CHAPTER 6
CONCLUSIONS

There are 3 main habitats in an area of 0.8 km^2 at Mai Muang Nao Arboretum, *viz.* 1) open, fire-damage, degraded areas, 2) open bog/marsh areas, and 3) shaded areas along the seasonal stream.

There are 59 families, 180 genera, and 262 species of vascular ground flora in the study area. The most abundant family found is Compositae with 20 genera and 30 species. The second largest family is Leguminosae, Papilionoideae with 9 genera and 29 species. Most members of these two families are annuals and flower between the end of the rainy season and during the early cool-dry season (October-November). Orchidaceae is the third largest family with 15 genera and 21 species. Most species abundances in this family range from medium, rare, and down to a few individuals due to forest destruction and economic exploitation.

There were 8 species of which the populations down to a few individuals remain, and they are in need of protection, *viz.*

1. *Lobelia nicotianaefolia* Roth *ex* Roem. & Schult. (Campanulaceae) #400
2. *Apostasia wallichii* R. Br. (Orchidaceae) #247
3. *Brachycorythis henryi* (Schltr.) Summ. (Orchidaceae) #223
4. *Pecteilis susannae* (L.) Raf. (Orchidaceae) #317
5. *Peristylus lacertiferus* (Lindl.) J. J. Sm. (Orchidaceae) #272
6. *Peristylus prainii* (Hk. f.) Krzl. (Orchidaceae) #211
7. *Phiaus tankervilleae* (Banks *ex* L' Her.) Bl. (Orchidaceae) #134
8. *Tainia viridifusca* (Hk. f.) Benth. & Hk. f. (Orchidaceae) #412

The most common species found in the hot-dry season (March-April) are *Scutellaria glandulosa* (Labiatae) and *Curcuma zedoaria* (Zingiberaceae). Common species found in the rainy season (May-October) are *Pimpinella cambogiana* (Umbelliferae), *Drosera peltata* (Droseraceae), and *Alloteropsis semialata* var. *semialata* (Gramineae). There are many common species which flower at the end of the rainy season and during the cool-dry season (November-February), *e.g. Crotalaria alata* and *Dunbaria bella* (both Leguminosae, Papilionoideae), *Blumea fistulosa* and

Blumeopsis flava (both Compositae); *Arundinella setosa* var. *setosa*, *Capillipedium parviflorum*, *Heteropogon contortus*, *Hyparrhenia rufa*, *Pseudopogonatherum contortum*, and *Setaria parviflora* (all Gramineae).

The flowering peak for all ground flora species is in October with 94 species and lowest in March with 28 species. The flowering peak of annual herbs is in November with 42 species and lowest in April and May with 5 species for both months. The flowering peak of perennial herbs is in June with 56 species and August and October which both have 55 species.

My work has resulted in identification changes for 6 species in the CMU herbarium, *viz.*

1. *Lobelia alsinoides* Lmk. to *L. heyniana* Roem. & Schult. (Campanulaceae) due to seed shape. Flora Malesiana (1960) has more details on distribution of this genus than Flore du Cambodge, du Laos et du Vietnam (1969) where *L. heyniana* is not included
2. *Crotalaria sessiliflora* L. to *C. calycina* Schrank (Leguminosae, Papilionoideae) due to the calyx size and petals color
3. *Indigofera linnaei* Ali to *I. spicata* Forssk. (Leguminosae, Papilionoideae) due to infructescence details and pod shape
4. *Urena lobata* L. ssp. *lobata* var. *lobata* to *Pavonia repanda* (Roxb. *ex* J. E. Sm.) Spreng. (Malvaceae) due to schizocarp appendage morphology
5. *Aneilema herbaceum* (Roxb.) Wall. *ex* Kunth to *Murdannia japonica* (Thunb.) Faden (Commelinaceae) following the revision by Faden (1991)
6. *Cyanotis cristata* (L.) D. Don to *C. barbata* D. Don (Commelinaceae) following Hooker (1894)

Eighteen species from this research are the first collection in the CMU herbarium, *viz.*

