

VASCULAR GROUND FLORA AT MAI MUANG NAO
ARBORETUM, CHIANG MAI PROVINCE

WANGWORN SANKAMETHAWEE

MASTER OF SCIENCE
IN BIOLOGY

GRADUATE SCHOOL
CHIANG MAI UNIVERSITY
FEBRUARY 2003

P 33

20 ส.ค. 2546



โครงการพัฒนาระบบการจราจรและพัฒนาระบบการจัดการทรัพยากรชีวภาพในประเทศไทย

c/o ศูนย์พันธุวิศวกรรมและเทคโนโลยีชีวภาพแห่งชาติ

อาคารสำนักงานพัฒนาวิทยาศาสตร์และเทคโนโลยีแห่งชาติ

73/1 ถนนพระรามที่ 6 เขตราชเทวี

กรุงเทพฯ 10400

**VASCULAR GROUND FLORA AT MAI MUANG NAO ARBORETUM,
CHIANG MAI PROVINCE**

WANGWORN SANKAMETHAWEE

**A THESIS SUBMITTED TO THE GRADUATE SCHOOL IN
PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
MASTER OF SCIENCE
IN BIOLOGY**

**GRADUATE SCHOOL
CHIANG MAI UNIVERSITY
FEBRUARY 2003**

**VASCULAR GROUND FLORA AT MAI MUANG NAO ARBORETUM,
CHIANG MAI PROVINCE**

WANGWORN SANKAMETHAWEE

**THIS THESIS HAS BEEN APPROVED
TO BE A PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF MASTER OF SCIENCE
IN BIOLOGY**

EXAMINING COMMITTEE

..... Assoc. Prof. Dr. Vilaiwan Anusarnsunthorn	CHAIRPERSON
..... Mr. James F. Maxwell	MEMBER
..... Assoc. Prof. Dr. Tavatchai Radanachalee	MEMBER
..... Dr. Somran Suddee	MEMBER

18 February 2003

© Copyright by the Graduate School, Chiang Mai University

ACKNOWLEDGEMENTS

This work was supported by the TRF/BIOTEC Special Program for Biodiversity Research and Training grant BRT_145001. I express my sincere gratitude to Assoc. Prof. Dr. Vilaiwan Anusarnsunthorn, my thesis adviser, who has taken care, and given advise to me during this research as well as her kindness invaluable helps.

My grateful thanks to J.F. Maxwell, my thesis co-adviser, for his field taxonomic assistance, all of his time on correcting my thesis as well as his valuable comments. My gratitude is given to the CMU Herbarium for being my study place where I have learnt many herbarium skills, and being my second home.

I would like to thank Mr. Pornpitak Panyarat, Head of Mai Muang Nao Arboretum for all of his logistic support as well as guiding and allowing me to survey in the study site including all facilities there. A Special thanks is given to Mrs. Jirawan Upla and her daughter (Namwan) for her willingness to cooking and stay with me during my fieldwork. Many thanks for all of the Arboretum's workers for their kind hospitality.

I would also like to thank Assoc. Prof. Dr. Tavatchai Radanachaless and Dr. Somran Suddee, my examining committee for their available correction as well as some Labiatae identifications by Dr. Somran. Many thank to Dr. Stephen Elliott for teaching me to utilise the Botanical database.

My sincere thank is given Pranee Palee for her kind help, advise, and being my companion both at day and night in the herbarium. Many thanks to all the CMU Herbarium family: Thidarach for Chalieng songs, printer and everything we shared, Netnapit for helping me on drawings and Kanjana for *Torenia benthamiana*, Supawan, Greuk, Rungtiwa, Kunakorn, Thanakorn, Kerby, Narumon, Amanda, Puttipong, and Suwaree are thanked for all of their advice and encouragement. Special thanks to Andy Pierce for lending me his useful motorbike during the last 5 months of my work. Sune Hansen also visited my study site and helped me for some collection.

Very special thanks to my sister Mutjita for her supports both of money and help in my fieldwork as well as Weera Kanpai who advanced money for my registration fees.

Sincerely thanks from my heart to my family for their love, encouragement and understanding in the ways I have done. Finally, thank to my little niece who always gives a beautiful smile to encourage me in the difficult times.

Wangworn Sankamethawee

Thesis Title	Vascular Ground Flora at Mai Muang Nao Arboretum, Chiang Mai Province	
Author	Miss Wangworn Sankamethawee	
M.S.	Biology	
Examining Committee		
	Assoc. Prof. Dr. Vilaiwan Anusarnsunthorn	Chairperson
	Mr. James F. Maxwell	Member
	Assoc. Prof. Dr. Tavatchai Radanachaless	Member
	Dr. Somran Suddee	Member

ABSTRACT

A study of the vascular ground flora was done at Mai Muang Nao Arboretum in Hod District, Chiang Mai Province. The area includes 0.8 km² of deciduous dipterocarp-oak with some pine forest on granite bedrock at 950-1,125 meters elevation and is adjacent to Mae Toh National Park. The study site is dominated by *Dipterocarpus obtusifolius* Teijsm. ex Miq. var. *obtusifolius* (Dipterocarpaceae) and many species of Fagaceae. Fieldwork was done twice a month from March 2001 to February 2002. This included collecting specimens of vascular ground flora up to c. 1.5 meter tall, as well as recording plant phenology, habitats, and abundance for each species. There are three main habitats, viz. 1) open, fire-damaged, degraded areas, 2) open bog/marsh areas, and 3) shaded areas with bamboo thickets along the seasonal stream. There are 59 families, 180 genera, and 262 species of vascular plants. The number of families of monocotyledons, dicotyledons, and pteridophytes, are 12, 37, and 10, respectively. The most common family is Compositae with 20 genera 30 species, then Leguminosae, Papilionoideae with 10 genera 29 species, including 10

species of *Crotalaria* – the most common genus there. Gramineae (grasses) is the most abundant family and is found throughout the area. Sixty five percent of the ground flora species are deciduous herbs and 25.3 % are annual. The peak flowering period is in October with 94 species.

Orchidaceae has 21 species, but most have medium and rare abundances and some species have only a few individuals. This area is clearly in need of protection and it would be an excellent site to promote nature education as well as develop a nursery for forest restoration.

ชื่อเรื่องวิทยานิพนธ์ พรรณไม้พื้นล่างในสวนรุกขชาติไม้เมืองหนาว จังหวัดเชียงใหม่

ชื่อผู้เขียน นางสาววัจวรรณ สัมเมธาวี

วิทยาศาสตร์มหาบัณฑิต สาขาวิชาชีววิทยา

คณะกรรมการสอบวิทยานิพนธ์

รศ. ดร. วิไลวรรณ อนุสารสุนทร ประธานกรรมการ

นายเจมส์ เอฟ แมกซ์เวลล์ กรรมการ

รศ. ดร. ธวัชชัย รัตนขเดช กรรมการ

ดร. สมราน สุดดี กรรมการ

บทคัดย่อ

สวนรุกขชาติไม้เมืองหนาว อำเภอฮอด จังหวัดเชียงใหม่ มีพื้นที่ประมาณ 500 ไร่ (0.8 กม.²) เป็นพื้นที่ป่าที่ต่อเนื่องกับอุทยานแห่งชาติแม่เงา ที่ระดับความสูงจากระดับน้ำทะเล 950-1,125 เมตร สภาพโดยทั่วไปเป็นป่ากึ่งผสมเต็งรังและมีสนกระจายอยู่ห่างๆ (deciduous dipterocarp-oak with some pine forest) บนเนินเขาสลับกับหุบเขา บนชั้นหินแกรนิต พรรณไม้เด่นในพื้นที่คือเหียง (*Dipterocarpus obtusifolius* Teijsm. ex Miq. var. *obtusifolius*: Dipterocarpaceae) และไม้วงศ์ก่อ (Fagaceae) หลายชนิด ได้สำรวจพรรณไม้พื้นล่างประเภทมีท่อลำเลียงที่มีการออกดอกผลหรือผลิตสปอร์ โดยมีความสูงไม่เกิน 1.5 เมตร เดือนละ 2 ครั้ง จากเดือนมีนาคม พ.ศ. 2544 ถึงเดือนกุมภาพันธ์ 2545 บันทึกชีวลักษณะ (phenology) ถิ่นที่อยู่ และความมากมายของแต่ละชนิด พบว่าพื้นที่ศึกษามีลักษณะถิ่นที่อยู่ (habitat) 3 แบบย่อย คือ 1) พื้นที่ป่าเสื่อมโทรมที่มีไฟป่า ซึ่งเป็นพื้นที่ส่วนใหญ่ 2) พื้นที่ชุ่มน้ำขนาดเล็ก (open bog/marsh areas) 3) พื้นที่ริมห้วยที่มีน้ำตามฤดูกาล (seasonal stream) และมีไฟปกคลุม จากการสำรวจพบพรรณไม้พื้นล่าง 59 วงศ์ 180 สกุล 262 ชนิด แบ่งเป็นพืชใบเลี้ยงเดี่ยว 12 วงศ์ พืชใบเลี้ยงคู่ 37 วงศ์ และกลุ่มเฟิน 10 วงศ์ โดยวงศ์ที่พบมากที่สุดคือวงศ์ดาวเรือง (Compositae) มี 20 สกุล 30 ชนิด รองลงมาคือวงศ์ถั่ว (Leguminosae,

Papilionoideae) มี 10 สกุล 29 ชนิด โดย *Crotalaria* เป็นสกุลที่พบมากที่สุดถึง 10 ชนิด ส่วนกลุ่มพืชที่ปกคลุมพื้นที่มากที่สุดคือวงศ์หญ้า (Gramineae) ทั้งนี้พรรณไม้ส่วนมากเป็นพืชล้มลุกผลัดใบอายุหลายปี (perennial, deciduous herb) คิดเป็นร้อยละ 65 และเป็นกลุ่มพืชอายุสั้นปีเดียว (annual herb) ร้อยละ 25.3 ในเดือนตุลาคมมีจำนวนพืชออกดอกมากที่สุดรวม 94 ชนิด

วงศ์กล้วยไม้ (Orchidaceae) แม้จะพบถึง 21 ชนิด แต่จำนวนประชากรของแต่ละชนิดมีน้อยมากและเสี่ยงต่อการสูญพันธุ์จากพื้นที่นี้ ดังนั้นพื้นที่นี้จึงมีความจำเป็นอย่างยิ่งที่ต้องมีการอนุรักษ์และยังมีความเหมาะสมในการพัฒนาเป็นแหล่งศึกษาธรรมชาติ รวมทั้งการจัดการเรือนเพาะชำและเพื่อการฟื้นฟูป่า

TABLE OF CONTENTS

	Page
Acknowledgements	iii
Abstract (in English)	v
Abstract (in Thai)	vii
LIST OF TABLES	xii
LIST OF ILLUSTRATIONS	xiii
CHAPTER 1 INTRODUCTION	1
CHAPTER 2 LITERATURE REVIEW	6
CHAPTER 3 MATERIALS AND METHODS	11
CHAPTER 4 RESULTS	15
Key to major groups	29
Monocotyledoneae	29
Amaryllidaceae	31
Araceae	33
Burmanniaceae	34
Commelinaceae	35
Cyperaceae	45
Eriocaulaceae	50
Gramineae	53
Liliaceae	64
Orchidaceae	72
Palmae	84
Xyridaceae	86
Zingiberaceae	89
Dicotyledoneae	97
Acanthaceae	100
Aristolochiaceae	110

TABLE OF CONTENTS

	Page
Asclepiadaceae	112
Balsaminaceae	114
Begoniaceae	115
Campanulaceae	117
Caryophyllaceae	120
Compositae	122
Convolvulaceae	147
Droseraceae	149
Euphorbiaceae	151
Gentianaceae	153
Guttiferae, Hypericeae	158
Labiatae	159
Leeaceae	173
Leguminosae	175
Lentibulariaceae	189
Loganiaceae	192
Lythraceae	193
Malvaceae	194
Melastomataceae	197
Myrsinaceae	200
Ochnaceae	201
Orobanchaceae	202
Oxalidaceae	203
Polygalaceae	204
Polygonaceae	206
Ranunculaceae	209
Rubiaceae	212
Rutaceae	219
Scrophulariaceae	220
Sterculiaceae	230

TABLE OF CONTENTS

	Page
Tiliaceae	232
Umbelliferae	234
Urticaceae	237
Verbenaceae	240
Violaceae	243
Pteridophytes	245
Parkeriaceae	246
Pteridaceae	248
Selaginellaceae	250
Thelypteridaceae	251
CHAPTER 5 DISCUSSION	253
CHAPTER 6 CONCLUSIONS	258
References cited	282
Appendices	290
<i>Curriculum vitae</i>	302

LIST OF TABLES

Table	Page
1 Summary of the vascular ground flora in the study area	15
2 Flowering ground flora found in the study area	17
3 Pteridophyte ground flora found in the study area	27
4 Summary of the vascular ground flora found in the study area	28
5 Table of shapes	301

