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VEGETATION AND VASCULAR FLORA ALONG THE YETAGUN–YADANA GAS PIPELINE, TANINTHAYI (TENASSERIM) DIVISION, MYANMAR

J. F. Maxwell[1]

ABSTRACT

Two mostly parallel overland gas pipelines have recently been constructed in peninsular Myanmar from wells in the Andaman Sea to supply gas for Thailand. The onshore pipelines extend mostly underground in a generally easterly direction from the beach to the Thai border at 1,025 m elevation for 67 km. Most of the lowland vegetation has been exploited, but from 600 m to the summit/border ridge, in the eastern half of the area, the vegetation is pristine. The area has a seasonal climate. The vegetation includes beach, backshore, mangrove, marsh, rice fields, deciduous dipterocarp–oak, primary evergreen, stream, disturbed, and secondary growth facies. Pipeline construction has created numerous problems including soil erosion, human access, conservation, and reforestation. A botanical database of 666 species is included.

Key words: flora, Myanmar, vegetation, Yadana gas pipeline

INTRODUCTION

The discovery of large amounts of gas below the Andaman Sea has been exploited in two areas. The Yadana gas field, operated by Total Fina, and the Yetagun area, owned by a joint venture of 5 oil companies, have underwater pipes leading from their wells to Daminseik village in peninsular Myanmar (14°35' north latitude, 97°55' east longitude). These two pipelines, both 60 cm diameter and mostly underground, as well as an access road, extend mostly parallel for 67 km east to the Thai border at Ban I-Tong in the western part of Kanchanaburi Province, Thailand (98°22' east longitude). After passing a gas metering station on the Myanmar side of the border, the gas pipelines are united and continue in Thailand to Ratchaburi Province where the gas is burned in an Electricity Generating Authority of Thailand (EGAT) power plant to make electricity.

Onshore construction of the pipelines began in 1997 and were completed by February 2000—the Yadana one being laid first. I visited the pipeline area on three occasions: 28 February–2 March 1996; 7–11 March 1998; and 15–28 October 1998.

The area is located between Ye and Tavoy (Dawei) in Taninthayi (Tenasserim) Division, Dawei District, Yebyu Township in peninsular Myanmar, about 320 km SE of Yangon (Rangoon). The eastern part of the pipeline lies in Kaleinaung Reserved Forest.

[1]CMU Herbarium, Department of Biology, Chiang Mai University, Chiang Mai 50200, Thailand
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Climate

Premier Oil Company established an environmental monitoring unit in 1998 to survey the pipeline route and nearby area. Rainfall and temperature were measured at three sites: Ohnbinkwin village, a small settlement at sea level, about 10 km inland from the Andaman Sea; Kanbauk, a small town near sea level 13 km east of Daminseik and just below the upper limits of the Heinze Estuary; and the border ridge above I-Tong Village at 1,025 m. This is the first time that such data have been recorded in the area. Although the data are incomplete, a basic idea of the temperature and especially rainfall can made (Figures 1–3).

The climate is distinctly seasonal (monsoonal) with a dry and relatively cool period from October to March. Temperatures peak in March–April, while rainfall is highest from June to September. The total annual rainfall at the three sites is:

Ohnbinkwin	6322 mm
Kanbauk	5492 mm
border ridge	5155 mm

History of the Forests

The earliest information available on the topography, vegetation, and timber resources of the Tavoy-Ye area was reported by T. H. Alpin in 1882 (SMITH, 1926). Alpin, a British forester, noted that both local ("Tavoyans") and Christian Karen people were already settled in the area and exploiting the forest—the Tavoyans commercially cutting trees and the Karen practicing slash-and-burn agriculture. Alpin's major concern was to establish a forest reserve (Kaleinaung) in the area in an effort to alleviate forest destruction by these people. It is quite obvious from Alpin's report that conservation measures were only intended to ensure that British logging interests would not be challenged and that there would be abundant supplies of logs (i.e. revenue) in the future. Lowland areas were originally covered with primary, deciduous, seasonal, hardwood growth which naturally includes much bamboo. The dominant species was *Xylia xylocarpa* (Roxb.) Taub. (Leguminosae, Mimosoideae), with *Lagerstroemia speciosa* (L.) Pers. var. *speciosa* (Lythraceae) and *Hopea odorata* Roxb. (Dipterocarpaceae) noted as common associates. *Tectona grandis* L.f. (teak, Verbenaceae) was noted to be absent from the area. Alpin provides some official statistics concerning timber extraction in the area, for example 3,371 logs of *Xylia* were removed in 1881–82, while 2,097 *Lagerstroemia* and 673 *Hopea* trees were counted in 1882 and destined for cutting. By 1926 there was no natural lowland forest remaining below about 150 m elevation (SMITH, 1926). Smith also noted that forest destruction by locals and Karen was quite extensive and that by 1926 most of the major waterways in the area, including the Zimba River and vast areas up to the border with Thailand, were already denuded. Smith found it "quite regrettable" that much of the inland forests were so inaccessible for further exploitation, but does provide some information about the potential of the remaining 832 km^2 of undisturbed forest (SMITH, 1926).

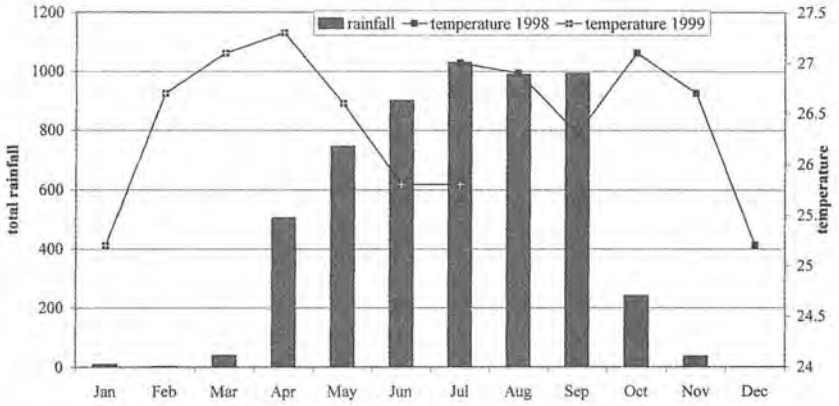

Figure 1. Rainfall (mm) and temperature (degrees Celsius) at Kanbauk, near sea level. Rainfall for the months of June-December are averages of 1998 and 1999 totals; for January–May, 1999 data are given.

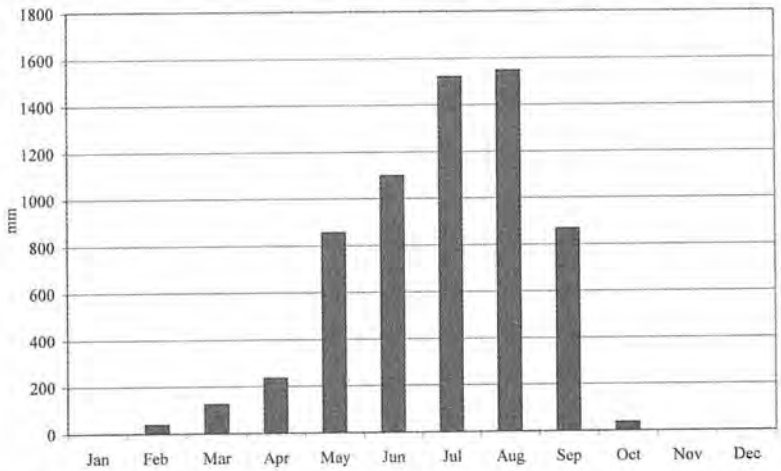

Figure 2. Monthly rainfall data at Ohnbinkwin village, sea level, for 2000.

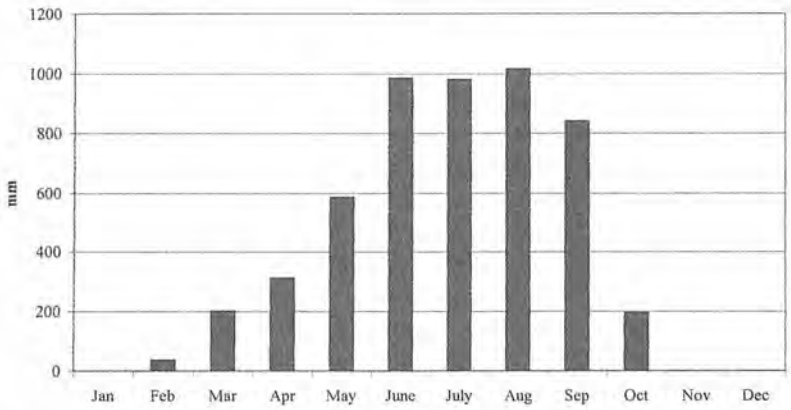

Figure 3. Monthly rainfall at the summit ridge at 1,025 m for 2000.

VEGETATION TYPES

Beach and Backshore Floras

Daminseik village, located on the beach about 300 m north of where the gas pipelines emerge from the Andaman Sea, is populated with about 400 people. Their main occupation is fishing, although rice cultivation is also done by a few families. Most of the original woody vegetation has been removed from the area, thus the beach and backshore are very open. Only a few mostly coppicing or fire-damaged individuals of *Casuarina equisetifolia* J.R. & G. Forst. (Casuarinaceae) and *Cocos nucifera* L. (Palmae) trees are on the beach. The herbaceous ground flora is well-developed with: *Polycarpaea corymbosa* (L.) Lmk. (Caryophyllaceae), *Borreria articularis* (L.f.) F.N. Will. and *Hedyotis pinifolia* Wall. *ex* G. Don (both Rubiaceae), *Launaea sarmentosa* (Willd.) Sch.-Bip. ex O.K. (Compositae), *Ipomoea pes-caprae* (L.) Sweet var. *pes-caprae* (Convolvulaceae), *Bulbostylis barbata* (Rottb.) Cl. and *Cyperus radicans* Nees & Meyen *ex* Kunth (both Cyperaceae), *Spinifex littoralis* (Burm. f.) Merr., and *Sporobolus harmandii* Henr. (both Gramineae).

The backshore is open, fire-damaged, and greatly disturbed by grazing and hacking. *Bidens pilosa* L. var. *minor* (Bl.) Sherff (Compositae), *Cymbopogon flexusous* (Nees *ex* Steud.) Wats. (Gramineae), and some of the herbs found on the beach are included in the ground flora. *Abrus precatorius* L. ssp. *precatorius* (Leguminosae, Papilionoideae), an annual vine, is also common. The woody vegetation is well-developed, but stunted. Some common trees are: *Erythrina orientalis* (L.) Merr. (Leguminosae, Papilionoideae), *Eugenia grandis* Wight and *Eugenia grata* Wight (Myrtaceae), *Diospyros ferrea* (Willd.) Bakh. var *ferrea* (Ebenaceae); *Ficus benjamina* L. var. *benjamina, Ficus microcarpa* L.f. var. *microcarpa*, and *Ficus rumphii* Bl. (Moraceae). Scandent plants are frequent with: *Capparis micracantha* DC. (Capparaceae), *Colubrina asiatica* (L.) Brongn. and *Ziziphus oenoplia* (L.) Mill. var. *oenoplia* (both Rhamnaceae), and *Derris scandens* (Roxb.) Bth. (Leguminosae, Papilionoideae). Evergreen treelets such as *Memecylon edule* Roxb. var. *edule* and var. *ovatum* (Sm.) Cl. (Melastomataceae), and *Pandanus odoratissimus* L.f. (Pandanaceae) are also present.

Marshes and Rice Fields

These are mostly seasonally wet, lowland, aquatic habitats with predominantely annual herbs. The water ranges from brackish to fresh and substrates vary from sand to mud. Many plants found here can be considered rice field weeds and most of them flower during the latter part of the rainy season, September–November. Most of the habitats are completely dry from about January to June. Some common examples are: *Nymphoides indica* (L.) O.K. (Gentianaceae/Menyanthaceae), *Utricularis aurea* Lour. and *Utricularia exoleta* R. Br. (Lentibulariaceae), *Xyris indica* L. and *Xyris pauciflora* Willd. (Xyridaceae), *Eriocaulon oryzetorum* Mart. (Eriocaulaceae), *Monochoria hastata* (L.) Solms and *Monochoria vaginalis* (Burm.f.) Presl (Pontederiaceae); *Cyperus haspan* L., *Cyperus polystachyos* Rottb. var. *polystachyos, Eleocharis philippinensis* Svens., *Fimbristylis ferruginea* (L.) Vahl, *Fimbristylis nutans* (Retz.) Vahl, *Fuirena ciliaris* (L.) Roxb., *Scirpus (Schoenoplectus) juncoides* Roxb. var. *juncoides* (all Cyperaceae), *Ischaemum barbatum* Retz., and *Sacciolepis indica* (L.) A. Chase (all Gramineae). An occasional population of *Tenagocharis latifolia*

(D. Don) Buch. (Butomaceae) and *Philydrum languinosum* Banks & Sol. *ex* Gaertn. (Philydraceae) can also be found in this habitat.

