VEGETATION AND DIVERSITY OF THE GROUND FLORA IN A DECIDUOUS DIPTEROCARP-OAK FOREST, NORTHERN THAILAND

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ABSTRACT

Mai Muang Nao is a unique arboretum, located in a deciduous dipterocarp-oak forest in Northern Thailand. A floristic survey was carried out during March 2001 – February 2002 in three main habitats: 1) open, fire-damaged, degraded areas (DF), 2) open bog/marsh areas (OB), and 3) shaded areas with bamboo thickets along a seasonal stream (SS). A total of 340 vascular plants were found, including of which 262 species were herbaceous ground flora, 67 tree species, 5 woody climbers, and 6 aquatics. The most abundant tree species was *Dipterocarpus obtusifolius* var. *obtusifolius* (Dipterocarpaceae). The vascular ground flora were in 59 families and 180 genera, including 2 families of monocotyledons, 37 of dicotyledons, and 10 of pteridophytes. The ground flora was collected with notes on phenology, habitat, and abundance for each species. Sixty-five percent of herbs were deciduous and 25 percent were annuals. Flowering peaked in October, with 94 species. The most common ground flora family was Compositae with 30 species. Twenty-one species of terrestrial orchids had medium or rare abundances and some species were represented by only a few individuals. Due to the high species richness and relative rarity of some species found here, this area is clearly worthy of protection and it would be an excellent site to promote nature education.

Key words: vegetation, ground flora, dipterocarp-oak forest, northern Thailand

INTRODUCTION

Mai Muang Nao Arboretum was established in 1995, and is part of the Mae Toh National Park. It is located in Baw Salee Subdistrict, Hod District, Chiang Mai Province, Northern Thailand (18° 8' N latitude, 89° 23' E longitude), and has an area of approximately 80 ha. General topographic features include small hills alternating with gullies at elevations of 900–1125 m along Highway 108 (Hod–Mae Sariang) (Fig. 1).

The bedrock consists of plutonic, Paleozoic and Precambrian granite which is at least 570 million years old. This bedrock includes some of the oldest rocks found in Thailand (BRAUN *ET AL.*, 1982). Due to forest destruction, the soil is generally eroded with little organic matter and much gravel.

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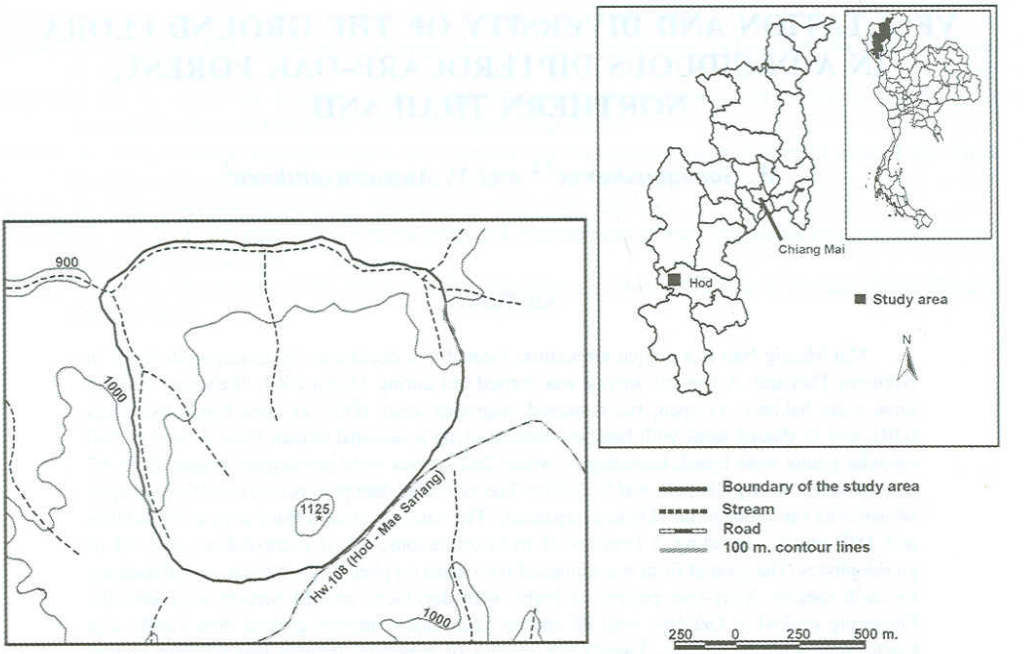

Figure 1. Mai Muang Nao Arboretum, the study area located in Hod district of Chiang Mai Province of northern Thailand. ★ indicates the highest peak in the study area (1125 m). See text for site description details.

There are three seasons in northern Thailand: cool-dry (November–February), hot-dry (March–April), and rainy (May–October). The average annual rainfall from two stations (1993–2000), Hod (*c.* 300 m elevation) and Mae Sariang (211 m elevation), is approximately 1,044 mm. The highest monthly rainfall is in August with about 185 mm. The mean maximum temperature at Mae Sariang (1993–2000) is 33°C and mean minimum 20°C.

Continuous forest destruction has resulted in decreased biodiversity over much of Thailand. The vegetation has suffered, especially the two species of *Pinus* (SANTISUK, 1997; MAXWELL *ET AL.*, 1995) and orchids (ELLIOTT, 2001). Since forest cover in Thailand has been rapidly decreasing, plant and animal populations have been disrupted and with serious consequence for ecological functions, especially a reduction in animal-dispersed plant species (ELLIOTT, 2001). In addition, it is not known how many species have disappeared, how many species still remain, and in what abundance. Vegetation surveys can help enumerate the number of species, their distribution, abundance, and ecology, so that conservation measures can be affected. Most Thai forests are in need of proper restoration, which can be done if detailed vegetation information of both trees and ground flora is done first. This study involved surveying the vegetation and collecting the vascular ground flora to provide regional information for further botanical studies, and a computerized botanical database.

METHODS

Fieldwork was done twice a month from March 2001 to February 2002, for 2–3 days at a time, while identification was done at CMU Herbarium. The vascular ground flora, including all herbs, vines, and woody species with flowers, fruits, or sporangia up to about 1.5 m tall, were collected. Some grasses and vines, which were slightly higher or longer, as well as aquatic plants, were collected. Other trees and climbers were listed with their abundances and habitats.

RESULTS

A total of 340 species (in 107 families) of vascular plants were recorded (Appendices) including 67 tree species (39 families), 5 woody climbers (5 families), 6 aquatics (4 families), and 262 herbaceous (59 families). The most common tree family was Dipterocarpaceae with 5 species, while the largest herbaceous family was Compositae with 30 species.

Vegetation

According to MAXWELL (2001), the forest in the study area was originally evergreen forest with pine (EG/Pine) and became degraded to deciduous diperocarp-oak forest (DOF), since it is dominated by *Dipterocarpus obtusifolius* var. *obtusifolius* (Dipterocarpaceae) and *Quercus kerrii* var. *kerrii* (Fagaceae). *D. tuberculatus* was mostly present as coppices, with very few mature trees in the area. It was usually found on lower slopes than the dominant *D. obtusifolius*. Two species of Pinaceae, *Pinus kesiya* and *P. merkusii*, were found here. They are now usually found at higher elevations in northern Thail EG/Pine forests, thus could be classified as Dipterocarp-oak + pine forest (DOF) (MAXWELL, 1995, 1997, 1998, 2001). The ground flora of this area included many species, restricted to other EG/Pine forests in the region, including Doi Suthep_Pui National Park and Doi Chiang Dao Wildlife Sanctuary (both in Chiang Mai Province) (MAXWELL, 1998, 2001; SMITHINAND, 1966; CMU Botanical Database), e.g. *Delphinium siamensis* (Ranunculaceae), *Smithia ciliata* (Leguminosae, Papilionoideae), *Rubia siamensis* (Rubiaceae), and in particular, several species of Compositae: *Anaphalis adnata, Crepis lignea, Inula nervosa, Inula wissmanniana forma wissmanniana, Laggera alata, Piloselloides hirsuta,* and *Saussurea peguensis*. The forest structure consisted of 2 main layers: the tree canopy (approximately 8–15 m high) and ground flora (up to 1.5 m high). The study area was separated into three main habitats as follows:

Open, fire-damaged, degraded area (DF).—This habitat covered more than 90% of the study area. The most common trees were *Dipterocarpus obtusifolius* var. *obtusifolius* and *Shorea obtusa* (both Dipterocarpaceae); *Quercus kerrii* var. *kerrii, Q. brandisiana, Castanopsis acuminatissima,* and *C. argyrophylla* (all Fagaceae). Most Fagaceae were evergreen except the most common oak, *Q. kerrii* which is deciduous. Referring to species abundances in the Appendix, the other common trees found included *Gluta usitata* (Anacardiaceae), *Tristaniopsis burmanica* var. *rufescens* (Myrtaceae), *Craibiodendron*

stellatum and *Vaccinium sprengelii* (both Ericaceae). Some tree species were rare, such as *Cassine glauca* var. *cochinchinensis* (Celastraceae), *Schoepfia fragrans* (Olacaceae), *Xantolis cambodiana* (Sapotaceae), and both *Pinus* species. *Ochna integerrima* (Ochnaceae) grows as a treelet usually taller than 2 m, but all those found were less than 1 m tall, due to forest fires and animals grazing. No woody climbers were found in this habitat and only a few common shrubs higher than 2 m, e.g. *Indigofera caloneura, I. colutea* (both Leguminosae, Papilionoideae), *Melastoma malabathricum* ssp. *malabathricum* (Melastomataceae), and *Grewia abutilifolia* (Tiliaceae).

