

An Assessment of Angiosperm Diversity of Adyar Estuary, Chennai – A Highly Degraded Estuarine Ecosystem, Tamil Nadu, India

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ABSTRACT: Estuaries are coastal ecosystems which are commonly known to support unique flora and fauna. The Adyar estuary is a severely damaged ecosystem due to developmental activities in the urban city of Chennai, Tamil Nadu, India. Botanical explorations were conducted in and around Adyar estuary during 2008 to 2010 to document the diversity and distribution of angiosperms. A total of 252 species and 2 varieties of angiosperms belonging to 196 genera, distributed in 64 families from 27 orders and 10 clades/groups were recorded and are arranged according to Angiosperm Phylogeny Group III Classification. It is observed that the flora of Adyar estuary also harbours a high level of non-native species. Anthropogenic threats to the estuary and its flora are identified and conservation strategies are briefly discussed.

INTRODUCTION

According to Pritchard (1967) an estuary may be defined as “a semi-enclosed coastal body of water which has a free connection with the open sea and within which sea water is measurably diluted by fresh water from land drainage”. It is an abode for unique flora and fauna and considered to be an unusually productive ecosystem. Estuaries have a unique combination of physical features, associated with their shape, catchment area, connection to the sea and tidal regime (Khedr 1998). Water salinity is considered as the dominant factor determining the distribution of plants in estuarine marshes (Odum 1988) and marine marshes (Partridge and Wilson 1989). Due to urbanization, estuarine wetlands are increasingly being replaced by residential/industrial areas throughout the world (Rosa *et al.* 2003). Pollution due to industrial and residential developments, recreation and other activities in both the estuary and its catchment area greatly affect these sensitive habitats, as well as living resources of the estuary (Kennish 2001). The Adyar estuary is a severely damaged ecosystem of urban Chennai, the capital city of Tamil Nadu state in Southern India (Figure 1). A cluster of industries, such as chemical factories, a battery company, plastic and rubber factories, and residential buildings are situated on the banks of the Adyar estuary (Figure 9A). The Adyar estuary acts as a sink for sewage discharge in Chennai, which adversely affect its self-purification capacity (Walther *et al.* 2003). There are two ways to reverse the quality and loss of any habitat: i) conservation of currently viable habitat and ii) restoration of degraded habitats. Conservation priorities and restoration measures must be decided based upon the inventorisation of biological diversity (Kunte *et al.* 1999). Botanical assessments, such as floristic composition and structure are essential to understand the extant of phytodiversity of any ecosystem (WCMC 1992). Hence, the present study

was carried out to document the angiosperm diversity of the Adyar estuary, as well as to identify the threats that prevail in the estuarine region and to suggest necessary conservation strategies.

MATERIALS AND METHODS

Study Site

The Adyar River (situated between 12°93' N and 80°15' E) traverses a distance of about 40 km; originates from Chembarambakkam tank, Kanchipuram district and enters Chennai City near Nandambakkam. It flows in a west-east direction for a distance of 13.5 km before entering the Bay of Bengal near Thiru Vi. Ka. Bridge. It collects surplus water from more than 200 tanks of the Chembarambakkam group and other irrigation tanks nearby, which have a combined catchment area of 857.2 km² (NRCD 2013). The climate is hot and humid for most of the year and characteristic of coastal areas. The average maximum temperature is about 36°C and minimum temperature is 28°C. The area receives rainfall during the northeast monsoon from September to November, and relative humidity ranges between 63 and 86%.

During the colonial period, there were large estates and garden houses along the Adyar estuary, which was considered one of the important areas of diverse vegetation in the City of Madras. Owing to the proximity to the sea, salinity of the soil and humid atmosphere, the estuary had littoral vegetation on the banks which had many mangrove species, psammophytes, fresh water aquatics and dry evergreen forest; at present they are sparsely distributed in fragments only in some parts of Adyar estuary. These coastal vegetations may be classified as littoral swamps (a predominant habitat) and tropical dry evergreen forest as per revised classification of forests proposed by Champion and Seth (1968). These vegetation types occur in sparse fragments along

the Adyar estuary and psammophytes are found in a gregarious patch on the coast of the Bay of Bengal near the mouth of the estuary. This estuarine wetland provides a habitat to numerous avian and other aquatic fauna. In 1987, recognising the importance of this ecosystem, the Tamil Nadu Forest Department declared the estuary as a protected area.

Previous Botanical Studies

Several noted botanists like Roxburgh (1795-1819), Gamble (1915-1936) and Mayuranathan (1929) conducted field surveys and collections from the Madras Coast, which also included the Adyar estuary. Rao (1957) published an article entitled "The Flora of Adyar" which mostly dealt with the ornamental and other cultivated plants of the Theosophical Society and had very little reference to the estuarine flora. Livingstone and Henry (1994) revised Mayuranathan's "The flowering plants of Madras City and its immediate neighbourhood" and made some significant additions to the flora. However, the baseline information available remains widely dispersed and inadequate. Hence, an attempt is made here to provide a comprehensive exclusive survey of the angiosperm diversity of Adyar estuary.

Data Collection

Regular field surveys were undertaken in and around the Adyar estuary between 2008 and 2010. Plants either with flowers or fruits were collected and photographed (Figures 2, 7-14), and identified or confirmed with available regional floras (Gamble 1915-1936; Matthew 1982; 1983; 1988; Livingstone and Henry 1994), revisions (Rajendran and Daniel 2002; Dutta and Deb 2004; Ansari 2008) and monographs (Sivarajan and Pradeep 1996; Singh 2000; 2001). Families are arranged according to Angiosperm Phylogeny Group III Classification (APG III 2009). Abbreviations of authors' names of plant names strictly follow Brummitt and Powell (1992). The standard herbarium technique given by Fosberg and Sachet (1965) was followed for preparation of herbarium specimens. Voucher specimens have been deposited at REEF, Puducherry, for reference. The current nomenclature of all taxa was further determined by referring to authentic databases, such as International Plant Names Index (IPNI), The Plant List and Tropicos.

RESULTS AND DISCUSSION

A total of 252 species and 2 varieties belonging to 197 genera distributed in 64 families from 27 orders and 10 clades/groups according to Angiosperm Phylogeny Group III Classification (2009) were recorded during the present study from Adyar estuary. These taxa are represented in table 1. Fabids (78 spp.), Lamiids (69 spp.), Malvids (62 taxa), Commelinids (24 spp.) and Campanulids (11 spp.) are the major clades/groups representing a total of 244 taxa that constitute 96% of the flora (Figure 3).

An analysis of the floristic diversity denotes that the family Fabaceae dominates the flora with 37 species, followed by Poaceae with 14 species, Malvaceae and Euphorbiaceae with 13 species each, Convolvulaceae and Amaranthaceae 12 species each and Apocynaceae and Asteraceae with 11 species each (Figure 4).

The dominant genera of the flora are *Ipomoea* (8 spp.), *Ficus* (6 spp.), *Solanum* (5 spp.), *Alternanthera*, *Cleome*, *Euphorbia*, *Phyllanthus* (4 spp. each), *Cyperus* and *Indigofera* (3 spp. each). The life-form composition analysis shows that herbs dominate the flora of Adyar estuary with a total of 125 species (49%), followed by trees with 59 species (23%), climbers with 44 species (18%) and shrubs with 26 species representing 10% of the flora (Figure 5).