1. *Hygrophila intermedia* Imlay (Acanthaceae) #397
2. *Hygrophila phlomoides* Nees #275, 396
3. *Impatiens craddockii* Hk. f. (Balsaminaceae) #211
4. *Gynura hmopengensis* H. Koy. (Compositae) #399
5. *Cyperus triceps* (Rottb.) Engl. (Cyperaceae) #214
6. *Fimbristylis cinnamometorum* (Vahl) Kunth (Cyperaceae) #226

7. *Fimbristylis fusca* (Nees) Cl. (Cyperaceae) #168
8. *Fimbristylis thomsonii* Boeck (Cyperaceae) # 156
9. *Fimbristylis yunnanensis* Cl. (Cyperaceae) #215
10. *Eriocaulon gracile* Mart. (Eriocaulaceae) #379
11. *Pogostemon cruciatus* (Benth.) Kuntz (Labiatae) #380
12. *Crotalaria melanocarpa* Wall. *ex* Benth. (Leguminosae, Papilionoideae)#365
13. *Peristylus prainii* (Hk. f.) Krzl. (Orchidaceae) #211
14. *Limnophila villifera* Miq. ssp. *gracilipes* (Craib *ex* Hoss.) Kam. (Scrophulariaceae) # 328
15. *Pedicularis nigra* Vaniot *ex* Bonati (Scrophulariaceae) #373
16. *Globba* sp. (Zingiberaceae) #212
17. *Thelypteris valida* (Christ) Tag. & K. Iwats. (Thelypteridaceae) #419
18. *Thelypteris xyloides* (Kunze) Ching (Thelypteridaceae) #410

Research problems

Some problems encountered in this study are:

1. The capsules of most Orchidaceae and some Zingiberaceae were either not produced or not found, thus descriptions as well as fruiting phenologies could not be made.
2. Some main floras *e.g.* Flore Générale de L' Indo-Chine and Flore du Cambodge du Laos et du Viêtnam are in French which I had difficulty reading and wasted much time.
3. *Zingiber* sp. and *Globba* sp. are unidentified due to lacking of references to determine the species for *Globba* and the characteristics of *Zingiber* sp. are not covered in "A synopsis of the genus *Zingiber* (Zingiberaceae) in Thailand.

Recommendations

The area is in need of protection and more scientific research, *e.g.* other aspects of the flora, ecology, ethnobotany, conservation, and nature education. There are two rice fields in the moist gullies at the boundaries of the arboretum and the farmers are trying to expand their fields as well as chop down trees for many purposes *e.g.* firewood, fences, house construction, and collecting rare plants for sell, *e.g.*

epiphytic orchids. During the years 2001-2002, agricultural fields have been expanding up the hill and now include about 19,200 m^2 or about 2.4 % of total area for growing cabbage, tomato, and corn. Although they have made an agreement on land use permission with the Royal Forest Department (RFD), they have not honored this agreement and RFD has not controlled them. In July 2002, I found another new forest area cleared between the arboretum and the Pine Improvement Center for rice cultivation which will probably expand in the future. Apart from these basic problems, the use of insecticides on crops and especially planting ornamentals around the villages add dangerous pollution to the stream and is a health hazard 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. All fires were started by humans, especially for clearing land and the incorrect 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). The workers at the arboretum usually do not work on weekends, thus fires started during this time are not extinguished. This is an other example where the RFD has failed to educate and control not only arsonists, but their own staff. RFD workers are not trained or encouraged to learn about the objectives of the arboretum and conservation.

During my fieldwork I found 3 bird traps in the hot-dry season, usually used for catching buttonquail (Turnicidae), which are edible. Cattle are also a cause of land abuse since the villagers allow them to graze throughout the whole area. These animals trample and eat vegetation as well as compact the soil.

From my observations at the local market and interviews with villagers about utilization of wild products, this forest is a prime place to find mushrooms, pine wood, pine resin, as well as bamboo shoots for consumption and culms construction. Some common edible mushrooms are *Russula* spp., *Lactarius* spp. (both Russulaceae), and *Amanita* spp. (Amanitaceae). Some vascular plants eaten and 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).