Deciduous Dipterocarp–Oak, Seasonal, Hardwood Forest (DOF)

Continuing east from Kanbauk village, the vegetation changes from mostly agricultural facies to a degraded, fire-damaged, single-story formation which is called a deciduous dipterocarp-oak facies (MAXWELL, 1988). This kind of vegetation is also found in northern Thailand and is dominated by *Dipterocarpus obtusifolius* Teijsm. *ex* Miq. var. *obtusifolius* (Dipterocarpaceae) and *Quercus kerrii* Craib var. *kerrii* (Fagaceae, oak). As in most other places where this forest occurs, the oak component is often sparse or absent due to selective logging. The DOF along the pipeline route seems to lack *Quercus kerrii* var. *kerrii* and in some places even *Dipterocarpus obtusifolius* var. *obtusifolius* is absent. DOF is fire-climax, secondary growth derived from evergreen hardwood forests which have been either clear-cut or severely damaged (MAXWELL *ET AL.*, 1997). Evidence for this can be seen to the east in hilly areas with intact, original, primary, evergreen, seasonal, hardwood forest (EF) where clear-cutting and fire have left gaps which are now covered with DOF growth. The DOF in the area experiences annual fire and continuous cutting, thus the canopy is maintained at usually less than 10 m, while the trees are often coppicing or otherwise damaged by hacking.

Other common trees in DOF include: *Anneslea fragrans* Wall. (Theaceae), *Dalbergia cana* Grah. *ex* Kurz. var. *cana* and *Dalbergia cultrata* Grah. *ex* Bth. (Leguminosae, Papilionoideae), *Tristaniopsis burmanica* (Griff.) Wils. & Wat. var. *burmanica* (Myrtaceae), *Holarrhena pubescens* (B.-H.) Wall. *ex* G. Don (Apocynaceae), and *Symplocos racemosa* Roxb. (Symplocaceae), and *Bridelia retusa* (L.) A. Juss. *Memecylon scutellatum* (Lour.) Naud. (Melastomataceae), a common evergreen treelet, is also found as well as *Dendrocalamus nudus* Pilg. (Gramineae, Bambusoideae), a bamboo. Woody climbers are present and all deciduous, viz. *Butea superba* Roxb, *Spatholobus parviflorus* (Roxb.) O.K. (both Leguminosae, Papilionoideae), and *Combretum punctatum* Bl. spp. *squamosum* (Roxb. *ex* G. Don) Exell (Combretaceae).

The ground flora in the study area conforms to that in DOF areas in Thailand (MAXWELL 1988, 1992; MAXWELL *ET AL.* 1995, 1997). Annual herbs, which are most developed during the latter part of the rainy season, September–November, are common and include: *Salomonia cantoniensis* Lour. var. *cantoniensis* (Polygalaceae), *Osbeckia chinensis* L. var. *chinensis*, *Sonerila erecta* Jack (both Melastomataceae), *Mitrasacme pygmaea* R. Br. (Loganiaceae), and *Selaginella minutifolia* Spring (Selaginellaceae). Numerous Gramineae (grasses) such as *Arthraxon castratus* (Griff.) Nara. *ex* Bor, *Dimeria kurzii* Hk. f., and *Pseudopogonatherum contortum* (Brongn.) A. Camus are also present.

Some deciduous counterparts are: *Eriosema chinense* Vog. (Leguminosae, Papilionoideae), *Scleria levis* Retz. (Cyperaceae), *Andropogon chinensis* (Nees) Merr., *Apluda mutica* L., *Arundinella setosa* Trin. var *setosa*, and *Eulalia fimbriata* (Hack.) O.K. (all Gramineae). *Argyreia mollis* (Burm. f.) Choisy (Convolvulaceae) is a deciduous perennial vine, *Helicteres angustifolia* L. (Sterculiaceae), a deciduous shrub, and *Eurycoma longifolia* Jack (Simaroubaceae), a deciduous treelet. Epiphytes are generally sparse with *Viscum ovalifolium* Wall. *ex* DC. (Loranthaceae/ Viscaceae), *Coelogyne trinervis* Lindl., and *Dendrobium formosum* Roxb. *ex* Lindl. (both Orchidaceae) as typical examples.

SMITH (1926) noted that DOF was very limited in extent and was found on lowland slopes and ridges. DOF has replaced the original deciduous hardwood + bamboo forest of the lowlands as well as lower parts of evergreen forest to the east which have been degraded since that time.

Degradation of the DOF, especially along streams, has produced a mosaic of DOF facies ranging from extensive areas of *Dendrocalamus nudus* and the grasses noted above, to a mixture with EF species. The DOF, in various edaphic states, continues to the lower parts of and often merges with EF.

Primary Evergreen, Seasonal, Hardwood Forest (EF)

With over a century of forest destruction by various villagers and British exploiters, the original extent of EF in the area has been greatly reduced. Various degrees of disturbance have eradicated all boundaries EF had with the original deciduous hardwood + bamboo forest of the lowlands. Some lowland streams retain vestiges of EF, while many upland areas still remain cleared (by hill tribes) or have secondary growth. The EF on the Myanmar side greatly resembles the original condition on the Thai side where EF has been completely destroyed (MAXWELL, 1995). The EF is the most botanically diverse kind of vegetation in the area and differs greatly in structure, species composition, resilience to damage, and conservation value to DOF. The EF in the study area can be included in the rapidly diminishing list of areas in SE Asia which still have basically intact, high-canopy, seasonal facies.

With canopy heights reaching 40–60 m, the EF in the region approximates the maximum height attained by seasonal, evergreen forests in the region. While the majority of species and individuals are evergreen, there are several canopy species, albeit few individuals, of deciduous trees. The best time to see the actual abundance of deciduous trees is during the hot–dry season from March–May when the deciduous trees are leafless or are producing new leaves. Some evergreen canopy species include: *Dipterocarpus costatus* Gaertn. f., *D. turbinatus* Gaertn. f., and *Hopea odorata* Roxb. (all Dipterocarpceae), *Dysoxylum excelsum* Bl. (Meliaceae), *Mangifera* sp. and *Swintonia schwenkii* (T. & B.) T. & B. *ex* Hk. f. (both Anacardiaceae), *Duabanga grandiflora* (Roxb. *ex* DC.) Walp. (Sonneratiaceae), and *Balakata baccata* (Roxb.) Ess. (Euphorbiaceae). Deciduous counterparts, many of which are both leafless and flower during March–May are: *Pterocymbium laoticum* Tard. and *Scaphium scaphigerum* (G. Don) Guib. & Pl. (both Sterculiaceae), *Parkia sumatrana* Miq. (Leguminosae, Mimosoideae), and *Tetrameles nudiflora* R. Br. *ex* Benn. (Datiscaceae). Since the canopy trees are so commercially valuable, exploitative logging interests have been active in the area for decades. This combined with the primitive agricultural practices and rampant forest destruction by hilltribe settlers has ruined large areas of the EF. What remains is pristine in many places, but patchy and much less extensive than it used to be.

The understorey, about 5–40 m tall, is typically dense, evergreen, and botanically diverse. Some common trees are: *Polyalthia simiarum* (Ham. *ex* Hk. f. & Th.) Bth. *ex* Hk. f. & Th. (Annonaceae), *Schima wallichii* (DC.) Korth. (Theaceae), *Aphanamixis polystachya* (Wall.) R. Park., *Chisocheton grandiflorus* (Kurz) Hiern and *Chisocheton patens* Bl. (all Meliaceae), *Xerospermum noronhianum* Bl. (Sapindaceae), *Gluta tavoyana* Wall. *ex* Hk. f. (Anacardiaceae), *Diospyros brandisiana* Kurz (which is cauliflorus) and *Diospyros dasyphylla* Kurz (Ebenaceae), *Horsfieldia amygdalina* (Wall.) Warb. var *amygdalina* and

Knema conferta (King) Warb. (both Myristicaceae); *Cinnamomun iners* Reinw. *ex* Bl., *Dehaasia cuneata* Bl., and *Phoebe cathia* (D. Don) Kosterm. (all Lauraceae); *Antidesma montanum* Bl. var. *montarum* and *Baccaurea ramiflora* Lour. (which is both ramiflorus and cauliflorus) (both Euphorbiaceae); *Castanopsis diversifolia* King *ex* Hk. f. and *Lithocarpus lappaceus* (Roxb.) Rehd. (both Fagaceae).

The shrub and treelet layer (less than 5 m high) layer is typically evergreen and includes: *Glycosmis ovoidea* Pierre (Rubiaceae), *Gomphandra quadrifida* (Bl.) Sleum. var. *quadrifida* (Icacinaceae), *Microtropis bivalvis* (Jack) Wall. *ex* Laws. and *Microtropis discolor* (Wall.) Wall. *ex* Arn. (Celastraceae), *Leea indica* (Burm. f.) Merr. (Leeaceae); *Ixora brunonis* Wall. *ex* G. Don, *Ixora coccinea* L., *Ixora diversifolia* Wall. *ex* Kurz, *Lasianthus longipedunculatus* Parker, *Pavetta indica* L., *Psychotria adenophylla* Wall., and *Psychotria montana* Bl. (all Rubiaceae); *Calamus erectus* Roxb., *Licuala paludosa* Griff., *Salacca wallichiana* Mart. (all Palmae), and *Gnetum gnemon* L. var. *tenerum* Mgf. (Gnetaceae).

Woody climbers are a conspicuous component in EF and include both evergreen and deciduous species. Some evergreen examples are: *Uvaria* aff. *leptopoda* (King) R.E. Fr. (Annonaceae), *Ancistrocladus tectorius* (Lour.) Merr. (Ancistrocladaceae), *Byttneria aspera* Colebr. (Sterculiaceae), *Grewia acuminata* Juss. (Tiliaceae), *Gouania leptostachya* DC. (Rhamnaceae), *Tetrastigma lanceolarium* (Roxb.) Pl., along streams (Vitaceae); *Acacia meeboldii* Craib (Leguminosae, Mimosoideae), *Bauhinia ferruginea* Roxb. and *Bauhinia rosea* Kurz (Leguminosae, Caesalpinioideae), *Coptosapelta flavescens* Korth. and *Uncaria macrophylla* Wall. (both Rubiaceae), *Chilocarpus denudatus* Bl. (Apocynaceae), *Sphenodesme involucrata* (Presl) Rob. var. *involucrata* (Verbenaceae); *Ficus aurantiacea* Griff. var. *aurantiacea*, with the main stem creeping up tree trunks (Moraceae), and *Poikilospermum suaveolens* (Bl.) Merr. (Urticaceae). *Entada rheedii* Spreng. ssp. *rheedii* (Leguminosae, Mimosoideae), *Congea tomentosa* Roxb. var. *tomentosa* and *Premna latifolia* Roxb. var. *mucronata* (Roxb.) Cl. (both Verbenaceae) are deciduous.

Several species of *Calamus*, e.g. *C. latifolius* Roxb. (Palmae) and other rattans are common and often extend high in the understorey. These are evergreen, herbaceous, thorny climbers which are exploited for handicraft material and cane for furniture.

Vines, most of which are found in open places, are common with: *Cayratia japonica* (Thunb.) Gagnep. and *Cissus hastata* Miq. (both Vitaceae), *Trichosanthes ovigera* Bl. (Cucurbitaceae), and *Merremia mammosa* (Lour.) Hall. f. (Convolvulaceae), as common examples.

The ground flora is typically dense, especially in shaded areas, and also includes a profusion of seedlings and saplings of woody species. Some angiosperm examples are: *Geophila repens* (L.) I.M. John., a creeper, and *Ophiorrhiza hispidula* Wall. *ex* G. Don var. *longipedunculata* Craib (both Rubiaceae); *Justicia caloneura* Kurz, *Peristrophe acuminata* Nees, *Staurogyne incana* (Bl.) O.K. (all Acanthaceae), *Siamosia thailandica* K. Lar. & T.M. Ped. (Amaranthaceae), *Amichotolype (Forrestia) mollissima* (Bl.) Hassk. forma *marginata* (Bl.) Back., *Pollia hasskarlii* R. Rao, and in wet places *Pollia thyrsiflora* (Bl.) Steud. (all Commelinaceae), *Alocasia longiloba* Miq. and *Aglaonema simplex* (Bl.) Bl. (both Araceae), *Tacca chantrieri* Andre (Taccaceae), and *Hypolytrum nemorum* (Vahl) Spreng. var. *nemorum* (Cyperaceae).