A phytogeographical analysis of the flora shows dominance of Pantropical elements (45%), followed by Paleotropical elements (25%), Asian (9%), Cultivated (6%), and the remaining 15% of the flora is represented by Asia-Australian, Cosmopolitan, Indian, Indomalasian, Indosrilankan and African elements (Figure 6). Out of 115 Pantropical elements recorded, about 35% of them belong to the Tropical American region. It reveals the expansion of the non-native flora in the study area; many of the non-native elements are naturalised and some of them are potential invasive species. It has been observed that about 40% of the species recorded from the Adyar estuary during the present study are occasional in distribution. Nearly 30% of the species recorded are commonly distributed and the remaining 30% are rare in distribution.

Urban areas are increasingly expanding into estuarine wetlands around the world. Due to concentration of industries and human habitations along the coastal waters in Chennai, there is heavy pollution of coastal water. For long-term conservation actions, it is essential to understand the influence of industries and human habitations on the vegetation and the composition and status of species in the Adyar estuary. This baseline data on the flora of Adyar estuary can provide both useful records of the present condition and a basis for future monitoring of change over time to the estuary.

During the present study, contamination of estuary water by non-biodegradable trash, especially plastics, thermocol, aluminium foil and rubber were observed to cause adverse effects on the sensitive mangrove habitats (Figures 9B – E); cattle grazing is also identified as one of the threats to the estuarine vegetation (Figure 9F). Environmental laws should be strictly enacted to prevent or to reduce the sewage discharge both from industries and residents. Similarly, dumping of non-biodegradable materials and heavy metals into the estuary should be prohibited. It is suggested to increase the vegetative cover by planting fast-growing native littoral tree species along the estuary. In addition, environmental awareness should be created among the people residing on the banks of the estuary regarding the importance of ecosystems, biodiversity and conservation of nature and their values.



FIGURE 1. Map showing the Adyar estuary in Chennai, Tamil Nadu, India. Source: <https://maps.google.com/>



FIGURE 2. A) A tiny island in the Adyar estuary; B) Elphinstone bridge across the Adyar estuary; C, D) Fragments of Tropical Dry Evergreen Forest on the banks of Adyar estuary; E) Nesting site of birds on the banks of Adyar estuary; F) A gregarious population of psammophytes on the coast of Bay of Bengal near Adyar estuary mouth.

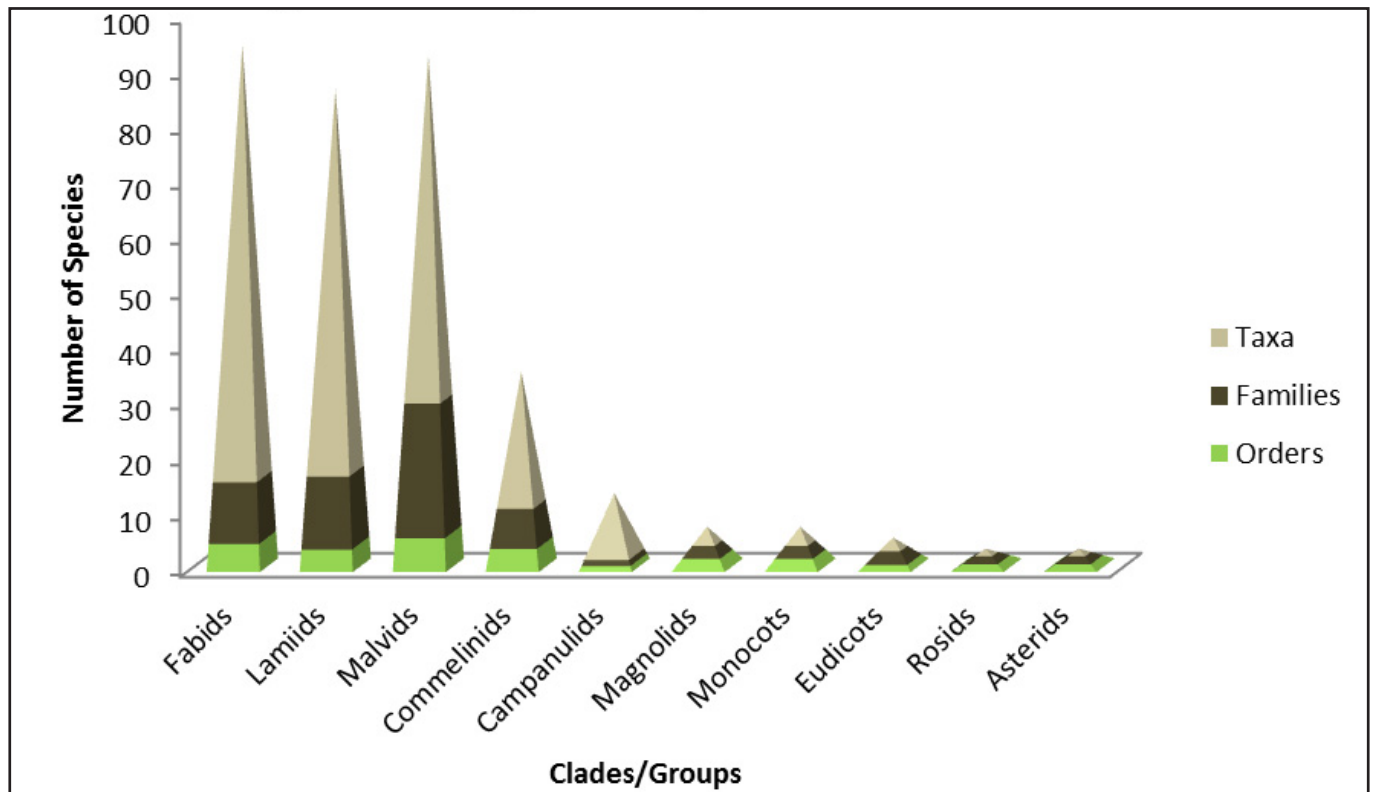


FIGURE 3. Diversity of Orders, Families and Taxa in each Clade.