Since this forest is fire-damaged, and deciduous, the canopy is open, light is not limiting, and trees are short (< 20 m tall). Consequently the ground flora was found to be well developed, especially Gramineae (grasses). There were 130 perennial deciduous herbs (50% of the total ground flora and 67% of deciduous herbs found in is the habitat). Common grasses included *Arundinella setosa* var. *setosa, Capillipedium parviflorum, Themeda triandra,* and *Pseudopogonatherum contortum.* Cyperaceae (sedges) were also widely distributed with *Frimbistylis thomsonii, F. yunnanensis, Carex continua,* and *C. cruciata.* Although Cyperaceae and Gramineae were most obvious, there was a high diversity of other ground flora. Abundant species, easily seen in the dry season, included the perennial evergreen palm, *Phoenix loureiri* var. *loureiri* (Palmae), which was common, restricted to fire-prone places, and is recognized as an indicator of this forest type (STOTT, 1984). Forty-two species of annual herbs (64% of the total annual herb flora) were found and most were common in open places, e.g. *Blumeopsis flava* and *Blumea fistulosa* (both Compositae), *Rungia parviflora* and *Justicia procumbens* (both Acanthaceae), and *Isodon lophanthoides* var. *lophantoides* (Labiatae).

Most of the monocots were deciduous and abundant or common in the hot-dry season. Some of these included *Curcuma zedoaria, Kaempferia rotunda, Globba reflexa, Zingiber* sp. (all Zingiberaceae), and *Murdannia edulis* (Commelinaceae). Common herbaceous dicots, flowering in the hot-dry season, were *Scutellaria glandulosa* (Labiatae), *Premna herbacea* (Labiatae), and *Piloselloides hirsuta* (Compositae).

In the early rainy season, a tiny insectivorous herb, *Drosera peltata* (Droseraceae) was commonly seen, especially in very open areas with eroded soils. It is an indicator of poor soils, especially nitrogen-deficient ones (SCHULZE *ET AL.*, 1997). The most common dicotyledon also found at higher elevations in other EG/PINE forests was *Pimpinella cambodgiana* (Umbelliferae) (MAXWELL, 1998, 2001). Deciduous herbs such as *Pouzolzia pentandra* (Urticaceae), *Abelmoschus moschatus* ssp. *tuberosus* (Malvaceae) and *Clitoria macrophylla* (Leguminosae-Papilionoideae) are good indicators of burnt areas since they have large underground storage organs. Most of the Commelinaceae flower in the rainy season; common species included *Murdannia macrocarpa, M. divergens, M. simplex, Cyanotis cristata,* and *C. barbata.*

In the late rainy season to cool-dry season (October–January), many species of Compositae flowered synchronously, e.g. *Inula nervosa* (Fig. 3), *I. indica, I. Cappa forma cappa, Anaphalis adnata, Laggera alata, Pluchea polygonata,* and *Vernonia squarrosa* var. *orientalis.* Most Leguminosae–Papilionoideae species also flowered in the same period, e.g. 10 species of the most common genus *Crotalaria, Codariocalyx motorius, Desmodium oblongum, D. heterocarpon,* and *Flemingia sootepensis.* A herbaceous vine known by villagers for it edible inflorescence, *Dunbaria bella,* was abundant here. *Isodon lophanthoides* var. *lophantoides* (Labiatae) also bloomed at this time and was very common over the whole area, especially in very open places.

Figure 2. *Inula nervosa* Wall. *ex* DC. (Compositae), one of the commonest species in this family. Photo: Wangworn Sankamethawee 15 November 2001.

Figure 3. *Curcuma zedoaria* (Berg.) Rosc. (Zingiberaceae), deciduous, perennial, aromatic herb which is edible and very common during the dry season, flowers when leafless. Photo: Wangworn Sankamethawee 4 May 2001.

Figure 4. *Gentiana timida* Kerr. (Gentianaceae), a deciduous ground herb with dimorphic leaves, corolla closes in mid-afternoon. Photo: Wangworn Sankamethawee 4 May 2001.

Figure 5. *Arundina graminifolia* (D. Don) Hochr. (Orchidaceae), perennial, deciduous, ground orchid, which is found more often than other orchids. Photo: Wangworn Sankamethawee 10 August 2001.

Two saprophytic/parasitic leafless Orobanchaceae were less abundant, i.e. *Aeginetia pedunculata* was rare and mostly found in very open places near the top of the hill, in grass clumps, usually covered by matted leaves. *Aeginetia indica* was also found in this habitat, but was easily seen on bare ground, and more common near the stream (SS). The type material of *Inula wissmanniana* forma *disciformia* (Compositae) was collected from this area, but our voucher specimen was forma *wissmanniana*, which grows both in DF and SS. It may be that forma *disciformia* is not a distinct taxon.

Open bog/marshy areas (OB).—This occurred in five small, seasonally moist gullies in shaded areas and three open, perennial marshes scattered over the study site, covering an area of *c.* 200 m^2. There were fewer tree species in this habitat; *Quercus brandisiana* (Fagaceae), *Vaccinium sprengelii* (Ericaceae), *Glochidion sphaerogynum* (Euphorbiaceae), and *Shorea obtusa* (Dipterocarpaceae), were mostly scattered at the edges of the bogs. Along these moist gullies, *Pinus kesiya* was scarce. Most Cyperaceae (sedges) were common, e.g. *Fimbristylis miliacea*, *Cyperus pilosus*, *Fuierena ciliaris*, and *Scirpus mucronatus*. Common evergreen species restricted to this habitat included *Pogostemon pentagonus* (Labiatae), *Rotala rotundifolia* (Lythraceae), *Impatiens chinensis* (Balsaminaceae), and *Limnophila villifera* ssp. *gracilipes* (Scrophulariaceae). Some deciduous species often occurred in seasonally drier soil, e.g. *Viola betonaetifolia* (Violaceae), *Pogostemon auricularius* (Labiatae), *Osbeckia chinensis* var. *chinensis* (Melastomataceae), and *Centranthera cochinchinensis* ssp. *cochinchinensis* (Scrophulariaceae). The ecotone of this habitat and DF included common species such as *Aeschenomene americana* a naturalized herb, *Desmodium microphyllum* (both Leguminosae, Papilionoideae), *Urena lobata* ssp. *lobata* var. *lobata* (Malvaceae), *Melastoma malabathricum* ssp. *malabathricum* (Melastomataceae), and *Justicia procumbens* (Acanthaceae). Although *Curcuma zedoaria* (Zingiberaceae) (Fig. 3) grows best in arid soils, it was also found here, as well as *Scutellaria glandulosa* (Labiatae) and *Murdannia edulis* (Commelinaceae) which were abundant in DF.

Within this habitat, the ground flora mostly flowered during the rainy season. Eight species had long flowering periods (> 5 months), e.g. *Hygrophila phomoides* (Acanthaceae), *Impatiens chinensis* (Balsaminaceae), *Lobelia zeylanica* (Campanulaceae), and *Crassocephalum crepidioides* (Compositae), and *Ranunculus siamensis* (Ranunculaceae). Three species flowered all year round, *viz. Spilanthes iabadicensis* (Compositae), *Hypericum japonicum* (Guttiferae), and *Polygonum persicaria* (Polygonaceae).

Annual species flowered for 1–3 months during the latter part of and after the rainy season, e.g. *Eriocaulon gracile*, *E. oryzetorum* (Eriocaulaceae), *Xyris capensis* (Xyridaceae), *Burmannia coelestis* (Burmanniaceae), *Drosera burmannii* (Droseraceae), *Utricularia scandens*, *U. minutissima*, and *U. hirta* (Lentibulariaceae). All these species were restricted to, but common in this habitat and preferred the non-flooded zones.

Many pteridophytes were found along moist gullies, e.g. *Equisetum debile* (Equisetaceae), *Thelypteris dentata*, *T. xyloides*, *T. valida* (all Thelypteridaceae), and *Onychium siliculosum* (Parkeriaceae). Six aquatic plants were collected in the rainy season, e.g *Alisma plantago* and *Sagittaria sagittifolia* ssp. *leucopetala* (both Alismataceae), *Monochoria vaginalis* (Pontederiaceae), *Blyxa aubertii*, *Ottelia alismoides* (both Hydrocharitaceae), and *Hydrolea zeylanica* (Hydrophyllaceae). *Rotala rotundifolia* (Lythraceae) was considered as ground flora here, since it was more common in the non-flooded and drier zones.

Three invasive alien species were found here and are starting to encroach up hills, such as *Mimosa diplotricha* var. *diplotricha* (Leguminosae, Mimosoideae), *Eupatorium adenophorum*, and *Tithonia diversifolia* (both Compositae).

Shaded areas along the seasonal stream (SS).—These form the northern boundary of the study area with bamboo thickets (*Bambusa tulda*) scattered along the stream banks. The stream dried out from December to June. The vegetation along the stream banks was similar to that of BB/DF and MXF types in the other forests, e.g. Doi Suthep–Pui, Doi Chiang Dao, Jae Sawn, and Doi Luang (MAXWELL, 1992, 1998, 2001; MAXWELL *ET. AL.*, 1997; CMU botanical database). It was dominated by *Bambusa tulda* (Gramineae, Bambusoideae). Many trees were evergreen, with the canopy dense and higher than in DF and OB (estimated canopy cover 90%). Several trees were restricted to this habitat and sparsely distributed, e.g. *Pittosporum nepaulense* (Pittosporaceae), *Protium serratum* (Burseracece), *Aglaia lawii* (Meliaceae), *Eriobotrya bengalensis forma bengalensis* and *Stranvaesia nussia* (both Rosaceae), *Syzygium albiflorum* (Myrtaceae), *Nyssa javanica* (Nyssaceae), *Diospyros winitii* (Ebenaceae), *Olea salicifolia* (Oleaceae), *Ficus semicordata* var. *semicordata* (Moraceae), *Lithocarpus elegans* (Fagaceae), and *Salix tetrasperma* (Salicaceae).