Although, there are three RFD units in the area, *viz.* Mae Toh National Park, Pine Improvement Center, and Mai Muang Nao Arboretum, there is a lack of cooperation on conservation. These three units should be organized for conservation purposes, *e.g.* vegetation information from the arboretum and forest restoration at the Pine Improvement Center. All this information should be distributed for education exhibition , 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 very appropriate for a reforestation nursery and for forest research. The original facilities for pine improvement could be changed for germination and growth of native plants, especially rare species and native trees, and improving research to reestablish deforested places in the area. Furthermore, RFD workers should be trained for nursery techniques, seed collection, seed selection, forest restoration planting, and forest protection/conservation.

The Arboretum has done some basic scientific work by having some tree names around cleared areas and nature trail. A new station of Mae Toh National Park is settled in the study area which could be more effective on 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.

A

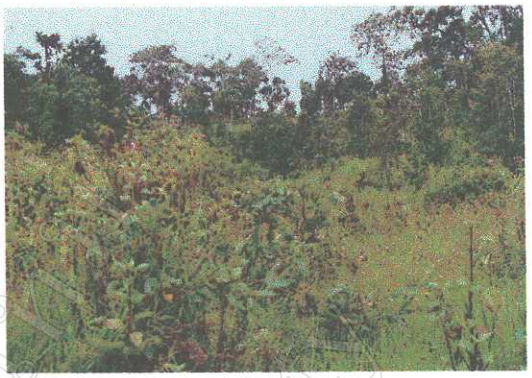

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Plate 1 A = degraded area in Mae Toh National Park

B = burnt place in the study area

C = habitat 1 (degraded, deciduous dipterocarp-oak + pine forest)

D = habitat 2 (marsh area), E = habitat 3 (seasonally dry stream)

F = habitat 3 (view of slopes)

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Plate 2 A = *Arisaema prazeri* Hk. f. #191 (Araceae)
B = *Scirpus mucronatus* L. #205 (Cyperaceae)
C = *Burmannia coelestis* D. Don # 329 (Burmanniaceae)
D = *Phoenix loureiri* Kunth var. *loureiri* # 133 (Palmae)
E = *Aneilema sinicum* Lindl. #178 (Commelinaceae)

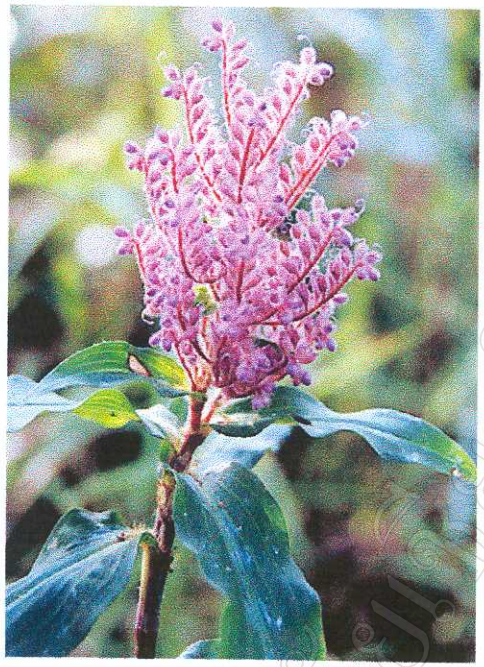

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Plate 3. Commelinaceae : A = *Floscopa scandens* Lour. # 331, B = *Murdannia gigantea* (Vahl) Bruck. # 249, C = *M. loureirii* (Hance) Rao *ex* Kam. #176, D = *M. scapiflora* (Roxb.) Royle #137