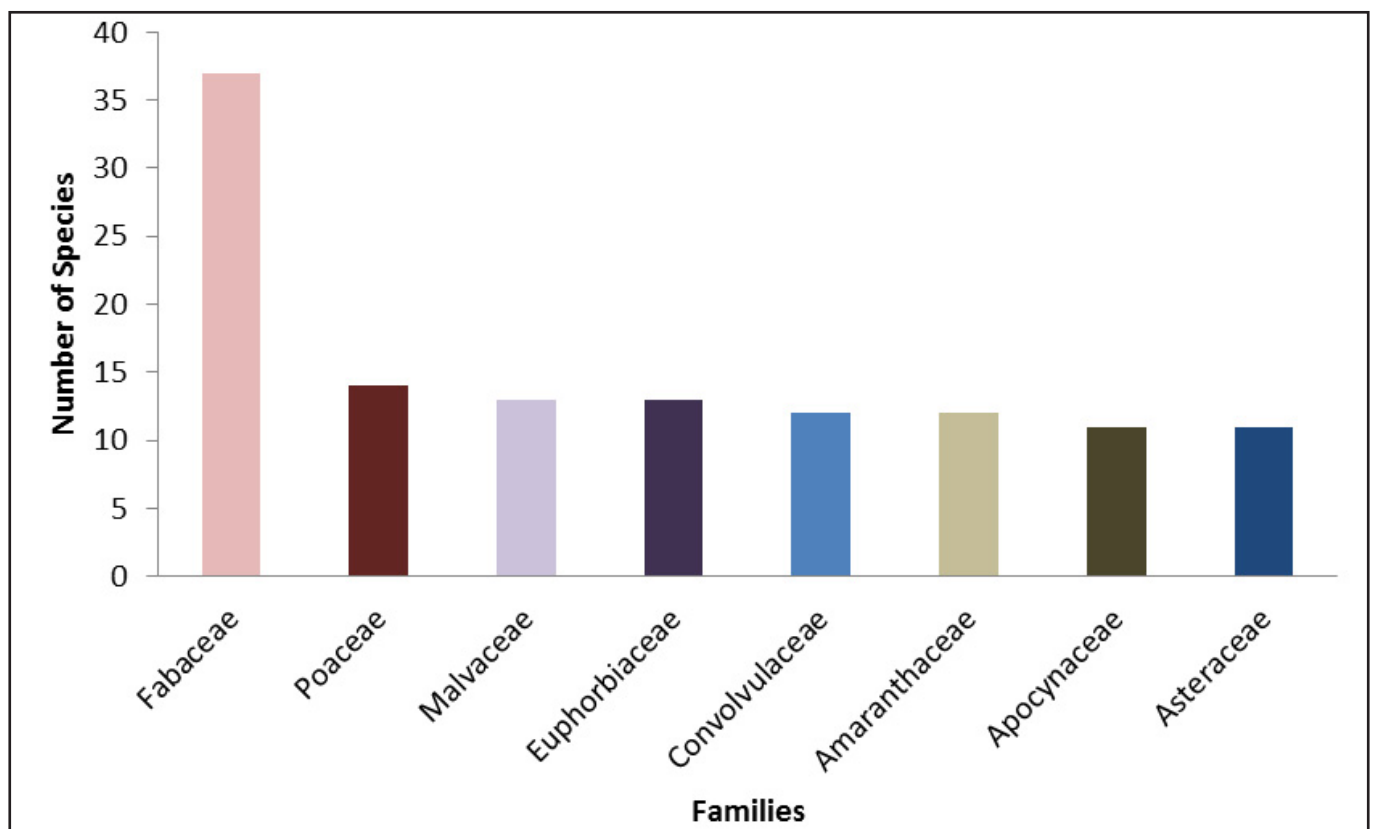


FIGURE 4. Diversity of Dominant Families.

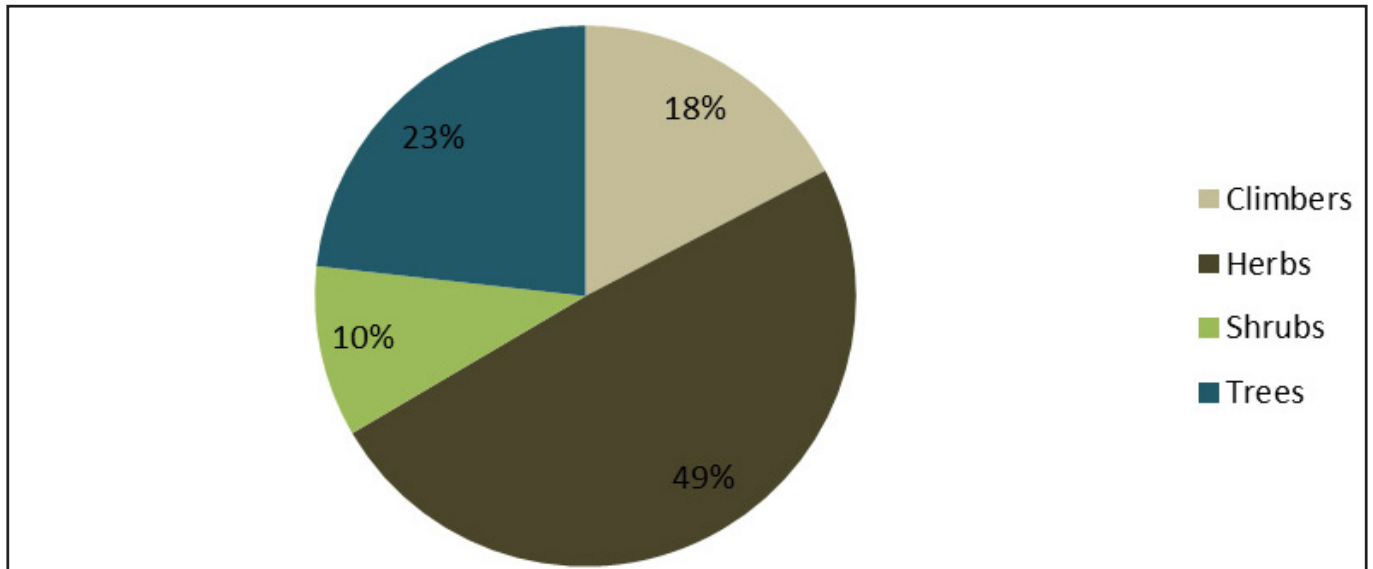


FIGURE 5. Diversity of Life-forms.

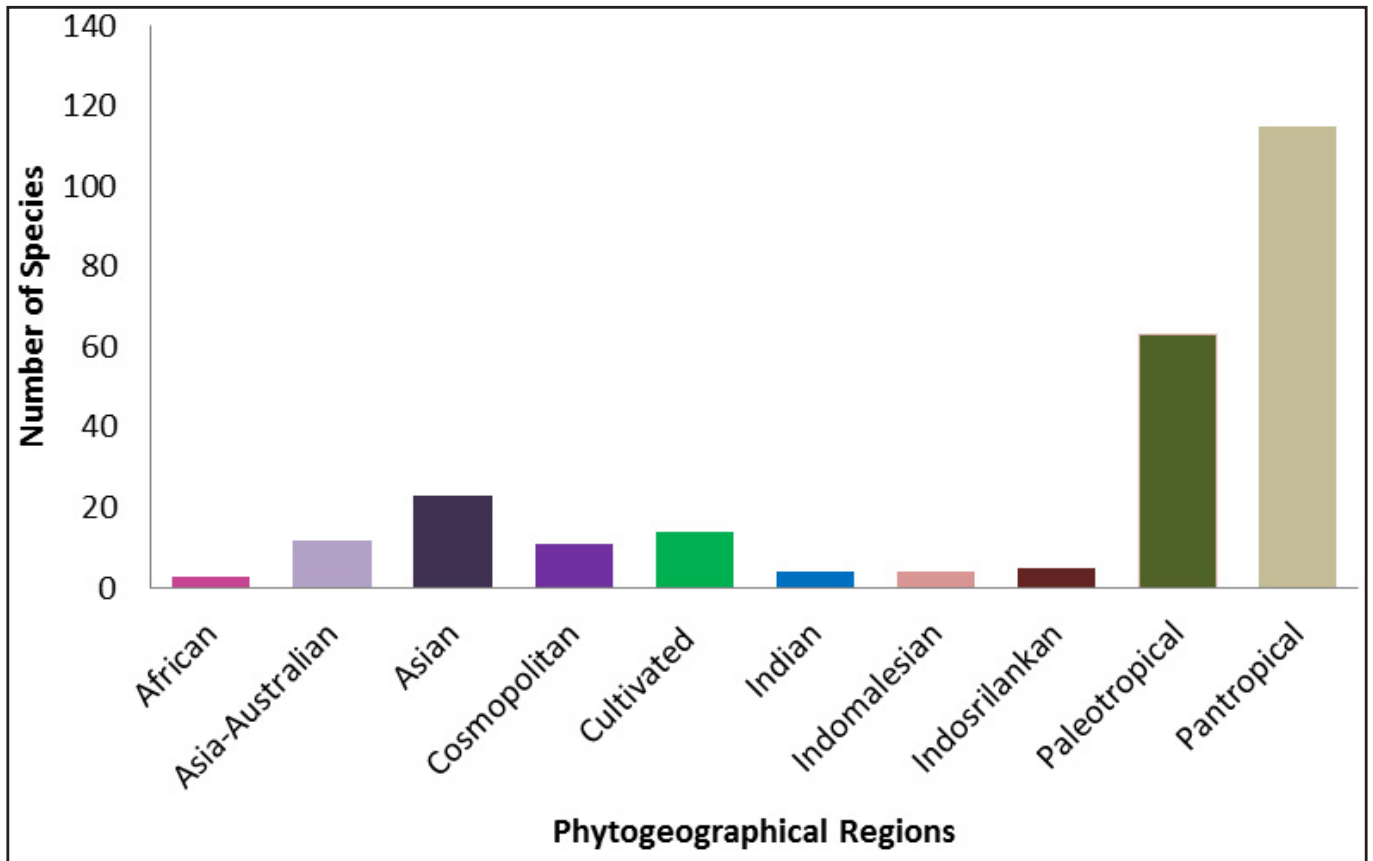


FIGURE 6. Phytogeographical Distribution of Angiosperms.