Pteridophytes are well represented in EF with most species being found in shaded places on the ground. Common examples are: *Asplenium apogamus* Mur. & Hat. (Aspleniaceae); *Bolbitis heteroclita* (Presl) Ching *ex* C. Chr., a creeper, *Bolbitis hookeriana*

K. Iw. (Lomariopsidaceae); *Heterogonium gurupahense* (C. Chr.) Holtt. and *Tectaria herpetocaulos* Holtt. (both Dryopteridaceae), *Microlepia herbacea* Ching & C. Chr. *ex* Tard. & C. Chr. (Dennstaedtiaceae) and *Pteris biaurita* L. (Pteridaceae) are found in more open, disturbed places.

Shaded stream zones include several geophytic pteridophytes which are not found outside of this habitat. Common examples include: *Angiopteris evecta* (Forst.) Hoffm. (Marattiaceae), *Cyathea podophylla* (Hk.) Copel. (Cyatheaceae), *Pteridrys australis* Ching (Dryopteridaceae), and *Diplazium simplicivenium* Holtt. (Athyriaceae). *Crepidomanes birmanicum* (Bedd.) K. Iw. (Hymenophyllaceae) is epiphytic while *Thelypteris ciliata* (Wall. *ex* Bth.) Ching (Thelypteridaceae) is an epilithic rheophyte.

Several species of bamboo (Gramineae, Bambusoideae) are found in some EF areas, especially places that have experienced some logging. These include: *Bambusa pallida* Munro, *Cephalostachyum pergracile* Munro, *Dendrocalamus longispathus* Kurz, and *Gigantochloa apus* (Schult.) Kurz.

Stream Flora

Several major streams and rivers flow through the area, such as the Mat Taw, Kawtama, Dawei Mayan, Zimba, and Dthi (Eithi). These are a vital component in the stability and perpetuation of the EF. Although they are permanent, continuously flowing waterways, their water levels fluctuate greatly between the rainy and dry seasons. I was fortunate to be able to visit these places during the dry season (March) since this is the peak flowering time for the species there. Stream zones are typically open, rocky, seasonally flooded or inundated, sparsely vegetated areas with amphibious (dry season) or seasonally rheophytic (rainy season) species. Many of them are deciduous during the rainy season when they are submerged and are also bent downstream by current flow. *Crateva magna* (Lour.) DC. (Capparaceae), *Barringtonia acutangula* (L.) Gaertn. (Lecythidaceae), and *Salix tetrasperma* Roxb. (Salicaceae), all trees, are usually found in sandy bank areas, while most of the other shrubs and treelets grow in lower levels. Typical representatives are: *Grewia sinuata* Wall. (Tiliaceae), *Eugenia myrtifolia* Roxb. (Myrtaceae), *Morindopsis capillaris* Kurz (Rubiaceae), *Rotula aquatica* Lour. (Boraginaceae), *Homonoia riparia* Lour. and *Phyllanthus reticulatus* Poir., which is often scandent, (both Euphorbiaceae), *Ficus abelii* Miq., which is epilithic, and *Ficus heterophylla* L.f. var. *heterophylla* (Moraceae).

Some amphibious herbs are *Cryptocoryne retrospiralis* (Roxb.) Kunth (Araceae), *Cyperus procerus* Rottb. var. *procerus* (Cyperaceae), and the edible fern *Diplazium esculentum* (Retz.) Sw. (Athyriaceae). *Crinum stenopetalum* Baker (Amaryllidaceae) is an aquatic herb found in shallow streams, while *Blyxa echinosperma* (Cl.) Hk. f. (Hydrocharitaceae), grows in less turbulent places.

Sin Yat Koe Falls, east of Kanbauk, is another botanically interesting area. The stream, which originates on a granite mountain rising to 1,025 m, flows on bedrock for most of its course, except at the base where the bottom is alluvial. I found several species in the lower falls zone which I have not seen elsewhere in the study area. These include: *Utricularia involvens* Ridl. (Lentibulariaceae), an aquatic or amphibious annual herb with a twining inflorescence; *Murdannia gigantea* (Vahl) Bruck. (Commelinaceae), and *Spathoglottis affinis* de Vr. (Orchidaceae), both deciduous ground herbs; *Begonia nivea* Parish *ex* Kurz (Begoniaceae), a small, deciduous, perennial, epilithic herb; *Clerodendrum nutans* Wall.

(Verbenaceae), a deciduous shrub; and *Wikstroemia ridleyi* Gamb. (Thymelaeaceae), an evergreen treelet.

The entire mountain has vast conservation value since the vegetation of the summit area, which is still partly intact, is the only peak in the region that has any original vegetation remaining. A survey of the remaining vegetation of the summit area of this mountain will enable competent biologists to plan an effective reforestation program as well as providing a local source of seeds and seedlings for restoration of deforested ridges of similar elevation to the west. The hydrological value of the mountain, as well as the recreational value of the falls, are also important conservation issues.

Disturbed Areas and Secondary Growth (DA, SG)

Areas disturbed by cutting, fire, and grazing redevelop in a successional manner, that is the original primary flora does not immediately reappear. Places that are suddenly opened to exposure and erosion, such as by logging, develop transitional stages of secondary growth which slowly develop into primary facies. Secondary growth species are fast-growing, sun-loving plants which differ from the original facies. Some distinctive secondary growth herbs, most of which differ from roadside and agricultural weeds, are: *Abelomoschus moschatus* Medic. ssp. *moschatus* var. *moschatus* (Malvaceae), *Osbeckia chinensis* L. var. *chinensis* (Melastomataceae), *Torenia flava* Ham. *ex* Bth. (Scrophulariaceae), all of which are annuals. Deciduous perennial herbs include: *Desmodium heterocarpon* (L.) DC. ssp. *heterocarpon* var. *strigosum* Mee. and *Desmodium triangulare* (Retz.) Merr. ssp. *triangulare* forma *triangulare* (Leguminosae, Papilionoideae), and *Costus speciosus* (Koen.) J.E. Sm. (Zingiberaceae).

Large, vigorous, fire-tolerant, perennial Gramineae (grasses) which rapidly invade and cover disturbed places, especially in hill tribe areas, are: *Imperata cylindrica* (L.) P. Beauv. var *major* (Nees) C.E. Hubb. *ex* Hubb. & Vaugh., *Pennisetum pedicellatum* Trin., *Phragmites vallatoria* (Pluk. *ex* L.) Veldk., *Saccharum arundinaceum* Retz. (especially along streams), and *Thysanolaena latifolia* (Roxb. *ex* Horn.) Honda.

Desmodium pulchellum (L.) Bth. (Leguminosae, Papilionoideae) is a deciduous treelet, while *Uvaria cordata* (Dun.) Alst. (Annonaceae) and *Bridelia stipularis* (L.) Bl. (Euphorbiaceae) are deciduous woody climbers. *Connarus semidecandrus* Jack (Connaraceae) is an evergreen woody climber commonly found in open, disturbed areas. Annual vines include: *Bonamia semidigyna* (Roxb.) Hall. f. var. *semidigyma* and *Merremia tridentata* (L.) Hall. f. ssp. *hastata* (Desr.) Oost. (both Convolvulaceae), and *Smilax ovalifolia* Roxb. (Smilacaceae). Some deciduous vines are: *Dioscorea bulbifera* L. and *Dioscorea pentaphylla* L. (Dioscoreaceae)

Secondary growth tree species are numerous, the most common being: *Hibiscus grewiifolius* Hassk. and *Hibiscus macrophyllus* Roxb. *ex* Horn. (Malvaceae), *Pterospermum semisagittatum* B.-H. *ex* Roxb. (Sterculiaceae), *Lagerstroemia floribunda* Jack var. *floribunda* and *Lagerstroemia speciosa* (L.) Pers. var. *speciosa* (Lythraceae), *Anthocephalus chinensis* (Lmk.) A. Rich. *ex* Walp. and *Mitragyna rotundifolia* (Roxb.) O.K. (both Rubiaceae), *Maesa ramentacea* (Roxb.) A. DC. (Myrsinaceae), *Alstonia scholaris* (L.) R. Br. var. *scholaris* (Apocynaceae); *Croton robustus* Kurz, *Macaranga denticulata* (Bl.) M.-A., *Macaranga gigantea* (Rchb. f. & Zoll.) M.-A. (all Euphorbiaceae), and *Streblus asper* Lour. var. *asper* (Moraceae). *Securinega virosa* (Roxb. *ex* Willd.) Baill. (Euphorbiaceae) is a common evergreen shrub or treelet which is found in SG.

Myanmar–Thai Border Ridge

This narrow, north–south-aligned ridge ranges from 900 to 1025 m elevation on granite and shale bedrocks. The original EF was destroyed by Karen people who have since left the area. More recent forest plundering has been done by Thais, including those from the border village of I-Tong, who have deforested most of the area on the Thai side. Pristine EF is extensive on the Myanmar side from below 800 m. Only a few degraded, fire-damaged patches of EF remnants can be found on the ridge. Exposure, fire, and erosion have prevented even SG regeneration. Most of the area is open and has numerous weeds. Some of the more common, mostly weedy herbs are: *Salomonia cantoniensis* Lour. var. *cantoniensis* (Polygalaceae), *Sida rhombifolia* L. ssp. *rhombifolia* (Malvaceae), *Exacum pteranthum* Wall. *ex* Griseb. (Gentianaceae); *Ageratum conyzoides* L., *Blumea balsamifera* (L.) DC., *Eupatorium odoratum* L., and *Synedrella nodiflora* (L.) Gaertn. (all Compositae); *Polygonum chinense* L. (Polygonaceae), *Hedychium gardnerianum* Rosc. (Zingiberceae), *Dioscorea glabra* Roxb. (Dioscoreaceae), *Fimbristylis adenolepis* Kern (Cyperaceae); *Arthraxon lanceolatus* (Roxb.) Hochst. var. *lanceolatus, Eulalia pallens* (Hack.) O.K., *Imperata cylindrica* (L.) P. Beauv. var. *major* (Nees) C.E. Hubb. *ex* Hubb. & Vaugh., *Pseudoechinolaena polystachya* (H.B.K.) Stapf, *Thysanolaena latifolia* (Roxb. *ex* Horn.) Honda (all Gramineae), and *Pteridium aquilinium* (L.) Kuhn. ssp. *aquilinum* var. *wightianum* (Ag.) Try. (Dennstaedtiaceae). *Melastoma malabathricum* L. ssp. *malabathricum* (Melastomataceae) and *Clerodendrum glandulosum* Colebr. *ex* Lindl. (Verbenaceae) are evergreen treelets, while *Dalbergia stipulacea* Roxb. (Leguminosae, Papilionoideae) is a deciduous woody climber. Some of the more common trees are: *Xanthophyllum flavescens* Roxb. (Polygalaceae), *Eurya acuminata* DC. var. *acuminata* (Theaceae), *Eugenia albiflora* Duth. *ex* Kurz (Myrtaceae), *Wendlandia paniculata* (Roxb.) DC. (Rubiaceae), *Vaccinium sprengelii* (D. Don) Sleum. (Ericaceae), *Helicia nilagirica* Bedd. (Proteaceae), *Cinnamomum iners* Reinw. *ex* Bl. (Lauraceae), *Glochidion sphaerogynum* (M.-A.) (Euphorbiaceae), *Ficus fistulosa* Reinw. *ex* Bl. var. *fistulosa* (Moraceae), and *Castanopsis argyrophylla* King *ex* Hk. f. (Fagaceae). Reforestation of the area is vital for reestablishment of biodiversity and erosion control.

REVEGETATION AND CONSERVATION

Control of erosion is of imminent concern to the integrity and stability of the road and both pipeline routes as well as minimizing damage to the forest ecosystem. Total Fina hydroseeded* introduced grass seeds along parts of their pipeline in February–March 1998 and by October 1998 many of these sprayed areas were covered with shallow-rooted grasses. Their tree planting program has been disastrous due to lack of proper care of the seedlings (no sludge or mulching, trees planted in their bags, etc.) No vegetation has developed on many road cuts or roadside verges (Fig. 4). Erosion was minimal in 1998 due to low rainfall, but in 1997, before the road or Total Fina's pipeline was completed, rainfall was above average and slumping occurred on many deforested hills. Such slumping is

*a process in which a mixture of seed + water + nutrient are sprayed on an area

inevitable along many parts of the road and both pipelines due to poorly designed construction paths (Fig. 5). Another potential disaster exists at the metering station (800 m) which is not only poorly situated, since it is next to a stream, but is also below a deforested slope extending 100 m in elevation. This is not only the steepest area of the pipeline and road routes, but also one of the most vulnerable places for landslides. There are already signs of severe erosion on the south side.

A competent and complete revegetation program must be devised and implemented immediately so that erosion, starting with the first rains in May 2002, can be subdued. A large labor force will be required, as well as an adequate budget and professional supervision. There are two important aspects of the revegetation plan: collection and dispersal of local grasses, and development of a nursery for production of bamboos and various hardwood species.