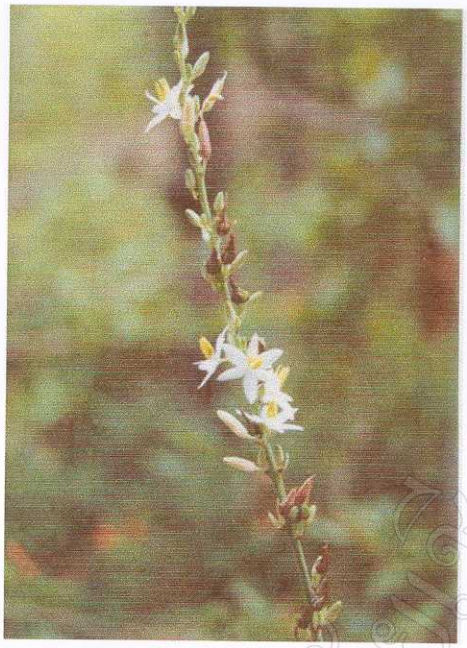

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Plate 4 Liliaceae: A = *Chlorophytum intermedium* Craib # 208, B = *Dianella ensifolia* (L.) DC. #376, C = *Disporum calcaratum* Wall. *ex* D. Don # 154, D = *Ophiopogon longifolius* Decne. #172, E = *Paris polyphylla* J. E. Sm. #175

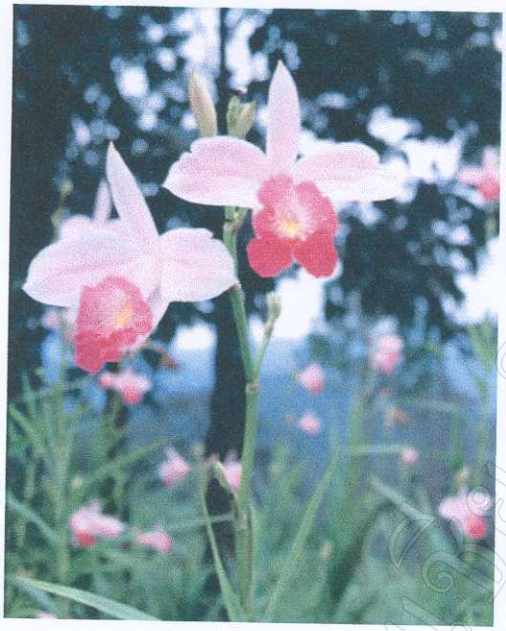

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Plate 5 Orchidaceae: A = *Arundina graminifolia* (D. Don) Hochr. # 248
B = *Pachystoma pubescens* Bl. #143
C = *Anthogonium gracile* Wall. *ex* Lindl. #303
D = *Geodorum recurvum* (Roxb.) Alston #164
E = *Pecteilis susannae* (L.) Raf. #317

A

C

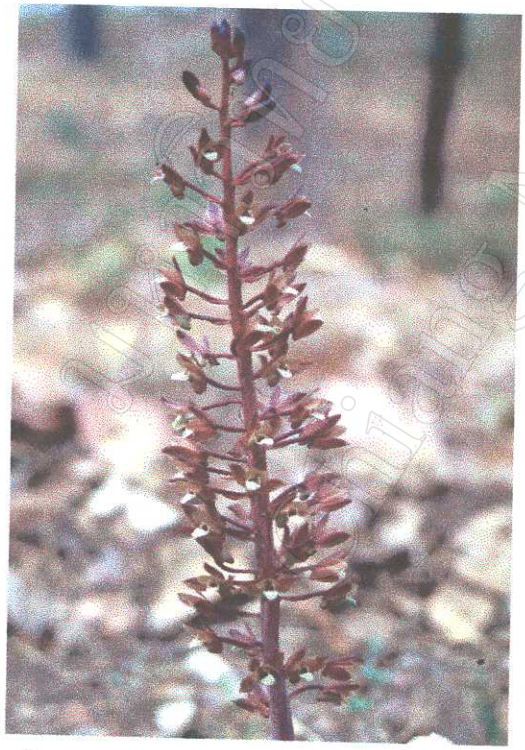

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Plate 6 Orchidaceae: A = *Cymbidium ensifolium* (L.) Sw. #160
B = *Eulophia macrobulbon* (Par. & Rchb. f.) Hk. f. #142
C & D = *E. spectabilis* (Dennst.) Suresh #159
E = *Brachycorythis henryi* (Schltr.) Summ. #223