FIGURE 7. Herbaceous species of sandy habitats: A) *Canavalia cathartica* (Fabaceae); B) *Ipomoea pes-caprae* (Convolvulaceae); C) *Launaea sarmentosa* (Asteraceae); D) *Pedalium murex* (Pedaliaceae); E) *Pupalia lappacea* var. *orbiculata* (Amaranthaceae); F) *Turnera subulata* (Passifloraceae).



FIGURE 8. Common herbs of Adyar estuary: A) *Commelina benghalensis* (Commelinaceae); B) *Crotalaria verrucosa* (Fabaceae); C) *Euphorbia cyathophora* (Euphorbiaceae); D) *Euphorbia heterophylla* (Euphorbiaceae); E) *Glinus oppositifolius* (Molluginaceae); F) *Macroptilium lathyroides* (Fabaceae).



FIGURE 9. Herbaceous undergrowth on the banks of the estuary: A) *Martynia annua* (Martyniaceae); B) *Pavonia zeylanica* (Malvaceae); C) *Phyla nodiflora* (Verbenaceae); D) *Rivinia humilis* (Phytolaccaceae); E) *Ruellia tuberosa* (Acanthaceae); F) *Stachytarpheta jamaicensis* (Verbenaceae).



FIGURE 10. Common shrubs of the estuary: A) *Abutilon indicum* (Malvaceae); B) *Flueggea leucopyrus* (Phyllanthaceae); C) *Ipomoea carnea* (Convolvulaceae); D) *Ochna obtusata* (Ochnaceae); E) *Rauvolfia tetraphylla* (Apocynaceae); F) *Ziziphus oenopolia* (Rhamnaceae).



FIGURE 11. Common climbers of the estuary: A) *Abrus precatorius* (Fabaceae); B) *Citrullus colocynthis* (Cucurbitaceae); C) *Mukia maderaspatana* (Cucurbitaceae); D) *Oxystelma secamone* (Apocynaceae); E) *Solanum trilobatum* (Solanaceae); F) *Tinospora cordifolia* (Menispermaceae).



FIGURE 12. Coastal arboreal species along the estuary: A) *Avicennia marina* (Acanthaceae); B) *Calophyllum inophyllum* (Calophyllaceae); C) *Excoecaria agallocha* (Euphorbiaceae); D) *Morinda pubescens* (Rubiaceae); E) *Pongamia pinnata* (Fabaceae); F) *Thespesia populnea* (Malvaceae).



FIGURE 13. Inland arboreal species of the Adyar estuary: A) *Acacia nilotica* (Fabaceae); B) *Ficus hispida* (Moraceae); C) *Lawsonia inermis* (Lythraceae); D) *Muntingia calabura* (Muntingiaceae); E) *Tabebuia rosea* (Bignoniaceae); F) *Terminalia catappa* (Combretaceae).



FIGURE 14. A) Residential and industrial buildings on the banks of Adyar estuary; B – D) Adyar estuary polluted with sewage discharges and non-biodegradable wastes; E) Pneumatophores of *Avicennia marina* covered by non-biodegradable plastics; F) Cattle grazing in the estuarine area.

TABLE 1. Enumeration of Angiosperms of Adyar Estuary according to Angiosperm Phylogeny Group III Classification (APG III 2009) (C – Climber, H – Herb, S – Shrub, T – Tree)

SL. NO.	NAME OF CLADES/ORDERS/ FAMILIES	NAME OF SPECIES/VARIETIES	LIFE- FORM	PHYTOGEOGRAPHICAL REGION	DISTRIBUTION	VOUCHER NUMBER	
MAGNOLIDS							
Piperales Bercht. and J. Presl							
1	Aristolochiaceae Juss., nom. cons.	Aristolochia bracteolata Lam.	C	Paleotropical	Rare	REEF1057	
Magnoliales Juss. ex Bercht. and J. Presl							
2	Annonaceae Juss., nom. cons.	Annona squamosa L.	T	Pantropical (Tropical American)	Rare	REEF1064	
3		Polyalthia longifolia (Sonn.) Thwaites	T	Indosrilankan	Common	REEF1135	
MONOCOTS							
Alismatales R. Br. ex Bercht. and J. Presl							
4	Araceae Juss., nom. cons.	Lemna aequinoctialis Welw.	H	Cosmopolitan	Common	REEF1158	
Asparagales Link							
5	Asparagaceae Juss., nom. cons.	Asparagus racemosus Willd.	C	Paleotropical	Rare	REEF1058	
6		Sansevieria roxburghiana Schult. and Schult.f.	H	Tropical Asian	Occasional	REEF1140	
COMMELINIDS							
Arecales Bromhead							
7	Arecaceae Bercht. and J. Presl, nom. cons.	Borassus flabellifer L.	T	Tropical Asian	Rare	REEF1071	
8		Phoenix sylvestris (L.) Roxb.	T	Tropical Asian	Rare	REEF1137	
Commelinales Mirb. ex Bercht. and J. Presl							
9	Commelinaceae Mirb., nom. cons.	Commelina benghalensis L.	H	Paleotropical	Occasional	REEF1089	
10	Pontederiaceae Kunth, nom. cons.	Eichhornia crassipes (Mart.) Solms	H	Pantropical (Tropical American)	Common	REEF1124	
Zingiberales Griseb.							
11	Musaceae Juss., nom. cons.	Musa paradisiaca L.	T	Cultivated	Rare	REEF1020	
12	Cannacee Juss., nom. cons.	Canna indica L.	H	Cultivated (Tropical American)	Occasional	REEF1070	
Poales Small							
13	Cyperaceae Juss., nom. cons.	Cyperus arenarius Retz.	H	Tropical Asian	Common	REEF1107	
14		Cyperus compressus L.	H	Cosmopolitan	Occasional	REEF1103	
15		Cyperus exaltatus Retz.	H	Paleotropical	Common	REEF1117	
16		Pycneus polystachyos (Rottb.) P. Beauv.	H	Cosmopolitan	Occasional	REEF1206	
17		Poaceae Barnhart, nom. cons.	Chloris barbata Sw.	H	Pantropical	Common	REEF1086
18			Cynodon dactylon (L.) Pers.	H	Cosmopolitan	Occasional	REEF1106
19			Dactyloctenium aegyptium (L.) Willd.	H	Cosmopolitan	Common	REEF1104
20			Digitaria ciliaris (Retz.) Koeler	H	Pantropical	Common	REEF1120
21			Echinochloa colona (L.) Link	H	Cosmopolitan	Common	REEF1126
22			Eleusine indica (L.) Gaertn.	H	Pantropical	Common	REEF1149
23	Poaceae Barnhart, nom. cons.	Eragrostiella bifaria (Vahl) Bor	H	Paleotropical	Occasional	REEF1123	
24		Eragrostis amabilis (L.) Wight and Arn.	H	Paleotropical	Common	REEF1150	
25		Panicum maximum Jacq.	H	Cosmopolitan	Rare	REEF1012	
26		Panicum psilopodium Trin.	H	Asian	Occasional	REEF1013	
27		Paspalum scrobiculatum L.	H	Paleotropical	Occasional	REEF1016	
28		Saccharum officinarum L.	H	Cultivated	Rare	REEF1239	
29		Setaria verticillata (L.) P. Beauv.	H	Cosmopolitan	Occasional	REEF1234	
30		Trachys muricata (L.) Pers. ex Trin.	H	Tropical Asian	Rare	REEF1228	
EUDICOTS							
Ranunculales Juss. ex Bercht. and J. Presl							
31	Papaveraceae Juss., nom. cons.	Argemone mexicana L.	H	Pantropical (Tropical American)	Rare	REEF1061	
32	Menispermaceae Juss., nom. cons.	Tinospora cordifolia (Willd.) Miers ex Hook.f. and Thomson	C	Tropical Asian	Occasional	REEF1227	

TABLE 1. CONTINUED.