Another reason for the dense canopy was due to woody climbers, viz. *Spatholobus parviflorus* (Leguminosae, Papilionoideae), *Amalocalyx microlobus* (Apocynaceae), *Celastrus paniculatus* (Celastraceae), *Connarus semidecandrus* (Connaraceae), and *Gnetum montanum* (Gnetaceae).

The ground flora was quite similar to that of other habitats. It consisted of widely distributed individuals of *Curcuma ecomata, Kaempferia rotunda,* and *Zingiber* sp. (all Zingiberaceae), *Scutellaria glandulosa* (Labiatae), *Justicia procumbens* (Acanthaceae), and *Ophiopogon longifolia* (Liliaceae). Common annual species restricted to the streambed in the dry season at SS were *Canscora diffusa* (Gentianaceae), *Blumea mollis*, and *Cyathocline purpurea* (both Compositae). Some common species along the steep banks were: *Selaginella ostenfeldii, S. kurzii* (Selaginellaceae), *Zingiber parishii, Globba* sp. (both Zingiberaceae), and *Pilea trinervia* (Urticaceae). Some common evergreen species were *Hygrophila intermedia, Sericocalyx parviflora,* and *Strobilanthes rex* (all Acanthaceae). Deciduous herbs were often found away from the stream in bamboo thickets and sometimes in burnt places, e.g. *Gomphostemma strobilinum* var. *acualis* (Labiatae), *Peliosanthes teta* ssp. *humilis* (Liliaceae), *Desmodium laxiflorum* ssp. *laxiflorum, D. pulchellum* (Leguminosae, Papilionoideae), and the saprophytic/parasitic, leafless *Aeginetia indica* (Orobanchaceae). Some common annuals found in moist shaded areas included *Blumea napifolia* (Compositae) and *Drymaria diandra* (Caryophyllaceae). Rare deciduous species included *Paris polyphylla* (Liliaceae) and *Begonia integrifolia* (Begoniaceae). Ground pteridophytes (ferns) appeared here, as well as along the gullies with *Thelypteris parasitica, T. dentata* (Thelypteridaceae), *Pteris venusta, P. ensiformis* (Pteridaceae), and *Dryopteris cochleata* (Dryopteridaceae) being common examples.

Habitat variation was found in some species. Observed individuals of *Isodon lophanthoides* (Labiatae) in DF and SS, had different sized leaf blades, flowers, as well as indumentum. The specimen from DF had entire bracts with the stamens included in the corolla lobes, while the specimen from SS had serrate or lobed bracts with the stamens distinctly exserted. *Murdannia simplex* (Commelinaceae) was also found in these two

habitats, but the specimen from SS was much larger and flowered almost three months later. *Pouzolzia pentandra* (Urticaceae) was common in DF and OB, but had different: sizes of leaf blades, height, inflorescence features, and root systems. It grew densely in flooded places without swollen storage roots, while the specimen from DF had large swollen storage roots and the leaves were more than four times larger than in OB.

DISCUSSION

The number of ground flora species at Mai Muang Nao is similar to that in DOF in Doi Suthep-Pui National Park (MAXWELL, 2001; CMU database 2002). The ground flora at Mai Muang Nao appeared to be approximately twice as rich as the whole flora in similar deciduous forest (DOF) (132 species) at Jae Sawn National Park (MAXWELL *ET AL.*, 1997), which is located at a lower (300–800 m) elevation. Compared to other forests in the north (MAXWELL, 1992, 1998, 2001; MAXWELL *ET AL.*, 1995, 1997; OGAWA *ET AL.*, 1961; STOTT, 1984) the vegetation at Mai Muang Nao is a typically northern association, especially the ground flora.

Many of the ground flora species have become rare (Appendix 1) due to disturbance, encroachment, commercial collecting, animal grazing, and especially forest fires. There were two rice fields in the moist gullies at the boundaries of the arboretum and the farmers have been expanding their farmlands and cutting trees for firewood, fences, house construction, *etc.* During 2001–2002, agricultural fields expanded up the hill and now included about 1.9 ha or about 2.4% of the total area. Although villagers have made an agreement regarding land usage with the Department of Parks, Wildlife and Plant Conservation (DPWP), they have not honored this agreement and DPWP has not controlled them. In July 2002, another cleared area was found between the arboretum and the Pine Improvement Center for rice cultivation, which will probably expand in the future. Some local people have been collecting rare plants for sale, including both terrestrial and epiphytic orchids. Apart from these basic problems, the use of insecticides on crops, and especially planting ornamentals and orchards around the villages, could pollute streams and create health hazards to people downstream.

Three fires occurred during the dry season (February–March) in 2001 and twice in February 2002, mostly in the western and southern parts of the study site and bordered by Highway 108. All fires were started by local people, especially for clearing land and the questionable belief that fire stimulates wild mushroom growth before the rainy season, especially for the edible and commercially valuable earthstar mushroom *Astraeus hygrometricus* (Pers) Morg. (Astraeaceae). As the workers at the arboretum usually do not work on weekends, fires started during this time are not extinguished. Cattle are also a cause for concern since the villagers allow them to graze throughout the entire area. These animals trample and eat vegetation as well as compact the soil.

From field observations at the local market and interviews with villagers about wild product utilization, this forest is a prime place to find mushrooms, pine wood, pine resin, as well as bamboo shoots for consumption and culms for construction. Some common edible mushrooms are *Russula* spp., *Lactarius* spp. (both Russulaceae), and *Amanita* spp. (Amanitaceae). Some edible vascular plants, including those sold as vegetables, are the inflorescences of *Curcuma zedoaria* (Zingiberaceae), flowers of *Dunbaria bella*

(Leguminosae, Papilionoideae); leaves, stems, and inflorescences of *Crassocephalum crepidioides* and *Spilanthes iabadicensis* (both Compositae), and young stems of *Selaginella ostenfeldii* (Selaginellaceae).

Some unidentified species, viz. *Zingiber* sp., *Globba* sp. (both Zingiberaceae), and *Laggera* sp. (Compositae) have been sent other herbaria including MO (Missouri Botanical Garden), L (Rijksherbarium-Leiden), A (Arnold Arboretum, Harvard University), CAS (California Academy of Science), and BKF (Royal Forest Department) where they may be eventually identified.

RECOMMENDATIONS

The Arboretum has done some basic scientific work by having some tree names displayed around cleared areas and a nature trail. A new station of Mae Toh National Park has been established in the study area, which could be more effective at promoting ecotourism and conservation education, if scientific knowledge of all local plants were complied with plant names, habitat information, ecology, specific plant uses, and other notes concerning biodiversity management.

Although there are three Parks Department units in the area—Mae Toh National Park, the Pine Improvement Center, and Mai Muang Nao Arboretum—there is a lack of cooperation on conservation. These three units could be organized for conservation purposes, and provide vegetation information from the arboretum and for forest restoration at the Pine Improvement Center. All this information should be available for education exhibitions, forestry training programs, and ecotourism. Some policies should be changed, especially since the Pine Improvement Center is now no longer working with pine plantations. This place would be appropriate for a reforestation nursery and for forest research. The original nursery facilities for pine improvement could be used for germination and growth of native plants, especially rare species and native trees, and improving research to re-establish deforested places in the area. Furthermore, park workers should be trained in nursery techniques, seed collection, seed selection, forest restoration planting, and forest protection/conservation. In addition, staff will also have to eradicate the invasive species (*Mimosa diplotricha, Eupatorium adenophorum,* and *Tithonia diversifolia*) that have been rapidly expanding and inhibiting the diversity of native flora.

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REFERENCES

BRAUN, F., E. V. BRAUN, A. HESS AND K. E. HOCH. 1982. Geological map of northern Thailand 1:250,000, Hanover, Sheet 5.

CMU Botanical database. 2002. CMU Herbarium, Faculty of Science, Chiang Mai University.

ELLIOTT, S. 2001. Exploitation and conservation. Pages 155-178 *in* J. F. Maxwell and S. Elliott (eds.), Vegetation and vascular flora of Doi Sutep-Pui National Park, Northern Thailand. *Thai Studies in Biodiversity* No. 5.

MAXWELL, J. F. 1992. Lowland vegetation (*c.* 450–800 m) of Doi Chiang Dao Wildlife Sanctuary, Chiang Mai Province, Thailand. *Tigerpaper (FAO)*, 19(3): 21–25.

MAXWELL, J. F. 1998. Upland vegetation of Doi Chiang Dao Wildlife Sanctuary, Chiang Mai Province, Thailand. *Tigerpaper (FAO)*, 25(3): 5–11.

MAXWELL, J. F. 2001. Reassessment of the forest types of Thailand. Pages 1-17 *in* J. F. Maxwell and S. Elliott (eds.),Vegetation and Vascular Flora of Doi Sutep-Pui National Park, Northern Thailand. *Thai Studies in Biodiversity* No. 5.

MAXWELL, J. F., S. ELLIOTT, AND V. ANUSARNSUNTHORN. 1997. The vegetation of Jae Sawn National Park, Lampang Province, Thailand. *Nat. Hist. Bull. Siam Soc.* 45: 71–79.

MAXWELL, J. F., S. ELLIOTT, P. PALEE AND V. ANUSARNSUNTHORN. 1995. The vegetation of Doi Khuntan National Park, Lamphun-Lampang Provinces, Thailand. *Nat. Hist. Bull. Siam Soc.* 43: 185–205.

OGAWA, H., K. YODA, AND T. KIRA. 1961. A preliminary survey on the vegetation of Thailand. *Nature and life in southeast Asia*. 1: 21–157.

SANTISUK, T. 1997. Geographical and ecological distributions of the two tropical pines, *Pinus kesiya & Pinus merkusii*, in Southeast Asia. *Thai. For. Bull. (Bot.)* 25: 102–116.

SMITHINAND, T. 1966. The vegetation of Doi Chiang Dao, a limestone massive in Chiang Mai, northern Thailand. *Nat. Hist. Bull. Siam Soc.* 21(1–2): 93–128.