LIST OF ILLUSTRATIONS

Figure	Page
1 Map of northern Thailand showing the study site and other places referred to	2
2 Detailed map of the study area	2
3 Annual rainfall at Hod and Mae Sariang (1993-2000)	4
4 Average rainfall at Hod and Mae Sariang (1993-2000)	4
5 Mean monthly temperature at Mae Sariang and Mai Muang Nao Arboretum	5
6 Flowering phenology of the vascular ground flora	16
7 <i>Crinum wattii</i> Baker	32
8 <i>Commelina diffusa</i> Burm. f. and <i>C. padulosa</i> Bl.	38
9 <i>Cyanotis barbata</i> D. Don and <i>C. cristata</i> (L.) D. Don	40
10 <i>Murdannia japonica</i> (Thunb.) Faden, <i>M. nudiflora</i> (L.) Bren., and <i>Aneilema sinicum</i> Lindl.	44
11 <i>Fimbristylis thomsonii</i> Boeck	49
12 <i>Eriocaulon oryzetorum</i> Mart. and <i>E. gracile</i> Mart.	52
13 <i>Arthraxon hispidus</i> (Thunb.) Makino var. <i>hispidus</i>	55
14 <i>Arundinella setosa</i> Trin. var. <i>setosa</i>	56
15 <i>Capillipedium parviflorum</i> (R. Br.) Stapf	58
16 <i>Sacciolepis indica</i> (L.) Chase	61
17 <i>Setaria parviflora</i> (Poir.) Kerg.	62
18 <i>Urochloa ruziziensis</i> (Germ. & Evr.) Morr. & Zul.	63
19 <i>Asparagus filicinus</i> Ham. ex D. Don	65
20 <i>Iphigenia indica</i> (L.) Gray ex Kunth	68
21 <i>Ophiopogon longifolius</i> Decne.	70
22 <i>Peliosanthes teta</i> Andr. ssp. <i>humilis</i> (Andr.) Jess.	71
23 <i>Xyris capensis</i> Thunb.	88
24 <i>Justicia procumbens</i> L.	104
25 <i>Rungia parviflora</i> (Retz.) Nees	109
26 <i>Aristolochia kerrii</i> Craib	111
27 <i>Begonia integrifolia</i> Dalz.	116
28 <i>Lobelia heyneana</i> Roem. & Schult. and <i>L. zeylanica</i> L.	119

LIST OF ILLUSTRATIONS

Figure	Page
29 <i>Drymaria diandra</i> Bl.	121
30 <i>Blumeopsis flava</i> (DC.) Gagnep., <i>Blumea napifolia</i> L., <i>B. mollis</i> (D. Don) Merr., and <i>B. fistulosa</i> (Roxb.) Kurz	127
31 <i>Elephantopus scaber</i> L. ssp. <i>scaber</i> var. <i>scaber</i>	132
32 <i>Eupatorium doichangensis</i> H. Koy.	134
33 <i>Lactuca parishii</i> Craib	139
34 <i>Vernonia cinerea</i> (L.) Less., <i>V. squarrosa</i> (D. Don) Less. var. <i>orientalis</i> Kit., <i>V. sutepensis</i> Kerr	146
35 <i>Drosera peltata</i> J. E. Sm. ex Willd. and <i>D. burmannii</i> Vahl	150
36 <i>Sauropus bicolor</i> Craib	152
37 <i>Exacum tetragonum</i> Roxb. and <i>Canscora diffusa</i> (Vahl) G. Don	154
38 <i>Pogostemon . cruciatus</i> (Benth.) Kuntz, <i>P. auricularius</i> (L.) Hassk., and <i>P. pentagonus</i> (C. B. Clark ex Hk. f.) Kuntz	167
39 <i>Salvia riparia</i> Kunth and <i>Teucrium quadrifarium</i> Buch.-Ham. ex D. Don	169
40 <i>Utricularia hirta</i> Klein ex Link, <i>U. minutissima</i> Vahl, and <i>U. scandens</i> Benj.	191
41 <i>Polygonum persicaria</i> L. and <i>P. chinensis</i> L.	208
42 <i>Ophiorrhiza hispidula</i> Wall. ex G. Don var. <i>hispidula</i>	214
43 <i>Rubia siamensis</i> Craib	218
44 <i>Torenia benthamiana</i> Hance	229
45 <i>Helicteres lanata</i> (Teijsm. & Binn.) Kurz	231
46 <i>Pilea trinervia</i> Wight	239
47 <i>Onychium siliculosum</i> (Desv.) C. Chr. and <i>Nephrolepis delicatula</i> (Decne.) Pichi-Ser.	247
48 <i>Pteris venusta</i> Kunze and <i>Arthromeris tatsienensis</i> (Franch. & Bureau ex Christ) Ching	249

LIST OF ILLUSTRATIONS

Plate		Page
1	A Degraded area in Mae Toh National Park	263
	B Burnt place in the study area	
	C Habitat 1	
	D Habitat 2	
	E Habitat 3	
	F Habitat 3	
2	A <i>Arisaema prazeri</i> Hk. f.	264
	B <i>Scirpus mucronatus</i> L.	
	C <i>Burmannia coelestis</i> D. Don	
	D <i>Phoenix loureiri</i> Kunth var. <i>loureiri</i>	
	E <i>Aneilema sinicum</i> Lindl.	
3	A <i>Floscopa scandens</i> Lour.	265
	B <i>Murdannia gigantea</i> (Vahl) Bruck.	
	C <i>M. loureirii</i> (Hance) Rao ex Kam.	
	D <i>M. scapiflora</i> (Roxb.) Royle	
4	A <i>Chlorophytum intermedium</i> Craib	266
	B <i>Dianella ensifolia</i> (L.) DC.	
	C <i>Disporum calcaratum</i> Wall. ex D. Don	
	D <i>Ophiopogon longifolius</i> Decne.	
	E <i>Paris polyphylla</i> J. E. Sm.	
5	A <i>Arundina graminifolia</i> (D. Don) Hochr.	267
	B <i>Pachystoma pubescens</i> Bl.	
	C <i>Anthogonium gracile</i> Wall. ex Lindl.	
	D <i>Geodorum recurvum</i> (Roxb.) Alston	
	E <i>Pecteilis susannae</i> (L.) Raf.	
6	A <i>Cymbidium ensifolium</i> (L.) Sw.	268
	B <i>Eulophia macrobulbon</i> (Par. & Rchb. f.) Hk. f.	
	C & D <i>E. spectabilis</i> (Dennst.) Suresh	
	E <i>Brachycorythis henryi</i> (Schltr.) Summ.	

LIST OF ILLUSTRATIONS

Plate	Page
7 A <i>Habenaria chlorina</i> Par. & Rchb. f	269
B <i>H. dentata</i> (Sw.) Schltr.	
C <i>Liparis paradoxa</i> (Lindl.) Rchb. f.	
D <i>Phiausia tankervilleae</i> (Banks ex L' Her.) Bl.	
8 A <i>Peristylus constrictus</i> (Lindl.) Lindl.	270
B <i>P. prainii</i> (Hk. f.) Krzl.	
C <i>Costus speciosus</i> (Koeh.) J. E. Sm.	
D <i>Hedychium gardnerianum</i> Rosc.	
E <i>Kaempferia rotunda</i> L.	
9 A <i>Curcuma ecomata</i> Craib	271
B <i>C. parviflora</i> Wall.	
C <i>C. zedoaria</i> (Berg.) Rosc.	
D <i>Globba</i> sp.	
E <i>Zingiber parishii</i> Hk. f.	
10 A <i>Barleria cristata</i> L.	272
B <i>Perilepta siamensis</i> (Cl.) Brem.	
C <i>Strobilanthes anfractuosus</i> Cl. ex Hoss.	
D <i>S. apricus</i> (Hance) T. And. var. <i>pedunculatus</i> (Craib) Ben.	
E <i>Ceropegia sootepensis</i> Craib	
11 A <i>Impatiens chinensis</i> L.	273
B <i>I. craddokii</i> Hk. f.	
C <i>Argyreia kerrii</i> Craib	
D <i>Gentiana timida</i> Kerr	
E <i>Lobelia nicotianaefolia</i> Roth ex Roem. & Schult.	
12 A <i>Blumea fistulosa</i> (Roxb.) Kurz	274
B <i>Crepis lignea</i> (Vant.) Bab.	
C <i>Piloselloides hirsuta</i> (Forsk.) C. Jeff.	
D <i>Vernonia squarrosa</i> (D. Don) Less. var. <i>orientalis</i> Kit.	

LIST OF ILLUSTRATIONS

Plate		Page
13	<p>A <i>Gynura pseudochina</i> (L.) DC.</p> <p>B <i>Crassocephalum crepidioides</i> (Benth.) S. Moore</p> <p>C <i>Pluchea polygonata</i> (DC.) Gagnep.</p> <p>D <i>Inula cappa</i> (Ham. ex D. Don) DC. <i>forma cappa</i></p> <p>E <i>I. indica</i> L.</p> <p>F <i>I. nervosa</i> Wall. ex DC.</p>	275
14	<p>A <i>Leea indica</i> (Burm. f.) Merr.</p> <p>B <i>Abelmoschus moschatus</i> Medic. ssp. <i>tuberosus</i> (Span.) Borss.</p> <p>C <i>Pavonia repanda</i> (Roxb. ex J. E. Sm.) Spreng.</p> <p>D <i>Ardisia crenata</i> Sims var. <i>crenata</i></p> <p>E <i>Elscholtzia winitiana</i> Craib</p> <p>F <i>Gomphostemma strobilinum</i> Wall. ex Benth. var. <i>acualis</i> (Kurz ex Hk. f.) Prain</p>	276
15	<p>A <i>Isodon lophanthoides</i> (Buch.-Ham. ex D. Don) H. Hara var. <i>lophanthoides</i></p> <p>B <i>Orthosiphon rubicundus</i> (D. Don) Benth.</p> <p>C <i>Pogostemon auricularius</i> (L.) Hassk.</p> <p>D <i>P. cruciatus</i> (Benth.) Kuntz</p> <p>E <i>Scutellaria glandulosa</i> Hk. f.</p>	277
16	<p>A <i>Chamaecrista leschenaultiana</i> (DC.) Degener</p> <p>B <i>Clitoria macrophylla</i> Wall. ex Benth.</p> <p>C <i>Crotalaria calycina</i> Schrank</p> <p>D <i>C. neriifolia</i> Wall. ex Benth.</p> <p>E <i>C. sessiliflora</i> L.</p> <p>F <i>Desmodium velutinum</i> (Willd.) DC. ssp. <i>velutinum</i> var. <i>velutinum</i></p>	278
17	<p>A <i>Melastoma malabathricum</i> L. ssp. <i>malabathricum</i></p> <p>B <i>Osbeckia chinensis</i> L. var. <i>chinensis</i></p> <p>C <i>Ochna integerrima</i> (Lour.) Merr.</p> <p>D <i>Aeginetia indica</i> Roxb.</p> <p>E <i>A. pedunculata</i> Wall.</p> <p>F <i>Biophytum umbraculum</i> Welw.</p>	279

LIST OF ILLUSTRATIONS

Plate		Page
18	A <i>Polygala longifolia</i> Poir.	280
	B <i>Ranunculus siamensis</i> Tam.	
	C <i>Delphinium siamensis</i> (Craib) Munz	
	D <i>Knoxia brachycarpa</i> R. Br. ex Hk. f.	
	E <i>Pavetta fruticosa</i> Craib	
19	A <i>Buchnera cruciata</i> Buch.-Ham. ex D. Don	281
	B <i>Limnophila villifera</i> Miq. ssp. <i>gracilipes</i> (Craib ex Hoss.) Kama.	
	C <i>Pedicularis nigra</i> Vaniot ex Bonati	
	D <i>Pimpinella cambodgiana</i> H. Boiss.	
	E <i>Pouzolzia pentandra</i> (Roxb.) Benn.	
	F <i>Premna herbacea</i> Roxb.	

CHAPTER 1

INTRODUCTION

Muang Nao Arboretum was established in 1993 and is located in Ban Mae Sanam Mai (village), Baw Salee Subdistrict, Hod District, Chiang Mai Province at approximately 18° 8' N latitude, 98° 23' E longitude, and at 950-1,125 m elevation along highway 108 (Hod-Mae Sariat) (Figure 2). It has an area of c. 0.8 km² and is under the auspices of the Forest Botany Division, Royal Forest Department. It is bounded on the north by a seasonal stream Huai Mae Loy, which is the southern boundary of Mae Toh National Park. The general topographic features are small hills alternating with gullies.

According to vegetation classification system for northern Thailand by Maxwell (2001), and CMU Herbarium database, this area is a deciduous dipterocarp-oak with pine, forest. This forest type is named due to being dominated by members of Dipterocarpaceae and Fagaceae and mixed with scattered *Pinus kesiya* Roy. ex Gord. (three-needled pine) and *P. merkusii* Jungh. & De Vriese (two-needled pine) (Pinaceae). There are three main habitats, viz. open, fire-damaged, degraded deciduous dipterocarp-oak with some pine; marshy areas (including open moist gullies); and partly shaded areas with bamboo thickets along the seasonal stream.

The most abundant deciduous tree species in the area are *Dipterocarpus obtusifolius* Teijsm. ex Miq. var. *obtusifolius*, *Shorea siamensis* Miq. var. *siamensis*, *S. obtusa* Wall. ex Bl. (all Dipterocarpaceae); *Quercus kerrii* Craib var. *kerrii* (Fagaceae); *Gluta usitata* (Wall.) Hou, and *Buchanania lanzan* Spreng (both Anacardiaceae). The most common evergreen tree species are *Lithocarpus lindleyanus* (Wall.) A. Camus, *Castanopsis argyrophylla* King ex Hk. f., *C. acuminatissima* (Bl.) A. DC. (all Fagaceae); and *Tristaniaopsis burmanica* (Griff.) Wils. var. *rufescens* (Hance) Parn. & Lug. (Myrtaceae).

Trees along the seasonal stream are mostly evergreen, and sparsely distributed, e.g. *Nyssa javanica* (Bl.) Wang. (Nyssaceae), *Eriobotrya bengalensis* (Roxb.) Hk. f. *forma bengalensis* (Rosaceae), and *Ficus semicordata* B.-H. ex J. E. Sm. var. *semicordata* (Moraceae). Some deciduous species include *Salix tetrasperma* Roxb. (Salicaceae) with only a few individuals left, *Glochidion sphaerogynum* (M.-A.) Kurz, (Euphorbiaceae), *Diospyros winitii* Flet. (Ebenaceae), and *Protium serratum* (Wall. ex Colebr.) Engl. (Burseraceae).