SL. NO.	NAME OF CLADES/ORDERS/FAMILIES	NAME OF SPECIES/VARIETIES	LIFE-FORM	PHYTOGEOGRAPHICAL REGION	DISTRIBUTION	VOUCHER NUMBER
ROSIDS						
Vitales Juss. ex Bercht. and J. Presl						
33	Vitaceae Juss., nom. cons.	<i>Cissus vitiginea</i> L.	C	Indosrilankan	Occasional	REEF1087
FABIDS						
Zygophyllales Griseb.						
34	Zygophyllaceae R. Br., nom. cons.	<i>Tribulus terrestris</i> L.	H	Cosmopolitan	Occasional	REEF1225
Malphigiales Juss. ex Bercht. and J. Presl						
35	Euphorbiaceae Juss., nom. cons.	<i>Acalypha indica</i> L.	H	Paleotropical	Common	REEF1044
36		<i>Acalypha lanceolata</i> Wall.	H	Paleotropical	Rare	REEF1045
37		<i>Croton bonplandianus</i> Baill.	H	Pantropical (Tropical American)	Common	REEF1108
38		<i>Euphorbia cyathophora</i> Murray	H	Pantropical (Tropical American)	Common	REEF1121
39		<i>Euphorbia heterophylla</i> L.	H	Pantropical (Tropical American)	Rare	REEF1164
40		<i>Euphorbia hirta</i> L.	H	Pantropical	Common	REEF1175
41		<i>Euphorbia serpens</i> Kunth	H	Pantropical	Occasional	REEF1152
42		<i>Excoecaria agallocha</i> L.	T	Asia-Australian	Occasional	REEF1153
43		<i>Jatropha curcas</i> L.	S	Pantropical (Tropical American)	Occasional	REEF1008
44		<i>Jatropha gossypifolia</i> L.	S	Pantropical	Common	REEF1171
45		<i>Micrococca mercurialis</i> (L.) Benth.	H	Paleotropical	Common	REEF1174
46		<i>Microstachys chamaelea</i> (L.) Müll.Arg.	H	Paleotropical	Occasional	REEF1142
47		<i>Ricinus communis</i> L.	S	Pantropical (Tropical American)	Common	REEF1220
48	Ochnaceae DC., nom. cons.	<i>Ochna obtusata</i> DC.	S	Tropical Asian	Rare	REEF1022
49	Phyllanthaceae Martinov, nom. cons.	<i>Flueggea leucopyrus</i> Willd.	S	Paleotropical	Rare	REEF1143
50		<i>Phyllanthus amarus</i> Schumach. and Thonn.	H	Pantropical (Tropical American)	Common	REEF1138
51		<i>Phyllanthus maderaspatensis</i> L.	H	Paleotropical	Occasional	REEF1196
52		<i>Phyllanthus reticulatus</i> Poir.	S	Paleotropical	Common	REEF1229
53		<i>Phyllanthus virgatus</i> G. Forst.	H	Paleotropical	Common	REEF1201
54	Passifloraceae Juss. ex Roussel, nom. cons.	<i>Passiflora foetida</i> L.	C	Pantropical (Tropical American)	Common	REEF1002
55		<i>Turnera subulata</i> Sm.	H	Pantropical (Tropical American)	Common	REEF1216
56	Calophyllaceae J. Agardh	<i>Calophyllum inophyllum</i> L.	T	Paleotropical	Occasional	REEF1080
Cucurbitales Juss. ex Bercht. and J. Presl						
57	Cucurbitaceae Juss., nom. cons.	<i>Benincasa hispida</i> (Thunb.) Cogn.	C	Cultivated	Occasional	REEF1040
58		<i>Citrullus colocynthis</i> (L.) Schrad.	C	Paleotropical	Occasional	REEF1100
59		<i>Citrullus lanatus</i> (Thunb.) Matsum. and Nakai	C	African	Rare	REEF1088
60		<i>Coccinia grandis</i> (L.) Voigt	C	Paleotropical	Common	REEF1092
61		<i>Luffa acutangula</i> (L.) Roxb.	C	Pantropical	Occasional	REEF1160
61		<i>Luffa cylindrica</i> (L.) M. Roem.	C	Pantropical	Occasional	REEF1132
63		<i>Momordica charantia</i> L.	C	Pantropical	Occasional	REEF1006
64		<i>Mukia maderaspatana</i> (L.) M. Roem.	C	Paleotropical	Common	REEF1004
Fabales Bromhead						
65	Fabaceae Lindl., nom. cons.	<i>Abrus precatorius</i> L.	C	Pantropical	Rare	REEF1041
66		<i>Acacia auriculiformis</i> A. Cunn. ex Benth.	T	Pantropical (Australian)	Rare	REEF1043
67		<i>Acacia nilotica</i> (L.) Delile	T	Paleotropical	Rare	REEF1047
68		<i>Aeschynomene aspera</i> L.	S	Tropical Asian	Occasional	REEF1051
69		<i>Aeschynomene indica</i> L.	H	Pantropical	Occasional	REEF1054
70		<i>Albizia lebbek</i> (L.) Benth.	T	Pantropical	Occasional	REEF1055
71		<i>Albizia saman</i> (Jacq.) Merr.	T	Pantropical	Occasional	REEF1139
72		<i>Bauhinia racemosa</i> Lam.	T	Asian	Rare	REEF1039
73		<i>Caesalpinia bonduc</i> (L.) Roxb.	S	Pantropical	Occasional	REEF1078

TABLE 1. CONTINUED.

