest

INTRODUCTION

Dover Forest (01°18′49″N, 103°46′34″E) is a secondary regrowth forest on abandoned plantation land. It is located in the southwest of Singapore Island, at the junction of Clementi Road and Commonwealth Avenue West, and along the Sungei Ulu Pandan. We use "Dover Forest" to refer collectively to two forest patches that are separated by a mowed lawn (Figs. 1, 2A, B). Based on Google Earth® satellite images, the total area of Dover Forest is estimated to be 26.2 ha: the western patch is 15.9 ha and the eastern patch is 10.4 ha.

Dover Forest was previously referred to by Castelletta et al. (2005) as "Ulu Pandan Canal". Part of the western patch of Dover Forest has been converted into open space and an educational institution, while the future land use of the rest of the forest is subject to further detailed planning (URA, 2008).

From the 1920s to the 1940s, Dover Forest was part of a rubber plantation (Surveyor-General, Federated Malay States and Straits Settlements, 1924; Survey Production Centre, South East Asia, 1945). We estimate that the rubber plantation was abandoned during World War II (1941–1945; Lew, 1965; Shepherd & Shepherd, 1968), and was not re-established thereafter. In the 1950s, low-density settlements were established within the forest, with sundry tree cultivation developing in place of the rubber plantations (Surveyor-General, Malaya, 1953). In the 1960s and 1970s, the vegetation was classified as mostly scrubland, suggesting that the area under tree cultivation had been cleared in the early 1960s save for the northern parts fringing the Sungei Ulu Pandan (Directorate of National Mapping, Malaysia, 1964; Chief Surveyor, Singapore, 1969a, 1969b; Singapore Mapping Unit, 1975). From the 1980s onwards, the vegetation was characterised as sundry tree cultivation (Singapore Mapping Unit, 1982, 1987, 1992, 2000).

Secondary forests can be a refuge and resource pool for local biodiversity (Turner & Corlett, 1996; Turner et al., 1997; McShea et al., 2009; Edwards et al., 2010, etc.). This paper aims to provide an accessible working checklist of the vascular plant species of Dover Forest, which can be used for evaluating the conservation value of the forest. In particular, nationally threatened species can be identified, and recommendations can be made for their conservation.

MATERIAL AND METHODS

In 2011, we surveyed five 20 × 20 m plots within the western patch of Dover Forest. The five plots were spaced at least 60 m apart from one another, and located at least 40 m from the forest edge. The location of each plot was randomly derived using the fTools v. 0.6.1 plugin for the Quantum GIS software v. 1.6.0 (Quantum GIS Development Team, 2010). Within each plot, we recorded all species of vascular plants. Where species could not be identified in the field,