Soil Stabilizing Grasses

Total Fina's hydroseeding program is impressive, but incomplete. Introduction of alien plants into any ecosystem often has unexpected and even disastrous effects on the environment. Introduced plants often become rampant weeds or provide refuges for harmful pathogens. Grasses are abundant throughout the region, thus it is quite unnecessary to import foreign stock. Local grass seeds should be collected from November to March by cutting the stems (culms) near ground level and immediately distributing the crop on open places that are not steep. Since the soil, in most places, has been heavily compacted and is of poor quality, it is recommended that the revegetation sites be harrowed prior to seeding. A few cm of topsoil, readily available from construction sites, should be put on the grass crop, perhaps also mixed with some compost or NPK fertilizer and harrowed or disced to mix seeds and soil. This method will protect the seed crop from animal predation and exposure, ensure maximum species diversity, as in nature; and provide optimum growth conditions when the rains come in May. Seeded areas must not be disturbed by construction, traffic, cattle, or fire.

Some common grasses, both annual and perennial species, which can be collected and spread are: *Apluda mutica* L., *Arundinella setosa* Trin. var. *setosa*, *Chrysopogon zeylanicus* (Nees) Trin., *Dimeria kurzii* Hk. f., *Eragrostis luzonensis* Steud., *Eulalia finbriata* (Hack.) O.K., *Eulalia pallens* (Hack.) O.K., *Imperata cylindrica* (L.) P. Beauv. var. *major* (Nees) C.E. Hubb. *ex* Hubb. & Vaugh., *Ischaemum indicum* (Houtt.) Merr. var. *indicum* subvar. *indicum, Microstegium vagans* (Nees *ex* Steud.) A. Camus, *Paspalum conjugatum* Berg., *Pennisetum pedicellatum* Trin., *Phragmites vallatoria* (Pluk. *ex* L.) Veldk., *Pseudoponatherum contortum* (Brongn.) A. Camus, *Saccharum arundinaceum* Retz., *Sacciolepis indica* (L.) A. Chase, and *Thysanolaena latifolia* (Roxb. *ex* Horn.) Honda.

Rhizome cuttings of the more robust perennial grasses could also be collected, nurtured in the nursery, and planted in May. The most effective species are: *Apluda mutica, Arundinella setosa* var. *setosa, Chrysopogon zeylanicus, Eulalia fimbriata, Eulalia pallens, Imperata cylindrica* var. *major, Pennisetum pedicellatum, Phragmites vallatoria, Saccharum arundinaceum,* and *Thysanolaena latifolia.* These species will be especially suitable on steep slopes, in places where vegetation is sparse, and in areas which have been successfully hydroseeded. *Chrysopogon (Vetiveria) zizanioides* (L.) Roberty, or vetiver grass, has been proclaimed in Thailand as being the best grass for soil stabilization. It is entirely unsuitable for any purpose in the construction zone.

Seeds of various common and vigorous dicot herbs should also be collected since many of them complement grasses in being both rapidly invasive and persistent. Some recommended plants are: *Desmodium heterocarpon* (L.) DC. ssp. *heterocarpon* var. *strigosum* Mee. (Leguminosae, Papilionoideae), *Blumea balsamifera* (L.) O.K. and *Eupatorium odoratum* L. (both Compositae), and *Celosia argentea* L. (Amaranthaceae).

Nursery

In addition to raising rhizomes from robust grasses, the various species of bamboo (Gramineae, Bambusoideae) found in the area should also be collected and grown. *Bambusa pallida* Munro, *Cephalostachyum pergracile* Munro, *Dendrocalamus longispathus* Kurz, *Dendrocalamus nudus* Pilg., and *Gigantochloa apus* (Schult.) Kurz are both abundant and easy to propagate from rhizomes or various means of culm cuttings.

Acacia mangium Willd. (Leguminosae, Mimosoideae), native to Australia–East Malesia, and *Eucalyptus camadulensis* Dehn. (Myrtaceae), from Australia, were by October 1998 the only surviving tree species planted by Total Fina. As noted above, it is doubtful that these trees will survive the hot–dry period from March to May. Using native tree species avoids problems that arise with introduced ones, especially the disadvantages with *Eucalyptus* spp. A carefully planned species selection, nursery technique, and replanting program are required. These are best done by experienced professionals (ELLIOTT *ET AL.*, 1998; KERBY *ET AL.*, 2000).

I have also noticed that many of the wooden stakes used to support the totally ineffective bamboo frames envisioned to control soil erosion had sprouts in October 1998. This should be investigated to find if there is any potential here for "instant" trees.

Conservation

The gas pipeline project has resulted in further degradation of the settled areas and deciduous dipterocarp-oak forest, while creating new access to the evergreen forest. Construction of the road and pipeline will not only provide more opportunities for logging and hunting, but will also cause disastrous erosion problems to the environment (Fig. 6). Little environmental regard was taken by contractors involved in the construction of the road and pipeline. Steep road cuts through several to many meters of friable, sedimentary-based subsoil, dumping of soil and other debris over verges; broad, steep paths over ridges, and unnecessarily wide roadside areas leveled are common. Erosion will result in the degradation of water resources, encourage widespread soilfluction (slumping which was widespread in deforested coastal areas during the rainy season of 1997), and cause a gradual decline in the stability of the forest and disrupt its biodiversity.

Immediate measures must be taken to prevent further logging, hunting, trapping, and fires in the evergreen forested area. Villagers must be warned that stream water and fish are contaminated with coliform pollutants and that the risk of flash floods will increase as the integrity of the forest decreases. The management of Premier and Total Fina oil companies, as well as the Myanmar government, must be convinced that construction of the road and pipeline in the evergreen forest will eventually cost them a lot of money since repair of collapsed roads, broken gas pipes, and compensation to villagers for damage to their land and livelihoods is inevitable.

Figure 4. Pipeline and road construction have caused serious soil erosion problems along most of the 67 km of their routes, especially in primary, evergreen, forested areas. Photo: Scott Poynton, 9 March 1998.

Figure 5. Within months after being exposed and contoured, many road cuts began to erode. Since the remaining subsoil lacks fertility, vegetation has been unable to recolonize. Photo: Scott Poynton, 8 March 1998.

Figure 6. The construction of a road to previously inaccessible forested areas has been exploited by the Myanmar military. Logging, hunting, as well as water contamination from human coliform bacteria and silt have become serious environmental problems. Photo: Sai Jai, 9 March 1998.

It is vital that competent landscape, nursery, and reforestation specialists, hydrologists, and biologists be invited to the area to assess the damage and make attempts to alleviate the problems. Avoiding the problems because of economic cost-benefit concepts which discount the environment will eventually result in rapidly increasing degrees of environmental deterioration which will prove to be more costly and irreparable than was ever imagined.

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Appendix. Enumeration[1] and Database

Abbreviations:

A	annual
Al	alluvium
Aq	aquatic
B	beach
BB	bamboo
C	canopy
Cr	creeping
D	deciduous
Da	disturbed area
DOF	deciduous dipterocarp-oak, seasonal, hardwood forest
E	evergreen
EF	primary evergreen, seasonal, hardwood forest
Ep	epiphytic
Epl	epilithic
F	fire-tolerant
G	ground flora
H	herb
Hp	hemi- (semi-) parasite
L	treelet
M	mangrove
N	naturalized/introduced
P	perennial
R	rheophyte, at least during the rainy season (amphibious)
S	shrub
Sc	scandent
Sg	secondary growth
St	streams
T	tree
U	understorey
V	vine
W	weed
WC	woody climber
Wp	seasonally wet places, *e.g.* rice fields, marshes

[1]This enumeration follows a modified Bentham and Hooker system of family arrangement as adopted in the CMU herbarium. It shows a theoretical evolutionary approach to various classes based almost entirely on reproductive morphology. For example, in the Angiospermae, Dicotyledeae are considered less advanced than Monocotyledoneae and among the former, Dilleniaceae is considered to have the most primitive (*i.e.* least advanced) flowering and fruiting features. Many other arrangements have been proposed. Gymnospermae and Pteridophyta have been placed last for herbarium convenience, but their evolutionary histories predate Angiospermae.

FAMILY	BOTANICAL NAME	HABIT	HABITAT	NOTES
ANGIOSPERMAE DICOTYLEDONEAE				
Dilleniaceae	*Dillenia parviflora* Griff. var. *kerrii* (Craib) Hoogl.	DT	DOF	C
Magnoliaceae	*Magnolia liliifera* (L.) Baill. var. *liliifera*	ET	EF, St	U
Annonaceae	*Cyathocalyx* sp.	ET	EF	U
	Desmos cochinchinensis Lour.	ESc	Da	C
	Goniothalamus griffithii Hk. f. & Thoms.	ET	EF	U
	Miliusa parviflora Ridl.	EL	EF	U
	Orophea cuneiformis King	ET	EF, St	U
	Orophea polycarpa A. DC.	ET	EF, St	U
	Oxymitra stenopetala Hk. f. & Th.	EL	EF	U
	Polyalthia simiarum (Ham. *ex* Hk. f. & Th. Bth. *ex* Hk. f. & Th.	ET	EF	U
	Uvaria aff. *leptopoda* (King) R.E. Fr.	EWc	EF	C
	Uvaria cordata (Dun.) Alst.	DWc	Da, Sg	C
	Uvaria curtisii King	EWc	EF, St	C, U
Menispermaceae	*Stephania crebra* For.	E? V	EF, Da	G
Capparaceae	*Capparis assamica* Hk. f. & Th.	EL	EF	U
	Capparis micracantha DC.	DSc	B, Da	C
	Capparis versicolor Griff.	EL	EF	U
	Crateva magna (Lour.) DC.	DT	St	Al, St
Moringaceae	*Moringa oleifera* Lmk.	DT	Da	planted, N
Violaceae	*Rinorea longiracemosa* (Kurz) Craib	ES	Da, Wp	U
Polygalaceae	*Salomonia cantoniensis* Lour. var. *cantoniensis*	AH	Da, Sg	G
	Xanthophyllum flavescens Roxb.	ET	EF	U
	Xanthophyllum virens Roxb.	ET	EF	U
Caryophyllaceae	*Polycarpaea corymbosa* (L.) Lmk.	AH	B	G
Guttiferae	*Calophyllum polyanthum* Wall. *ex* Pl. & Tr.	ET	EF	U
	Cratoxylum formosum (Jack) Dyer ssp. *pruniflorum* (Kurz) Gog.	DT	DSg, DOF	C
	Garcinia cowa Roxb.	DT	DOF	C
	Garcinia mangostana L.	ET	Da	planted
Theaceae	*Adinandra integerrima* T. And. *ex* Miq.	ET	EF	U
	Anneslea fragrans Wall.	DT	DOF	C, F
	Eurya accuminata DC. var. *wallichiana* Dyer	ET	Da/Sg	C
	Eurya acuminata DC. var. *acuminata*	EL, ET	Da	U
	Schima wallichii (DC.) Korth.	ET	EF	U,C
Dipterocarpaceae	*Dipterocarpus alatus* Roxb. *ex* G Don	DT	Da	C
	Dipterocarpus costatus Gaertn. f.	ET	EF	C
	Dipterocarpus obtusifolius Teijsm. *ex* Miq. var. *obtusifolius*	DT	DOF	C, F
	Dipterocarpus turbinatus Gaertn. f.	ET	EF	C
	Hopea odorata Roxb.	ET	EF, St	C
Ancistrocladaceae	*Ancistrocladus tectorius* (Lour.) Merr.	EWC	EF	U