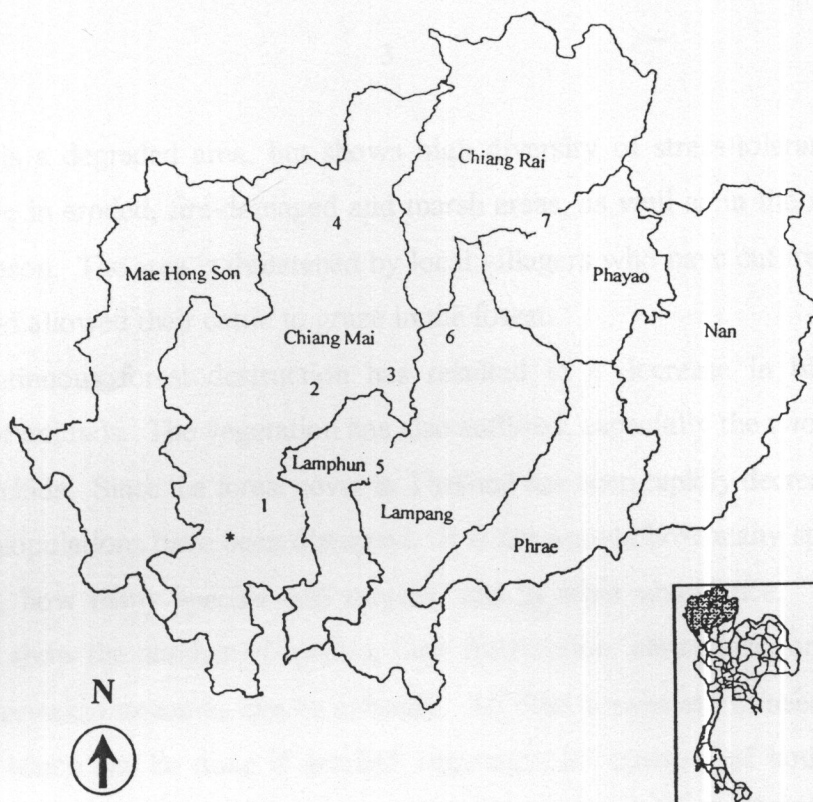


Figure 1 Map of northern Thailand showing the study site and other places referred to
 * = Mai Muang Nao Arboretum , 1 = Mae Soi Conservation Area (in Awp Luang National Park), 2 = Doi Suthep-Pui National Park, 3 = Doi Muang Awn, 4 = Doi Chiang Dao Wildlife Sanctuary, 5 = Doi Khuntan National Park, 6 = Jae Sawn National Park, 7 = Doi Luang National Park
 Source: Multiple Cropping Center, Faculty of Agriculture, Chiang Mai University

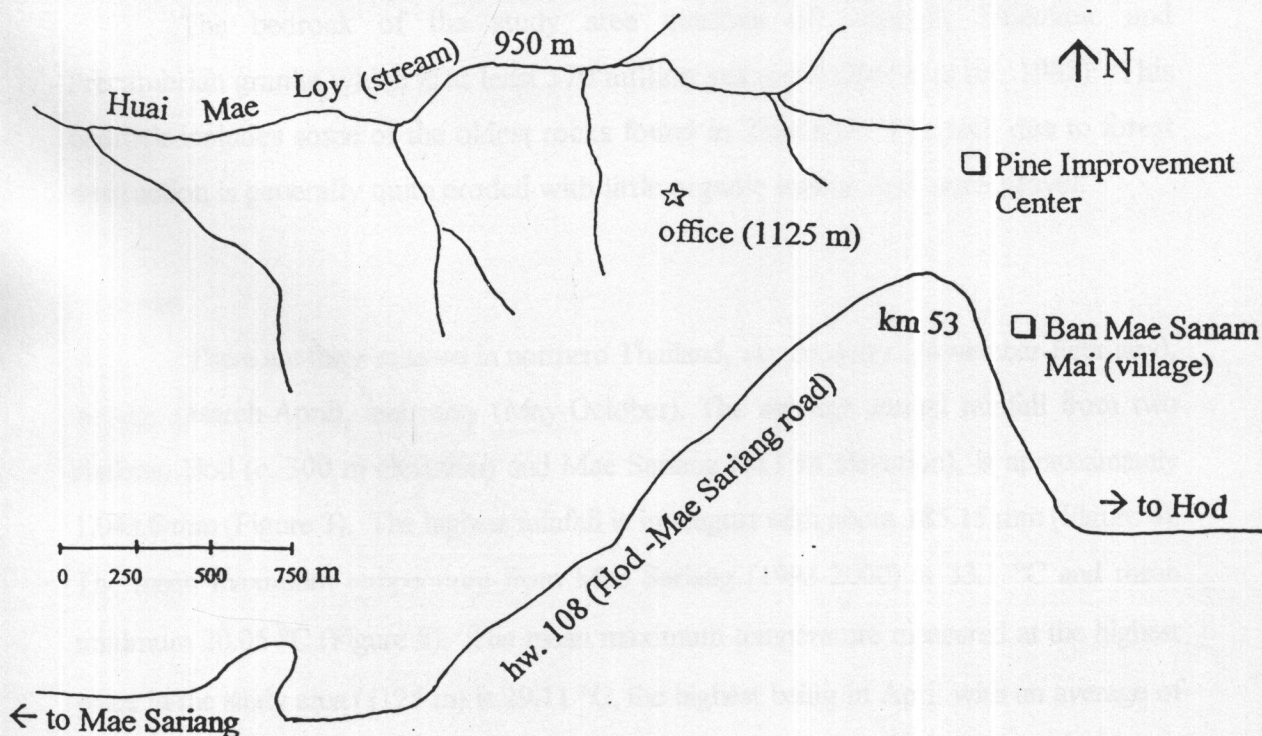


Figure 2 Detailed map of the study area

This is a degraded area, but shows high diversity of stress-tolerant species, which survive in eroded, fire-damaged and marsh areas, as well as in the stream bed in the dry season. The area is threatened by local villagers who have cut trees, burned the forest, and allowed their cattle to graze in the forest.

Continuous forest destruction has resulted in a decrease in biodiversity, especially for animals. The vegetation has also suffered, especially the two species of *Pinus* and orchids. Since the forest cover in Thailand has been rapidly decreasing, plant and animal populations have been disrupted. It is not known how many species have disappeared, how many species still remain, and in what abundance. Vegetation surveys can show the number of species, their distribution, abundance, and ecology, so that conservation measures can be effected. All Thai forests are in need of proper restoration, which can be done if detailed vegetation information of both trees and ground flora is done. My study involved surveying and collecting the vascular ground flora to provide regional information as well as collecting specimens for botanical studies, and computing a vegetation database.

Geology

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

Climate

There are three seasons in northern Thailand, viz. cool-dry (November-February), hot-dry (March-April), and rainy (May-October). The average annual rainfall from two stations, Hod (c. 300 m elevation) and Mae Sariang (211 m elevation), is approximately 1,043.6 mm (Figure 3). The highest rainfall is in August with about 185.15 mm (Figure 4). The mean maximum temperature from Mae Sariang (1993-2000) is 33.1 °C and mean minimum 20.05 °C (Figure 5). The mean maximum temperature measured at the highest place in the study area (1125 m) is 29.11 °C, the highest being in April with an average of 32.77 °C, the hottest day was 35 °C on 28 April 2002. The mean minimum is 19.16 °C, and the coldest month is December (mean = 13.99 °C), with a minimum of 11 °C.

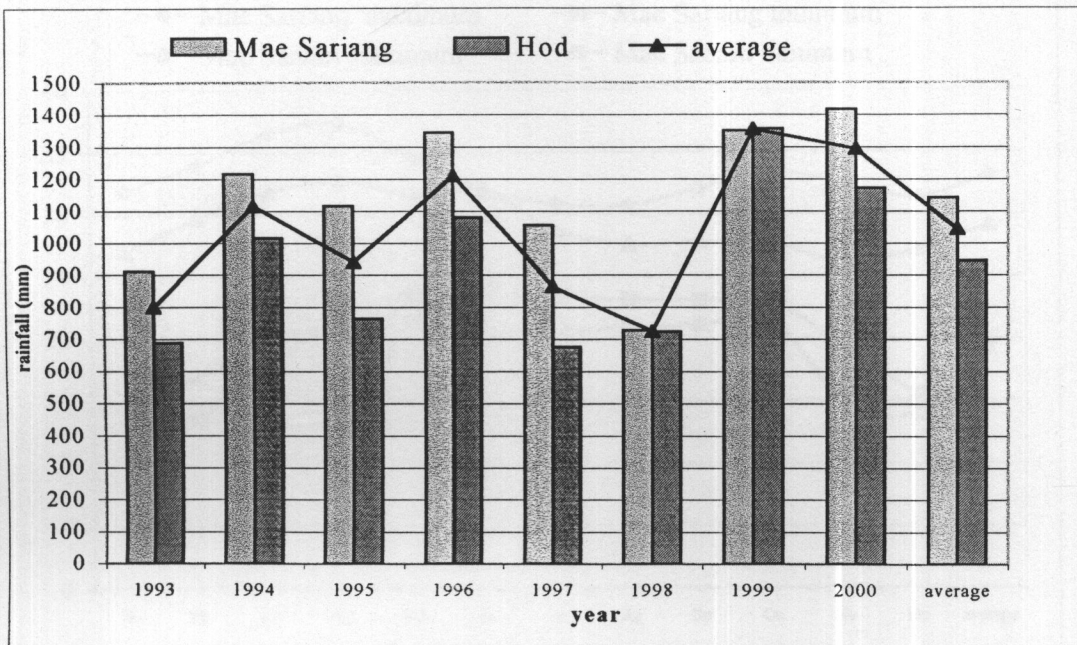


Figure 3 Annual rainfall at Hod (c. 300 m) and Mae Sariang (211 m) meteorological stations (1993-2000)

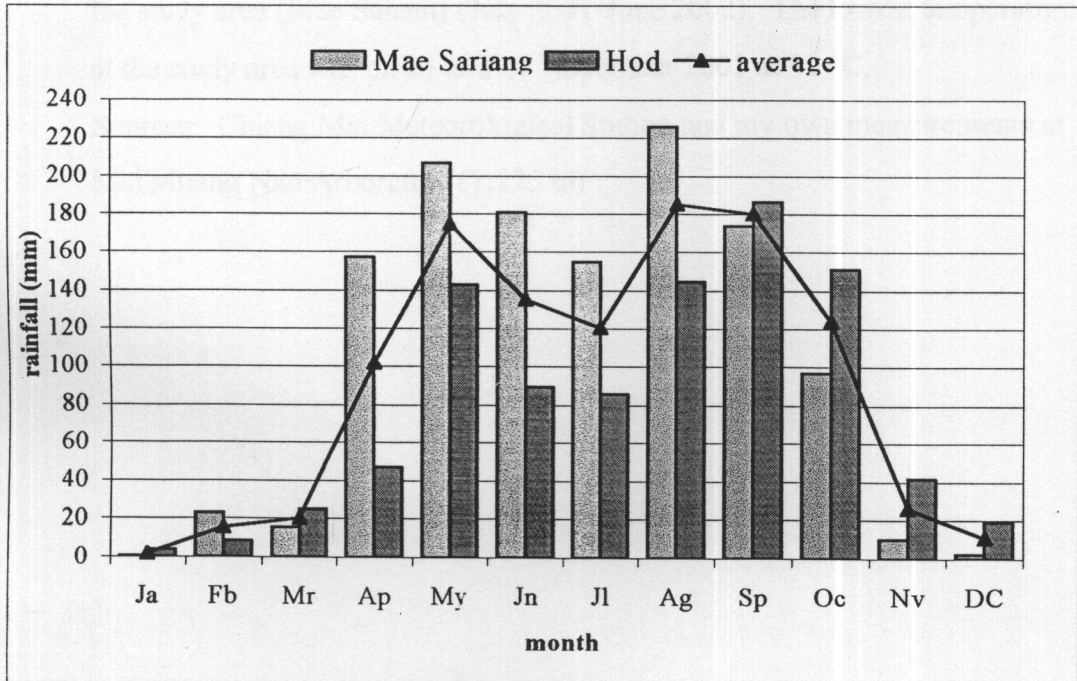


Figure 4 Average rainfall at Hod (c. 300 m) and Mae Sariang (211 m) meteorological stations (1993-2000)

Source: Chiang Mai Meteorological Station

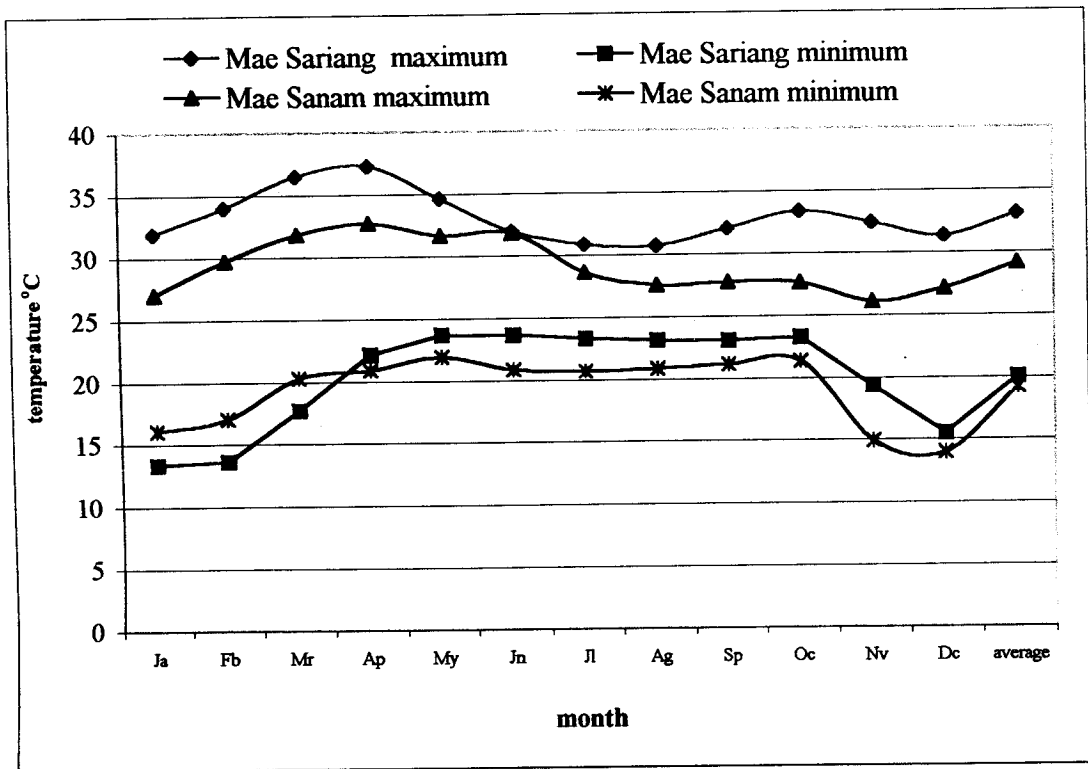


Figure 5 Mean monthly temperatures at Mae Sariat (211 m) (1993-2000) and at the study area (Mae Sanam) (July 2001-June 2002). The lowest temperature at the study area was on 24 and 27 November 2001 at 11 °C.