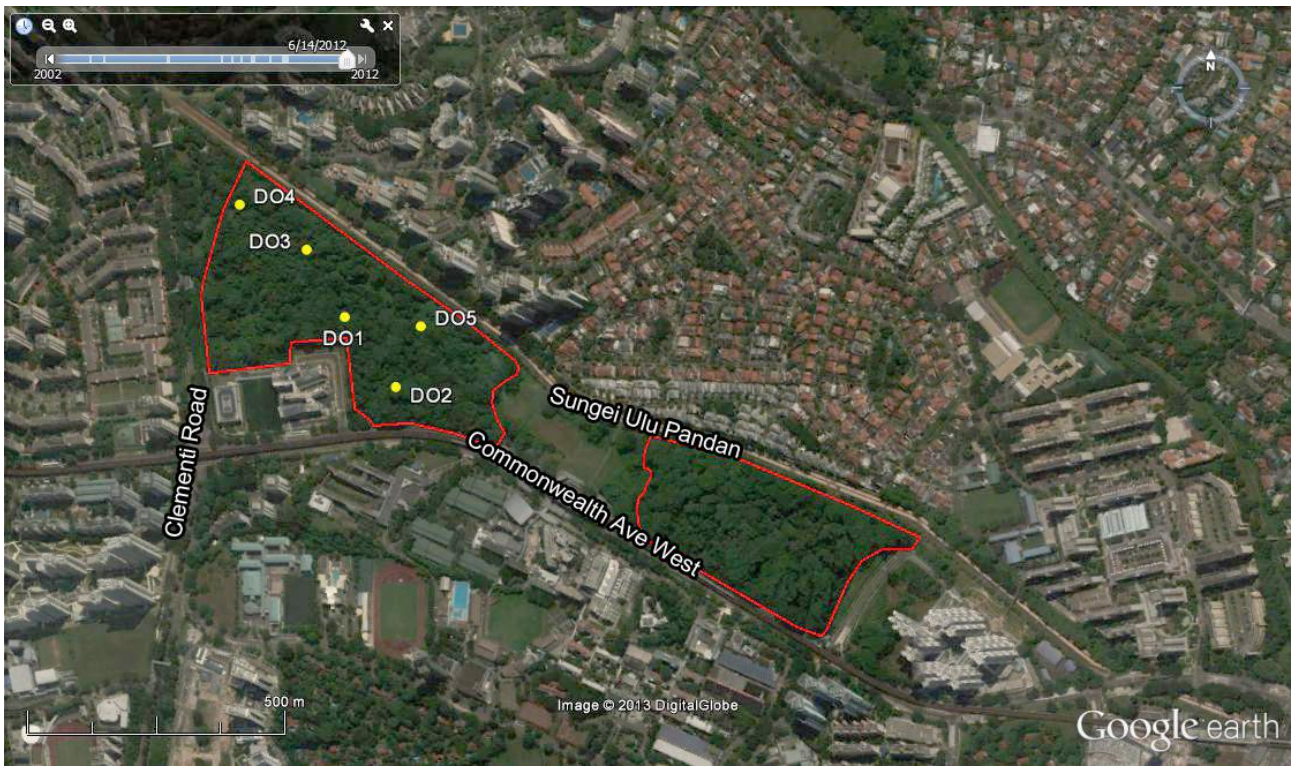

Fig. 1. Dover Forest with respect to nearby landmarks (Google, 2012). The red outlines show the extent of the forest at 14 Jun.2012 (date that the satellite image was acquired). The five surveyed plots are shown as yellow dots and labelled DO1–DO5.

Fig. 2. Some characteristic aspects of Dover Forest: A, the eastern patch with the Dover Mass Rapid Transit Train Station shown on the right; B, the western patch with the overhead train track shown on the right; C, a mixed stand of cultivated fruit tree species such as *Dimocarpus longan*, *Aphanamixis polystachya*, and strangling *Ficus* species; and D, a dense undergrowth comprising a mix of *Piper sarmentosum*, and saplings of *Hevea brasiliensis* and *Ptychosperma macarthurii*. (Photographs by: Louise Neo.)

specimens were collected for their identities to be further determined in the laboratory or in the Singapore Botanic Gardens Herbarium (SING). To estimate species dominance, stem diameter at breast height (DBH; measured at 1.3 m above the ground) was recorded for all woody stems with a DBH ≥5 cm. Palms (Arecaceae) were not measured owing to the difficulty in measuring the true stems for some species. The species for which DBHs were measured were ranked by the mean number of stems per plot.

To supplement the forest plots, we also surveyed both patches of the forest through ad hoc exploration in the year 2012. We also included plant species recorded from six 20 × 5 m transect surveys conducted in both patches of the forest in 2010 and 2011 by Yeo (2011). Unlike the plots, the transects included forest edge species.

A checklist of all vascular plant species recorded from Dover Forest was compiled. The nomenclature and national status category of each species was derived from a recent checklist of the total vascular plant flora of Singapore (Chong et al., 2009).

RESULTS AND DISCUSSION

A total of 136 species from 55 families was recorded. The species, their native or exotic status, and their national conservation status categories are presented in Appendix 1. Based on Chong et al. (2009), 69 of the recorded species are native, 57 are exotic, and 10 are cryptogenic (equivalent to the "Weed of Uncertain Origin" category of Chong et al. [2009]). Of the native species, one was deemed presumed nationally extinct in Chong et al. (2009), eight are nationally critically endangered, five are nationally endangered, and seven are nationally vulnerable (Table 1). The species presumed to be nationally extinct is *Syzygium myrtifolium*, and probably persisted from cultivation from non-Singaporean provenance. Of the eight critically endangered species, four are likely to have persisted from cultivated rather than local provenance. They are: the belinjau, *Gnetum gnemon* var. *gnemon*; rambai, *Baccaurea motleyana*; rambutan, *Nephelium lappaceum*; and yellow flame, *Peltophorum pterocarpum*. The other four critically endangered species are: *Cordia dichotoma*, *Ficus kerkhovenii*, *Glochidion rubrum*, and *Melicope lunu-ankenda*.