A

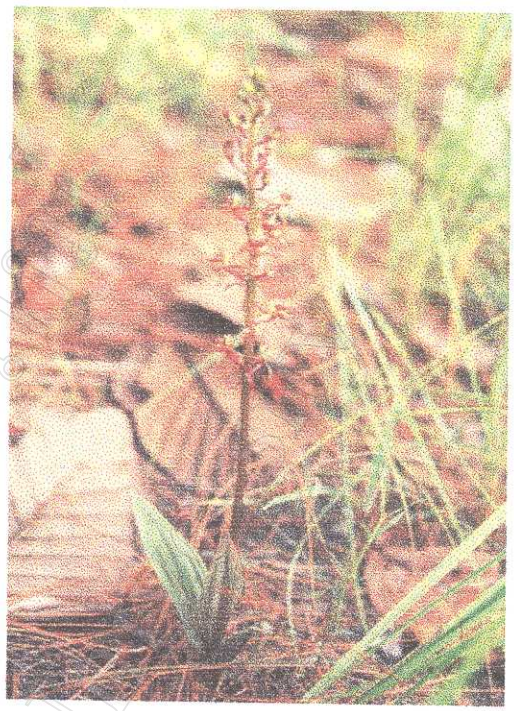

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Plate 7 Orchidaceae: A = *Habenaria chlorina* Par. & Rchb. f. #236, B = *H. dentata* (Sw.) Schltr. #286, C = *Liparis paradoxa* (Lindl.) Rchb. f. #187, D = *Phiaus tankervilleae* (Banks *ex* L' Her.) Bl. #134

A

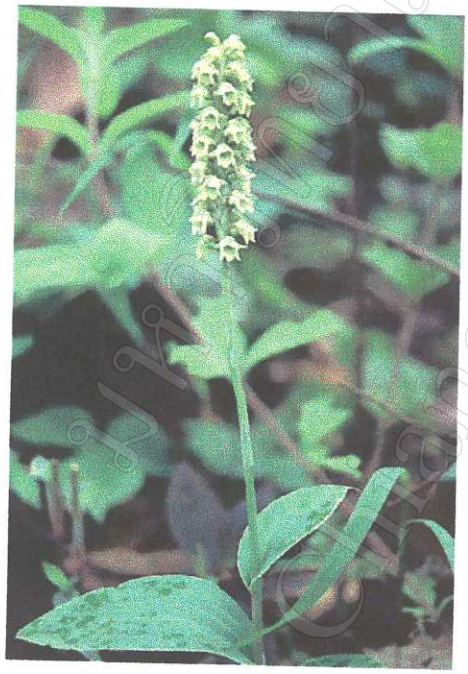

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Plate 8 A-B Orchidaceae: A= *Peristylus constrictus* (Lindl.) Lindl. #188, B = *P. prainii* (Hk. f.) Krzl. #211, C-E Zingiberaceae: C = *Costus speciosus* (Koeh.) J. E. Sm. #246, D = *Heydichium gardnerianum* Rosc. #290, E = *Kaempferia rotunda* L. #290

A

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E

Plate 9 Zingiberaceae: A = *Curcuma ecomata* Craib #167
B = *C. parviflora* Wall. #259
C = *C. zedoaria* (Berg.) Rosc. #194
D = *Globba* sp. #212
E = *Zingiber parishii* Hk. f. #243

A

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Plate 10 A-D Acanthaceae: A = *Barleria cristata* L. #294
B = *Perilepta siamensis* (Cl.) Brem. #366
C = *Strobilanthes anfractuosus* Cl. *ex* Hoss. #386
D = *S. apricus* (Hance) T. And. var. *pedunculatus* (Craib) Ben. #364
E = *Ceropegia sootepensis* Craib #195 (Asclepiadaceae)