SL. NO.	NAME OF CLADES/ORDERS/FAMILIES	NAME OF SPECIES/VARIETIES	LIFE-FORM	PHYTOGEOGRAPHICAL REGION	DISTRIBUTION	VOUCHER NUMBER
74		<i>Cajanus cajan</i> (L.) Millsp.	H	Pantropical	Occasional	REEF1079
75		<i>Canavalia cathartica</i> Thouars	C	Paleotropical	Common	REEF1082
76		<i>Chamaecrista absus</i> (L.) H.S. Irwin and Barneby	H	Pantropical	Rare	REEF1032
77		<i>Clitoria ternatea</i> L.	C	Pantropical	Rare	REEF1098
78		<i>Crotalaria pallida</i> Aiton	H	Pantropical	Occasional	REEF1116
79		<i>Crotalaria verrucosa</i> L.	H	Pantropical	Common	REEF1102
80		<i>Derris trifoliata</i> Lour.	C	Paleotropical	Rare	REEF1119
81		<i>Desmanthus virgatus</i> (L.) Willd.	S	Pantropical	Rare	REEF1105
82		<i>Erythrina variegata</i> L.	T	Paleotropical	Occasional	REEF1151
83		<i>Indigofera colutea</i> (Burm.f.) Merr.	H	Paleotropical	Rare	REEF1180
84		<i>Indigofera linnaei</i> Ali	H	Asia-Australian	Common	REEF1128
85		<i>Indigofera tinctoria</i> L.	S	Paleotropical	Occasional	REEF1167
86		<i>Lysiloma latisiliquum</i> (L.) Benth.	T	Pantropical (Tropical American)	Common	REEF1027
87		<i>Macroptilium lathyroides</i> (L.) Urb.	H	Pantropical (Tropical American)	Common	REEF1010
88		<i>Peltophorum pterocarpum</i> (DC.) Baker ex B. Heyne	T	Asia-Australian	Common	REEF1193
89		<i>Pithecellobium dulce</i> (Roxb.) Benth.	T	Pantropical (Tropical American)	Occasional	REEF1134
90		<i>Pongamia pinnata</i> (L.) Pierre	T	Paleotropical	Occasional	REEF1200
91		<i>Prosopis juliflora</i> (Sw.) DC.	T	Pantropical (Tropical American)	Common	REEF1136
92		<i>Rhynchosia aurea</i> (Willd.) DC.	C	Indosrilankan	Common	REEF1208
93		<i>Rhynchosia minima</i> (L.) DC.	C	Pantropical	Rare	REEF1219
94		<i>Senna occidentalis</i> (L.) Link	S	Pantropical (Tropical American)	Common	REEF1036
95		<i>Senna siamea</i> (Lam.) H.S. Irwin and Barneby	T	Pantropical (Tropical Asian)	Occasional	REEF1035
96		<i>Sesbania sesban</i> (L.) Merr.	T	Pantropical (Paleotropical)	Rare	REEF1210
97		<i>Tamarindus indica</i> L.	T	Paleotropical	Occasional	REEF1248
98		<i>Tephrosia purpurea</i> (L.) Pers.	H	Pantropical (Paleotropical)	Rare	REEF1246
99		<i>Tephrosia villosa</i> (L.) Pers.	H	Paleotropical	Rare	REEF1144
100		<i>Teramnus labialis</i> (L.f.) Spreng.	C	Pantropical	Rare	REEF1223
101		<i>Vigna radiata</i> (L.) Wilczek	C	Paleotropical	Rare	REEF1251
Rosales Bercht. and J. Presl						
102	Rhamnaceae Juss., nom. cons.	<i>Ziziphus mauritiana</i> Lam.	T	Pantropical	Occasional	REEF1254
103		<i>Ziziphus oenopolia</i> (L.) Mill.	S	Asia-Australian	Occasional	REEF1215
104	Ulmaceae Mirb., nom. cons.	<i>Holoptelea integrifolia</i> Planch.	T	Tropical Asian	Rare	REEF1179
105	Moraceae Gaudich., nom. cons.	<i>Ficus amplissima</i> Sm.	T	Tropical Asian	Occasional	REEF1166
106		<i>Ficus benghalensis</i> L.	T	Tropical Asian	Occasional	REEF1176
107		<i>Ficus hispida</i> L.f.	T	Asia-Australian	Occasional	REEF1110
108		<i>Ficus microcarpa</i> L.f.	T	Pantropical	Occasional	REEF1183
109		<i>Ficus racemosa</i> L.	T	Asia-Australian	Rare	REEF1165
110		<i>Ficus religiosa</i> L.	T	Tropical Asian	Common	REEF1184
111		<i>Streblus asper</i> Lour.	T	Asian	Occasional	REEF1244
MALVIDS						
Myrtales Juss. ex Bercht. and J. Presl						
112	Combretaceae R. Br., nom. cons.	<i>Terminalia catappa</i> L.	T	Pantropical	Rare	REEF1145
113	Lythraceae J. St.-Hil., nom. cons.	<i>Lawsonia inermis</i> L.	S	Paleotropical	Common	REEF1157
114		<i>Punica granatum</i> L.	T	Pantropical	Rare	REEF1204
115	Myrtaceae Juss., nom. cons.	<i>Psidium guajava</i> L.	T	Cultivated (Tropical American)	Rare	REEF1203
116		<i>Syzygium cumini</i> (L.) Skeels	T	Pantropical	Occasional	REEF1249
Brassicales Bromhead						
117	Moringaceae Martinov, nom. cons.	<i>Moringa oleifera</i> Lam.	T	Tropical Asian	Rare	REEF1005
118	Caricaceae Dumort., nom. cons.	<i>Carica papaya</i> L.	T	Cultivated (Tropical American)	Rare	REEF1033
119	Capparaceae Juss., nom. cons.	<i>Crateva religiosa</i> G. Forst.	T	Asia-Australian	Rare	REEF1090

TABLE 1. CONTINUED.