FAMILY	BOTANICAL NAME	HABIT	HABITAT	NOTES
Malvaceae	*Abelmoschus moschatus* Medic. ssp. *moschatus* var. *moschatus*	AH	Da, Sg	G
	Hibiscus grewiifolius Hassk.	DT	Da, Sg	C
	Hibiscus macrophyllus Roxb. *ex* Horn.	DT	Sg	C
	Sida rhombifolia L. ssp. *rhombifolia*	DPH	Da/Sg	G, W
	Thespesia lampas (Cav.) Dalz. & Gibs. var. *lampas*	DL	Da, Sg	C, F
	Urena lobata L. ssp. *lobata* var. *lobata*	AH	Da	G, W
Bombacaceae	*Bombax anceps* Pierre var. *anceps*	DT	DOF	C, F
	Bombax ceiba L.	DT	Da/Sg	C
	Ceiba pentandra (L.) Gaertn.	DT	Da/Sg	often planted, C, N
	Durio zibethinus Murr.	ET	Da	planted, C
Sterculiaceae	*Byttneria aspera* Colebr.	EWc	EF	C, U
	Helicteres angustifolia L.	DS	DOF	U, F
	Helicteres hirsuta Lour.	DS	Da, Sg	U
	Leptonychia caudata (Wall. *ex* G. Don) Bur.	EL	EF	U
	Pterocymbium laoticum Tard.	DT	EF	C
	Pterospermum diversifolum Bl.	ET	Da, EF	C
	Pterospermum semisagittatum B.-H. *ex* Roxb.	DT	Sg, BB	U, C, F
	Scaphium scaphigerum (D. Don) Guib. & Pl.	DT	EF	C
Tiliaceae	*Grewia acuminata* Juss.	EWc	EF	U, C
	Grewia laevigata Vahl	DT	Sg, BB	C
	Grewia sinuata Wall.	DL	St	Al, R
	Microcos paniculata L.	DT	Da, Sg	C
	Pentace floribunda King	ET	EF	U
	Triumfetta rhomboidea Jacq.	AH, L	Da, Sg	G
Elaeocarpaceae	*Elaeocarppus robustus* Roxb.	DT	Da, Sg	C
	Elaeocarpus rugosus Roxb.	ET	Da	U
Malpighiaceae	*Hiptage benghalensis* (L.) Kurz ssp. *benghalensis*	EWC	EF	C
Rutaceae	*Aegle marmelos* (L.) Corr.	DT	Da/Sg	C
	Atalantia monophylla (L.) DC.	EL	Da/Sg	U
	Citrus grandis (L.) Osb.	EL, ET	Da	planted, C
	Glycosmis ovoidea Pierre	EL	EG	U
	Glycosmis pentaphylla (Retz.) DC. var. *pentaphylla*	ES	Da/Sg, EF	C, Al, U
	Melicope pteleifolia (Champ. *ex* Bth) T. Hart.	EL	EF	U
Simaroubaceae	*Eurycoma longifolia* Jack	DL	DOF	C, F
	Quassia indica (Gaertn.) Noot.	ET	St	U
Ochnaceae	*Ochna integerrima* (Lour.) Merr.	DL, DS	DOF	C
Meliaceae	*Aglaia oligophylla* Miq.	EL, ET	EF	U
	Aphanamixis polystachya (Wall.) R. Parker	ET	EF	U
	Chisocheton grandiflorus (Kurz) Hiern	ET	EF	U
	Chisocheton patens Bl.	ET	EF	U, C
	Dysoxylum excelsum Bl.	ET	ET	U, C
	Sandoricum koetjape (Burm. f.) Merr.	ET	EF	U
Icacinaceae	*Gomphandra quadrifida* (Bl.) Sleum. var. *quadrifida*	EL	EF	U

FAMILY	BOTANICAL NAME	HABIT	HABITAT	NOTES
	Gonocaryum lobbianum (Miers) Kurz	EL, ET	EF	U
	Phytocrene bracteata Wall.	EWC	EF	U, C
Aquifoliaceae	*Ilex macrophylla* Wall. *ex* Hk. f.	ET	EF	U
Celastraceae	*Bhesa robusta* (Roxb.) Hou	ET	EF	U, C
	Microtropis bivalvis (Jack) Wall. *ex* Laws.	EL	EF	U
	Microtropis discolor (Wall.) Wall. *ex* Arn.	EL	EF	U
	Salacia chinensis L.	D/EWC	Da/Sg	C
Rhamnaceae	*Colubrina asiatica* (L.) Brongn.	ESc	B	C
	Gouania leptostachya DC.	EWc	EF	C, U
	Ventilago leiocarpa Bth.	EWC	EF	U, C
	Ziziphus glabra Roxb.	EWC	Da, EF	U, C
	Ziziphus nummularia (Burm. f.) Wight & Arn.	DL	Da, Sg	C
	Ziziphus oenoplia (L.) Mill. var. *oenoplia*	ESc	B	C
Vitaceae	*Cayratia japonica* (Thunb.) Gagnep.	AV	Da, Sg	G
	Cissus adnata (Wall. *ex* Wight & Arn.) Roxb.	EV	Da, EF	U, C
	Cissus hastata Miq.	EV	Da, EF	U, C
	Tetrastigma hookeri (Laws.) Pl.	EWC	EF	U, C
	Tetrastigma lanceolarium (Roxb.) Pl.	EWc	EF, S	U, C
Leeaceae	*Leea indica* (Burm. f.) Merr.	EL	EF	U
Sapindaceae	*Allophyllus cobbe* (L.) Raeusch.	EL	EF	U
	Lepisanthes rubiginosa (Roxb.) Leenh.	ET	Da, Sg	U
	Xerospermum noronhianum Bl.	ET	EF	C
Staphyleaceae	*Turpinia pomifera* (Roxb.) Wall. *ex* DC.	ET	EF	U
Anacardiaceae	*Anacardium occidentale* L.	ET	Da	planted, C, N
	Bouea oppositifolia (Roxb.) Meisn.	ET	Da	planted, C, N
	Gluta tavoyana Wall. *ex* Hk. f.	ET	EF	U
	Lannea coromandelica (Houtt.) Merr.	DT	DOF	C
	Mangifera indica L.	ET	Da	planted, C, N
	Mangifera sp.	ET	EF	C
	Semecarpus cochinchinensis Engl.	ET	EF	U
	Spondias pinnata (L. f.) Kurz	DT	DOF, Da	C, F
	Swintonia floribunda Griff.	ET	EF	U
	Swintonia schwenkii (T. & B.) T. & B. *ex* Hk. f.	ET	EF	C

FAMILY	BOTANICAL NAME	HABIT	HABITAT	NOTES
Connaraceae	*Cnestis palala* (Lour.) Merr. var. *palala*	DWC	Da/Sg	U
	Connarus semidecandrus Jack	EWc	Da, Sg	C, U
Leguminosae, Mimosoideae	*Acacia meeboldii* Craib	EWc	EF	C, U
	Acacia pennata (L.) Willd. ssp. *pennata*	DWc	Da, Sg	C, U, F
	Adenanthera microsperma Teijsm. & Binn.	DT	Da/Sg	C
	Albizia lebbeck (L.) Bth.	DT	Da/Sg	C
	Archidendron jiringa (Jack) Niels.	DT	Da/Sg	C
	Entada rheedii Spreng. ssp. *rheedii*	DWC	EF	C
	Mimosa diplotricha C. Wright *ex* Sauv. var. *diplotricha*	AH, AV	Da, Sg	N, W
	Mimosa pigra L.	EL	Da, Sg	N, W
	Mimosa pudica L.	EH	Da, Sg	W, N
	Parkia sumatrana Miq.	DT	EF	C
	Xylia xylocarpa (Roxb.) Taub. var. *kerrii* (Craib & Hutch.)	DT	DOF, BB	C
Leguminosae, Caesalpinioideae	*Bauhinia ferruginea* Roxb.	EWc	EF	C, U
	Bauhinia rosea Kurz	EWc	EF	C, U
	Caesalpinia andamanica (Prain) Hatt.	EWc	EF	C, U
	Caesalpinia crista L.	EWc	M	C
	Caesalpinia digyna Rottl.	DSc	Da	C
	Cassia fistula L.	DT	Da, BB	C
	Chamaecrista mimosoides (L.) Greene (*Cassia mimosoides* L.)	AH	Da	N, W
	Senna alata (L.) Roxb. (*Cassia alata* L.)	EL	Da	C, N
	Senna timorensis (DC.) Ir. & Barn. (*Cassia timorensis* DC.)	DT	Da/Sg	C, N
	Senna tora (L.) Roxb. (*Cassia tora* L.)	AH	Da	N, W
	Tamarindus indica L.	ET	Da	planted, C, N
Leguminosae, Papilionoideae	*Abrus percatorius* L. ssp. *precatorius*	AV	B, Da	G
	Aeschynomene indica L.	AH, ES	Da	C
	Butea superba Roxb.	DWC	DOF	C, F
	Callerya (Millettia) atropurpurea (Wall.) Schot	ET	Da,St	C, U
	Crotalaria pallida Ait.	AH	Da	G, W
	Cruddasia sp.	V	DOF, BB	G
	Dalbergia cana Grah. *ex* Kurz. var. *cana*	DT	DOF	C, F
	Dalbergia candenatensis (Denn.) Prain	EWC	M	C
	Dalbergia cultrata Grah. *ex* Bth.	DTD	DOF, BB	C, F
	Dalbergia stipulacea Roxb.	DWc	Da, DOF, BB	C, F
	Derris scandens (Roxb.) Bth.	ESc	B, Da	C
	Derris trifolia Lour.	EV	M	C
	Desmodium auricomum Grah. *ex* Bth.	AH	Da, Sg	G, W
	Desmodium fusca (Wall.) Kurz var. *fusca*	AV	Da, BB	G
	Desmodium heterocarpon (L.) DC. ssp. *heterocarpon* var. *strigosum* Mee.	DPH	Da, Sg	G, F
	Desmodium pulchellum (L.) Bth.	DL	DOF, DSg	C, F
	Desmodium triangulare (Retz.) Merr. spp. forma *triangulare*	DPH	Da, Sg	G, F
	Desmodium triquetrum (L.) DC. ssp. *triquetrum*	DL, DS	Da, Sg	G, F
	Dunbaria fusca (Wall.) Kurz	AV	Da, Sg	C
	Eriosema chinense Vog.	DPH	DOF	G

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	Erythrina orientalis (L.) Merr.	DT	B, Da	C
	Flemingia sootepensis Craib	DL, DS	DOF	U, F
	Flemingia stricta Roxb. *ex* Ait. f.	DL	Da, Sg, BB	G
	Flemingia strobilifera (L.) R. Br. *ex* Ait. f. var. *strobilifera*	DL	DOF, BB	U, F
	Geissapsis cristata Wight & Arn.	DPH	DOF	G
	Macroptilium atropurpureum (DC.) Urb.	AH	Da	G, W, N
	Millettia (Pongamia) pinnata (L.) Gees.	ET	M	C
	Millettia glaucescens Kurz var. *siamensis* Craib	ET	EF	U
	Mucuna gigantea (Willd.) DC.	EWc	M	C, U
	Pterocarpus macrocarpus Kurz	DT	DOF	C, F
	Pueraria phaseoloides (Roxb.) Bth. var. *phaseoloides*	AV	DOF	G
	Spatholobus parviflorus (Roxb.) O.K.	DWC	DOF	C, F
	Uraria crinita (L.) Desv. *ex* DC.	AH	Da, Sg	G
Dichapetalaceae	*Dichapetalum longipetalum* (Turcz.) Engl.	EWC	EF	U
Droseraceae	*Drosera peltata* J.E. Sm. *ex* Willd.	AH	Wp	G
Rhizophoraceae	*Carallia brachiata* (Lour.) Merr.	ET	EF	U
	Ceriops decandra (Griff.) Hou	EL, ET	M	C
	Ceriops tagal (Pers.) C.B. Rob.	EL, ET	M	C
	Rhizophora apicluta Bl.	EL, ET	M	C
Combretaceae	*Calycopteris floribunda* (Roxb.) Lmk.	DWC	Da/Sg	C
	Combretum punctatum Bl. ssp. *squamosum* (Roxb. *ex* G. Don)	DWC	DOF	C, F
	Lumnitzera littorea (Jack) Voigt	EL, ET	M	C
	Terminalia bellirica (Gaertn.) Roxb.	DT	BB, DOF	C, F
	Terminalia calamansanai (Blanco) Rolfe	DT	DSg	C, F
	Terminalia tomentosa Wight & Arn. var. *microcarpa* Kurz	DT	Da, BB	C
Myrtaceae	*Eugenia acuminatissima* Kurz	ET	EF	U
	Eugenia albiflora Duth. *ex* Kurz	ET	EF	U
	Eugenia cumini (L.) Druce	DT	DOF	C, F
	Eugenia grandis Wight	ET	B, Sg	C
	Eugenia grata Wight	ET	B, Sg	C
	Eugenia myrtifolia Roxb.	DS, DT	St	Al, R
	Eugenia oblata Roxb.	ET	Sg	C
	Eugenia operculata Roxb.	ET	Sg	C
	Eugenia toddalioides Wight	ET	EF	U
	Psidium guajava L.	EL	Da	planted, N
	Psidium guineense Swartz	ES	Da, Sg	C, N
	Tristaniopsis burmanica (Griff.) Wils. & Wat. var. *burmanica*	ET	DOF, BB/Da	C, F
Lecythidaceae	*Barringtonia acutangula* (L.) Gaertn.	ET	St	Al
	Barringtonia augusta Kurz	ET	St	C
	Careya arborea Roxb.	DT	DOF	C
Melastomataceae	*Melastoma malabathricum* L. ssp. *malabathricum*	EL	Da, Sg	C
	Memecylon edule Roxb. var. *edule*	EL	B	C
	Memecylon edule Roxb. var. *ovatum* (Sm.) Cl.	EL	B	C
	Memecylon scutellatum (Lour.) Naud.	EL, ES	DOF	C, F