Sources: Chiang Mai Meteorological Station and my own measurements at Mai Muang Nao Arboretum (1,125 m)

CHAPTER 2

LITERATURE REVIEW

Thailand is one of the most biodiverse areas in the world. It is a unique place represents the fauna and flora which characterizes the Indo-Burma biogeographic province (Ashton, 1989). Since 1961, Thai forest included 53.33 % of the total area of the country deceased to 25.28 % in 1998. Maxwell and Elliott (2001) estimate that now c. 15 % of Thailand has forest cover. The northern part of Thailand is now the largest forested area of the country with about 43.5 % of total forest cover (Rojanapaiwong, 2000).

Thai forests can be divided into 2 major groups, viz. deciduous and evergreen, due to climate, soil moisture, and elevation (Maxwell and Elliott, 2001). Neal (1967) noted that the largest forest type in Thailand is deciduous forest, which included 147,000 km² (46%) mainly occurring in the north and northeast (Rundel and Boonpragob, 1995).

In northern Thailand, the vegetation has the Indo-Burmese and southern Chinese floristic elements (Smitinand, 1966; Ashton, 1989). Maxwell has developed a simplified classification system for Thai forests from his surveys in various areas throughout Thailand. The main vegetation types in northern Thailand (Maxwell, 2001) are:

1. Deciduous forest with bamboo (BB/DF)
2. Deciduous dipterocarp-oak forest (DOF)
3. Mixed evergreen + deciduous forest (MXF)
4. Primary evergreen forest (EGF)
5. Primary evergreen forest with pine (EG/PINE)
6. Disturbed areas and secondary growth (DA/SG)
7. Aquatic

Deciduous dipterocarp forest covers the largest area in Southeast Asia extending from northeast India and Burma through Thailand to the Mekong river region of Indo-China (Rundel and Boonpragob, 1995). The highest elevation of Thai dipterocarps is about 1,300 m in dry dipterocarp forest on Doi Suthep (Smitinand, 1969). Deciduous dipterocarp-oak forest (DOF) is open and dry and degraded areas

from the lowlands up to about 800-900 m elevation, and is a secondary, fire climax facies (Maxwell and Elliott, 2001). Sometimes this forest is called savanna (Stott, 1984 and Ogawa *et al.*, 1961). DOF is named because of being dominated by Dipterocarpaceae and Fagaceae. In upper elevations this forest is often mixed with *Pinus kesiya* Roy. *ex* Gord. (Pinaceae, tree-needled pine), so this can be called deciduous dipterocarp-oak + pine forest.

Northern Thailand has two kinds of deciduous forest *viz.* primary and secondary, which are fire-tolerant forests, and less a botanically diverse as upland evergreen areas (Maxwell, 1998). On the upland of Doi Chiang Dao Wildlife Sanctuary, the primary deciduous forest was dominated by *Tectona grandis* L. f. (Verbenaceae, teak). After it was destroyed for commercial logging, it was replaced with bamboo and with other no commercial value deciduous trees. Degraded deciduous forest is replaced and dominated by deciduous dipterocarps (Dipterocarpaceae) and oaks (Fagaceae), which grow in evergreen hardwood pine areas. Dipterocarp-oak + pine forest are found in EG/Pine areas (c. 1,000-1,550 m). Many species are found in lowland DOF, but not found in degraded EG/Pine, such as *Shorea obtusa* Wall. *ex* Bl. (Dipterocarpaceae), *Quercus kerrii* Craib var. *kerrii*, *Q. kingiana* Craib (both Fagaceae). Maxwell (1992) noted that DOF in the lowland (c. 450-800 m) of Doi Chiang Dao is a climax secondary growth facies like on the eastern side of Doi Suthep-Pui National Park. Smitinand (1966) made a primitive vegetation survey of Doi Chiang Dao. He found a total of 109 families, 377 genera, and 570 species. The most common family was Orchidaceae with 88 species, followed by Gramineae with 39 species, and Compositae with 34 species. Compositae was a good representation of northern elements as *Adenostemma lavenia* (L.) O.K., *Blumea fistulosa* (Roxb.) Kurz, *Siegesbeckia orientalis* L., and *Inula cappa* (Ham. *ex* D. Don) DC. were very widespread.

In Doi Suthep, DOF forest has 82% deciduous trees, which shed their leaves in the hot-dry season and producing new leaves before the rainy season. The forest canopy is open and usually does not exceed 20 m (Maxwell and Elliott, 2001; Ogawa *et al.*, 1961). Since this forest is deciduous and has an open canopy, the ground flora well developed, especially in Gramineae (grasses). The consequence dry grasses and leaf litter accumulation in the dry season is fire, which is all caused by human activities.

Fire is a significant ecological factor for DOF ecosystems (Stott, 1984). Selection has resulted in a fire-tolerant vegetation in DOF areas. Some examples enabling some plants to survive here are some trees having thickened bark, many herbaceous ground plants are perennials having thickened storage roots, bulbs, corms and rhizomes. The most common tree species in DOF areas in northern Thailand are *Dipterocarpus obtusifolius* Teijsm. ex Miq. var. *obtusifolius*, *D. tuberculatus* Roxb. var. *tuberculatus*, *Shorea siamensis* Miq. var. *siamensis* (all Dipterocarpaceae), *Quercus kerrii* Craib var. *kerrii*, *Q. brandisiana* Kurz, and *Castanopsis argyrophylla* King ex Hk. f. which is evergreen (all Fagaceae). Maxwell and Elliott (2001) mentioned that the fire resistant palm *Phoenix loureiri* Kunth. var. *loureiri* (Palmae) is easily recognized as an indicator of this forest type. Other common characteristic DOF treelets and trees are *Ochna integerrima* (Lour.) Merr. (Ochnaceae), *Gluta usitata* (Wall.) Hou, and *Buchanania lanzan* Spreng. (both Anacardiaceae).

Maxwell (2001) concluded that there are at least 195 families and 2,247 species of vascular plants in Doi Suthep-Pui National Park. He recorded 533 species (23.72 %) in DOF. There were 274 species of ground flora, 40 % being annual, with many common species, e.g. *Polygala longifolia* Poir. (Polygalaceae), *Biophytum umbraculum* Welw. (Oxalidaceae), *Crotalaria alata* D. Don, *C. albida* Hey. ex Roth, *Indigofera hirsuta* L. (all Leguminosae, Papilionoideae), *Gynura integrifolia* Gagnep. (Compositae). Grasses (Gramineae) are very diverse and dominant. Most are deciduous such as *Apluda mutica* L., *Aristida cumingiana* Trin. & Rupr., *Arundinella setosa* Trin. var. *setosa*, and *Capillipedium assimile* (Steud.) A. Camus.

Phuakam (1994) studied on herbaceous ground flora on the eastern side of Doi Suthep, at elevation 670-750 m. She found total 24 families, 60 genera, and 71 species in an area of 3,960 m² in an ecotone of DOF and MXF. The most common family was Zingiberaceae with 13 species. The flowering peak of herbaceous ground flora was in July and lowest in February.

Maxwell (2000) studied the vegetation in Doi Luang National Park (Chiang Rai, Lampang, and Phayao Provinces) (Figure 1). The DOF, there is similar to that on Doi Suthep-Pui in being dominated with Dipterocarpaceae and Fagaceae, as well as the typically deciduous ground flora. The more abundant ground herbs are *Crotalaria acicularis* B.-H. ex Benth. and *C. neriifolia* Wall. ex Benth. (Leguminosae,

Papilionoideae), *Inula cappa* (Ham. ex D. Don) DC. *forma cappa* and *I. indica* L. (Compositae), and *Premna nana* Coll. & Hemsl. (Verbenaceae). From CMU database analysis, there are 1,155 species of vascular plants of which 439 species are herbaceous ground flora (38 %) of the total flora.

Palee and Maxwell (2000) studied vascular flora of Doi Muang Awn (Figure 1) which is an isolated limestone hill. They found total of 69 families, and 227 species. The database shows there are 95 species of ground herb (41.85 %).

Maxwell *et al.* (1997) surveyed the vegetation in Jae Sawn National Park, Lampang, Lamphun Provinces from August 1995 to 1997. They found 1,353 species of vascular plants, with 410 species of herbaceous ground herb (30.3 %). The DOF is found from about 300-800 m. The herbaceous plants are similar to those found in BB/DF forest. The tree component is slightly similar to DOF in Doi Suthep-Pui National Park (Maxwell and Elliott, 2001), and Doi Khuntan National Park (Maxwell *et al.*, 1995). *Quercus kerrii* Craib var. *kerrii* and *Q. kingiana* Craib are very common, but uncommon at Doi Khuntan. The ground flora is mostly deciduous and many places are dominated by Gramineae (grasses) such as *Apluda mutica* L., *Themeda triandra* Forssk., and *Arundinella setosa* Trin. var. *setosa*. More open, fire-damaged areas have many annual herbs such as *Crotalaria alata* D. Don. (Leguminosae, Papilionoideae).

Maxwell (1996) studied the flora in the Mae Soi Conservation area (Figure 1) (now is a part of Awp Luang National Park), Chom Tong District from December 1989 to July 1993. There is deciduous dipterocarp-oak forest present in the lowland vegetation. He found a total of 149 families and 806 species. The CMU Herbarium database shows that there are 175 species of herbaceous plants (20.61 % of the total flora).

Maxwell *et al.* (1995) studied the flora in Doi Khuntan National Park (Figure 1), Lamphun-Lampang Provinces from May 1993 to June 1995. They found at least 165 families and 1,285 species of vascular plants. Deciduous dipterocarp-oak forest is mainly located at 325-850 m with *Pinus merkusii* Jungh. & De Vriese scattered in the upper range from 800-900 m. The CMU database shows that there are 319 species of herbaceous plants (24.28 % of the total flora). Some typical ground herbs are: *Blumeopsis flava* (DC.) Gagnep. (Compositae), *Euphorbia capillaris* Gagnep.

(Euphorbiaceae), *Barleria cristata* L. and *Andrographis laxiflora* (Bl.) Lind. (both Acanthaceae). Gramineae (Grasses) are very common with *Arundinella setosa* Trin. var. *setosa*, *Capillipedium parviflorum* (R. Br.) Stapf, *Heteropogon contortus* (L.) P. Beauv. ex Roem. & Schult., and *Hyparrhenia rufa* (Nees) Stapf var. *siamensis* Clay. Common Cyperaceae (sedges) include *Carex indica* L. var. *microcarpa* T. Koy., *C. speciosa* Kunth, *Rhynchospora rubra* (Lour.) Mak., *Scleria kerrii* Turr., and *S. levis* Retz.

Santisuk (1997) mentioned that pine-deciduous dipterocarp forest is extensively developed on the plateau-like rolling hills of Bo Luang-Mae Sanam–Om Koi areas, but the commercial logging in 1986 has destroyed the original vegetation.

Phengklai *et al.* (1988) studied the vegetation in a bog area along the road 1099 (Bo Luang–Om Koi Road), which is near Ban Mae Sanam (village). The study site is at 850 m elevation in pine-dipterocarp forest. They found 99 species of seed plants, mostly herbs, *e.g.* *Aristolochia kerrii* Craib (Aristolochiaceae), *Impatiens chinensis* L. (Balsaminaceae), *Cyperus brevifolius* (Rottb.), *C. compactus* Retz., *Fimbristylis cinnamometorum* (Vahl) Kunth, *F. dichotoma* (L.) Vahl (all Cyperaceae), *Dysophylla cruciata* Benth., and *Elscholtzia winitiana* Craib (both Labiatae).

Two new taxa were collected from this area, *viz.* *Ranunculus siamensis* Tam. (Ranunculaceae) was collected from Bo Luang in 1978 (Tamura, 1997). The type of *Inula wissmanniana* Hand.-Mzt. *forma disciformia* H. Koy. (Compositae) was collected from Mae Sanam (Koyama, 1984). Many species have been collected from the Mae Sanam area, *e.g.* *Piloselloides hirsuta* (Forssk.) C. Jeff. (Koyama, 1981), *Cyathocline purpurea* (Ham. ex D. Don) O. Ktz. (Koyama, 1983), *Blumeopsis flava* (DC.) Gagnep., *Pluchea polygonata* (DC.) Gagnep. (Koyama, 1984), and *Artemisia japonica* Thunb. (Koyama, 1989).