SL. NO.	NAME OF CLADES/ORDERS/FAMILIES	NAME OF SPECIES/VARIETIES	LIFE-FORM	PHYTOGEOGRAPHICAL REGION	DISTRIBUTION	VOUCHER NUMBER
120	Cleomaceae Bercht. and J. Presl	<i>Cleome aspera</i> J. König ex DC.	H	Indian	Occasional	REEF1093
121		<i>Cleome rutidosperma</i> DC. var. <i>burmannii</i> (Wight and Arn.) Siddiqui and S.N. Dixit	H	Indomalesian	Rare	REEF1101
122		<i>Cleome gynandra</i> L.	H	Pantropical	Common	REEF1091
123		<i>Cleome viscosa</i> L.	H	Paleotropical	Common	REEF1099
124	Brassicaceae Burnett, nom. cons.	<i>Brassica juncea</i> (L.) Czern.	H	Cultivated	Rare	REEF1077
Malvales Juss. ex Bercht. and J. Presl						
125	Muntingiaceae C. Bayer and al.	<i>Muntingia calabura</i> L.	T	Cultivated (Tropical American)	Occasional	REEF1015
126	Malvaceae Juss., nom. cons.	<i>Abutilon indicum</i> (L.) Sweet	S	Pantropical	Common	REEF1042
127		<i>Ceiba pentandra</i> (L.) Gaertn.	T	Pantropical	Rare	REEF1030
128		<i>Corchorus aestuans</i> L.	H	Pantropical	Occasional	REEF1096
129		<i>Guazuma ulmifolia</i> Lam.	T	Pantropical (Tropical American)	Common	REEF1028
130		<i>Hibiscus vitifolius</i> L.	S	Pantropical	Common	REEF1113
131		<i>Malvastrum coromandelianum</i> (L.) Garcke	H	Pantropical	Rare	REEF1162
132		<i>Melochia corychorifolia</i> L.	H	Pantropical	Occasional	REEF1024
133		<i>Pavonia zeylanica</i> (L.) Cav.	H	Paleotropical	Rare	REEF1011
134		<i>Sida acuta</i> Burm.f.	H	Pantropical	Common	REEF1221
135		<i>Sida cordata</i> (Burm.f.) Borss. Waalk.	H	Pantropical	Occasional	REEF1231
136		<i>Sida cordifolia</i> Roxb.	H	Pantropical	Occasional	REEF1209
137		<i>Thespesia populnea</i> (L.) Sol. ex Corrêa	T	Pantropical	Occasional	REEF1213
138		<i>Waltheria indica</i> L.	H	Pantropical	Occasional	REEF1214
Sapindales Juss. ex Bercht. and J. Presl						
139	Anacardiaceae R. Br., nom. cons.	<i>Lannea coromandelica</i> (Houtt.) Merr.	T	Asian	Common	REEF1172
140	Sapindaceae Juss., nom. cons.	<i>Cardiospermum halicacabum</i> L.	C	Pantropical	Common	REEF1031
141	Rutaceae Juss., nom. cons.	<i>Aegle marmelos</i> (L.) Corrêa	T	Indomalesian	Rare	REEF1049
142		<i>Limonia acidissima</i> L.	T	Asian	Rare	REEF1159
143		<i>Murraya koenigii</i> (L.) Spreng.	T	Paleotropical	Occasional	REEF1017
144	Meliaceae Juss., nom. cons.	<i>Azadirachta indica</i> A. Juss.	T	Paleotropical	Common	REEF1074
145		<i>Melia azedarach</i> L.	T	Pantropical	Occasional	REEF1188
Santalales R. Br. ex Bercht. and J. Presl						
146	Santalaceae R. Br., nom. cons.	<i>Santalum album</i> L.	T	Asia-Australian	Rare	REEF1141
Caryophyllales Juss. ex Bercht. and J. Presl						
147	Polygonaceae Juss., nom. cons.	<i>Antigonon leptopus</i> Hook. and Arn.	C	Pantropical (Tropical American)	Common	REEF1065
148	Amaranthaceae Juss., nom. cons.	<i>Achyranthes aspera</i> L.	H	Pantropical	Common	REEF1048
149		<i>Aerva lanata</i> (L.) Juss. ex Schult.	H	Pantropical	Occasional	REEF1050
150		<i>Alternanthera paronychioides</i> A. St.-Hil.	H	Pantropical (Tropical American)	Rare	REEF1056
151		<i>Alternanthera pungens</i> Kunth	H	Pantropical (Tropical American)	Occasional	REEF1060
152		<i>Alternanthera sessilis</i> (L.) R. Br. ex DC.	H	Asian	Common	REEF1053
153		<i>Alternanthera ficoidea</i> (L.) Sm.	H	Pantropical (Tropical American)	Occasional	REEF1062
154		<i>Amaranthus spinosus</i> L.	H	Pantropical	Common	REEF1063
155		<i>Amaranthus viridis</i> L.	H	Pantropical (Tropical American)	Occasional	REEF1052
156		<i>Celosia argentea</i> L.	H	Pantropical	Occasional	REEF1085
157		<i>Gomphrena globosa</i> L.	H	Pantropical	Rare	REEF1111
158		<i>Gomphrena serrata</i> L.	H	Pantropical (Tropical American)	Common	REEF1186
159		<i>Pupalia lappacea</i> (L.) Juss. var. <i>orbiculata</i> (B. Heyne ex Wall.) Towns.	H	Paleotropical	Occasional	REEF1202
160	Aizoaceae Martinov, nom. cons.	<i>Corbichonia decumbens</i> (Forssk.) Exell	H	Paleotropical	Rare	REEF1095
161		<i>Sesuvium portulacastrum</i> (L.) L.	H	Pantropical	Common	REEF1233

TABLE 1. CONTINUED.

SL. NO.	NAME OF CLADES/ORDERS/FAMILIES	NAME OF SPECIES/VARIETIES	LIFE-FORM	PHYTOGEOGRAPHICAL REGION	DISTRIBUTION	VOUCHER NUMBER
162		<i>Trianthema portulacastrum</i> L.	H	Pantropical	Common	REEF1226
163		<i>Trianthema triquetra</i> Rottler ex Willd.	H	Paleotropical	Rare	REEF1148
164	Phytolaccaceae R. Br., nom. cons.	<i>Rivinia humilis</i> L.	H	Pantropical (Tropical American)	Rare	REEF1238
165	Nyctaginaceae Juss., nom. cons.	<i>Boerhavia diffusa</i> L.	H	Pantropical	Occasional	REEF1076
166		<i>Boerhavia erecta</i> L.	H	Pantropical	Common	REEF1069
167		<i>Pisonia grandis</i> L.	T	Paleotropical	Rare	REEF1198
168	Molluginaceae Bartl., nom. cons.	<i>Glinus oppositifolius</i> (L.) DC.	H	Paleotropical	Common	REEF1185
169		<i>Mollugo nudicaulis</i> Lam.	H	Paleotropical	Rare	REEF1133
170		<i>Mollugo pentaphylla</i> L.	H	Paleotropical	Occasional	REEF1190
171	Basellaceae Raf., nom. cons.	<i>Basella alba</i> L.	C	Tropical	Rare	REEF1038
172	Portulacaceae Juss., nom. cons.	<i>Portulaca oleracea</i> L.	H	Cosmopolitan	Occasional	REEF1199
173	Cactaceae Juss., nom. cons.	<i>Acanthocereus tetragonus</i> (L.) Hummelinck	S	Pantropical (Tropical American)	Occasional	REEF1046
ASTERIDS						
Ericales Bercht. and J. Presl						
174	Sapotaceae Juss., nom. cons.	<i>Mimusops elengi</i> L.	T	Asia-Australian	Rare	REEF1173
LAMIIDS						
Gentianales Juss. ex Bercht. and J. Presl						
175	Rubiaceae Juss., nom. cons.	<i>Benkara malabarica</i> (Lam.) Tirveng.	S	Indosrilankan	Rare	REEF1059
176		<i>Ixora pavetta</i> Andrews	S	Indian	Occasional	REEF1169
177		<i>Morinda pubescens</i> Sm.	T	Indomalesian	Occasional	REEF1019
178		<i>Oldenlandia corymbosa</i> (L.) Lam.	H	Paleotropical	Occasional	REEF1129
179		<i>Psydrax dicoccus</i> Gaertn.	T	Indomalesian	Occasional	REEF1083
180		<i>Spermacoce articularis</i> L.f.	H	Pantropical	Occasional	REEF1241
181		<i>Spermacoce hispida</i> L.	H	Asia-Australian	Occasional	REEF1212
182	Apocynaceae Juss., nom. cons.	<i>Calotropis gigantea</i> (L.) W.T. Aiton	S	Pantropical	Common	REEF1081
183		<i>Cascabela thevetia</i> (L.) Lippold	S	Pantropical	Rare	REEF1147
184		<i>Catharanthus roseus</i> (L.) G. Don	H	Pantropical	Occasional	REEF1034
185		<i>Hemidesmus indicus</i> (L.) R. Br. ex Schult.	C	Indian	Occasional	REEF1178
186		<i>Marsdenia sylvestris</i> (Retz.) P.I. Forst.	C	Paleotropical	Rare	REEF1181
187		<i>Nerium oleander</i> L.	S	Pantropical (Old World) Cultivated	Rare	REEF1021
188		<i>Oxystelma secamone</i> (L.) K. Schum.	C	Pantropical	Rare	REEF1014
189		<i>Pentstemon capensis</i> (L.f.) Bullock	C	Indian	Rare	REEF1194
190		<i>Pergularia daemia</i> (Forssk.) Chiov.	C	Paleotropical	Rare	REEF1195
191		<i>Rauvolfia tetraphylla</i> L.	S	Pantropical (Tropical American)	Occasional	REEF1207
192		<i>Tylophora indica</i> (Burm.f.) Merr.	C	Asian	Common	REEF1217
Boraginales Juss. ex Bercht. and J. Presl						
193	Boraginaceae Juss., nom. cons.	<i>Coldenia procumbens</i> L.	H	Paleotropical	Occasional	REEF1097
194		<i>Cordia dichotoma</i> G. Forst.	T	Paleotropical	Common	REEF1094
195		<i>Heliotropium curassavicum</i> L.	H	Pantropical	Rare	REEF1182
196		<i>Heliotropium indicum</i> L.	H	Pantropical	Common	REEF1112
197		<i>Trichodesma indicum</i> (L.) R. Br.	H	Asian	Rare	REEF1224
Solanales Juss. ex Bercht. and J. Presl						
198	Convolvulaceae Juss., nom. cons.	<i>Evolvulus nummularius</i> (L.) L.	H	Pantropical	Occasional	REEF1115
199		<i>Hewittia malabarica</i> (L.) Suresh	C	Pantropical	Rare	REEF1177
200		<i>Ipomoea cairica</i> (L.) Sweet	C	Pantropical	Common	REEF1114
201		<i>Ipomoea carnea</i> Jacq.	S	Pantropical (Tropical American)	Common	REEF1007
202		<i>Ipomoea eriocarpa</i> R. Br.	C	Paleotropical	Rare	REEF1025

TABLE 1. CONTINUED.