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	Osbeckia chinensis L. var. *chinensis*	AH	Da, DOF	F
	Sonerila erecta Jack	AH	Da, DOF	G
	Sonerila picta Korth.	AH	EF	Epl
Lythraceae	*Lagerstroemia floribunda* Jack var. *floribunda*	DT	Da, DSg	C
	Lagerstroemia speciosa (L.) Pers. var. *speciosa*	DT	Da, DSg	C
	Rotala pentandra (Roxb.) Blatt. & Hallb.	AH	Aq, Wp	G
Crypteroniaceae	*Crypteronia paniculata* Bl. var. *paniculata*	DT	Da/Sg	C
Sonneratiaceae	*Duabanga grandiflora* (Roxb. *ex* DC.) Walp.	ET	EF	U, C
	Sonneratia alba J. Sm.	ET	M	C
Cucurbitaceae	*Gymnopetalum integrifolium* (Roxb.) Kurz	AV	Da	Al
	Trichosanthes ovigera Bl.	AV	Da, Sg	U
Begoniaceae	*Begonia nivea Parish ex* Kurz	DPH	EF-BB, St	Epl
	Begonia yunnanensis Lev.	DPH	EF-BB	G
Datiscaceae	*Tetrameles nudiflora* R. Br. *ex* Benn.	DT	EF	C
Araliaceae	*Trevesia palmata* (DC.) Vis.	EL, ET	EF	U, St
Rubiaceae	*Aidia cochinchinensis* Lour.	ET	EF	U
	Anthocephalus chinensis (Lmk.) A. Rich. *ex* Walp.	DT	Da, Sg	C
	Argostemma verticillatum Wall.	AH	EF	Epl, St
	Borreria alata (Aubl.) DC.	AH	Da	G, W
	Borreria articulata (L.f.) F.N. Will.	AH	B	G
	Borreria repens DC.	AH	Da	W
	Canthium glabrum Bl.	ET	EG	C, St
	Canthium horridum Bl.	EL	EF	U
	Canthium pedunculare Cav.	EL	EG	U, St
	Catunaregam spathulifolia Tirv.	DL	DOF	C
	Coptosapelta flavescens Korth. (var. *flavescens*)	EWc	EF	C, U
	Gardenia erythroclada Kurz	DL, DT	DOF	C
	Geophila repens (L.) I.M. John.	EH	EF	G, Cr
	Greenea secunda (Griff.) Craib	ES	EF	U
	Hedyotis capitellata Wall. *ex* G. Don var. *pedicellata* (Pit.)	EV	Da	G
	Hedyotis pinifolia Wall. *ex* G. Don	AH	B	G
	Hedyotis tetrangularis (Korth.) Walp.	AH	DOF	G
	Hedyotis vestita R. Br. *ex* G. Don	AH	Da, EF-BB	G
	Ixora brunonis Wall. *ex* G. Don	EL	EF	U
	Ixora cibdela Craib var. *puberula* Craib	EL	EF	U
	Ixora coccinea L.	EL, ES	EF	U
	Ixora diversifolia Wall. *ex* Kurz	EL	EF	U
	Ixora grandifolia Zoll. & Mor. var. *grandifolia*	EL	EF	U
	Ixora javanica (Bl.) DC. var. *retinerivia* Corn.	EL	EF	U
	Lasianthus longipedunculatus Parker	EL	EF	U
	Lasianthus stercorarius Bl.	EL	EF	U
	Mitragyna rotundifolia (Roxb.) O.K.	DT	DOF	C, F
	Morinda coreia Ham.	DT	DOF	C
	Morindopsis capillaris Kurz	ES, DS	St	Al,R
	Mussaenda variolosa Wall. *ex* G. Don	EWC	EF	U
	Mycetia paniculiformis Fuku.	EH, EL	EF	G

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	Ophiorrhiza hispidula Wall. *ex* G. Don var. *longipedunculata*	EH	EF	G
	Oxyceros longiflora (Lmk.) Yama.	ESc	EF	U
	Pavetta indica L.	EL	EF	U
	Psychotria adenophylla Wall.	EL	EF	U
	Psychotria monticola Kurz	EL	EF	U
	Psychotria ophioxyloides Wall.	EL	EF	U
	Psychotria stipulacea Wall. var. *stipulacea*	DS	EF, BB	U
	Rennellia speciosa (Wall. *ex* Kurz) Hk. f.	ES	EF	U
	Tamilnadia uliginosa (Retz.) Tirv. & Sastre	ET	EF	U
	Uncaria macrophylla Wall.	EWc	EF	C
	Wendlandia paniculata (Roxb.) DC.	ET	Da, EF	C
Compositae	*Adenostemma lavenia* (L.) O.K. var. *angustifolium* Edgew.	AH	EF	St, Al, R
	Adenostemma lavenia (L.) O.K. var. *lavenia*	AH	Da	G,W
	Ageratum conyzoides L.	AH	Da	G, W,N
	Bidens pilosa L. var. *minor* (Bl.) Sherff	AH	Da, B	G, W
	Blumea balsamifera (L.) DC.	DPH	Da	G, W
	Blumea napifolia DC.	AH	Da	W
	Crassocephalum crepidioides (Bth.) S. Moore	AH	Da	G, W, N
	Eclipta prostrata (L.) L.	AH, PH	Da	W
	Elephantopus scaber L. var. *scaber*	EH	Da	G, W
	Eupatorium odoratum L.	A, DPH	Da	G, W, N
	Launaea sarmentosa (Willd.) Sch.-Bip. *ex* O.K.	AH, PH	B	G, Cr
	Pluchea indica (L.) Less.	ES	M	C
	Sphaeranthus africanus L.	AH	Da	G, W, N
	Spilanthes paniculata Wall. *ex* DC.	AH	Da	G, W
	Vernonia cinerea (L.) Less. var. *cinerea*	AH	Da	G, W
Campanulaceae	*Codonopsis parviflora* Wall. *ex* A. DC.	EH	Da, EF	G
Ericaceae	*Vaccinium sprengelii* (D. Don) Sleum.	EL, ET	Da, EF	C, U
Plumbaginaceae	*Aegialites rotundifolia* Roxb.	EL	M	C
Myrsinaceae	*Ardisia arborescens* Wall. *ex* A. DC.	ET	EF	U
	Ardisia attenuata Wall. *ex* A. DC.	ES, EL	EF, St	U
	Ardisia colorata Roxb.	ET	EF	U
	Ardisia littoralis Andr.	EL	M	C
	Ardisia polycephala Wall. *ex* A. DC.	ES	EF	U
	Embelia sessiliflora Kurz	DWC	Da, Sg	G
	Labisia pumila (Bl.) F.-Vill. & Naves	EH	EF	G
	Maesa montana A. DC.	EL, ESc	Da, EF	U
Sapotaceae	*Manilkara hexandra* (Roxb.) Dub.	ET	Da	planted, C
Ebenaceae	*Diospyros brandisiana* Kurz	ET	EF	U
	Diospyros dasyphylla Kurz	ET	EF	U
	Diospyros diepenhorstii Miq.	ET	EF	U
	Diospyros ferrea (Willd.) Bakh. var. *ferrea*	EL	B	C
Symplocaceae	*Symplocos racemosa* Roxb.	DT	DOF	C, F
Oleaceae	*Jasminum multiflorum* (Burm. f.) Andr.	DV	Da, Sg	C
	Olea salicifolia Wall. *ex* G. Don	ET	Da	C

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Apocynaceae	*Aganosma marginata* (Roxb.) G. Don	DWC	DOF	C
	Alstonia scholaris (L.) R. Br. var. *scholaris*	DT	Da, Sg	C
	Catharanthus roseus (L.) G. Don	A/PH	Da	G, N
	Cerbera odollam Gaertn.	ET	M	C
	Chilocarpus denudatus Bl.	EWc	EF	C
	Holarrhena pubescens (Buch.-Ham.) Wall. *ex* G. Don	DT	DOF	C, F
	Hunteria zeylanica (Retz.) Gard. *ex* Thw.	ET	EF	U
	Plumeria cultivars	DL	Da	planted, N
	Tabernaemontana corymbosa Roxb. *ex* Wall.	Da	BB, EF	U
Asclepiadaceae	*Finlaysonia obovata* Wall.	EV	M	G
	Streptocaulon juventas (Lour.) Merr.	EV	Da, Sg	G
Loganiaceae	*Fagraea fragrans* Roxb.	ET	Da, Sg	C
	Mitrassacme pygmaea R. Br.	AH	DOF	G
Gentianaceae	*Canscora diffusa* (Vahl) G. Don	AH	DOF, EF	St, G
	Exacum pteranthum Wall. *ex* Griseb.	AH	Da, EF	G, Epl
	Nymphoides indica (L.) O.K.	DH	Aq	G
Boraginaceae	*Cordia obliqua* Willd.	EWc	Da, EF	C
	Rotula aquatica Lour.	DH, DS	St	Al, R
Convolvulaceae	*Argyreia mollis* (Burm. f.) Choisy	DPV	DOF	G
	Bonamia semidygna (Roxb.) Hall. f. var. *semidygna*	AV	Da, Sg	C
	Ipomoea carnea Jacq. var. *fistulosa* (Mart. *ex* Choisy) Aust.	DH, SD	Da	G, N
	Ipomoea mauritiana Jacq.	AV	Da, Sg	C
	Ipomoea pes-caprae (L.) Sweet var. *pes-caprae*	A, EV	B	G, Cr
	Merremia mammosa (Lour.) Hall. f.	AV	Da, EF	G, C
	Merremia tridentata (L.) Hall. f. ssp. *hastata* (Desr.) Oost.	AV	Da, Sg	G
	Merremia umbellata (L.) Hall. f. ssp. *orientalis* (Hall. f.) Oost.	AV	Da, Sg	G
Scrophulariaceae	*Adenosma* aff. *hirsuta* (Miq.) Kurz	AH	EF, St	G, Al
	Adenosma indiana (Lour.) Merr.	AH	Da	G, W
	Limnophila rugosa (Roth) Merr.	AH	St, EF	G
	Lindenbergia indica (L.) Vat.	AH	Da, Wp	G, Epl
	Lindernia anagallis (Burm. f.) Penn.	AH	Da	G
	Microcarpaea minima (Kom.) Merr.	AH	Da, Wp	G
	Scoparia dulcis L.	AH	Da	G, W, N
	Torenia cordifolia Roxb.	AH	BB, EF	G, Epl
	Torenia flava B.-H. *ex* Bth.	AH	Da, Sg	G, W
Orobanchaceae	*Aeginetia indica* Roxb.	DPH	BB, EF	G
Lentibulariaceae	*Utricalaria aurea* Lour.	AH	Aq	floating
	Utricularia bifida L. var. *bifida*	AH	Aq, Wp	G
	Utricularia exoleta R. Br.	AH	Aq	floating
	Utricularia involvens Ridl.	AH	Aq, Wp	G
	Utricularia punctata Wall. *ex* A. DC.	AH	Aq	floating

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Gesneriaceae	*Aeschynanthus bracteata* Wall. *ex* Cl.	EH	EF	Ep
	Didissandra sp.	AH	EF, St	Epl
	Rhynchoglossum obliquum Bl.	AH	EF, St	Epl
	Rhynchotechum obovatum (Griff.) B.L. Burtt	EH	EF, St	G
	Stauranthera grandiflora Bth.	AH	EF, St	G
Bignoniaceae	*Fernandoa adenophylla* (Wall. *ex* G. Don) Steen.	DT	Da, Sg	C
	Oroxylum indicum (L.) Kurz	DL, DT	Da, Sg	U
	Radermachera glandulosa (Bl.) Miq.	ET	EF	C
	Stereospermum colais (B.-H. *ex* Dill.) Mabb.	DT	DOF	C, F
Pedaliaceae	*Sesamum orientale* L.	AH	Da	planted, G, N
Acanthaceae	*Acanthus ebracteatus* Vahl	EV	M	C
	Acanthus ilicifolius L.	EH, ES	M	C
	Andrographis paniculata (Burm. f.) Nees	AH	BB, DOF	G
	Asystasiella neesiana (Wall.) Lindau	AH	EF	G
	Barleria strigosa Willd.	DPH	BB, DSg	G
	Cystacanthus pulcherrimus (T. And.) Cl.	EH	EF	C
	Justicia caloneura Kurz	EH	EF	G
	Lepidagathis incurva Ham. *ex* D. Don	DPH	EF	G
	Peristrophe acuminata Nees	AH	EF	G
	Staurogyne glauca (Nees) O.K.	AH	EF/BB	G
	Staurogyne incana (Bl.) O.K.	AH	EF	G
	Thunbergia grandiflora Roxb.	EWC, EV	Da, EF	U, C
Verbenaceae	*Avicennia alba* Bl.	EL, ET	M	C
	Avicennia marina (Forsk.) Vierh.	EL, ET	M	C
	Callicarpa arborea Roxb. var. *arborea*	DT	Da, DSg	C
	Clerodendrum glandulosum Colebr. *ex* Lindl.	EL	Da, EF	C
	Clerodendrum inerme Gaertn.	ESc	M	C
	Clerodendrum infortunatum L.	EL	Da/Sg	C
	Clerodendrum neriifolium Wall. *ex* Schauer	ESc	M	C
	Clerodendrum nutans Wall. *ex* D. Don	DS	BB-EF	U
	Congea tomentosa Roxb. var. *tomentosa*	DWC	EF	C
	Premna corymbosa (Brum. f.) Willd. var. *corymbosa*	ESc	M	C
	Premna latifolia Roxb. var. *mucronata* (Roxb.) Cl.	DWC	EF	U, C
	Sphenodesme ferruginea (Griff.) Briq.	EWC	Da, EF	C
	Sphenodesme involucrata (Presl) Rob. var. *involucrata*	EWC	EF	U, C
	Stachytarpheta indica (L.) Vahl	EH	Da	G, W
	Vitex quinata (Lour.) Will.	ET	EF	U
Labiatae	*Gomphostemma microdon* Dunn	EH	EF	G
	Hyptis brevipes Poit.	DPH	Da	G, F
	Hyptis suaveolens (L.) Poit.	AH	Da	G
	Leucas zeylanica (L.) R. Br.	AH	Da	G, Al
	Pogostemon auricularius (L.) Hassk.	AH	Wp	G
	Scutellaria discolor Wall. *ex* Bth. var. *cyrtopoda* (Miq.) Back.	AH	EF	Epl
Amaranthaceae	*Achyranthes bidentata* Bl. var. *bidentata*	EH	Da, EF	G
	Alternanthera sessilis (L.) DC. var. *sessilis*	EH	Da	G, Cr
	Celosia argentea L.	AH	Da	G, W
	Siamosia thailandica K. Lar. & T.M. Ped.	EH	EF, St	G