Bo Luang (5 km from the study site) was chosen to be a collecting site for the fourth Thai-Danish Botanical Exhibition in 1964 (Larsen, 1966). Many species of vascular plants were collected, but no species list was made.

CHAPTER 3

MATERIALS AND METHODS

Fieldwork was done twice a month from March 2001 to February 2002, for 2-3 days at a time. The vascular ground flora included all herbs, vine, and woody species with flowers, fruits, or sporangia up to about 1.5 meter tall were collected. Some grasses and vines, which were slightly higher or longer were also collected. The methods of collection, preservation, and curation follow those developed and refined by Maxwell (1975a, 1975b) and are used in the CMU Herbarium.

Collection

Herbaceous specimens were dug up with their roots, rhizomes, bulbs, or corms. Flowering/fruiting branches of woody plants were cut off by pruning shears and then the height and basal height diameter were measured. Field notes were made for each collection including: location, habitat/microhabitat, elevation, colour of vegetative and flower/fruit parts, smell, and sap (if present). Bulbs, rhizomes, or corms were cut vertically and the flesh inside removed and the stems of some succulent species were slit for faster drying.

Specimens were carefully collected with the leaves in good condition (rejecting rips or insect damage) with mature inflorescences or infructescences. In some deciduous species such as some Zingiberaceae, which flower before leafing, flowering plants were marked so that leaves could be collected later.

The specimens were carefully arranged in a single sheet of folded newspaper for pressing. Both surfaces of leaves were shown in equal proportion, the margins not overlapping, and all part completely inside the newspaper. The bases of pruned petioles and pedicels were left to indicate their positions. Some flowers of every species were preserved in 70 % methyl alcohol in film containers, labeled, and numbered for identifying in the herbarium.

Some irregular, membranous, or delicate flowers, viz. Acanthaceae, Balsaminaceae, Commelinaceae, Campanulaceae, Labiatae, Lentibulariaceae, Orobanchaceae, Orchidaceae, Scrophulariaceae, and Zingiberaceae were put in 70 %

methanol in plastic bags for liquid preservation. Extra flowers/fruits for each species were also collected.

A pair of plywood frames (32 x 46 cm) were used to press the collected specimens. Specimens were carefully pressed immediately after taking notes. The plywood frames were then tightly tied.

After finishing fieldwork each day, the presses were opened and the specimens checked again for neatness and notes checked. The specimens were then bundled and put in a large plastic bag and 95 % methanol was poured on them and the bag tied. This method ensures that the specimens will not rot before returning to CMU for drying.

Drying

At CMU the specimen bags were opened and the bundles untied in preparation for drying. Each specimen is then placed on a thin, metal, corrugated drying plate with a piece of cardboard or cloth/foam pad to make the specimens dry flat. The stacks of specimens are then tightly tied between strong metal/bamboo frames and then put in a drying oven. CMU ovens have spotlights to provide heat and specimens usually take 15-24 hours to dry, depending on the number of specimens and the amount of moisture to be removed. The temperature generally is about 70 - 80°C.

Preservation techniques

Herbarium specimens must be protected from being eaten by various insects. Care must be taken during poisoning since the chemical used is poisonous to humans. A special room is used and rubber gloves, gown, and a gas mask are required. Twenty five grams of mercuric chloride (HgCl_2) is dissolved in one liter of 95 % methanol or ethanol. Specimens are dipped in this solution using forceps and a brush, and then put back in the newspaper and kept in a box, usually for several days to dry.

Mounting technique

To make glue for mounting specimens on herbarium sheets (32 x 46 cm), 10 g of methyl cellulose is gradually dissolved in 1000 ml of boiled water and stirred to become glue, then cooled to room temperature. The glue is poured and spread on a

grass plate (46 x 64 cm). The lower side of each poisoned specimen is put on the glue plate, then transferred to the herbarium sheet using forceps. Delicate specimens are turned over in the newspaper and brushed with glue, then the herbarium paper placed on the specimen. Sometimes specimens are put in packets or envelopes on the sheet. Each mounted specimen is covered with a plastic sheet (32 x 46 cm) to prevent specimens sticking together. The label is pasted on the lower right corner of the sheet. To avoid the label getting wet from the glue one more plastic sheet is put under the label and one on top. Each specimen is put on a piece of cardboard alternating with plastic sheets and cardboard. The bundles are pressed overnight with weights and the specimens are removed and left to dry, usually for a day.

Mounted specimens are sewn on the sheet and then registered. Extra parts are put in an envelope placed on the herbarium sheet. Each specimen is put in a paper folder which has the CMU family number and botanical name. The specimens are put in herbarium cabinets according to family and genus. Groups of related specimens are put in genus covers. The name of each genus is written on the lower right corner and the CMU family number on the lower left side. The CMU herbarium uses a modified Bentham & Hooker system for arranging flowering plant families. Pteridophytes are arranged according to Tagawa & Iwatsuki (1979-1989) in the Flora of Thailand.

Liquid preservation

Preservation of flowers for the families mentioned above is done with 70% methanol with a bit of glycerol added. All bottles have an aluminum top. The specimen number is written on a piece of clear plastic and put in the bottom of the bottle. The family, specimen number, and species name are written on a piece of herbarium paper and put inside facing outside, while the collector's name and number are written on the other side. The bottle top is sealed with a thin piece of plastic and tightened as much as possible. The bottle is briefly inverted to let the glycerol mix with the alcohol. These liquid collections are kept in a separate room in the herbarium. "In liquid collection" is noted on the upper right corner of the herbarium label to indicate that flowering material is preserved in alcohol.

Identification

The main references used to determine flowering plant families are Hutchinson (1967) and Geesink *et al.* (1981), while Tagawa & Iwatsuki (1979) was used for pteridophytes. Mauric (1999) was used to find references for families and genera. The CMU collection was also extensively used to help identifications.

Not all species collected for this flora have been described because of time and thesis length limits. At least one species of each flowering family has been described for the family representatives. All descriptions (130 species) are based on my collections. Sixty three species were chosen to make line drawings to show more details, especially plants with small flowers which were too small to photograph. Most of plants with larger flowers were taken and 94 species are shown in this thesis.

CHAPTER 4
RESULTS

The study area was divided to 3 main habitats, viz.

- 1) Open, fire-damage, degraded areas
- 2) Open bog/marsh areas
- 3) Shaded areas along the seasonal stream

There were 59 families, 180 genera, and 261 species of vascular ground flora found in the study area. The number of families of monocotyledons, dicotelydons and pteridophytes are 12, 37, and 10 respectively (Tables 2-4). There are 195 species of perennial herbs of with 170 are deciduous, and 25 are evergreen (Table 1).

Table 1 Summary of vascular ground flora in the study area

total	species	% of total ground flora
annual herb	67	25.3
perennial herb	195	74.7
- deciduous	170	65.1
- evergreen	25	9.6
total	262	100

The most abundant family is Compositae with 30 species, then Leguminosae, Papilionioideae with 29 species, and Orchidaceae with 21 species. The most common genus is *Crotalaria* (Leguminosae, Papilionioideae) with 10 species. The peak of flowering period is in October with 94 species (36 % of total) and lowest in March with 28 species (10.7 % of total) (Figure 6).

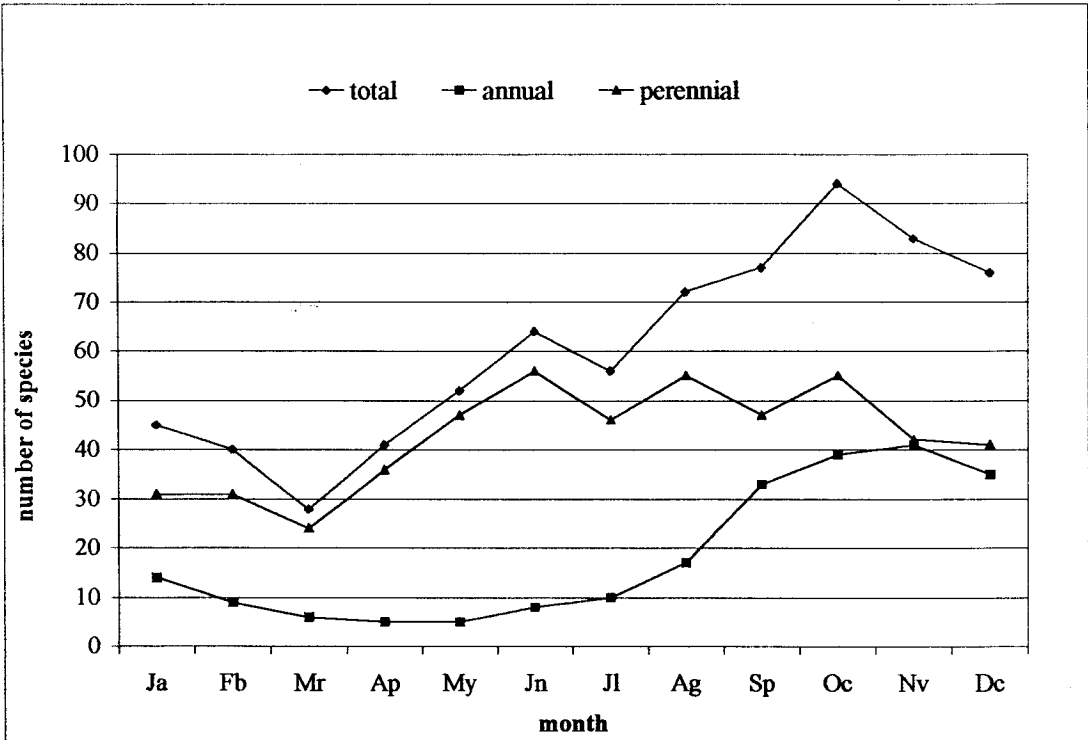


Figure 6 Flowering phenology of the vascular ground flora in the study area (March 2001- February 2002)

Table 2 Flowering ground flora found at Mai Muang Nao Arboretum during March 2001-February 2002 *

Family	Botanical name	Voucher number	Abundance	Life mode	Habit	Habitat	Leafing	Flowering	Fruiting	Figure	Plate
Acanthaceae	<i>Barleria cristata</i> L. *	294	4	pd/gro	h	1	My - Fb	Sp - Nv	Sp - Fb	-	10A
	<i>Hygrophila intermedia</i> Imlay	397	3	pe/gro, epl	h	3	Ja - Dc	Ja - Fb	Fb - My	-	-
	<i>Hygrophila phlomoides</i> Nees *	275, 396	2	pd/gro, aqu	h	2	My - Fb	Ag - Ja	Ag - Oc	-	-
	<i>Justicia procumbens</i> L. *	264	3	a/gro	h	1, 2	JI - Dc	Ag - Nv	Sp - Ja	24	-
	<i>Perilepta siamensis</i> (Cl.) Brem. *	366	4	pd/gro	h	1	My - Ja	Nv - Dc	Dc - Fb	-	10B
	<i>Rungia parviflora</i> (Retz.) Nees	283	4	a/gro	h	1	Ag - Nv	Sp - Oc	Sp - Nv	25	-
	<i>Sericocalyx quadrifarius</i> (Wall. ex Nees) Brem. *	288	4	pd/gro	h	3	JI - Fb	Sp - Nv	Nv - Fb	-	-
	<i>Strobilanthes anfractuosus</i> Cl. ex Hoss.	386	3	pe/gro, epl	h	3	Ja - Dc	Dc - Ja	Dc - Ja	-	10C
	<i>Strobilanthes apricus</i> (Hance) T. And. var. <i>pedunculatus</i> (Craib) Ben. *	364	3	pd/gro	h	1	Jn - Fb	Nv - Ja	Nv - Fb	-	10D
	<i>Thunbergia similis</i> Craib	233	3	pd/gro	v	1	Jn - Dc	JI - Ag	JI - Sp	-	-
Amaryllidaceae	<i>Crinum wattii</i> Baker *	217	2	pd/gro	h	1	Ap - Nv	My - Jn	Jn - Oc	7	-
Araceae	<i>Arisaema praerit</i> Hk. f. *	191	3	pd/gro	h	1	Jn - Oc	Jn - JI	Ag - Ja	-	1A
Aristolochiaceae	<i>Aristolochia kerrii</i> Craib *	163	3	pd/gro	v	1	Ap - Oc	Ap - Jn	?	26	-
Asclepiadaceae	<i>Ceropegia sootepensis</i> Craib *	195	2	pd/gro	v	1	Ap - Sp	Ap - Jn	JI - Sp	-	10E
Balsaminaceae	<i>Impatiens chinensis</i> L.	207	4	pe/gro, aqu	h	2	Ja - Dc	Mr - Dc	Mr - Dc	-	11A
	<i>Impatiens craddockii</i> Hk. f. *	221	2	a/gro	h	1	JI - Nv	JI - Oc	Ag - Nv	-	11B
Begoniaceae	<i>Begonia integrifolia</i> Dalz. *	245	2	pd/gro	h	3	JI - Sp	JI - Ag	?	27	-
Burmanniaceae	<i>Burmannia coelestis</i> D. Don *	329	2	a/gro	h	2	Nv - Ja	Nv - Ja	Nv - Ja	-	1C
Campanulaceae	<i>Lobelia heyntiana</i> Roem. & Schult. *	325	3	a/gro	h	1, 2	Ag - Dc	Oc - Dc	Oc - Dc	28	-
	<i>Lobelia nicotianaeifolia</i> Roth ex Roem. & Schult.	400	1	pd/gro	h	1, 3	Jn - Mr	Ja - Fb	Fb - Ap	-	11E
	<i>Lobelia zeylanica</i> L.	274	2	a/gro	h	2, 3	Jn - Dc	JI - Dc	JI - Dc	28	-
Caryophyllaceae	<i>Drymaria diandra</i> Bl. *	391	4	a/gro	h	1, 3	Oc - Ja	Nv - Dc	Nv - Fb	29	-
Commelinaceae	<i>Aneilema sinicum</i> Lindl. *	178, 267	4	pd/gro	h	1, 3	Ap - Oc	My - Jn	My - Sp	10	1E
	<i>Commelina diffusa</i> Burm. f.	292	3	pe/gro	h	3	Ja - Dc	Sp - Oc	Sp - Nv	8	-