SL. NO.	NAME OF CLADES/ORDERS/FAMILIES	NAME OF SPECIES/VARIETIES	LIFE-FORM	PHYTOGEOGRAPHICAL REGION	DISTRIBUTION	VOUCHER NUMBER
203		<i>Ipomoea hederifolia</i> L.	C	Pantropical (Tropical American)	Occasional	REEF1154
204		<i>Ipomoea marginata</i> (Desr.) Verdc.	C	Paleotropical	Common	REEF1131
205		<i>Ipomoea obscura</i> (L.) Ker Gawl.	C	Paleotropical	Occasional	REEF1130
206		<i>Ipomoea pes-caprae</i> Roth	C	Pantropical	Common	REEF1168
207		<i>Ipomoea pes-tigridis</i> L.	C	Paleotropical	Rare	REEF1155
208		<i>Merremia tridentata</i> (L.) Hallier f.	C	Paleotropical	Rare	REEF1023
209		<i>Operculina turpethum</i> (L.) Silva Manso	C	Paleotropical	Occasional	REEF1003
210	Solanaceae Juss., nom. cons.	<i>Capsicum annum</i> L.	H	Cultivated (Tropical American)	Occasional	REEF1084
211		<i>Datura innoxia</i> Mill.	H	Pantropical	Occasional	REEF1118
212		<i>Datura metel</i> L.	H	Pantropical	Common	REEF1109
213		<i>Physalis angulata</i> L.	H	Pantropical (Tropical American)	Occasional	REEF1197
214		<i>Solanum americanum</i> Mill.	H	Pantropical (Tropical American)	Occasional	REEF1232
215		<i>Solanum lycopersicum</i> L.	H	Cultivated	Occasional	REEF1161
216		<i>Solanum torvum</i> Sw.	S	Pantropical (Tropical American)	Occasional	REEF1222
217		<i>Solanum trilobatum</i> L.	C		Occasional	REEF1240
218		<i>Solanum virginianum</i> L.	H	Asian	Occasional	REEF1242
Lamiales Bromhead						
219	Oleaceae Hoffmanns. and Link, nom. cons.	<i>Jasminum angustifolium</i> Willd.	C	Indosrilankan	Occasional	REEF1170
220	Scrophulariaceae Juss., nom. cons.	<i>Scoparia dulcis</i> L.	H	Pantropical (Tropical American)	Common	REEF1236
221	Pedaliaceae R. Br., nom. cons.	<i>Pedaliium murex</i> L.	H	Paleotropical	Occasional	REEF1192
222		<i>Sesamum indicum</i> L.	H	Cultivated	Occasional	REEF1235
223	Lamiaceae Martinov, nom. cons.	<i>Hyptis suaveolens</i> (L.) Poit.	H	Pantropical (Tropical American)	Common	REEF1127
224		<i>Ocimum tenuiflorum</i> L.	H	Pantropical	Common	REEF1001
225		<i>Premna corymbosa</i> Rottler and Willd.	C	Paleotropical	Rare	REEF1205
226	Acanthaceae Juss., nom. cons.	<i>Asystasia gangetica</i> (L.) T. Anderson	H	Pantropical	Occasional	REEF1066
227		<i>Avicennia marina</i> (Forssk.) Vierh.	T	Paleotropical	Occasional	REEF1067
228		<i>Avicennia officinalis</i> L.	T	Paleotropical	Rare	REEF1073
229		<i>Barleria prionitis</i> L.	H	Paleotropical	Occasional	REEF1037
230		<i>Blepharis repens</i> (Vahl) Roth	H	Paleotropical	Occasional	REEF1075
231		<i>Dicliptera paniculata</i> (Forssk.) I. Darbysh.	H	Paleotropical	Rare	REEF1191
232		<i>Echolium viride</i> (Forssk.) Alston	H	Paleotropical	Occasional	REEF1125
233		<i>Ruellia patula</i> Jacq.	H	Pantropical	Common	REEF1029
234		<i>Ruellia tuberosa</i> L.	H	Pantropical (Tropical American)	Common	REEF1237
235	Bignoniaceae Juss., nom. cons.	<i>Kigelia africana</i> (Lam.) Benth.	T	African	Rare	REEF1026
236		<i>Millingtonia hortensis</i> L.f.	T	Asian	Occasional	REEF1189
237		<i>Spathodea campanulata</i> P. Beauv.	T	African	Occasional	REEF1211
238		<i>Tabebuia rosea</i> (Bertol.) DC.	T	Cultivated (Tropical American)	Occasional	REEF1245
239		<i>Tecoma stans</i> (L.) Kunth	S	Cultivated (Tropical American)	Rare	REEF1247
240	Verbenaceae J. St.-Hil., nom. cons.	<i>Lantana camara</i> L.	S	Pantropical (Tropical American)	Common	REEF1009
241		<i>Phyla nodiflora</i> (L.) Greene	H	Cosmopolitan	Common	REEF1230
242		<i>Stachytarpheta jamaicensis</i> (L.) Vahl	H	Pantropical (Tropical American)	Occasional	REEF1243
243	Martyniaceae Horan., nom. cons.	<i>Martynia annua</i> L.	H	Pantropical (Tropical American)	Rare	REEF1163

TABLE 1. CONTINUED.

SL. NO.	NAME OF CLADES/ORDERS/FAMILIES	NAME OF SPECIES/VARIETIES	LIFE-FORM	PHYTOGEOGRAPHICAL REGION	DISTRIBUTION	VOUCHER NUMBER
CAMPANULIDS						
Asterales Link						
244	Asteraceae Bercht. and J. Presl, nom. cons.	<i>Blumea axillaris</i> DC.	H	Paleotropical	Occasional	REEF1068
245		<i>Blumea obliqua</i> (L.) Druce	H	Asia-Australian	Occasional	REEF1072
246		<i>Cyanthillium cinereum</i> (L.) H. Rob.	H	Pantropical	Occasional	REEF1250
247		<i>Eclipta prostrata</i> (L.) L.	H	Pantropical (Tropical American)	Common	REEF1122
248		<i>Grangea maderaspatana</i> (L.) Poir.	H	Paleotropical	Rare	REEF1187
249		<i>Launaea sarmentosa</i> (Willd.) Sch.Bip. ex Kuntze	H	Paleotropical	Common	REEF1156
250		<i>Parthenium hysterophorus</i> L.	H	Pantropical (Tropical American)	Common	REEF1018
251		<i>Tridax procumbens</i> L.	H	Pantropical (Tropical American)	Common	REEF1146
252		<i>Vernonia elaeagnifolia</i> DC.	C	Asia-Australian	Rare	REEF1218
253		<i>Wedelia trilobata</i> (L.) Hitchc.	H	Pantropical (Tropical American)	Occasional	REEF1252
254		<i>Xanthium indicum</i> J. König ex Roxb.	H	Pantropical	Occasional	REEF1253

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