SCHULZE, W., E. D. SCHULZE, J. S. PATE, AND A. N. GILLISON. 1997. The nitrogen supply from soils and insects during growth of the pitcher plants *Nepenthes mirabilis, Cephalotus follicularis*, and *Darlingtonia californica*. *Oecologia* 112(4): 464–471.

STOTT, P. 1984. The savanna forests of Mainland Southeast Asia: an ecological survey. Progress in *Physical Geography* 8(3): 315–335.

Appendices. Abbreviations used.

Abundance

1	only few individuals
2	rare
3	medium
4	common
5	abundant

Habit

h	herb
s	shrub
l	treelet
v	vine
sc	scandent
par	parasitic
wee	weed

Month

Ja	January
Fb	February
Mr	March
Ap	April
My	May
Jn	June
Jl	July
Ag	August
Sp	September
Oc	October
Nv	November
Dc	December

Habitat

DF	degraded, fire-damaged areas
OB	marshes
SS	shaded areas, near streams

Life mode

a	annual
pe	perennial evergreen
pd	perennial deciduous
aqu	aquatic
amp	amphibious
epl	epilithic
gro	ground
nat	naturalized, not native
par	parasitic
wee	weed

Appendix 1. Ground flora and its ecological characteristics in the Mai Muang Arboretum.

Family	Botanical name	Voucher number	Abundance	Life mode	Habit	Habitat	Leafing	Flowering	Fruiting
Monocotyledoneae									
Amaryllidaceae	*Crinum wattii Baker*	217	2	pd/gro	h	DF	Ap - Nv	My - Jn	Jn - Oc
Araceae	*Arisaema prazeri* Hk. f.	191	3	pd/gro	h	DF	Jn - Oc	Jn - Jl	Ag - Ja
Burmanniaceae	*Burmannia coelestis* D. Don	329	2	a/gro	h	OB	Nv - Ja	Nv - Ja	Nv - Ja
Commelinaceae	*Murdannia simples* (Vahl) Bren.	178, 267	4	pd/gro	h	DF,SS	Ap - Oc	My - Jn	My - Sp
	Commelina diffusa Burm. f.	292	3	pe/gro	h	SS	Ja - Dc	Sp - Oc	Sp - Nv
	Commelina padulosa Bl.	276	3	pe/gro	h	SS	My - Nv	Ag - Sp	Sp - Oc
	Cyanotis barbata D. Don	306	4	pd/gro	h	DF	Jy - Nv	Sp-Oc	Sp-Nv
	Cyanotis cristata (L.) D. Don	261	4	a/gro	h	DF,OB	Ag - Nv	Sp - Oc	Sp - Nv
	Floscopa scandens Lour.	331	3	pe/gro	h	SS	Ja - Dc	Nv - Dc	Nv - Ja
	Murdania edulis (Stokes) Faden	137, 184	4	pd/gro	h	DF	My - Ag	Mr - Ap	Ap - Jn
	Murdannia macrocarpa D. Y. Hong	249	4	pd/gro	h	DF	Ag - Fb	Ag - Nv	Nv - Ja
	Murdannia divergens (Cl.) Brück.	266	3	pd/gro	h	DF	Jl - Oc	Ag - Oc	Sp - Oc
	Murdannia spectabilis (Kurz) Faden	176	4	pd/gro	h	DF	My - Ag	My - Jn	Jn - Jl
	Murdannia nudiflora (L.) Bren.	322	3	a/gro	h	DF,OB	Jl - Nv	Ag - Sp	Sp - Oc
Cyperaceae	*Carex continua* Cl.	225	4	pd/gro	h	DF	My - Fb	Jl - Oc	Jl - Dc
	Carex cruciata Wahl.	394	4	pd/gro	h	DF	Ja - Dc	Dc - Fb	Dc - My
	Cyperus cyperoides (L.) O.K.	177	3	pd/gro	h	DF	My - Sp	My - Jn	My -Ag
	Cyperus flavidus Retz.	228	3	a/gro	h	OB	Jn - Sp	Jl - Sp	Jl - Sp
	Cyperus pilosus Vahl	238	2	pd/gro	h	OB	Jn - Ag	Jl - Ag	Jl - Ag
	Cyperus triceps (Rottb.) Engl.	214	2	pd/gro	h	DF	My - Ag	Jn - Jl	Jn - Ag
	Fimbristylis cinnamometorum (Vahl) Kunth	226	3	pd/gro	h	DF	Jn - Sp	Jl - Ag	Jl - Ag
	Fimbristylis fusca (Nees) Cl.	168	3	pd/gro	h	OB	My - Ag	My - Ag	My - Ag
	Fimbristylis miliacea (L.) Vahl	256	4	a/gro	h	OB	Ag - Sp	Ag - Sp	Ag - Sp
	Fimbristylis straminea Turrill	282	4	a/gro	h	DF	Ag - Oc	Sp - Oc	Sp - Oc
	Fimbristylis thomsonii Boeck	156	4	pd/gro	h	DF	Mr - Ag	Mr - Jn	Mr - Ag
	Fimbristylis yunnanensis Cl.	215	4	pd/gro	h	DF	My - Ag	Jn - Ag	Jn - Ag
	Fuierena ciliaris (L.) Roxb.	239	2	pe/gro, aqu	h	OB	Jl - Ag	Jl - Ag	Jl - Ag
	Rhynchospora hirticeps (Kuk.) T. Koy.	227	3	pd/gro	h	DF	Jn - Sp	Jl - Ag	Jl - Sp
	Scirpus mucronatus L.	205	3	pe/gro, aqu	h	OB	leafless	My - Ag	My - Ag
	Scleria terrestris (L.) Fass.	181	3	pd/gro	h	DF	Jn - Nv	My - Oc	My - Oc
Eriocaulaceae	*Eriocaulon gracile* Mart.	379	3	a/gro	h	OB	Ag - Ja	Sp - Ja	Sp - Ja
	Eriocaulon oryzetorum Mart.	255	3	a/gro, aqu	h	OB	Ag - Dc	Ag - Oc	Ag - Dc

Family	Botanical name	Voucher number	Abundance	Life mode	Habit	Habitat	Leafing	Flowering	Fruiting
Gramineae	*Alloteropsis semialata* Hitch. var. *semialata*	179	5	pd/gro	h	DF	Ap - Sp	My - Jl	My - Jl
	Arthraxon hispidus (Thunb.) Makino var. *hispidus*	338	4	a/gro	h	DF	Ag - Ja	Sp - Ja	Sp - Ja
	Arundinella setosa Trin. var. *setosa*	336	5	pd/gro	h	DF	Jl - Ja	Oc - Nv	Oc - Dc
	Capillipedium parviflorum (R. Br.) Stapf	340	5	pd/gro	h	DF	Ap - Ja	Oc - Dc	Oc - Dc
	Heteropogon contortus (L.) P. Beauv. *ex* Roem. & Schult.	320	5	pd/gro	h	DF,OB	Jl - Nv	Sp - Oc	Oc - Ja
	Hyparrhenia rufa (Nees) Stapf	368	5	pd/gro	h	DF	Ag - Ja	Nv - Ja	Nv - Ja
	Pseudopogonatherum contortum (Brongn.) A. Camus	367	5	pd/gro	h	DF	Sp - Ja	Nv - Dc	Nv - Dc
	Saccicolepis indica (L.) A. Chase	337	4	a/gro	h	DF,OB	My - Dc	Oc - Dc	Oc - Dc
	Setaria parviflora (Poir.) Kerg.	339	5	a/gro	h	DF	Jn - Dc	Oc - Dc	Oc - Dc
	Sporolobus indicus (L.) R. Br. var. *flaccidus* (Roem. & Schult.) Veldk.	301	4	pd/gro	h	DF	My - Dc	Oc - Nv	Oc - Ja
	Themeda triandra Forssk.	360	4	pd/gro	h	DF	My - Dc	Oc - Nv	Oc - Dc
	Urochloa ruziziensis (Germ. & Evr.) Morr. & Zul.	323	4	pd/gro, nat	h	DF	Ag - Dc	Oc - Nv	Ag - Dc
Liliaceae	*Asparagus filicinus* Ham. *ex* D. Don	174	3	pd/gro	h	DF	Mr - Dc	Ap - My	?
	Chlorophytum intermedium Craib	208	2	pd/gro	h	DF	Mr - Oc	Jn - Jl	Jn - Oc
	Dianella ensifolia (L.) DC.	376	3	pd/gro	h	DF	Oc - Mr	Dc - Ja	Ja - Mr
	Disporum calcaratum Wall. *ex* D. Don	154, 241	3	pd/gro	h	DF	Ap - Ja	Ap - Jn	Jl - Nv
	Iphigenia indica (L.) Gray *ex* Kunth	250	2	pd/gro	h	DF	Ag - Nv	Ag	Ag - Dc
	Ophiopogon longifolius Decne.	172	3	pd/gro	h	DF	My - Ja	Ap - Jn	Jn - Ja
	Paris polyphylla J. E. Sm.	175	2	pd/gro	h	SS	My - Nv	My - Jn	Sp - Oc
	Peliosanthes teta Andr. ssp. *humilis* (Andr.) Jessop	204, 244	3	pd/gro	h	DF	My - Fb	My - Jn	Jl - Nv
Orchidaceae	*Anthogonium gracile* Wall. *ex* Lindl.	303	3	pd/gro	h	DF	Sp - Nv	Sp - Nv	?
	Apostasia wallichii R. Br.	247	1	pd/gro	h	DF	My - Fb	Ag	?
	Arundina graminifolia (D. Don) Hochr.	248	3	pd/gro	h	DF	Jn - Dc	Ag - Oc	Sp -Dc
	Brachycorythis henryi (Schltr.) Summ.	223	1	pd/gro	h	SS	Jl - Ag	Jl - Ag	?
	Cymbidium ensifolium (L.) Sw.	160	2	pd/gro	h	DF	My - Oc	Ap - Jn	?
	Eulophia macrobulbon (Par. & Rchb. f.) Hk. f.	142, 193	2	pd/gro	h	DF	My - Sp	Fb - Mr	?
	Eulophia spectabilis (Dennst.) Suresh	159	2	pd/gro	h	DF	My - Oc	Ap - Jn	?
	Geodorum recurvum (Roxb.) Alston	164	2	pd/gro	h	DF,SS	My - Sp	My - Jn	?
	Habenaria chlorina Par. & Rchb. f.	236	3	pd/gro	h	DF	Ag - Sp	Ag	?
	Habenaria dentata (Sw.) Schltr.	286	2	pd/gro	h	DF,SS	Ag - Oc	Sp - Oc	?
	Habenaria malintana (Blanco) Merr.	319	2	pd/gro	h	DF	Sp - Oc	Oc	?
	Liparis paradoxa (Lindl.) Rchb. f.	187	3	pd/gro	h	DF	My - Jl	Jn - Jl	?