The species for which we measured basal area are presented in Appendix 2, and are ordered by the mean number of stems measured per plot, except for species for which only a single individual was measured. The species found to occur most frequently was *Dillenia suffruticosa*, which averaged 5.20 stems per plot, but occupied about 0.8% of the basal area of a plot on average. It was followed by *Nephelium lappaceum*, which averaged 4.40 stems per plot while occupying 3.45% of the basal area of a plot on average. The most dominant species by basal area that we measured was Indian mango, *Mangifera indica*, but only a single individual with a basal area of 2,942 cm^2 occurred in the plots that we sampled. Overall, the sapling and tree species of Dover Forest are a mixture of those cultivated for their food or ornamental value, and native pioneer species typical of young secondary forests in Singapore (Boo, 1996; Shono et al., 2006).

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

Nativeness	National Status Category	No. of Species	Percentage (of all species)	Percentage (of all native species)
Exotic	Naturalised	25	18.38	—
	Casual	21	15.44	—
	Cultivated only	11	8.09	—
Cryptogenic	Cryptogenic	10	7.35	—
Native	Presumed nationally extinct (persistence from cultivation)	1	0.74	1.45
	Critically endangered (persistence from cultivation)	4	2.94	5.80
	Critically endangered	4	2.94	5.80
	Endangered	5	3.68	7.25
	Vulnerable	7	5.15	10.14
	Common	48	35.29	69.57

Exotic and cryptogenic species comprise about half of the species recorded from Dover Forest. Species that have been known to characterise the exotic-dominated secondary forest vegetation type in Singapore (e.g., see Boo, 1996) were found, such as *Falcataria moluccana*, *Acacia auriculiformis*, *Spathodea campanulata*, etc. As would be expected from the history of cultivation of Dover Forest, many of the exotic species are food species, e.g., jackfruit, *Artocarpus heterophyllus*; starfruit, *Averrhoa carambola*; longan, *Dimocarpus longan* (Fig. 2C); tapioca, *Manihot esculenta*; wild pepper, *Piper sarmentosum* (Fig. 2D); etc. Other exotics may have been planted for ornamental purposes, e.g., *Dracaena fragrans*, *Dracaena sanderiana*, *Epipremnum aureum*, *Heliconia psittacorum*, etc.

The native species recorded from Dover Forest include the saplings of pioneer species similar to those which have been recorded from other studies of young secondary forest vegetation in Singapore (e.g., Boo, 1996; Shono et al., 2006), e.g., *Arthrophyllum diversifolium*, *Caryota mitis*, *Macaranga gigantea*, *Syzygium lineatum*, etc.

CONCLUSIONS

The vascular plant flora of Dover Forest is almost half exotic, and comprises of many food and ornamental species persisting from past sundry cultivation in the area. About 15% of the vascular plant species recorded from Dover Forest are nationally threatened.

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APPENDIX 1

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

S/No.	Species	Nativeness	National Status
	ACANTHACEAE		
1.	*Asystasia gangetica* (L.) T.Anderson subsp. *micrantha* (Nees) Ensermu	Exotic	Naturalised
	ADIANTACEAE		
2.	*Adiantum latifolium* Lam.	Exotic	Naturalised
	ANACARDIACEAE		
3.	*Mangifera indica* L.	Exotic	Casual
	APIACEAE		
4.	*Centella asiatica* (L.) Urb.	Native	Common
	APOCYNACEAE		
5.	*Hoya verticillata* (Vahl) G.Don var. *verticillata*	Native	Common
	ARACEAE		
6.	*Aglaonema commutatum* Schott	Exotic	Casual
7.	*Alocasia macrorrhizos* (L.) G.Don	Exotic	Naturalised
8.	*Colocasia esculenta* (L.) Schott	Exotic	Casual
9.	*Dieffenbachia seguine* (Jacq.) Schott var. *seguine*	Exotic	Casual
10.	*Epipremnum aureum* (Linden ex André) Bunting	Exotic	Casual
11.	*Philodendron erubescens* K.Koch & Augustin	Exotic	Cultivated only
12.	*Syngonium podophyllum* Schott	Exotic	Naturalised
	ARALIACEAE		
13.	*Arthrophyllum diversifolium* Blume	Native	Common
	ARECACEAE		
14.	*Caryota mitis* Lour.	Native	Common
15.	*Cocos nucifera* L.	Exotic	Naturalised
16.	*Elaeis guineensis* Jacq.	Exotic	Cultivated only
17.	*Ptychosperma macarthurii* (H.Wendl. ex anon.) H.Wendl. ex Hook.f.	Exotic	Naturalised
	ASPARAGACEAE		
18.	*Cordyline fruticosa* (L.) A.Chev.	Exotic	Casual
19.	*Dracaena fragrans* (L.) Ker Gawl.	Exotic	Casual
20.	*Dracaena braunii* Engl. (= *Dracaena sanderiana* Sander)	Exotic	Cultivated only
21.	*Dracaena surculosa* Lindl.	Exotic	Cultivated only
	ASPLENIACEAE		
22.	*Asplenium longissimum* Blume	Native	Common
23.	*Asplenium nidus* L.	Native	Common
	ASTERACEAE		
24.	*Mikania micrantha* Kunth	Exotic	Naturalised