A

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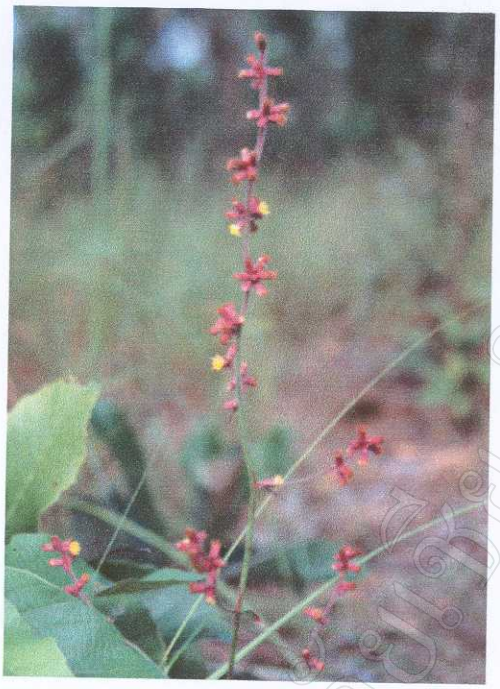
B

E

C

Plate 11 A = *Impatiens chinensis* L. #207, B = *I. craddokii* Hk. f. #221 (Balsaminaceae), C = *Argyreia kerrii* Craib #230 (Convolvulaceae), D = *Gentiana timida* Kerr #173 (Gentianaceae), E = *Lobelia nicotianaefolia* #400 (Campanulaceae)



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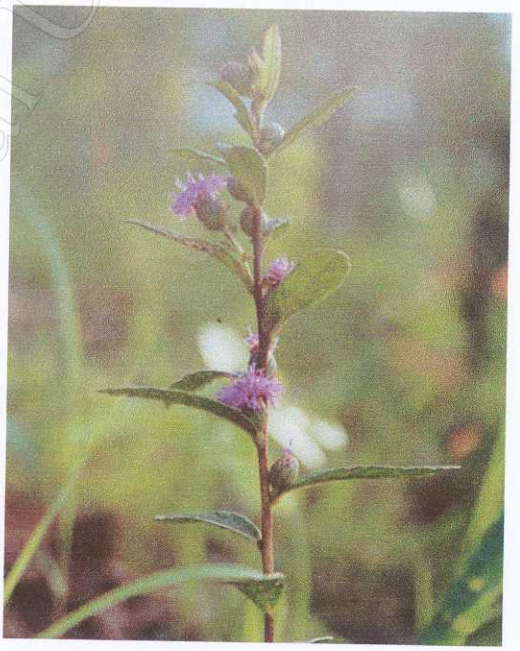

D

Plate 12 Compositae: A = *Blumea fistulosa* (Roxb.) Kurz #146
B = *Crepis lignea* (Vant.) Bab. #182
C = *Piloselloides hirsuta* (Forsk.) C. Jeff. #144
D = *Vernonia squarrosa* (D. Don) Less. var. *orientalis* Kit. #271

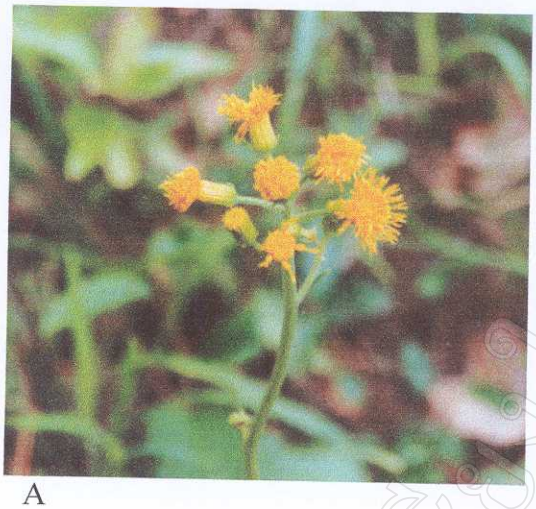

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Plate 13 Compositae: A = *Gynura pseudochina* (L.) DC. #198
B = *Crassocephalum crepidioides* (Benth.) S. Moore #385
C = *Pluchea polygonata* (DC.) Gagnep. #144
D = *Inula cappa* (Ham. *ex* D. Don) DC. *forma cappa* #343
E = *I. indica* L. #374, F = *I. nervosa* Wall. *ex* DC. #363