Family	Botanical name	Voucher number	Abundance	Life mode	Habit	Habitat	Leafing	Flowering	Fruiting
	Pachystoma pubescens Bl.	143	2	pd/gro	h	DF	My - Ag	Fb - Mr	Mr - Ap
	Pecteilis susannae (L.) Raf.	317	1	pd/gro	h	DF	Sp - Nv	Oc	?
	Peristylus constrictus (Lindl.) Lindl.	188	3	pd/gro	h	DF,SS	My - Sp	Jn - Jl	?
	Peristylus lacertiferus (Lindl.) J. J. Sm.	272	1	pd/gro	h	DF	Ag - Oc	Ag - Sp	?
	Peristylus prainii (Hk. f.) Krzl.	211	1	pd/gro	h	SS	My - Oc	Jn - Jl	?
	Phaius tankervilleae (Banks *ex* L'Her.) Bl.	134	1	pd/gro	h	OB	Mr - Sp	Mr - Ap	Ap - Nv
	Tainia angustifolia (Lindl.) Benth. *ex* Hk. f.	284	2	pd/gro, epl	h	SS	Jn - Nv	Sp - Oc	?
	Tainia viridifusca (Hk. f.) Benth. *ex* Hk. f.	412	1	pd/gro	h	SS	Jn - Dc	Ja - Fb	?
	Zeuxine affinis (Lindl.) Benth. *ex* Hk. f.	421	2	pd/gro	h	SS	Oc - Mr	Fb - Mr	?
Palmae	*Phoenix loureiri* Kunth var. *loureri*	133	4	pe/gro	l	DF	Ja - Dc	Mr - Ap	Ap - Jn
Xyridaceae	*Xyris capensis* Thunb.	277	3	pd/gro	h	OB	Ag - Dc	Ag - Nv	Ag - Dc
Zingiberaceae	*Costus speciosus* (Koeh.) J. E. Sm.	246	2	pd/gro	h	SS	My - Ja	Ag - Sp	Ag - Nv
	Curcuma ecomata Craib	167	3	pd/gro	h	DF,SS	Jn - Oc	Ap - Jn	?
	Curcuma parviflora Wall.	259	2	pd/gro	h	DF	Jl - Oc	Jl - Oc	?
	Curcuma zedoaria (Berg.) Rosc.	194	5	pd/gro	h	DF	My - Oc	Mr - My	?
	Globba reflexa Craib	169	4	pd/gro	h	DF	Ap - Sp	Ap - My	My - Ag
	Globba sp.	212	2	pd/gro	h	SS	My - Oc	Jn - Jl	Ag - Sp
	Hedychium gardnerianum Rosc.	290	3	pd/gro	h	SS	Mr - Dc	Ag - Oc	Ag - Dc
	Kaempferia rotunda L.	149, 240	4	pd/gro	h	DF	My - Sp	Ap - My	?
	Zingiber parishii Hk. f.	243	2	pd/gro	h	SS	Jl - Oc	Ag - Sp	?
	Zingiber sp.	262, 357	4	pd/gro	h	DF,SS	Jn - Dc	Ag - Oc	Oc - Dc
Dicotyledoneae									
Acanthaceae	*Barleria cristata* L.	294	4	pd/gro	h	DF	My - Fb	Sp - Nv	Sp - Fb
	Hygrophila intermedia Imlay	397	3	pe/gro, epl	h	SS	Ja - Dc	Ja - Fb	Fb - My
	Hygrophila phlomoides Nees	275, 396	2	pd/gro,aqu	h	OB	My - Fb	Ag - Ja	Ag - Oc
	Justicia procumbens L.	264	3	a/gro	h	DF,OB	Jl - Dc	Ag - Nv	Sp - Ja
	Rungia parviflora (Retz.) Nees	283	4	a/gro	h	DF	Ag - Nv	Sp - Oc	Sp - Nv
	Sericocalyx quadrifarius (Wall. *ex* Nees) Brem.	288	4	pd/gro	h	SS	Jl - Fb	Sp - Nv	Nv - Fb
	Strobilanthes apricus (Hance) T. And. *ex* Benth. var. *pedunculatus* (Craib) Ben.	364	3	pd/gro	h	DF	Jn - Fb	Nv - Ja	Nv - Fb
	Strobilanthes auriculata Nees	366	4	pd/gro	h	DF	My - Ja	Nv - Dc	Dc - Fb
	Strobilanthes rex Cl.	386	3	pe/gro, epl	h	SS	Ja - Dc	Dc - Ja	Dc - Ja
	Thunbergia similis Craib	233	3	pd/gro	v	DF	Jn - Dc	Jl - Ag	Jl - Sp

Family	Botanical name	Voucher number	Abundance	Life mode	Habit	Habitat	Leafing	Flowering	Fruiting
Aristolochiaceae	*Aristolochia kerrii* Craib	163	3	pd/gro	v	DF	Ap - Oc	Ap - Jn	?
Asclepiadaceae	*Ceropegia sootepensis* Craib	195	2	pd/gro	v	DF	Ap - Sp	Ap - Jn	Jl - Sp
Balsaminaceae	*Impatiens craddockii* Hk. f.	221	2	a/gro	h	DF	Jl - Nv	Jl - Oc	Ag - Nv
	Impatiens chinensis L.	207	4	pe/gro, aqu	h	OB	Ja - Dc	Mr - Dc	Mr - Dc
Begoniaceae	*Begonia integrifolia* Dalz.	245	2	pd/gro	h	SS	Jl - Sp	Jl - Ag	?
Buddlejaceae	*Buddleja asiatica* Lour.	406	3	pd/gro	l	DF	My- Fb	Nv - Fb	Ja - Mr
Campanulaceae	*Lobelia zeylanica* L.	274	2	a/gro	h	OB,SS	Jn - Dc	Jl - Dc	Jl - Dc
	Lobelia heyniana Roem. & Schult.	325	3	a/gro	h	DF,OB	Ag - Dc	Oc - Dc	Oc - Dc
	Lobelia nicotianaefolia Roth *ex* Roem. & Schult.	400	1	pd/gro	h	DF,SS	Jn - Mr	Ja - Fb	Fb - Ap
Caryophyllaceae	*Drymaria diandra* Bl.	391	4	a/gro	h	DF,SS	Oc - Ja	Nv - Dc	Nv - Fb
Compositae	*Anaphalis adnata* DC.	345	3	a/gro	h	DF	My- Dc	Nv - Dc	Nv - Fb
	Artemisia japonica Thunb. var. *japonica*	139	4	pd/gro	h	DF	Jy - Ja	Oc - Dc	No - Mr
	Blumea fistulosa (Roxb.) Kurz	146	5	a/gro	h	DF	Nv-Ap	Dc-Mr	Mr - My
	Blumea mollis (D. Don) Merr.	416	3	a/gro	h	SS	Dc - Ap	Ja - Fb	Fb - Ap
	Blumea napifolia DC.	403	4	a/gro	h	SS	Oc - Mr	Ja - Fb	Fb - Mr
	Blumeopsis flava (DC.) Gagnep.	375	5	a/gro	h	DF	Sp - Fb	Dc - Ja	Dc- Mr
	Conyza leucantha (D. Don) Lud. & Rav.	389	3	pd/gro	h	DF	Sp - Fb	Dc - Ja	Dc - Fb
	Conyza sumatrensis (Retz.) Walk.	166	4	a/gro	h	DF	Mr - Oc	Ap - Jn	Ap - Ag
	Cosmos sulphureus Cav.	349	3	a/gro, esc	h	DF	Oc - Dc	Oc - Nv	Oc - Ja
	Crassocephalum crepidioides (Benth.) S. Moore	385	3	a/gro, nat	h	OB	Jl - Fb	Oc - Ja	Nv - Mr
	Crepis lignea (Vant.) Bab.	182	3	pd/gro	h	DF	Jn - Sp	Ap - Jn	My - Jn
	Cyathocline purpurea (Ham. *ex* D. Don) O.K.	398	3	a/gro, epl	h	SS	Nv- Ap	Ja - Fb	Mr - Ap
	Elephantopus scaber L. ssp. *scaber* var. *scaber*	304	3	pe/gro	h	DF	Ja - Dc	Sp - Oc	Sp - Ja
	Eupatorium doichangense H. Koy.	312	3	pd/gro	h	DF	Jn - Nv	Sp - Oc	Oc - Dc
	Gynura hmopengensis H. Koy.	399	2	pd/gro	h	SS	Sp - Mr	Ja - Fb	Fb - Mr
	Gynura pseudochina (L.) DC.	198	3	pd/gro	h	DF	My- Ag	Jn - Jl	Jl - Ag
	Inula cappa (Ham. *ex* D. Don) DC. *forma cappa*	343	3	pd/gro	h	DF	Ag - Fb	Nv - Dc	Dc - Fb
	Inula indica L.	374	3	pd/gro	h	DF	My- Fb	Dc - Ja	Dc - Mr
	Inula nervosa Wall. *ex* DC.	363	4	pd/gro	h	DF	Oc - Dc	Nv - Dc	Dc - Ja
	Inula wissmanniana Hand.-Mzt. *forma wissmanniana*	401	2	pd/gro	h	DF,SS	Jl - Mr	Ja - Fb	Fb - Ap
	Lactuca parishii Craib	422	2	pd/gro	h	SS	Nv- Mr	Ja - Fb	Fb - Mr
	Laggera alata (D. Don) Sch.-Bip. *ex* Oliv.	393	4	pd/gro	h	DF	Nv- Mr	Dc - Fb	Ja - Ap
	Laggera sp.	405	4	pd/gro	h	DF	Jl - Mr	Dc - Fb	Ja - Ap