S/No.	Species	Nativeness	National Status
25.	*Sphagneticola trilobata* (L.) Pruski	Exotic	Naturalised
	BIGNONIACEAE		
26.	*Spathodea campanulata* P.Beauv.	Exotic	Naturalised
	BLECHNACEAE		
27.	*Stenochlaena palustris* (Burm.f.) Bedd.	Native	Common
	BORAGINACEAE		
28.	*Cordia dichotoma* G.Forst.	Native	Critically endangered
	CLUSIACEAE		
29.	*Garcinia mangostana* L.	Exotic	Casual
	COMBRETACEAE		
30.	*Terminalia catappa* L.	Native	Common
	CONVOLVULACEAE		
31.	*Erycibe tomentosa* Blume	Native	Common
32.	*Ipomoea cairica* (L.) Sweet	Exotic	Naturalised
33.	*Merremia umbellata* (L.) Hallier f.	Weed of uncertain origin	Cryptogenic
	DENNSTAEDTIACEAE		
34.	*Lindsaea ensifolia* Sw.	Native	Common
	DILLENIACEAE		
35.	*Dillenia suffruticosa* (Griff. ex Hook.f. & Thomson) Martelli	Native	Common
36.	*Tetracera indica* (Christm. & Panz.) Merr.	Native	Common
	DIOSCOREACEAE		
37.	*Dioscorea bulbifera* L.	Weed of uncertain origin	Cryptogenic
38.	*Dioscorea sansibarensis* Pax	Exotic	Naturalised
	EUPHORBIACEAE		
39.	*Acalypha siamensis* Oliv. ex Gage	Exotic	Casual
40.	*Claoxylon indicum* (Reinw. ex Blume) Hassk.	Native	Common
41.	*Hevea brasiliensis* (Willd. ex A.Juss.) Müll.Arg.	Exotic	Naturalised
42.	*Macaranga bancana* (Miq.) Mull.Arg.	Native	Common
43.	*Macaranga gigantea* (Rchb.f. & Zoll.) Mull.Arg.	Native	Common
44.	*Mallotus paniculatus* (Lam.) Mull.Arg.	Native	Common
45.	*Manihot esculenta* Crantz	Exotic	Naturalised
	FABACEAE		
46.	*Acacia auriculiformis* A.Cunn. ex Benth.	Exotic	Naturalised
47.	*Adenanthera pavonina* L.	Exotic	Naturalised
48.	*Albizia saman* (Jacq.) Merr.	Exotic	Casual
49.	*Andira inermis* (W. Wright) Kunth ex DC.	Exotic	Casual
50.	*Desmodium triflorum* (L.) DC.	Weed of uncertain origin	Cryptogenic
51.	*Falcataria moluccana* (Miq.) Barneby & J.W.Grimes	Exotic	Naturalised
52.	*Mimosa diplotricha* C.Wright	Exotic	Naturalised