A

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Plate 14 A = *Leea indica* (Burm. f.) Merr. #192 (Leeaceae)
B-C Malvaceae: B = *Abelmoschus moschatus* Medic. ssp. *tuberosus* (Span.) Borss. #162, C = *Pavonia repanda* (Roxb. *ex* J. E. Sm.) Spreng. #341
D = *Ardisia crenata* Sims var. *crenata* #189 (Myrsinaceae)
E-F Labiatae: E = *Elscholtzia winitiana* Craib #381
F = *Gomphostemma strobilinum* Wall. *ex* Benth. *var. acualis* (Kurz *ex* Hk. f.) Prain #287

A

B

C

D

E

Plate 15 Labiatae: A = *Isodon lophanthoides* (Buch.-Ham. *ex* D. Don) H. Hara. var. *lophanthoides* #377
B = *Orthosiphon rubicundus* (D. Don) Benth. #148
C = *Pogostemon auricularius* (L.) Hassk. #253
D = *P. cruciatus* (Benth.) Kuntz #380
E = *Scutellaria glandulosa* Hk. f. #153

A

D

B

E

C

F

Plate 16 A = *Chamaecrista leschenaultiana* (DC.) Degener #295 (Leguminosae, Caesalpinioideae)

B-F Leguminosae, Papilionoideae: B = *Clitoria macrophylla* Wall. *ex* Benth. #321

C = *Crotalaria calycina* Schrank #297

D = *C. neriifolia* Wall. *ex* Benth. #359

E = *C. sessiliflora* L. #302

F = *Desmodium velutinum* (Willd.) DC. ssp. *velutinum* var. *velutinum* #315

A

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B

E

C

F

Plate 17 A-B Melastomataceae: A = *Melastoma malabathricum* L. ssp. *malabathricum* #219
B = *Osbeckia chinensis* L. var. *chinensis* #152
C = *Ochna integerrima* (Lour.) Merr. #131 (Ochnaceae)
D-E Orobachaceae: D= *Aeginetia indica* Roxb. # 265
E = *A. pedunculata* Wall. #311
F = *Biophytum umbraculum* Welw. #258 (Oxalidaceae)

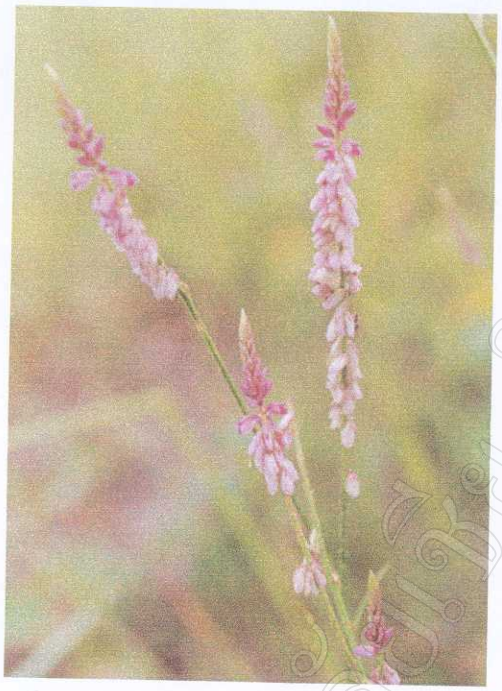

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Plate 18 A = *Polygala longifolia* Poir. #252 (Polygalaceae)
B-C Ranunculaceae: B = *Ranunculus siamensis* Tam. #147
C = *Delphinium siamensis* (Craib) Munz # 270
D-E Rubiaceae: D = *Knoxia brachycarpa* R. Br. *ex* Hk. f. #200
E = *Pavetta fruticosa* Craib #196

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F

Plate 19 A-C Scrophulariaceae: A = *Buchnera cruciata* Buch.-Ham. *ex* D. Don #308
B = *Limnophila villifera* Miq. ssp. *gracilipes* (Craib *ex* Hoss.) Kama. #328
C = *Pedicularis nigra* Vaniot *ex* Bonati #373
D = *Pimpinella cambodgiana* H. Boiss. # 199 (Umbelliferae)
E = *Pouzolzia pentandra* (Roxb.) Benn. #183 (Urticaceae)
F = *Premna herbacea* Roxb. #171 (Verbenaceae)