Family	Botanical name	Voucher number	Abundance	Life mode	Habit	Habitat	Leafing	Flowering	Fruiting
	Piloselloides hirsuta (Forsk.) C. Jeff.	170	4	pd/gro	h	DF	Ap - Oc	My - Jn	My - Jl
	Pluchea polygonata (DC.) Gagnep.	144	3	pd/gro	h	DF	Oc - Ap	Dc - Mr	Fb - Ap
	Saussurea peguensis Cl.	407	2	pd/gro	h	DF	Jl - Fb	Dc - Ja	Ja - Fb
	Spilanthes iabadicensis A. H. Moore	390	4	a/gro	h	OB,SS	Ja - Dc	Ja - Dc	Ja - Dc
	Vernonia squarrosa (D. Don) Less. var. *orientalis* Kit.	271	4	pd/gro	h	DF	Jn - Nv	Ag - Oc	Sp - Nv
	Vernonia sutepensis Kerr	356	2	pd/gro	h	SS	My- Fb	Nv - Dc	Nv - Ja
	Vernonia cinerea (L.) Less. var. *cinerea*	145	3	pd/gro	h	DF	Nv - Jn	Ja - Mr	Oc - Ap
Convolvulaceae	*Argyreia kerrii* Craib	230	2	pd/gro	v	DF	Jl - Dc	Jl - Ag	Jl - Dc
	Ipomoea siamensis Craib	242	2	pd/gro	v	DF	Jl - Nv	Ag - Sp	Ag - Ja
Droseraceae	*Drosera burmannii* Vahl	392	3	pd/gro	h	OB	Nv - Fb	Nv - Fb	Nv - Fb
	Drosera peltata J. E. Sm. *ex* Willd.	197	5	pd/gro	h	DF	Jn - Ag	Jn - Jl	Jl - Ag
Euphorbiaceae	*Sauropus bicolor* Craib	180	4	pd/gro	h	DF	Mr - Oc	Ap - Ag	Jl - Oc
Gentianaceae	*Canscora diffusa* (Vahl) G. Don	136	2	a/gro, epl	h	SS	Dc - Mr	Dc - Mr	Dc - Mr
	Exacum tetragonum Roxb.	334	2	a/gro	h	SS	Oc - Nv	Nv	?
	Gentiana timida Kerr	173	3	pd/gro	h	DF	Oc - Ja	Mr - Jn	?
	Swertia angustifolia Ham. *ex* D. Don	309	3	a/gro	h	DF	Ag - Dc	Sp - Nv	Oc - Fb
Guttiferae	*Hypericum japonicum* Thunb.	157	3	a/gro	h	OB	Ja - Dc	Ja - Dc	Ja - Dc
Labiatae	*Elscholtzia winitiana* Craib	381	3	pd/gro	h	DF	Oc - Ja	Dc - Ja	Ja
	Gomphostemma wallichii Prain	285	2	pd/gro	h	SS	Jl - Fb	Sp - Oc	Sp - Dc
	Gomphostemma strobilinum Wall. *ex* Benth. var. *acualis* (Kurz *ex* Hk. f.) Prain	287	3	pd/gro	h	SS	Ag - Dc	Sp - Nv	Nv - Dc
	Hyptis suaveolens (L.) Poit.	348	4	a/gro	h	DF	Oc - Dc	Oc - Nv	Oc - Ja
	Isodon lophanthoides (Buch.-Ham. *ex* D. Don) H. Hara var. *lophanthoides*	377, 388	4	a/gro	h	DF	Nv - Ja	Dc	Ja
	Leucas decemdentata (Willd.) J. Sm.	257	4	pd/gro	h	DF	My - Dc	Ag - Oc	Ag - Dc
	Orthosiphon rubicundus (D. Don) Benth.	148	4	pd/gro	h	DF	Ap - Oc	Ap - Jn	Ap - Ag
	Pogostemon auricularius (L.) Hassk.	253	2	pd/gro, aqu	h	OB	Jn - Oc	Ag - Sp	Sp - Oc
	Pogostemon cruciatus (Benth.) Kuntz	380	2	pd/gro	h	OB	Nv - Ja	Dc - Ja	Ja
	Pogostemon pentagonus (C. B. Clark *ex* Hk. f.) Kuntz	203	3	pe/gro, aqu	h	OB	Jn - Dc	Jn - Oc	Jl - Oc
	Premna herbacea Roxb.	171	4	pd/gro	h	DF	Mr - Oc	Mr - My	My - Ag
	Premna nana Coll. & Hemsl.	185	3	pd/gro	h	DF	Ap - Ag	My - Jn	Jn - Jl
	Salvia riparia Kunth	409	3	pd/gro, nat	h	DF	Sp - Mr	Dc - Ja	Ja - Mr
	Scutellaria glandulosa Hk. f.	153	5	pd/gro	h	DF	Mr - Oc	Mr - My	Ap - Jl
	Teucrium quadrifarium Buch.-Ham. *ex* D. Don	332	3	pd/gro	h	DF,SS	Jn - Dc	Oc - Nv	Nv - Dc

Family	Botanical name	Voucher number	Abundance	Life mode	Habit	Habitat	Leafing	Flowering	Fruiting
Leeaceae	*Leea indica* (Burm. f.) Merr.	192	4	pe/gro	h	DF	Ap - Ja	Jn - Jl	Jn - Nv
Leguminosae, Caesalpinioideae	*Chamaecrista leschenaultiana* (DC.) Degener	295	2	a/gro	h	DF	Ag- Nv	Sp - Oc	Sp - Nv
Leguminosae, Papilionoideae	*Aeschenomene americana* L.	324	4	a/gro, nat	h	DF,OB	Sp - Nv	Sp - Nv	Sp - Dc
	Clitoria macrophylla Wall. *ex* Benth.	321	3	pd/gro	v	DF	Jl - Nv	Ag - Sp	Ag - Nv
	Codariocalyx motarius (Houtt.) Ohashi	316	4	pd/gro	h	DF	Ag - Dc	Oc	Oc - Ja
	Crotalaria neriifolia Wall. *ex* Benth.	359	2	pd/gro	h	DF	Oc - Dc	Nv - Dc	Nv - Dc
	Crotalaria acicularis Ham. *ex* Benth.	362	3	a/gro	h	DF	Nv - Dc	Nv - Dc	Nv - Ja
	Crotalaria calycina Schrank	297	3	a/gro	h	DF	Ag - Dc	Sp - Nv	Sp - Dc
	Crotalaria dubia Grah. *ex* Benth.	383	2	a/gro	h	DF	Nv - Dc	Nv - Dc	Nv - Dc
	Crotalaria ferruginea Grah. *ex* Benth.	346	4	a/gro	h	DF	Oc - Ja	Nv - Dc	Nv - Fb
	Crotalaria melanocarpa Wall. *ex* Benth.	365	3	a/gro	h	DF	Nv - Dc	Nv - Dc	Nv - Dc
	Crotalaria montana Heyne *ex* Roth var. *montana*	361	4	a/gro	h	DF	Oc - Dc	Nv - Dc	Nv - Fb
	Crotalaria sessiliflora L.	302	4	pd/gro	h	DF	Ag - Dc	Oc - Nv	Oc - Dc
	Crotalaria alata D. Don	300	4	a/gro	h	DF	Ag - Dc	Sp - Nv	Sp - Dc
	Crotalaria albida Heyne *ex* Roth	371	3	a/gro	h	DF	Nv - Dc	Nv - Dc	Nv - Dc
	Desmodium laxiflorum DC. ssp. *laxiflorum*	289	2	pd/gro	h	SS	Jl - Ja	Sp - Oc	Sp - Ja
	Desmodium oblongum Wall. *ex* Benth.	344	4	pd/gro	v, h	DF	Sp - Dc	Nv - Dc	Nv - Ja
	Desmodium pulchellum (L.) Benth.	355	2	pd/gro	h	DF,SS	My- Dc	Nv	Nv - Dc
	Desmodium velutinum (Willd.) DC. ssp. *velutinum* var. *velutinum*	315	2	pd/gro	h	DF	Jn - Ja	Sp - Oc	Sp -Ja
	Desmodium heterocarpon (L.) DC. ssp. *heterocarpon* var. *heterocarpon*	314	4	pd/gro	h	DF	Jl - Fb	Oc - Nv	Oc - Fb
	Desmodium kurzianum (O.K.) Oha.	372	2	pd/gro	h	DF	Jl - Dc	Nv - Dc	Nv - Dc
	Desmodium microphyllum (Thunb. *ex* Murr.) DC.	140	4	pe/gro	h	DF,OB	Bb - Oc	Dc - Mr	Mr - Jl
	Dunbaria bella Prain	141	5	pd/gro	v	DF	Jn - Mr	Oc - Fb	Dc - Fb
	Eriosema chinense Vog.	155	4	pd/gro	h	DF	Ap - Ja	Ap - Ag	My - Dc
	Flemingia sootepensis Craib	342	3	pd/gro	h	DF	Sp - Fb	Nv - Dc	Nv - Fb
	Indigofera caloneura Kurz	165, 404	3	pd/gro	l	DF	Ap - Fb	My - Jn	Jn - Fb
	Indigofera colutea (Burm. f.) Merr.	237	3	pd/gro	s	DF	My- Dc	Jl - Ag	Ag - Dc
	Indigofera spicata Forssk. var. *spicata*	305	3	pd/gro	h	DF	Ap - Ja	Ag - Oc	Sp - Dc
	Indigofera squalida Prain	186, 296	3	pd/gro	h	DF	My- Nv	Jn - Jl	Ag - Oc
	Lespedeza parviflora Kurz	384	3	pd/gro	s, l	DF	Oc - Ja	Dc	Dc - Fb