S/No.	Species	Nativeness	National Status
53.	*Mimosa pigra* L.	Exotic	Naturalised
54.	*Mimosa pudica* L.	Exotic	Naturalised
55.	*Peltophorum pterocarpum* (DC.) Backer ex K.Heyne	Native	Critically endangered (persistence from cultivation)
56.	*Pueraria phaseoloides* (Roxb.) Benth.	Exotic	Naturalised
	FLAGELLARIACEAE		
57.	*Flagellaria indica* L.	Native	Common
	GENTIANACEAE		
58.	*Fagraea fragrans* Roxb.	Native	Common
	GNETACEAE		
59.	*Gnetum gnemon* L. var. *gnemon*	Native	Critically endangered (persistence from cultivation)
	HELICONIACEAE		
60.	*Heliconia psittacorum* L.f.	Exotic	Casual
	LAMIACEAE		
61.	*Clerodendrum laevifolium* Blume	Native	Common
62.	*Clerodendrum paniculatum* L.	Exotic	Casual
63.	*Premna serratifolia* L.	Native	Vulnerable
64.	*Vitex pinnata* L.	Native	Common
	LAURACEAE		
65.	*Cinnamomum iners* Reinw.	Native	Common
	MALVACEAE		
66.	*Durio zibethinus* L.	Exotic	Casual
	MELASTOMATACEAE		
67.	*Clidemia hirta* (L.) D.Don	Exotic	Naturalised
	MELIACEAE		
68.	*Aphanamixis polystachya* (Wall.) Parker	Native	Endangered
69.	*Lansium domesticum* Corrêa	Exotic	Cultivated only
70.	*Sandoricum koetjape* (Burm.f.) Merr.	Native	Endangered
	MENISPERMACEAE		
71.	*Tinospora crispa* (L.) Hook.f. & Thomson	Exotic	Casual
	MORACEAE		
72.	*Artocarpus heterophyllus* Lam.	Exotic	Casual
73.	*Artocarpus integer* (Thunb.) Merr.	Exotic	Casual
74.	*Ficus apiocarpa* Miq.	Native	Endangered
75.	*Ficus aurata* Miq. var. *aurata*	Native	Vulnerable
76.	*Ficus benjamina* L.	Weed of uncertain origin	Cryptogenic
77.	*Ficus caulocarpa* (Miq.) Miq.	Native	Common
78.	*Ficus fistulosa* Reinw. ex Blume	Native	Common

S/No.	Species	Nativeness	National Status
79.	*Ficus grossularioides* Burm.f. var. *grossularioides*	Native	Common
80.	*Ficus heteropleura* Blume	Native	Common
81.	*Ficus kerkhovenii* Valeton	Native	Critically endangered
82.	*Ficus microcarpa* L.f.	Native	Common
83.	*Ficus punctata* Lam.	Exotic	Cultivated only
84.	*Ficus variegata* Blume	Native	Common
85.	*Ficus vasculosa* Wall. ex Miq.	Native	Endangered
	MUSACEAE		
86.	*Musa* cultivar	Exotic	Cultivated only
	MYRICACEAE		
87.	*Myrica esculenta* Buch.-Ham.	Native	Common
	MYRTACEAE		
88.	*Rhodamnia cinerea* Jack	Native	Common
89.	*Syzygium aqueum* (Burm.f.) Alston	Exotic	Cultivated only
90.	*Syzygium borneense* (Miq.) Miq.	Native	Common
91.	*Syzygium grande* (Wight) Walp.	Native	Common
92.	*Syzygium lineatum* (DC.) Merr. & L.M.Perry	Native	Common
93.	*Syzygium myrtifolium* Walp.	Native	Presumed nationally extinct (persistence from cultivation)
94.	*Syzygium polyanthum* (Wight) Walp.	Native	Vulnerable
	OLEANDRACEAE		
95.	*Nephrolepis auriculata* (L.) Trimen	Weed of uncertain origin	Cryptogenic
	ORCHIDACEAE		
96.	*Bromheadia finlaysoniana* (Lindl.) Miq.	Native	Common
	OXALIDACEAE		
97.	*Averrhoa carambola* L.	Exotic	Casual
	PANDANACEAE		
98.	*Pandanus amaryllifolius* Roxb.	Exotic	Casual
	PASSIFLORACEAE		
99.	*Passiflora laurifolia* L.	Exotic	Naturalised
	PENTAPHYLACACEAE		
100.	*Adinandra dumosa* Jack	Native	Common
	PHYLLANTHACEAE		
101.	*Antidesma bunius* (L.) Spreng.	Exotic	Casual
102.	*Baccaurea motleyana* (Müll.Arg.) Müll.Arg.	Native	Critically endangered (persistence from cultivation)
103.	*Bridelia stipularis* (L.) Blume	Native	Vulnerable
104.	*Bridelia tomentosa* Blume	Native	Common
105.	*Glochidion rubrum* Blume	Native	Critically endangered