* species described, ** for abbreviations see p. 28

Table 2 (continued)

	<i>Commelina padulosa</i> Bl. *	276	3	pe/gro	h	3	My - Nv	Ag - Sp	Sp - Oc	8	-
	<i>Cyanotis barbata</i> D. Don	306	4	pd/gro	h	1	Jy - Nv	Sp - Oc	Sp - Nv	9	-
	<i>Cyanotis cristata</i> (L.) D. Don *	261	4	a/gro	h	1, 2	Ag - Nv	Sp - Oc	Sp - Nv	9	-
	<i>Floscopa scandens</i> Lour. *	331	3	pe/gro	v	3	Ja - Dc	Nv - Dc	Nv - Ja	-	3A
	<i>Murdannia gigantea</i> (Vahl) Bruck.	249	4	pd/gro	h	1	Ag - Fb	Ag - Nv	Nv - Ja	-	3B
	<i>Murdannia japonica</i> (Thunb.) Faden	266	3	pd/gro	h	1	Jl - Oc	Ag - Oc	Sp - Oc	10	-
	<i>Murdannia loureirii</i> (Hance.) Rao ex Kam.	176	4	pd/gro	h	1	My - Ag	My - Jn	Jn - Jl	-	3C
	<i>Murdannia nudiflora</i> (L.) Bren.	322	3	a/gro	h	1, 2	Jl - Nv	Ag - Sp	Sp - Oc	10	-
	<i>Murdannia scapiflora</i> (Roxb.) Royle *	137, 184	4	pd/gro	h	1	My - Ag	Mr - Ap	Ap - Jn	-	3D
	<i>Anaphalis adnata</i> DC.	345	3	a/gro	h	1	My - Dc	Nv - Dc	Nv - Fb	-	-
	<i>Artemisia japonica</i> Thunb. var. <i>japonica</i> *	139	4	pd/gro	h	1	Jy - Ja	Oc - Dc	No - Mr	-	-
	<i>Blumea fistulosa</i> (Roxb.) Kurz *	146	5	a/gro	h	1	Nv - Ap	Dc - Mr	Mr - My	30	12A
	<i>Blumea mollis</i> (D. Don) Merr.	416	3	a/gro	h	3	Dc - Ap	Ja - Fb	Fb - Ap	30	-
	<i>Blumea napifolia</i> DC.	403	4	a/gro	h	3	Oc - Mr	Ja - Fb	Fb - Mr	30	-
	<i>Blumeopsis flava</i> (DC.) Gagnep. *	375	5	a/gro	h	1	Sp - Fb	Dc - Ja	Dc - Mr	30	-
	<i>Conyza leucantha</i> (D. Don) Lud. & Rav. *	389	3	pd/gro	h	1	Sp - Fb	Dc - Ja	Dc - Fb	-	-
	<i>Conyza sumatrensis</i> (Retz.) Walk.	166	4	a/gro	h	1	Mr - Oc	Ap - Jn	Ap - Ag	-	-
	<i>Cosmos sulphureus</i> Cav.	349	3	a/gro, esc	h	1	Oc - Dc	Oc - Nv	Oc - Ja	-	-
	<i>Crassocephalum crepidioides</i> (Benth.) S. Moore *	385	3	a/gro, nat	h	2	Jl - Fb	Oc - Ja	Nv - Mr	-	13B
	<i>Crepis lignea</i> (Vant.) Bab. *	182	3	pd/gro	h	1	Jn - Sp	Ap - Jn	My - Jn	-	12B
	<i>Cyathocline purpurea</i> (Ham. ex D. Don) O. K.	398	3	a/gro, epl	h	3	Nv - Ap	Ja - Fb	Mr - Ap	-	-
	<i>Elephantopus scaber</i> L. ssp. <i>scaber</i> var. <i>scaber</i> *	304	3	pe/gro	h	1	Ja - Dc	Sp - Oc	Sp - Ja	31	-
	<i>Eupatorium doichangense</i> H. Koy. *	312	3	pd/gro	h	1	Jn - Nv	Sp - Oc	Oc - Dc	32	-
	<i>Gynura himpomensis</i> H. Koy. *	399	2	pd/gro	h	3	Sp - Mr	Ja - Fb	Fb - Mr	-	-
	<i>Gynura pseudochina</i> (L.) DC.	198	3	pd/gro	h	1	My - Ag	Jn - Jl	Jl - Ag	-	13A
	<i>Inula cappa</i> (Ham. ex D. Don) DC. <i>forma cappa</i>	343	3	pd/gro	h	1	Ag - Fb	Nv - Dc	Dc - Fb	-	13D
	<i>Inula indica</i> L.	374	3	pd/gro	h	1	My - Fb	Dc - Ja	Dc - Mr	-	13E
	<i>Inula nervosa</i> Wall. ex DC. *	363	4	pd/gro	h	1	Oc - Dc	Nv - Dc	Dc - Ja	-	13F

Table 2 (continued)

	<i>Inula wismanniana</i> Hand.-Mzt. <i>forma wismanniana</i>	401	2		pd/gro	h	1, 3	Jl - Mr	Ja - Fb	Fb - Ap	-	-
	<i>Lactuca parishii</i> Craib *	422	2		pd/gro	h	3	Nv - Mr	Ja - Fb	Fb - Mr	33	-
	<i>Laggera alata</i> (D. Don) Sch.-Bip. ex Oliv.	393	4		pd/gro	h	1	Nv - Mr	Dc - Fb	Ja - Ap	-	-
	<i>Laggera</i> sp.	405	4		pd/gro	h	1	Jl - Mr	Dc - Fb	Ja - Ap	-	-
	<i>Piloselloides hirsuta</i> (Forsk.) C. Jeff. *	170	4		pd/gro	h	1	Ap - Oc	My - Jn	My - Jl	-	12C
	<i>Pluchea polygonata</i> (DC.) Gagnep. *	144	3		pd/gro	h	1	Oc - Ap	Dc - Mr	Fb - Ap	-	13C
	<i>Saussurea peguensis</i> Cl.	407	2		pd/gro	h	1	Jl - Fb	Dc - Ja	Ja - Fb	-	-
	<i>Spilanthes tabadicensis</i> A. H. Moore *	390	4		a/gro	h	2, 3	Ja - Dc	Ja - Dc	Ja - Dc	-	-
	<i>Vernonia cinerea</i> (L.) Less. var. <i>cinerea</i>	145	3		pd/gro	h	1	Nv - Jn	Ja - Mr	Oc - Ap	34	-
	<i>Vernonia squarrosa</i> (D. Don) Less. var. <i>orientalis</i> Kit.	271	4		pd/gro	h	1	Jn - Nv	Ag - Oc	Sp - Nv	34	12D
	<i>Vernonia sutezensis</i> Kerr *	356	2		pd/gro	h	3	My - Fb	Nv - Dc	Nv - Ja	34	-
Convolvulaceae	<i>Argyreia kerrii</i> Craib *	230	2		pd/gro	v	1	Jl - Dc	Jl - Ag	Jl - Dc	-	11C
	<i>Ipomoea siamensis</i> Craib	242	2		pd/gro	v	1	Jl - Nv	Ag - Sp	Ag - Ja	-	-
Cyperaceae	<i>Carex continua</i> Cl. *	225	4		pd/gro	h	1	My - Fb	Jl - Oc	Jl - Dc	-	-
	<i>Carex cruciata</i> Vahl.	394	4		pd/gro	h	1	Ja - Dc	Dc - Fb	Dc - My	-	-
	<i>Cyperus cyperoides</i> (L.) O.K. *	177	3		pd/gro	h	1	My - Sp	My - Jn	My - Ag	-	-
	<i>Cyperus flavidus</i> Retz.	228	3		a/gro	h	2	Jn - Sp	Jl - Sp	Jl - Sp	-	-
	<i>Cyperus pilosus</i> Vahl	238	2		pd/gro	h	2	Jn - Ag	Jl - Ag	Jl - Ag	-	-
	<i>Cyperus triceps</i> (Roth.) Engl.	214	2		pd/gro	h	1	My - Ag	Jn - Jl	Jn - Ag	-	-
	<i>Fimbristylis cinnamometorum</i> (Vahl) Kunth	226	3		pd/gro	h	1	Jn - Sp	Jl - Ag	Jl - Ag	-	-
	<i>Fimbristylis fusca</i> (Nees) Cl.	168	3		pd/gro	h	2	My - Ag	My - Ag	My - Ag	-	-
	<i>Fimbristylis miliacea</i> (L.) Vahl	256	4		a/gro	h	2	Ag - Sp	Ag - Sp	Ag - Sp	-	-
	<i>Fimbristylis straminea</i> Turrill	282	4		a/gro	h	1	Ag - Oc	Sp - Oc	Sp - Oc	-	-
	<i>Fimbristylis thomsonii</i> Boeck *	156	4		pd/gro	h	1	Mr - Ag	Mr - Jn	Mr - Ag	11	-
	<i>Fimbristylis yunnanensis</i> Cl.	215	4		pd/gro	h	1	My - Ag	Jn - Ag	Jn - Ag	-	-
	<i>Fuierena ciliaris</i> (L.) Roxb.	239	2		pe/gro, aqu	h	2	Jl - Ag	Jl - Ag	Jl - Ag	-	-

Table 2 (continued)

	<i>Rhynchospora hirticeps</i> (Kuk.) T. Koy.	227	3		pd/gro	h	1	Jn - Sp	Jl - Ag	Jl - Sp	-	-
	<i>Scirpus mucronatus</i> L.	205	3		pe/gro, aqu	h	2	leafless	My - Ag	My - Ag	-	1B
	<i>Scleria terrestris</i> (L.) Fass.	181	3		pd/gro	h	1	Jn - Nv	My - Oc	My - Oc	-	-
Droseraceae	<i>Drosera burmannii</i> Vahl	392	3		pd/gro	h	2	Nv - Fb	Nv - Fb	Nv - Fb	35	-
	<i>Drosera peltata</i> J. E. Sm. ex Willd. *	197	5		pd/gro	h	1	Jn - Ag	Jn - Jl	Jl - Ag	35	-
Eriocaulaceae	<i>Eriocaulon gracile</i> Mart. *	379	3		a/gro	h	2	Ag - Ja	Sp - Ja	Sp - Ja	12	-
	<i>Eriocaulon oryzetorum</i> Mart.	255	3		a/gro, aqu	h	2	Ag - Dc	Ag - Oc	Ag - Dc	12	-
Euphorbiaceae	<i>Sauropus bicolor</i> Craib *	180	4		pd/gro	h	1	Mr - Oc	Ap - Ag	Jl - Oc	36	-
Gentianaceae	<i>Canescora diffusa</i> (Vahl) G. Don *	136	2		a/gro, epl	h	3	Dc - Mr	Dc - Mr	Dc - Mr	37	-
	<i>Exacum tetragonum</i> Roxb. *	334	2		a/gro	h	3	Oc - Nv	Nv	?	37	-
	<i>Gentiana timida</i> Kerr *	173	3		pd/gro	h	1	Oc - Ja	Mr - Jn	?	-	11D
	<i>Swerthia angusifolia</i> Ham. ex D. Don *	309	3		a/gro	h	1	Ag - Dc	Sp - Nv	Oc - Fb	-	-
Gramineae	<i>Alloteropsis semialata</i> Hitch. var. <i>semialata</i>	179	5		pd/gro	h	1	Ap - Sp	My - Jl	My - Jl	-	-
	<i>Arthraxon hispidus</i> (Thunb.) Makino var. <i>hispidus</i> *	338	4		a/gro	h	1	Ag - Ja	Sp - Ja	Sp - Ja	13	-
	<i>Arundinella setosa</i> Trin. var. <i>setosa</i>	336	5		pd/gro	h	1	Jl - Ja	Oc - Nv	Oc - Dc	14	-
	<i>Capillipedium parviflorum</i> (R. Br.) Stapf *	340	5		pd/gro	h	1	Ap - Ja	Oc - Dc	Oc - Dc	15	-
	<i>Heieropogon contortus</i> (L.) P. Beauv. ex Roem. & Schult.	320	5		pd/gro	h	1, 2	Jl - Nv	Sp - Oc	Oc - Ja	-	-
	<i>Hyparrhenia rufa</i> (Nees) Stapf	368	5		pd/gro	h	1	Ag - Ja	Nv - Ja	Nv - Ja	-	-
	<i>Pseudopogonatherum contortum</i> (Brongn.) A. Camus	367	5		pd/gro	h	1	Sp - Ja	Nv - Dc	Nv - Dc	-	-
	<i>Sacciolepis indica</i> (L.) A. Chase *	337	4		a/gro	h	1, 2	My - Dc	Oc - Dc	Oc - Dc	16	-
	<i>Setaria parviflora</i> (Poir.) Kerg.	339	5		a/gro	h	1	Jn - Dc	Oc - Dc	Oc - Dc	17	-
	<i>Sporolobus indicus</i> (L.) R. Br. var. <i>flaccidus</i> (Roem. & Schult.) Veldk.	301	4		pd/gro	h	1	My - Dc	Oc - Nv	Oc - Ja	-	-
	<i>Themeda triandra</i> Forssk.	360	4		pd/gro	h	1	My - Dc	Oc - Nv	Oc - Dc	-	-
	<i>Urochloa ruizizensis</i> (Germ. & Eyr.) Morr. & Zul.	323	4		pd/gro, nat	h	1	Ag - Dc	Oc - Nv	Ag - Dc	18	-
Guttiferae	<i>Hypericum japonicum</i> Thunb. *	157	3		a/gro	h	2	Ja - Dc	Ja - Dc	Ja - Dc	-	-