Family	Botanical name	Voucher number	Abundance	Life mode	Habit	Habitat	Leafing	Flowering	Fruiting
	Smithia ciliata Roy.	299	4	a/gro	h	DF	Ag- Nv	Sp - Oc	Sp - Nv
Lentibulariaceae	*Utricularia minutissima* Vahl	278	2	a/gro	h	OB	microscopic	Ag - Dc	Ag - Dc
	Utricularia scandens Benj.	279	2	a/gro	v	OB	microscopic	Ag - Dc	Ag - Dc
	Utricularia hirta Klein *ex* Link	370	2	a/gro	h	OB	microscopic	Nv - Dc	Nv - Dc
Lythraceae	*Rotala rotundifolia* (Ham. *ex* Roth) Koeh.	135	4	pe/amp	h	OB	Ja - Dc	Fb - My	Ap - Jl
Malvaceae	*Abelmoschus moschatus* Medic. ssp. *tuberosus* (Span.) Borss.	162	3	pd/gro	h	DF	Mr - Oc	Ap - Ag	Ap - Oc
	Pavonia repanda (Roxb. *ex* J. E. Sm.) Spreng.	341	3	pd/gro	h	DF	Sp - Fb	Oc - Nv	Oc - Fb
	Urena lobata L. ssp. *lobata* var. *lobata*	347	3	pd/gro	h	DF,OB	Sp - Fb	Nv - Dc	Nv - Fb
Melastomataceae	*Melastoma malabathricum* L. ssp. *malabathricum*	219	4	pe/gro	s, l	DF,OB	Ja - Dc	Mr - Oc	Ap - Nv
	Osbeckia chinensis L. var. *chinensis*	152	3	pd/gro	h	OB	Ap - Oc	Ap - Jn	Ap - Oc
	Sonerila erecta Jack	326	4	a/gro	h	DF	Sp - Dc	Oc - Nv	Nv - Dc
Myrsinaceae	*Ardisia crenata* Sims var. *crenata*	189	4	pe/gro	h	DF,OB	Ja - Dc	Ap - Jn	My - Dc
Ochnaceae	*Ochna integerrima* (Lour.) Merr.	131	3	pd/gro	l	DF	Mr - Oc	Fb - Mr	Ap - Ag
Orobanchaceae	*Aeginetia pedunculata* Wall.	311	2	pd/par	h	DF	leafless	Oc	Oc - Dc
	Aeginetia indica Roxb.	265	3	pd/par	h	DF,SS	leafless	Ag - Oc	Oc - Ja
Oxalidaceae	*Biophytum umbraculum* Welw.	258	4	a/gro	h	DF,OB	Ag- Nv	Ag - Sp	Ag - Nv
Polygalaceae	*Polygala persicariifolia* DC.	333	2	a/gro	h	DF,SS	Sp - Nv	Oc - Nv	Nv - Dc
	Polygala umbonata Craib	260	3	a/gro	h	DF,SS	Ag - Oc	Ag - Oc	Ag - Oc
	Polygala longifolia Poir.	252	3	a/gro	h	DF	Ag - Dc	Ag -Nv	Ag - Dc
Polygonaceae	*Polygonum chinensis* L.	350	3	pd/gro	h	SS	Jl - Ja	Oc - Dc	Oc - Ja
	Polygonum persicaria L.	206	3	a/gro	h	OB	Ja - Dc	Ja - Dc	Ja - Dc
Ranunculaceae	*Delphinium siamense* (Craib) Munz	270, 281	2	pd/gro	h	DF	Jn - Ja	Ag - Dc	Sp - Ja
	Ranunculus siamensis Tam.	147	3	pe/gro, aqu	h	OB,SS	Ja - Dc	Mr - Sp	Ap - Sp
Rubiaceae	*Borreria brachystema* (R. Br. *ex* Benth.) Valet.	310	4	a/gro	h	DF	Sp - Nv	Sp - Oc	Oc - Fb
	Borreria laevis (Lamk.) Griseb.	190	3	a/gro	h	DF,OB	My- Ag	Jn - Jl	Jn - Ag
	Hedyotis uncinella Hk. & Arn. var. *cephalophora* Craib	251	3	pd/gro	h	DF	Jl - Nv	Ag - Sp	Ag -Nv
	Knoxia brachycarpa R. Br. *ex* Hk. f.	200	3	pd/gro	h	DF	My- Oc	Jn - Ag	Jl - Oc
	Mussaendra parva Wall. *ex* D. Don	130	4	pe/gro	sc	DF	Ja - Dc	Ja - Ap	Mr - Oc
	Ophiorhiza hispidula Wall. *ex* G. Don var. *hispidula*	209	3	a/gro	h	SS	My- Sp	Jn - Jl	Jl - Sp
	Pavetta fruticosa Craib	196	3	pd/gro	h	DF	Mr- Nv	Ap - My	My - Sp
	Rubia siamensis Craib	213	3	pd/gro	h	DF	My- Nv	Jn - Jl	Jl - Oc
	Clausena excavata Burm. f. var. *villosa* Hk. f.	132	3	pd/gro	h	DF	Mr- Nv	Fb - Ap	Ap - Sp

Family	Botanical name	Voucher number	Abundance	Life mode	Habit	Habitat	Leafing	Flowering	Fruiting
Scrophulariaceae	*Alectra avensis* (Benth.) Merr.	330	3	a/gro	h	DF	Oc - Dc	Oc - Dc	Oc - Dc
	Buchnera cruciata Buch.- Ham. *ex* D. Don	308	4	a/gro	h	DF	Ag - Dc	Sp - Dc	Sp - Fb
	Centranthera cochinchinensis (Lour.) Merr. ssp. *cochinchinensis*	327	2	a/gro	h	OB	Sp - Nv	Oc - Nv	Oc - Dc
Scrophulariaceae	*Limnophila villifera* Miq. ssp. *gracilipes* (Craib ex Hoss.) Kama.	328	3	a/gro	h	OB	My- Dc	Sp - Dc	Nv - Dc
	Limnophila chinensis (Osb.) Merr.	291	2	a/gro	h	OB	Ag- Nv	Sp - Oc	Sp - Nv
	Lindernia pusilla (Willd.) Bold.	202	3	a/gro	h	OB	My- Ag	Jn - Jl	Jn - Ag
	Pedicularis nigra Vaniot *ex* Bonati	373	3	pd/gro	h	DF	Sp - Fb	Dc - Ja	Dc - Fb
	Phtheirospermum parishii Hk. f.	358	3	a/gro	h	DF	Nv - Dc	Nv - Dc	Nv - Dc
	Sopubia trifida Buch.- Ham. *ex* D. Don	335	4	a/gro	h	DF	Sp - Dc	Sp - Dc	Sp - Fb
	Torenia violacea (Aza. *ex* Blanco) Pennell	263	2	a/gro	h	DF,OB	Jn - Oc	Ag - Sp	Ag - Oc
	Torenia benthamiana Hance	307	3	a/gro	h	DF	Oc - Nv	Oc	Oc - Nv
Sterculiaceae	*Hericteres lanata* (Teijsm. & Binn.) Kurz	222	2	pe/gro	s	DF,SS	Mr - Dc	Jn - Jl	Ag - Nv
Tiliaceae	*Grewia lacei* Drum. & Craib	224	3	pe/gro	l	DF	Mr - Dc	Jn - Jl	Jl - Dc
	Grewia abutilifolia Vent. *ex* Juss.	161	3	pd/gro	s	DF	Ap - Dc	Ap - Ag	Ap - Oc
	Triumfetta pilosa Roth	280	3	pd/gro	h	DF,OB	Jl - Ja	Sp - Oc	Sp - Ja
Umbelliferae	*Heracleum barmanicum* Kurz	318	3	pd/gro	h	DF	Jn - Nv	Sp - Oc	Oc - Fb
	Pimpinella cambodgiana H. Boiss.	199	5	pd/gro	h	DF	My- Nv	Jn - Oc	Jl - Dc
Urticaceae	*Pilea trinervia* Wight	268	3	a/gro	h	SS	Jl - Dc	Jl - Oc	Ag - Nv
	Pouzolzia pentandra (Roxb.) Benn.	183	4	pd/gro	h	DF,OB	Ap - Dc	My - Ag	Jl - Nv
Verbenaceae	*Clerodendrum serratum* (L.) Moon var. *wallichii* Cl.	235	2	pd/gro	s	DF	My - Dc	Jl - Ag	Jl - Oc
Violaceae	*Viola betonaetifolia* J. E. Sm.	138	2	pd/gro	h	OB	Fb - Nv	Mr - Jn	Mr - Jl
Pteridophyta									
Dennstaedtiaceae	*Hypolepis punctata* (Thunb.) Mett. *ex* Kuhn	423	2	pd/gro	h	SS	Ja - Dc	Fb - Mr	
Dryopteridaceae	*Dryopteris cochleata* (D. Don) C. Chr.	352	4	pd/gro	h	DF,SS	My - Fb	Nv	
Equisetaceae	*Equitesum debile* Roxb. *ex* Vauch.	293	4	pe/gro	h	OB,SS	Ja - Dc	Ja - Dc	
Lycopodiaceae	*Lycopodium cernuum* L.	395	2	pd/gro	h	DF	Nv - Mr	Dc - Ja	
Oleandraceae	*Nephrolepis delicatula* (Dcne.) Pichi-Ser.	351	3	pd/gro, epl	h	SS	Jl - Fb	Nv	
Parkeriaceae	*Adiantum philippense* L.	210	3	pd/gro, epl	h	DF,SS	My - Oc	Mr - Ag	
	Onychium siliculosum (Desv.) C. Chr.	411	2	pd/gro	h	OB	Jn - Dc	Fb	
	Pityrogramma calomelanos (L.) Link.	415	2	pd/gro, epl	h	SS	Jn - Mr	Fb	