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Polygonaceae	*Polygonum chinense* L.	A, EH	Da	G, W
	Polygonum flaccidum Meissn.	AH, PH	St	G, Al
Piperaceae	*Piper betel* L.	EV	Da	planted, U, N
	Piper caninum Bl.	EV	EF	G
	Piper pothiforme Wall. *ex* C. DC.	EV	EF	G
Myristicaceae	*Horsfieldia amygdalina* (Wall.) Warb. var. *amygdalina*	ET	EF	U
	Knema conferta (King) Warb.	ET	EF	U
Lauraceae	*Actinodaphne sesquipedalis* Hk. f. & Th.	ET	EF	U
	Cassytha filiformis L.	E, Ep, V	Da, B	C
	Cinnamomum iners Reinw. *ex* Bl.	ET	EF	U
	Cryptocarya sp.	ET	EF	U
	Dehaasia cuneata Bl.	ET	EF	U
	Litsea aff. *leiophylla* Kurz	ET	Da, EF	U
	Litsea nuculanea Kurz	EL	EF/BB	U
	Litsea semecarpifolia Wall. *ex* Nees	DT	Da, Sg	C
	Phoebe cathia (D. Don) Kosterm.	ET	EF	U
	Phoebe lanceolata (Wall. *ex* Nees) Nees	ET	EF	U
Proteaceae	*Helicia formosana* Hemsl. var. *oblanceolata* Sleum.	ET	EF	U
	Helicia nilagirica Bedd.	ET	BB, EF	U
Thymelaeaceae	*Wikstroemia ridleyi* Gamb.	EL	BB-EF, St	U
Loranthaceae	*Elytranthe albida* Bl.	E, Hp, S	EF	C, Ep
	Scurrula ferruginea (Jack) Dans.	E, Hp, S	Da, BB	C, Ep
	Viscum ovalifolium Wall. *ex* DC.	E, Hp, S	DOF	U, C, Ep
Euphorbiaceae	*Antidesma acidum* Retz.	DL	DOF, BB	U, F
	Antidesma montanum Bl. var. *montanum*	EL, ET	EF	U
	Antidesma velutinosum Bl.	ET	EF	U
	Antidesma velutinum Tul.	EL	EF	U
	Aporusa octandra (B.-H. *ex* D. Don) Vick. var. *octandra*	DT	DOF	C
	Aporusa roxburghii Baill.	ET	EF, St	U
	Aporusa villosa (Lindl.) Baill.	DT	DOF	C
	Baccaurea ramiflora Lour.	ET	EF	U
	Balakata baccata (Roxb.) Ess.	ET	EF	U,C
	Bridelia retusa (L.) A. Juss.	DT	DOF, BB	C
	Bridelia stipularis (L.) Bl.	DWc	Da, EF	C
	Bridelia tomentosa Bl.	DS	Da, BB	C
	Chaetocarpus castanocarpus (Roxb.) Thw.	ET	Da, EF	U
	Croton robustus Kurz	DT	DOF, BB	C, F
	Euphorbia antiquorum L.	DL	Da	C
	Excoecaria agallocha L.	ET	M	C
	Glochidion coccineum (B.-H.) M.-A.	DL, DS	M	C
	Glochidion sphaerogynum (M.-A.) Kurz	DT	Da, DSg	C
	Hevea brasilensis (Willd. *ex* A. Juss.) M.-A.	DT	Da	planted, C, N
	Homonoia riparia Lour.	DS	St	Al, R
	Macaranga denticulata (Bl.) M.-A.	ET	Da, EF	C
	Macaranga gigantea (Rchb. f. & Zoll.) M.-A.	ET	Da, Sg	C

FAMILY	BOTANICAL NAME	HABIT	HABITAT	NOTES
	Macaranga triloba (Reinw. *ex* Bl.) M.-A.	ET	Da, Sg	C
	Mallotus decipiens M.-A.	EL	EF	U
	Mallotus helferi M.-A.	EL, ET	EF	U
	Mallotus paniculatus (Lmk.) M.-A.	DT	Da, Sg	C
	Mallotus resinosus (Blanco) Merr. var. *resinosus*	ES	Da, EF	U
	Manihot esculenta Crantz	EH	Da	planted, C, N
	Phyllanthus elegans Wall. *ex* M.-A.	Da	DSg, BB	U
	Phyllanthus emblica L.	DL, DT	Da, DOF	C
	Phyllanthus reticulatus Poir.	DSc	St	Al, R
	Sauropus garrettii Craib	EL	Da, EF	U
	Securinega virosa (Roxb. *ex* Willd.) Baill.	ES, EL	Da, Sg	C
	Suregada multiflora (A. Juss.) Baill.	ET	Da	U
Ulmaceae	*Aphananthe cuspidata* (Bl.) Pl.	ET	EF, St	U
Moraceae	*Artocarpus heterophylla* Lmk.	ET	Da	planted, N
	Ficus abelii Miq.	EEpl, S	EF, St	R
	Ficus altissima Bl.	ET	EF	C
	Ficus aruantiacea Griff. var. *aruantiacea*	EWc	EF	G, Cr
	Ficus benjamina L. var. *benjamina*	ET	B, Da	C
	Ficus chartacea Wall. *ex* King var. *chartacea*	DL	Da, Sg	U
	Ficus fistulosa Reinw. *ex* Bl. var. *fistulosa*	ET	EF, Da, Sg	U
	Ficus fistulosa Reinw. *ex* Bl. var. *tengerenis* (Miq.) O.K.	DT	Da, BB	U
	Ficus globosa Bl.	EEpT	EF	U, C
	Ficus heterophylla L. f. var. *heterophylla*	EH	EF	G, Cr
	Ficus hispida L. f. var. *hispida*	DT	Da, Sg	C
	Ficus microcarpa L. f. var. *microcarpa* forma *microcarpa*	ET	B, Sg	C
	Ficus pumila L.	EWC	EF	U, Cr
	Ficus ribes Reinw. *ex* Bl. var. *ribes*	EL, ET	EF	U
	Ficus rumphii Bl.	DT	B	C
	Ficus semicordata B.-H. *ex* J.E. Sm. var. *semicordata*	DT	Sg, Da	U, C
	Streblus asper Lour. var. *asper*	ET	Da, Sg	C
Urticaceae	*Boehmeria malabarica* Wall. *ex* Wedd.	DL	St	Al
	Debregeasia longifolia (Burm. f.) Wedd.	EL, ES	St	Al
	Poikilospermum suaveolens (Bl.) Merr.	EWC	EF	U
Juglandaceae	*Engelhardia spicata* Lechen. *ex* Bl. var. *spicata*	DT	Da	C
Casuarinaceae	*Casuarina equisetifolia* J.R. & G. Forst.	ET	B	C
Fagaceae	*Castanopsis argyrophylla* King *ex* Hk. f.	ET	EF	C
	Castanopsis diversifolia King *ex* Hk. f.	ET	EF	U, C
	Lithocarpus lappaceus (Roxb.) Rehd.	ET	EF	U
	Lithocarpus sp.	ET	EF	C
	Lithocarpus sp.	ET	EF	U
Salicaceae	*Salix tetrasperma* Roxb.	DT	St	Al,R
MONOCOTYLEDONEAE				
Butomaceae	*Tenagocharis latifolia* (D. Don) Buch.	AH	Aq, Wp	G

FAMILY	BOTANICAL NAME	HABIT	HABITAT	NOTES
Hydrocharitaceae	*Blyxa echinosperma* (Cl.) Hk. f.	AqH	St	Al, R
Commelinaceae	*Commelina benghalensis* L.	AH	Da	G, W
	Cyanotis cristata (L.) D. Don	AH	B	G
	Amischotolype (Forrestia) mollissima (Bl.) Hassk. forma *marginata* (Bl.) Back.	EV	EF, St	G
	Murdannia gigantea (Vahl) Bruck.	DPH	St	G
	Pollia hasskarlii R. Rao	EH	EF	G
	Pollia thyrsiflora (Bl.) Steud.	EH	EF, St	G
Flagellariaceae	*Flagellaria indica* L.	EV	M	C
Xyridaceae	*Xyris indica* L.	AH	Aq, Wp	G
	Xyris pauciflora Willd.	AH	Aq, Wp	G
Eriocaulaceae	*Eriocaulon cinereum* R. Br.	AH	Wp	G
	Eriocaulon oryzetorum Mart.	AH	Wp	G
	Eriocaulon wightianum Mart.	AH	Wp	G
Bromeliaceae	*Ananas comosus* (L.) Merr.	EH	Da	planted, C, N
Musaceae	*Musa paradisiaca* L.	AH	Da	planted, C, N
Zingiberaceae	*Amomum* sp.	EH	EF	G
	Costus speciosus (Koeh.) J.E. Sm.	DPH	Da, DOF, BB	G, F
	Curcuma Sp.	DPH	BB, DSg	G, F
	Etlingera littoralis (Kon.) Gise.	EH	EF	G
	Globba stenothyrsa Bak.	DPH	EF	G
	Hedychium gardnerianum Rosc.	DPH	Da, EF	G
	Zingiber gracile Jack	DPH	BB, DSg	G, F
Marantiaceae	*Donax cannaeformis* (G. Forst.) K. Sch.	EH	EF, St	G
Liliaceae	*Gloriosa superba* L.	EV	Da, M	C
	Iphigenia indica (L.) A. Gray *ex* Kunth	DPH	BB, DSg	G
Agavaceae	*Dracaena angustifolia* Roxb.	EL	EF	U
Amaryllidaceae	*Crinum stenophyllum* Baker	AqH	St	Al, R
Pontederiaceae	*Monochoria hastata* (L.) Solms	AH	Aq, Wp	G
	Monochoria vaginalis (Burm. f.) Presl	AH	Aq, Wp	G
Smilacaceae	*Smilax ovalifolia* Roxb.	EV	Da, BB, Sg	U, C
Araceae	*Aglaonema simplex* (Bl.) Bl.	EH	EF	G
	Alocasia longiloba Miq.	EH	EF	G
	Alocasia macrorhizos (L.) G. Don	EH	Wp	G
	Amorphophallus muelleri Bl.	DPH	Da, EF	G
	Amorphophallus yunnanensis Engl.	DPH	EF	G
	Colocasia esculenta (L.) Schott	EH	Da, Wp	C
	Cryptocoryne retrospiralis (Roxb.) Kunth	EH	St	Al, R
	Lasia spinosa (L.) Thw.	EH	Wp	G
	Pothos scandens L.	CrV	EF	U
Dioscoreaceae	*Dioscorea bulbifera* L.	DPV	Da, DSg	G
	Dioscorea glabra Roxb	DPV	Da, DSg	G
	Dioscorea pentaphylla L.	DPV	Da, DSg	G