Table 2 (continued)

Labiales	<i>Elsholtzia winitiana</i> Craib *	381	3	pd/gro	h	1	Oc - Ja	Dc - Ja	Ja	-	14E
	<i>Gomphostemma strobilinum</i> Wall. ex Benth. var. <i>acutalis</i> (Kurz ex Hk. f.) Prain *	287	3	pd/gro	h	3	Ag - Dc	Sp - Nv	Nv - Dc	-	14F
	<i>Gomphostemma wallichii</i> Prain	285	2	pd/gro	h	3	Jl - Fb	Sp - Oc	Sp - Dc	-	-
	<i>Hyptis suaveolens</i> (L.) Poit.	348	4	a/gro	h	1	Oc - Dc	Oc - Nv	Oc - Ja	-	-
	<i>Isodon lophanthoides</i> (Buch.-Ham. ex D. Don) H. Hara var. <i>lophanthoides</i> *	377, 388	4	a/gro	h	1/3	Nv - Ja	Dc	Ja	-	15A
	<i>Leucas decedentata</i> (Willd.) J. Sm. *	257	4	pd/gro	h	1	My - Dc	Ag - Oc	Ag - Dc	-	-
	<i>Orthosiphon rubicundus</i> (D. Don) Benth. *	148	4	pd/gro	h	1	Ap - Oc	Ap - Jn	Ap - Ag	-	15B
	<i>Pogostemon auricularius</i> (L.) Hassk.	253	2	pd/gro, aqu	h	2	Jn - Oc	Ag - Sp	Sp - Oc	38	15C
	<i>Pogostemon cruciatus</i> (Benth.) Kuntz *	380	2	pd/gro	h	2	Nv - Ja	Dc - Ja	Ja	38	-
	<i>Pogostemon pentagonus</i> (C. B. Clark ex Hk. f.) Kuntz	203	3	pe/gro, aqu	h	2	Jn - Dc	Jn - Oc	Jl - Oc	38	-
	<i>Salvia riparia</i> Kunth *	409	3	pd/gro, nat	h	1	Sp - Mr	Dc - Ja	Ja - Mr	39	-
	<i>Scutellaria glandulosa</i> Hk. f. *	153	5	pd/gro	h	1	Mr - Oc	Mr - My	Ap - Jl	-	15E
	<i>Teucrium quadrifarium</i> Buch.-Ham. ex D. Don *	332	3	pd/gro	h	1, 3	Jn - Dc	Oc - Nv	Nv - Dc	39	-
	<i>Leea indica</i> (Burm. f.) Merr. *	192	4	pe/gro	h	1	Ap - Ja	Jn - Jl	Jn - Nv	-	14A
	<i>Chamaecrista leschenaultiana</i> (DC.) Degener *	295	2	a/gro	h	1	Ag - Nv	Sp - Oc	Sp - Nv	-	16A
Leguminosae, Caesalpinioideae	<i>Aeschomene americana</i> L.	324	4	a/gro, nat	h	1, 2	Sp - Nv	Sp - Nv	Sp - Dc	-	-
Papilionoideae	<i>Clitoria macrophylla</i> Wall. ex Benth. *	321	3	pd/gro	v	1	Jl - Nv	Ag - Sp	Ag - Nv	-	16B
	<i>Crotalaria acicularis</i> Ham. ex Benth.	362	3	a/gro	h	1	Nv - Dc	Nv - Dc	Nv - Ja	-	-
	<i>Crotalaria alata</i> D. Don	300	4	a/gro	h	1	Ag - Dc	Sp - Nv	Sp - Dc	-	-
	<i>Crotalaria albida</i> Heyne ex Roth	371	3	a/gro	h	1	Nv - Dc	Nv - Dc	Nv - Dc	-	-
	<i>Crotalaria calycina</i> Schrank *	297	3	a/gro	h	1	Ag - Dc	Sp - Nv	Sp - Dc	-	16C
	<i>Crotalaria dubia</i> Grah. ex Benth.	383	2	a/gro	h	1	Nv - Dc	Nv - Dc	Nv - Dc	-	-
	<i>Crotalaria ferruginea</i> Grah. ex Benth.	346	4	a/gro	h	1	Oc - Ja	Nv - Dc	Nv - Fb	-	-
	<i>Crotalaria melanocarpa</i> Wall. ex Benth.	365	3	a/gro	h	1	Nv - Dc	Nv - Dc	Nv - Dc	-	-

Table 2 (continued)

Lentibulariaceae	<i>Crotalaria montana</i> Heyne ex Roth var. <i>montana</i>	361	4	a/gro	h	l	Oc - Dc	Nv - Dc	Nv - Fb	-	-
	<i>Crotalaria nerifolia</i> Wall. ex Benth.	359	2	pd/gro	h	l	Oc - Dc	Nv - Dc	Nv - Dc	-	16D
	<i>Crotalaria sessiliflora</i> L.	302	4	pd/gro	h	l	Ag - Dc	Oc - Nv	Oc - Dc	-	16E
	<i>Desmodium heterocarpon</i> (L.) DC. ssp. <i>heterocarpon</i> var. <i>heterocarpon</i>	314	4	pd/gro	h	l	Jl - Fb	Oc - Nv	Oc - Fb	-	-
	<i>Desmodium kurzianum</i> (O.K.) Oha.	372	2	pd/gro	h	l	Jl - Dc	Nv - Dc	Nv - Dc	-	-
	<i>Desmodium laxiflorum</i> DC. ssp. <i>laxiflorum</i>	289	2	pd/gro	h	3	Jl - Ja	Sp - Oc	Sp - Ja	-	-
	<i>Desmodium microphyllum</i> (Thunb. ex Murr.) DC.	140	4	pd/gro	h	1,2	Bb - Oc	Dc - Mr	Mr - Jl	-	-
	<i>Desmodium motorium</i> (Houtt.) Merr.	316	4	pd/gro	h	l	Ag - Dc	Oc	Oc - Ja	-	-
	<i>Desmodium oblongum</i> Wall. ex Benth.	344	4	pd/gro	v, h	l	Sp - Dc	Nv - Dc	Nv - Ja	-	-
	<i>Desmodium pulchellum</i> (L.) Benth.	355	2	pd/gro	h	1,3	My - Dc	Nv	Nv - Dc	-	-
	<i>Desmodium velutinum</i> (Willd.) DC. ssp. <i>velutinum</i> var. <i>velutinum</i> *	315	2	pd/gro	h	l	Jn - Ja	Sp - Oc	Sp - Ja	-	16F
	<i>Dunbaria bella</i> Prain *	141	5	pd/gro	v	l	Jn - Mr	Oc - Fb	Dc - Fb	-	-
	<i>Eriosema chinense</i> Vog. *	155	4	pd/gro	h	l	Ap - Ja	Ap - Ag	My - Dc	-	-
	<i>Flemingia strobilifera</i> Craib *	342	3	pd/gro	h	l	Sp - Fb	Nv - Dc	Nv - Fb	-	-
	<i>Indigofera caloneura</i> Kurz	165, 404	3	pd/gro	l	l	Ap - Fb	My - Jn	Jn - Fb	-	-
	<i>Indigofera colutea</i> (Burm. f.) Merr.	237	3	pd/gro	s	l	My - Dc	Jl - Ag	Ag - Dc	-	-
	<i>Indigofera spicata</i> Forssk. var. <i>spicata</i> *	305	3	pd/gro	h	l	Ap - Ja	Ag - Oc	Sp - Dc	-	-
	<i>Indigofera squalida</i> Prain	186, 296	3	pd/gro	h	l	My - Nv	Jn - Jl	Ag - Oc	-	-
	<i>Lespedeza parviflora</i> Kurz	384	3	pd/gro	s, l	l	Oc - Ja	Dc	Dc - Fb	-	-
	<i>Smithia ciliata</i> Roy. *	299	4	a/gro	h	l	Ag - Nv	Sp - Oc	Sp - Nv	-	-
	<i>Utricularia hirta</i> Klein ex Link *	370	2	a/gro	h	2	microscopic	Nv - Dc	Nv - Dc	40	-
	<i>Utricularia minutissima</i> Vahl	278	2	a/gro	h	2	microscopic	Ag - Dc	Ag - Dc	40	-
	<i>Utricularia scandens</i> Benj.	279	2	a/gro	v	2	microscopic	Ag - Dc	Ag - Dc	40	-
Liliaceae	<i>Asparagus filicinus</i> Ham. ex D. Don *	174	3	pd/gro	h	l	Mr - Dc	Ap - My	?	19	-
	<i>Chlorophyllum intermedium</i> Craib	208	2	pd/gro	h	l	Mr - Oc	Jn - Jl	Jn - Oc	-	4A
	<i>Dianella ensifolia</i> (L.) DC.	376	3	pd/gro	h	l	Oc - Mr	Dc - Ja	Ja - Mr	-	4B

Table 2 (continued)

	<i>Disporum calcaratum</i> Wall. ex D. Don *	154, 241	3	pd/gro	h	l	Ap - Ja	Ap - Jn	Jl - Nv	-	4C
	<i>Iphigenia indica</i> (L.) Gray ex Kunth *	250	2	pd/gro	h	l	Ag - Nv	Ag	Ag - Dc	20	-
	<i>Ophiopogon longifolius</i> Deene.	172	3	pd/gro	h	l	My - Ja	Ap - Jn	Jn - Ja	21	4D
	<i>Paris polyphylla</i> J. E. Sm. *	175	2	pd/gro	h	3	My - Nv	My - Jn	Sp - Oc	-	4F
	<i>Peliosanthes teta</i> Andr. ssp. <i>humilis</i> (Andr.) Jessop	204, 244	3	pd/gro	h	l	My - Fb	My - Jn	Jl - Nv	22	-
Loganiaceae	<i>Buddleja asiatica</i> Lour. *	406	3	pd/gro	l	l	My - Fb	Nv - Fb	Ja - Mr	-	-
Lythraceae	<i>Rotula rotundifolia</i> (Ham. ex Roth) Koeh. *	135	4	pe/amp	h	2	Ja - Dc	Fb - My	Ap - Jl	-	-
Malvaceae	<i>Abelmoschus moschatus</i> Medic. ssp. <i>tuberosus</i> (Span.) Borss. *	162	3	pd/gro	h	l	Mr - Oc	Ap - Ag	Ap - Oc	-	14B
	<i>Pavonia repanda</i> (Roxb. ex J. E. Sm.) Spreng. *	341	3	pd/gro	h	l	Sp - Fb	Oc - Nv	Oc - Fb	-	14C
	<i>Urena lobata</i> L. ssp. <i>lobata</i> var. <i>lobata</i>	347	3	pd/gro	h	1, 2	Sp - Fb	Nv - Dc	Nv - Fb	-	-
Melastomataceae	<i>Melastoma malabathricum</i> L. ssp. <i>malabathricum</i> *	219	4	pe/gro	s, l	1, 2	Ja - Dc	Mr - Oc	Ap - Nv	-	17A
	<i>Osbeckia chinensis</i> L. var. <i>chinensis</i>	152	3	pd/gro	h	2	Ap - Oc	Ap - Jn	Ap - Oc	-	17B
	<i>Sonerilia erecta</i> Jack *	326	4	u/gro	h	l	Sp - Dc	Oc - Nv	Nv - Dc	-	-
Myrsinaceae	<i>Ardisia crenata</i> Sims var. <i>crenata</i> *	189	4	pe/gro	h	1, 2	Ja - Dc	Ap - Jn	My - Dc	-	14D
Ochnaceae	<i>Ochna integerrima</i> (Lour.) Merr. *	131	3	pd/gro	l	l	Mr - Oc	Fb - Mr	Ap - Ag	-	17C
Orchidaceae	<i>Anthogonium gracile</i> Wall. ex Lindl. *	303	3	pd/gro	h	l	Sp - Nv	Sp - Nv	?	-	5C
	<i>Apostasia wallichii</i> R. Br. *	247	1	pd/gro	h	l	My - Fb	Ag	?	-	-
	<i>Arundina graminifolia</i> (D. Don) Hochr.	248	3	pd/gro	h	l	Jn - Dc	Ag - Oc	Sp - Dc	-	5A
	<i>Brachycorythis henryi</i> (Schltr.) Summ. *	223	1	pd/gro	h	3	Jl - Ag	Jl - Ag	?	-	6E
	<i>Cymbidium ensifolium</i> (L.) Sw. *	160	2	pd/gro	h	l	My - Oc	Ap - Jn	?	-	6A
	<i>Eulophia macrobulbon</i> (Par. & Rehb. f.) Hk. f.	142, 193	2	pd/gro	h	l	My - Sp	Fb - Mr	?	-	6B
	<i>Eulophia spectabilis</i> (Dennst.) Suresh *	159	2	pd/gro	h	l	My - Oc	Ap - Jn	?	-	6C, D
	<i>Geodorum recurvum</i> (Roxb.) Alston	164	2	pd/gro	h	1, 3	My - Sp	My - Jn	?	-	5D
	<i>Habenaria chlorina</i> Par. & Rehb. f. *	236	3	pd/gro	h	l	Ag - Sp	Ag	?	-	7A
	<i>Habenaria dentata</i> (Sw.) Schltr.	286	2	pd/gro	h	1, 3	Ag - Oc	Sp - Oc	?	-	7B
	<i>Habenaria malintana</i> (Blanco) Merr.	319	2	pd/gro	h	l	Sp - Oc	Oc	?	-	-
	<i>Liparis paradoxa</i> (Lindl.) Rehb. f. *	187	3	pd/gro	h	l	My - Jl	Jn - Jl	?	-	7C