S/No.	Species	Nativeness	National Status
106.	*Glochidion zeylanicum* Blume var. *zeylanicum*	Native	Vulnerable
107.	*Phyllanthus debilis* Klein ex Willd.	Exotic	Naturalised
	PIPERACEAE		
108.	*Piper betle* L.	Exotic	Casual
109.	*Piper sarmentosum* Roxb.	Native	Common
	POACEAE		
110.	*Imperata cylindrica* (L.) P.Beauv.	Weed of uncertain origin	Cryptogenic
111.	*Ottochloa nodosa* (Kunth) Dandy	Native	Common
112.	*Megathyrsus maximus* (Jacq.) B.K.Simon & S.W.L.Jacobs	Exotic	Naturalised
113.	*Saccharum arundinaceum* Retz.	Weed of uncertain origin	Cryptogenic
	PRIMULACEAE		
114.	*Ardisia elliptica* Thunb.	Native	Endangered
115.	*Embelia ribes* Burm.f.	Native	Common
	PTERIDACEAE		
116.	*Pteris ensiformis* Burm.f.	Weed of uncertain origin	Cryptogenic
117.	*Taenitis blechnoides* (Willd.) Sw.	Native	Common
118.	*Taenitis interrupta* Hook. & Grev.	Native	Common
	RUBIACEAE		
119.	*Gynochthodes sublanceolata* Miq.	Native	Common
120.	*Ixora congesta* Roxb.	Native	Common
121.	*Ixora javanica* (Blume) DC.	Exotic	Cultivated only
122.	*Oxyceros longiflorus* (Lam.) T.Yamazaki	Native	Vulnerable
123.	*Paederia foetida* L.	Native	Common
	RUTACEAE		
124.	*Clausena excavata* Burm.f.	Native	Common
125.	*Melicope lunu-ankenda* (Gaertn.) T.G.Hartley	Native	Critically endangered
126.	*Murraya paniculata* (L.) Jack	Exotic	Cultivated only
	SAPINDACEAE		
127.	*Dimocarpus longan* Lour.	Exotic	Cultivated only
128.	*Guioa pubescens* (Z. & M.) Radlk.	Native	Vulnerable
129.	*Nephelium lappaceum* L.	Native	Critically endangered (persistence from cultivation)
	SCHIZAEACEAE		
130.	*Lygodium microphyllum* (Cav.) R.Br.	Native	Common
	SMILACACEAE		
131.	*Smilax setosa* Miq.	Native	Common
	SOLANACEAE		
132.	*Solanum torvum* Sw.	Exotic	Naturalised

S/No.	Species	Nativeness	National Status
	THELYPTERIDACEAE		
133.	*Christella dentata* (Forsk.) Brownsey & Jermy	Weed of uncertain origin	Cryptogenic
134.	*Pronephrium triphyllum* (Sw.) Holttum	Native	Common
	VITACEAE		
135.	*Cissus hastata* Miq.	Weed of uncertain origin	Cryptogenic
136.	*Leea indica* (Burm.f.) Merr.	Native	Common

APPENDIX 2

Mean percentage basal area per plot of sub-canopy and canopy species sampled from Dover 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 ± Standard Error of the Mean	Mean No. Of Stems per Plot ± Standard Error of the Mean
1.	*Dillenia suffruticosa*	0.79 ± 0.08	5.20 ± 5.20
2.	*Nephelium lappaceum*	3.45 ± 1.01	4.40 ± 2.91
3.	*Averrhoa carambola*	1.98 ± 0.30	4.20 ± 2.85
4.	*Cinnamomum iners*	3.95 ± 0.88	3.40 ± 1.91
5.	*Hevea brasiliensis*	6.87 ± 3.45	2.40 ± 1.75
6.	*Aphanamixis polystachya*	0.82 ± 0.23	2.20 ± 0.66
7.	*Vitex pinnata*	5.55 ± 3.53	1.00 ± 0.55
8.	*Baccaurea motleyana*	12.11 ± 7.00	0.80 ± 0.80
9.	*Macaranga gigantea*	5.39 ± 3.86	0.80 ± 0.49
10.	*Melicope lunu-ankenda*	0.64 ± 0.07	0.80 ± 0.49
11.	*Dracaena fragrans*	0.35 ± 0.08	0.60 ± 0.40
12.	*Dimocarpus longan*	9.61 ± 9.03	0.40 ± 0.40
13.	*Syzygium aqueum*	7.95 ± 7.53	0.40 ± 0.40
14.	*Syzygium grande*	1.92 ± 0.41	0.40 ± 0.40
15.	*Ficus fistulosa*	0.85 ± 0.62	0.40 ± 0.24
16.	*Mangifera indica*	28.72	0.20
17.	*Acacia auriculiformis*	20.40	0.20
18.	*Glochidion zeylanicum* var. *zeylanicum*	4.34	0.20
19.	*Syzygium lineatum*	2.36	0.20
20.	*Durio zibethinus*	2.01	0.20