FAMILY	BOTANICAL NAME	HABIT	HABITAT	NOTES
Palmae	*Areca cathecu* L.	ET	Da	planted, C, N
	Arenga wightii Griff.	EL, ET	EF	U
	Borassus flabellifer L.	ET	Da	C
	Calamus erectus Griff.	EH, EV	EF	U
	Calamus latifolius Roxb.	EV	EF	U, C
	Calamus viminalis Willd.	EWC	EF	U
	Caryota mitis Lour.	EL	EF	U
	Cocos nucifera L.	ET	B, Da	often planted, C
	Korthalsia ? scaphigera Griff. *ex* Mart.	EV	EF, St	U
	Licuala paludosa Griff.	EL	EF	U
	Nipa fruticans Wurmb	EL	M	C
	Phoenix loureiri Kunth var. *loureiri*	EL	DOF	G
	Salacca wallichiana Mart.	EL	EF	U
Pandanaceae	*Pandanus odoratissimus* L. f.	EL	B	C
	Pandanus sp.	ET	EF	C
Taccaceae	*Tacca chantrieri* Andre	EH	EF	G
	Tacca leontopetaloides (L.) O.K.	DPH	B	G
Philydraceae	*Philydrum languinosum* Banks & Sol. *ex* Gaertn.	AH	Aq, Wp	G
Burmanniaceae	*Burmannia coelestis* D. Don	AH	Da	G
	Burmannia wallichii (Miers) Hk. f.	AH	BB, DSg	G
Orchidaceae	*Aerides falcata* Lindl.	E, Ep, H	Da	U
	Bulbophyllum sp.	E, Ep, H	DOF, EF	U
	Cirrhopetalum lepidum (Bl.) Schltr.	EH	M, St	Ep
	Cleistostoma appendiculatum (Lindl.) Bth. & Hk. f. *ex* Jacks.	EH	Da, Sg	Ep
	Coelogyne trinervis Lindl.	EH	DOF	Ep
	Cymbidium bicolor Lindl.	E, Ep,H	Da	U
	Dendrobium formosum Roxb. *ex* Lindl.	EH	DOF	Ep
	Luisia psyche Rchb. f.	EH	M, St	Ep
	Pomatocalpa spicata Breda	EEpH	EF	U
	Spathoglottis affinis de Vr.	DPH	BB-EF, St	G
	Trias picta (Par. & Rchb. f.) Parish & Hemsl.	EEpH	EF	U
Cyperaceae	*Bulbostylis barbata* (Rottb.) Cl.	AH	B	G
	Cyperus compactus Retz.	AH	Da	G, W
	Cyperus cyperoides (L.) O.K.	AH	Da	G, W
	Cyperus haspan L.	AH	Aq, M	G
	Cyperus polystachyos Rottb. var. *polystachyos*	AH	M, Aq, Wp	G
	Cyperus procerus Rottb. var. *procerus*	EH	St	Al, R
	Cyperus radians Nees & Meyen *ex* Kunth	AH	B	G
	Eleocharis congesta D. Don	AH	M, Aq, Wp	G
	Eleocharis geniculata (L.) Roem. & Schult.	AH	M, Aq, Wp	G
	Eleocharis philippinensis Svens.	AH	Aq, Wp	G
	Fimbristylis acuminata Vahl	AH	M, Aq, Wp	G
	Fimbristylis adenolepis Kern	AH	Da	G
	Fimbristylis bisumbellata (Forssk.) Bub.	AH	Da, St	G
	Fimbristylis disticha Boeck.	AH	DOF, Wp	G
	Fimbristylis ferruginea (L.) Vahl	AH	M, Aq, Wp	G
	Fimbristylis insignis Thw.	AH	DOF, Wp	G
	Fimbristylis nutans (Retz.) Vahl	AH	Wp	G
	Fuirena ciliaris (L.) Roxb.	AH	M, Wp	G

FAMILY	BOTANICAL NAME	HABIT	HABITAT	NOTES
	Hypolytrum nemorum (Vahl) Spreng. var. *nemorum*	EH	EF	G
	Scirpus (Schoenoplectus) juncoides Roxb. var. *juncoides*	AH	Wp	G
	Scleria levis Retz.	DPH	Da, DOF	G
Gramineae	*Andropogon chinensis* (Nees) Merr.	DPH	DOF	F, G
	Apluda mutica L.	DPH	DOF	F, G
	Arthraxon castratus (Griff.) Nara. *ex* Bor	AH	Da, DOF	G
	Arthraxon lanceolatus (Roxb.) Hochst. var. *lanceolatus*	AH	Da	G
	Arundinella holcoides (Kunth) Trin.	AH	Da	Epl
	Arundinella pumila (Hochst. *ex* Rich.) Steud.	AH	BB-EF, DOF	Epl
	Arundinella setosa Trin. var. *setosa*	DPH	DOF	G
	Brachiaria burmanica Bor	EH	DOF	planted, G
	Chloris virgata Sw.	DPH	DOF	F, G
	Chrysopogon zeylanicus (Nees) Thw.	DPH	DOF	G, F
	Cymbopogon flexuosus (Nees *ex* Steud.) Wats.	DPH	B, Da	G
	Cynodon dactylon (L.) Pers.	EH	Da, M	G
	Cyrtococcum oxyphyllum (Steud.) Stapf	EH	EF, St	G
	Cyrtococcum patens (L.) A. Camus	AH	Da, EF	G
	Digitaria radicosa (Presl) Miq.	AH	Da	G, W
	Digitaria setigera Roth *ex* Roem. & Schult. var. *setigera*	AH	Da, St	G, Al
	Dimeria kurzii Hk. f.	AH	BB-DOF	G
	Eragrostis luzonensis Steud.	AH	Da, Al	G
	Eragrostis sp.	AH	DOF	G
	Eulalia fimbriata (Hack.) O.K.	DPH	DOF	G, F
	Eulalia pallens (Hack.) O.K.	DPH	Da	G, F, W
	Imperata cylindrica (L.) P. Beauv. var. *minor* (Nees) C.E. Hubb.	DPH	Da	G, F, W
	Ischaemum barbatum Retz.	AH	M, Wp	G
	Ischaenum indicum (Houtt.) Merr. var. *indicum* subvar. *indicum*	AH	DOF-BB, Da	G
	Ischaemum muticum L.	AH	Da	W
	Lophatherum gracilie Brongn. var. *gracile*	AH	Da	G, W
	Microstegium vagans (Nees *ex* Steud.) A. Camus	DPH	Da	G, F
	Mnesithea laevis (Retz.) Kunth var. *laevis*	AH	Da	G, W
	Ottochloa nodosa (Kunth) Dandy	AH	Da, Sg	G
	Panicum auritum Presl *ex* Nees	AH	Da	G, W
	Panicum notatum Retz.	DPH	Da, DSg	St, G
	Paspalum conjugatum Berg.	AH	Da	G, W
	Paspalum orbiculare Forst.	AH	Da, Al	G, W
	Pennisetum pedicellatum Trin.	DPH	Da	G, W, F
	Phragmites vallatoria (Pluk. *ex* L.) Veldk.	EH	Da, Sg	G, W, F
	Pogonatherum paniceum (Lmk.) Hack.	AH	BB-EG	G
	Pseudoechinolaena polystachya (H.B.K.) Stapf	AH	Da	G, W
	Pseudopogonatherum contortum (Brongn.) A. Camus	AH	DOF	G
	Saccharum arundinaceum Retz.	EH	Da, Al	G, W
	Sacciolepis indica (L.) A. Chase	AH	Da	G, W
	Setaria palmifolia (Koen.) Stapf var. *palmifolia*	EH	Da, EF, Al	G
	Spinifex littoreus (Burm. f.) Merr.	PEH	B	G

FAMILY	BOTANICAL NAME	HABIT	HABITAT	NOTES
	Sporobolus harmandii Henr.	AH	B	G
	Sporobolus indicus (L.) R. Br. var. *major* (Buse) Baa.	AH	Wp	G
	Thysanolaena latifolia (Roxb. *ex* Horn.) Honda	EH	Da, Sg	G, W, F
Gramineae, Bambusoideae	*Bambusa articulata* Kurz	EH	EF	U
	Bambusa pallida Munro	EH	EF/BB	U
	Cephalostachyum pergracile Munro	EH	EF/BB	U
	Dendrocalamus longispathus Kurz	EH	EF/BB	U
	Dendrocalamus nudus Pilg.	EH	BB, DOF	C
	Gigantochloa apus (Schult.) Kurz	EH	EF/BB	U
	Schizostachyum jaculans Holtt.	EH	Da, BB	C
GYMNOSPERMAE				
Gnetaceae	*Gnetum gnemon* L. var. *tenerum* Mgf.	EL	EF	U
PTERIDOPHYTA				
Selaginellaceae	*Selaginella chrysorrhizos* Spring	AH	BB-DOF	Epl
	Selaginella minutifolia Spring	AH	BB-DOF	Epl
	Selaginella roxburghii (Hk. & Grev.) Spring var. *roxburghii*	AH	BB-DOF	G
Marattiaceae	*Angiopteris evecta* (Forst.) Hoffm.	EH	EF, St	G
Osmundaceae	*Osmunda vachellii* Hk.	EH	EF/St	G
Gleicheniaceae	*Dicranopteris linearis* (Burm. f.) Underw. var. *linearis*	EH	Da	G
Schizaeaceae	*Lygodium flexuosum* (L.) Sw.	DPV	Da, Sg	G
	Lygodium *microphyllum* (Cav.) R. Br.	EV	Da, Wp	G
	Lygodium salicifolium Presl	AV	Da	G
Hymenophyllaceae	*Crepidomanes birmanicum* (Bedd.) K. Iw.	PV	EF, St	Ep
Cyatheaceae	*Cyathea podophylla* (Hk.) Copel.	EH	EF, St	G
Dennstaedtiaceae	*Acrostichium aureum* L.	PH	M	G
	Microlepia herbacea Ching & C. Chr. *ex* Tard. & C. Chr.	EH	Da, EF	G
	Pteridium aquilinum (L.) Kuhn ssp. *aquilinum* var. *wightianum* (Ag.) Try.	EH	Da	G, F
Davalliaceae	*Davallia denticulata* (Burm. f.) Mett. *ex* Kuhn	DPH	Da, BB	Ep
Parkeriaceae	*Ceratopteris thalictroides* (L.) Brongn.	AH	Wp	G
	Cheilanthes belangeri (Bory) C. Chr.	DPH	Da, DSg	G
	Onychium siliculosum (Desv.) C. Chr.	EH	Da	G
	Pityrogramma calomelanos (L.) Link	EH	Da	G
Vittariaceae	*Antrophyum callifolium* Bl.	EH	EF	Ep
	Vittaria elongata Sw.	EH	Da, EF	Ep
Pteridaceae	*Pteris biaurita* L.	EH	Da, EF	G
	Pteris blumeana Ag.	EH	EF, St	G
	Stenochlaena palustris (Burm. f.) Bedd.	EV	M, Wp	G
Aspleniaceae	*Asplenium apogamum* Mur. & Hat.	EH	EF	G
Blechnaceae	*Blechnum orientale* L.	EH	EF	G

FAMILY	BOTANICAL NAME	HABIT	HABITAT	NOTES
Lomariopsidaceae	*Bolbitis appendiculata* (Willd.) K. Iwats.	EH	EF	G
	Bolbitis heteroclita (Presl) Ching *ex* C. Chr.	EH	EF	G, Cr
	Bolbitis hookeriana K. Iw.	EH	EF	G
Dryopteridaceae	*Heterogonium gurupahense* (C. Chr.) Holtt.	EH	EF	G
	Pteridrys australis Ching	EH	EF, St	G
	Tectaria herpetocaulos Holtt.	EH	EF	G
	Tectaria impressa (Fee) Holtt.	EH	EF	G
Thelypteridaceae	*Thelypteris ciliata* (Wall. *ex* Bth.) Ching	EH	EF, St	Epl, R
	Thelypteris papilio (Hope) K. Iw.	EH	EF, St	G
Athyriaceae	*Diplazium esculentum* (Retz.) Sw.	EH	St	Al, R, G
	Diplazium simplicivenium Holtt.	EH	EF, St	G
Polypodiaceae	*Drymoglossum piloselloides* (L.) Presl	E, H	Da	U, Ep
	Drynaria quercifolia (L.) J. Sm.	DPH	Da, Sg	U, Ep
	Leptochilus decurrens Bl.	EH	EF, St	Epl
	Microsorum pteropus (Bl.) Copel.	EH	St, EF/BB	Epl
	Microsorum punctatum (L.) Copel.	EH	Da	U, Ep
	Pyrrosia adnascens (Sw.) Ching	EH	Da	U, Ep

Summary of collecting results:

Division	Subdivision	Class	Families	Species, *etc.*
Spermatophyta (seed plants)	Angiospermae (flowering plants)	Dicotyledoneae	95	474
		Monocotyledoneae	25	147
	Gymnospermae (cone plants)	Gnetatae	1	1
Pteridophyta (fern allies & ferns)			19	44
		total	140	666