Family	Botanical name	Voucher number	Abundance	Life mode	Habit	Habitat	Leafing	Flowering	Fruiting
Polypodiaceae	*Arthromeris tatsienensis* (French. & Bureau *ex* Christ) Ching	234	3	pd/gro	h	DF	My - Ja	Jl	
Pteridaceae	*Pteris biaurita* L.	353	3	pe/gro	h	SS	Jn - Mr	No - Fb	
	Pteris ensiformis Burm. f.	414	3	pd/gro	h	SS	My - Fb	Fb	
	Pteris venusta Kunze	354	4	pd/gro	h	DF,SS	Ja - Dc	No - Fb	
Selaginellaceae	*Selaginella kurzii* Baker	387	3	a/gro	h	SS	Jl - Ja	Nv - Dc	
	Selaginella ostenfeldii Hieron.	313	3	pd/gro	h	SS	Jn - Oc	Ag - Nv	
Thelypteridaceae	*Thelypteris dentata* (Forssk.) St. John	413	3	pe/gro	h	OB,SS	Ja - Dc	Fb	
	Thelypteris nudata (Roxb.) Morton	420	2	pe/gro	h	OB	Ja - Dc	Fb	
	Thelypteris parasitica (L.) Fosb.	218	5	pd/gro	h	OB,SS	My - Fb	Jn - Ag	
	Thelypteris valida (Christ) Tag. & K. Iwats.	419	3	pe/gro	h	OB,SS	Ja - Dc	Fb	
	Thelypteris xyloides (Kunze) Ching	410	3	pe/gro	h	DF,SS	Ja - Dc	Fb	

Appendix 2. List of trees, woody climbers and invasive plants found at Mai Muang Nao Arboretum.

Family	Scientific name	Habit	Phenology	Abundance	Habitat
Anacardiaceae	*Buchanania lanzan* Spreng.	t	pd	3	DF
	Gluta usitata (Wall.) Hou	t	pd	4	DF
Apocynaceae	*Amalocalyx microlobus* Pierre *ex* Spire	wc	pd	1	DF
Bignoniaceae	*Stereospermum neuranthum* Kurz	t	pd	3	DF
Burseraceae	*Canarium subulatum* Guill.	t	pd	3	DF
	Protium serratum (Wall. *ex* Colebr.) Engl.	t	pd	3	SS
Caprifoliaceae	*Viburnum sambicinum* Bl. var. *tomentosum* Hall. f.	t	pe	3	SS
Celastraceae	*Cassine glauca* (Rottb.) Kuntze var. *cochinchinensis* Pierre	t	pe	2	DF
	Celastrus paniculatus Willd.	wc	pd	2	DF,SS
Combretaceae	*Terminalia chebula* Retz. var. *chebula*	t	pd	3	DF
Compositae	*Eupatorium adenophorum* Spreng.	invasive	a	4	OB
	Tithonia diversifolia (Hemsl.) A. Gray	invasive	a	5	DF
Connaraceae	*Connarus semidecandrus* Jack	wc	pe	2	SS
Dilleniaceae	*Dillenia aurea* Sm. var. *aurea*	t	pd	3	DF
Dipterocarpaceae	*Dipterocarpus obtusifolius* Teijsm. *ex* Miq. var. *obtusifolia*	t	pd	5	DF
	Dipterocarpus tuberculatus Roxb. var. *tuberculatus*	t	pd	4	DF
	Shorea obtusa Wall. *ex* Bl.	t	pd	5	DF
	Shorea roxburghii G. Don	t	pd	2	DF
	Shorea siamensis Miq. var. *siamensis*	t	pd	2	DF
Ebenaceae	*Diospyros winitii* Flet.	t	pe	3	SS
Ericaceae	*Craibiodendron stellatum* (Pierre) W.W. Sm.	t	pd	4	DF
	Vaccinium sprengelii (D. Don) Sleum.	t	pd	4	DF
Euphorbiaceae	*Aporusa villosa* (Lindl.) Baill.	t	pd	3	DF
	Glochidion sphaerogynum (M.-A.) Kurz	t	pe	3	OB,SS
	Phyllanthus emblica L.	t	pd	3	DF
Fagaceae	*Castanopsis acuminatissima* (Bl.) A. DC.	t	pe	4	DF
	Castanopsis argyrophylla King *ex* Hk. f.	t	pe	4	DF
	Castanopsis indica (Roxb.) A. DC.	t	pe	3	SS
	Castanopsis tribuloides (Sm.) A. DC.	t	pe	4	DF
	Lithocarpus elegans (Bl.) Hatus *ex* Soep.	t	pe	2	SS
	Lithocarpus lindleyanus (Wall.) A. Camus	t	pd	4	DF

Family	Scientific name	Habit	Phenology	Abundance	Habitat
	Lithocarpus sootepensis (Craib) A. Camus	t	pe	1	SS
	Quercus brandisiana Kurz	t	pd	4	DF,OB,SS
	Quercus kerrii Craib var. *kerrii*	t	pd	5	DF,OB,SS
	Quercus kingiana Craib	t	pd	2	DF
Gnetaceae	*Gnetum montanum* Mgf.	wc	pe	2	SS
Guttiferae, Hypericaceae	*Cratoxylum formosum* (Jack) Dyer ssp. *pruniflorum* (Kurz) Gog.	t	pd	3	DF
Juglandaceae	*Engelhardia spicata* Lechen. *ex* Bl. var. *spicata*	t	pd	3	DF,SS
Lauraceae	*Phoebe lanceolata* (Wall. *ex* Nees) Nees	t	pe	3	SS
Leguminosae, Caesalpinioideae	*Bauhinia variegata* L.	t	pd	3	DF
Leguminosae, Mimosoideae	*Albizia chinensis* (Osb.) Merr.	t	pd	1	DF
	Albizia odoratissima (L. f.) Benth.	t	pd	2	SS
	Mimosa diplotricha C. Wight *ex* Sauv. var. *diplotricha*	invasive	a	5	DF,OB
Leguminosae, Papilionoideae	*Dalbergia cultrata* Grah. *ex* Benth.	t	pd	3	DF
	Spatholobus parviflorus (Roxb.) O. K.	wc	pd	3	OB,SS
Loganiaceae	*Strychnos nux-vomica* L.	t	pd	3	DF
Malpighiaceae	*Hiptage benghalensis* (L.) Kurz ssp. *candicans* (Hk. f.) Siri.	t	pd	2	DF
Meliaceae	*Aglaia lawii* (Wight) Sald. & Rama.	t	pe	1	SS
	Heynea trijuga Roxb. Sims	t	pd	1	SS
Moraceae	*Ficus semicordata* B.-H. *ex* J. E. Sm. var. *semicordata*	t	pe	3	SS
	Ficus superba (Miq.) Miq. var. *superba*	t	pd	2	DF,OB
Moraceae	*Ficus virens* Ait. var. *virens*	t	pd	1	DF,OB
Myrtaceae	*Syzygium albiflorum* (Duth. *ex* Kurz) Bahadur & R.C. Gour	t	eg	3	SS
	Tristaniopsis burmanica (Griff.) Wils. & Wat. var. *rufescens* (Hance) Parn. & Lug.	t	eg	4	DF
Nyssaceae	*Nyssa javanica* (Bl.) Wang.	t	eg	1	SS
Ochnaceae	*Ochna integerrima* (Lour.) Merr.	t	pd	4	DF
Olacaceae	*Schoepfia fragrans* Wall.	t	eg	1	DF
Oleaceae	*Olea salicifolia* Wall. *ex* G. Don	t	eg	1	SS
Pinaceae	*Pinus kesiya* Roy. *ex* Gord.	t	pe	2	DF,SS
	Pinus merkusii Jungh. & De Vriese	t	pe	1	DF
Pittosporaceae	*Pittosporum nepaulense* (DC.) Rehd. & Wils.	t	pg	2	OB,SS
Proteaceae	*Helicia nilagirica* Bedd.	t	pe	1	DF
Rhamnaceae	*Ziziphus rugosa* Lmk. var. *rugosa*	t	pd	2	DF
Rosaceae	*Eriobotrya bengalensis* (Roxb.) Hk. f. *forma bengalensis*	t	pe	2	SS
	Stranvaesia nussia (D. Don) Decne	t	pe	1	SS

Family	Scientific name	Habit	Phenology	Abundance	Habitat
Rubiaceae	*Gardenia sootepensis* Hutch.	t	pd	3	DF
	Wendlandia tinctoria (Roxb.) DC. ssp. *floribunda* (Craib) Cowan	t	ped	3	DF,SS
Salicaceae	*Salix tetrasperma* Roxb.	t	pd	1	SS
Sapotaceae	*Xantolis burmanica* (Coll. & Hemsl.) P. Royen	t	pd	1	DF
	Xantolis cambodiana (Pierre *ex* Dubard) P. Royen	t	pd	3	DF
Sterculiaceae	*Eriolaena candollei* Wall.	t	pd	2	DF
	Sterculia villosa Roxb.	t	pd	2	DF
Symplocaceae	*Symplocos racemosa* Roxb.	t	pd	1	DF
Theaceae	*Anneslea fragrans* Wall.	t	pd	3	DF
Verbenaceae	*Vitex peduncularis* Wall. *ex* Schauer	t	pd	3	DF