Table 2 (continued)

	<i>Pachystoma pubescens</i> Bl.	143	2	pd/gro	h	1	My - Ag	Fb - Mr	Mr - Ap	-	5B
	<i>Pecteilis susannae</i> (L.) Raf. *	317	1	pd/gro	h	1	Sp - Nv	Oc	?	-	5E
	<i>Peristylus constrictus</i> (Lindl.) Lindl.	188	3	pd/gro	h	1, 3	My - Sp	Jn - Jl	?	-	8A
	<i>Peristylus lacertiferus</i> (Lindl.) J. J. Sm.	272	1	pd/gro	h	1	Ag - Oc	Ag - Sp	?	-	-
	<i>Peristylus prairii</i> (Hk. f.) Krzl. *	211	1	pd/gro	h	3	My - Oc	Jn - Jl	?	-	8B
	<i>Phaius tankervilleae</i> (Banks ex L' Her.) Bl.	134	1	pd/gro	h	2	Mr - Sp	Mr - Ap	Ap - Nv	-	7D
	<i>Tainia angustifolia</i> (Lindl.) Benth. ex Hk. f.	284	2	pd/gro, epl	h	3	Jn - Nv	Sp - Oc	?	-	-
	<i>Tainia viridiflora</i> (Hk. f.) Benth. & Hk. f. *	412	1	pd/gro	h	3	Jn - Dc	Ja - Fb	?	-	-
	<i>Zeuxine affinis</i> (Lindl.) Benth. ex Hk. f.	421	2	pd/gro	h	3	Oc - Mr	Fb - Mr	?	-	-
Orobanchaceae	<i>Aeginetia indica</i> Roxb.	265	3	pd/par	h	1, 3	leafless	Ag - Oc	Oc - Ja	-	17D
	<i>Aeginetia pedunculata</i> Wall. *	311	2	pd/par	h	1	leafless	Oc	Oc - Dc	-	17E
Oxalidaceae	<i>Biophytum umbraculum</i> Welw. *	258	4	a/gro	h	1, 2	Ag - Nv	Ag - Sp	Ag - Nv	-	17F
Palmae	<i>Phoenix loureiri</i> Kunth var. <i>loureiri</i> *	133	4	pe/gro	l	1	Ja - Dc	Mr - Ap	Ap - Jn	-	1D
Polygalaceae	<i>Polygala longifolia</i> Poir.	252	3	a/gro	h	1	Ag - Dc	Ag - Nv	Ag - Dc	-	18A
	<i>Polygala persicariifolia</i> DC.	333	2	a/gro	h	1, 3	Sp - Nv	Oc - Nv	Nv - Dc	-	-
	<i>Polygala umbonata</i> Craib *	260	3	a/gro	h	1, 3	Ag - Oc	Ag - Oc	Ag - Oc	-	-
Polygonaceae	<i>Polygonum chinensis</i> L. *	350	3	pd/gro	h	3	Jl - Ja	Oc - Dc	Oc - Ja	4l	-
	<i>Polygonum persicaria</i> L.	206	3	a/gro	h	2	Ja - Dc	Ja - Dc	Ja - Dc	4l	-
Ranunculaceae	<i>Delphinium siamense</i> (Craib) Munz *	270, 281	2	pd/gro	h	1	Jn - Ja	Ag - Dc	Sp - Ja	-	18C
	<i>Ranunculus siamensis</i> Tam. *	147	3	pe/gro, aqu	h	2, 3	Ja - Dc	Mr - Sp	Ap - Sp	-	18B
Rubiaceae	<i>Borreria brachystema</i> (R. Br. ex Benth.) Valet. *	310	4	a/gro	h	1	Sp - Nv	Sp - Oc	Oc - Fb	-	-
	<i>Borreria laevis</i> (Lamk.) Griseb.	190	3	a/gro	h	1, 2	My - Ag	Jn - Jl	Jn - Ag	-	-
	<i>Hedyotis uncinella</i> Hk. & Arn. var. <i>cephalophora</i> Craib	251	3	pd/gro	h	1	Jl - Nv	Ag - Sp	Ag - Nv	-	-
	<i>Knoxia brachycarpa</i> R. Br. ex Hk. f.	200	3	pd/gro	h	1	My - Oc	Jn - Ag	Jl - Oc	-	18D
	<i>Mussaendra parva</i> Wall. ex D. Don	130	4	pe/gro	sc	1	Ja - Dc	Ja - Ap	Mr - Oc	-	-
	<i>Ophiorhiza hispidula</i> Wall. ex G. Don var. <i>hispidula</i> *	209	3	a/gro	h	3	My - Sp	Jn - Jl	Jl - Sp	42	-

Table 2 (continued)

	<i>Pavetta fruticosa</i> Craib *	196	3	pd/gro	h	1	Mr-Nv	Ap-My	My-Sp	-	18E
	<i>Rubia siamensis</i> Craib *	213	3	pd/gro	h	1	My-Nv	Jn-Jl	Jl-Oc	43	-
Rutaceae	<i>Clausena excavata</i> Burm. f. var. <i>villosa</i> Hk. f. *	132	3	pd/gro	h	1	Mr-Nv	Fb-Ap	Ap-Sp	-	-
Scrophulariaceae	<i>Alectra avensis</i> (Benth.) Merr. *	330	3	a/gro	h	1	Oc-Dc	Oc-Dc	Oc-Dc	-	-
	<i>Buchnera cruciata</i> Buch.-Ham. ex D. Don *	308	4	a/gro	h	1	Ag-Dc	Sp-Dc	Sp-Fb	-	19A
	<i>Centranthera cochinchinensis</i> (Lour.) Merr. ssp. <i>cochinchinensis</i> *	327	2	a/gro	h	2	Sp-Nv	Oc-Nv	Oc-Dc	-	-
	<i>Limnophila chinensis</i> (Osbeck) Merr.	291	2	a/gro	h	2	Ag-Nv	Sp-Oc	Sp-Nv	-	-
	<i>Limnophila villifera</i> Miq. ssp. <i>gracilipes</i> (Craib ex Hoss.) Kana.	328	3	a/gro	h	2	My-Dc	Sp-Dc	Nv-Dc	-	19B
	<i>Lindernia pusilla</i> (Willd.) Bold.	202	3	a/gro	h	2	My-Ag	Jn-Jl	Jn-Ag	-	-
	<i>Pedicularis nigra</i> Vaniot ex Bonati *	373	3	pd/gro	h	1	Sp-Fb	Dc-Ja	Dc-Fb	-	19C
	<i>Phtheirospermum parishii</i> Hk. f. *	358	3	a/gro	h	1	Nv-Dc	Nv-Dc	Nv-Dc	-	-
	<i>Sopubia trifida</i> Buch.-Ham. ex D. Don *	335	4	a/gro	h	1	Sp-Dc	Sp-Dc	Sp-Fb	-	-
	<i>Torenia benthamiana</i> Hance *	307	3	a/gro	h	1	Oc-Nv	Oc	Oc-Nv	44	-
	<i>Torenia violacea</i> (Aza. ex Blanco) Pennell	263	2	a/gro	h	1, 2	Jn-Oc	Ag-Sp	Ag-Oc	-	-
Sterculiaceae	<i>Hericteres lanata</i> (Teijsm. & Binn.) Kurz *	222	2	pe/gro	s	1, 3	Mr-Dc	Jn-Jl	Ag-Nv	45	-
Tiliaceae	<i>Grewia abutilifolia</i> Vent. ex Juss. *	161	3	pd/gro	s	1	Ap-Dc	Ap-Ag	Ap-Oc	-	-
	<i>Grewia lacei</i> Drum. & Craib	224	3	pe/gro	l	1	Mr-Dc	Jn-Jl	Jl-Dc	-	-
	<i>Triumfetta pilosa</i> Roth *	280	3	pd/gro	h	1, 2	Jl-Ja	Sp-Oc	Sp-Ja	-	-
Umbelliferae	<i>Heracleum barmanicum</i> Kurz *	318	3	pd/gro	h	1	Jn-Nv	Sp-Oc	Oc-Fb	-	-
	<i>Pimpinella cambodgiana</i> H. Boiss. *	199	5	pd/gro	h	1	My-Nv	Jn-Oc	Jl-Dc	-	19D
Urticaceae	<i>Pilea trinervia</i> Wight	268	3	a/gro	h	3	Jl-Dc	Jl-Oc	Ag-Nv	46	-
	<i>Pouzolzia pentandra</i> (Roxb.) Benn. *	183	4	pd/gro	h	1, 2	Ap-Dc	My-Ag	Jl-Nv	-	19E
Verbenaceae	<i>Clerodendrum serratum</i> (L.) Moon var. <i>wallichii</i> Cl. *	235	2	pd/gro	s	1	My-Dc	Jl-Ag	Jl-Oc	-	-
	<i>Premna herbacea</i> Roxb. *	171	4	pd/gro	h	1	Mr-Oc	Mr-My	My-Ag	-	19F
	<i>Premna nana</i> Coll. & Hemsl.	185	3	pd/gro	h	1	Ap-Ag	My-Jn	Jn-Jl	-	-
Violaceae	<i>Viola betonaetifolia</i> J. E. Sm. *	138	2	pd/gro	h	2	Fb-Nv	Mr-Jn	Mr-Jl	-	-

Table 2 (continued)

Xyridaceae	<i>Xyris capensis</i> Thunb. *	277	3	pd/gro	h	2	Ag - Dc	Ag - Nv	Ag - Dc	23	-
Zingiberaceae	<i>Costus speciosus</i> (Koeh.) J. E. Sm. *	246	2	pd/gro	h	3	My - Ja	Ag - Sp	Ag - Nv	-	8C
	<i>Curcuma ecomata</i> Craib	167	3	pd/gro	h	1, 3	Jn - Oc	Ap - Jn	?	-	9A
	<i>Curcuma parviflora</i> Wall.	259	2	pd/gro	h	1	Jl - Oc	Jl - Oc	?	-	9B
	<i>Curcuma zeadoria</i> (Berg.) Rosc. *	194	5	pd/gro	h	1	My - Oc	Mr - My	?	-	9C
	<i>Globba reflexa</i> Craib *	169	4	pd/gro	h	1	Ap - Sp	Ap - My	My - Ag	-	-
	<i>Globba</i> sp.	212	2	pd/gro	h	3	My - Oc	Jn - Jl	Ag - Sp	-	9D
	<i>Hedychium gardnerianum</i> Rosc.	290	3	pd/gro	h	3	Mr - Dc	Ag - Oc	Ag - Dc	-	8D
	<i>Kaempferia rotunda</i> L. *	149, 240	4	pd/gro	h	1	My - Sp	Ap - My	?	-	8E
	<i>Zingiber parishii</i> Hk. f. *	243	2	pd/gro	h	3	Jl - Oc	Ag - Sp	?	-	9E
	<i>Zingiber</i> sp.	262, 357	4	pd/gro	h	1, 3	Jn - Dc	Ag - Oc	Oc - Dc	-	-

Table 3 Pteridophyte ground flora found at Mai Muang Nao Arboretum during March 2001 – February 2002

Family	Botanical name	Voucher number	Abundance **	Life mode **	Habit **	Habitat **	Leafing	Strobili/sori	Figure
Dennstaedtiaceae	<i>Hypolepis punctata</i> (Thunb.) Mett. ex Kuhn	423	2	pd/gro	h	3	Ja – Dc	Fb – Mr	-
Dryopteridaceae	<i>Dryopteris cochleata</i> (D. Don) C. Chr.	352	4	pd/gro	h	1, 3	My – Fb	Nv	-
Equisetaceae	<i>Equisetum debile</i> Roxb. ex Vauch.	293	4	pe/gro	h	2, 3	Ja – Dc	Ja – Dc	-
Lycopodiaceae	<i>Lycopodium cernuum</i> L.	395	2	pd/gro	h	1	Nv – Mr	Dc – Ja	-
Oleandraceae	<i>Nephrolepis delicatula</i> (Dcne.) Pichi-Ser.	351	3	pd/gro, epl	h	3	Jl – Fb	Nv	47
Parkeriaceae	<i>Adiantum philippense</i> L.	210	3	pd/gro, epl	h	1, 3	My – Oc	Mr – Ag	-
	<i>Onychium siliculosum</i> (Desv.) C. Chr.	411	2	pd/gro	h	2	Jn – Dc	Fb	47
	<i>Pityrogramma calomelanos</i> (L.) Link. *	415	2	pd/gro, epl	h	3	Jn – Mr	Fb	-
Polypodiaceae	<i>Arthromeris tatsienensis</i> (French. & Bureau ex Christ) Ching	234	3	pd/gro	h	1	My – Ja	Jl	48
Pteridaceae	<i>Pteris biauaria</i> L.	353	3	pe/gro	h	3	Jn – Mr	No – Fb	-
	<i>Pteris ensiformis</i> Burm. f.	414	3	pd/gro	h	3	My – Fb	Fb	-
	<i>Pteris venusta</i> Kunze *	354	4	pd/gro	h	1, 3	Ja – Dc	No – Fb	48
Selaginellaceae	<i>Selaginella kurzii</i> Baker	387	3	a/gro	h	3	Jl – Ja	Nv – Dc	-
	<i>Selaginella ostenfeldii</i> Hieron. *	313	3	pd/gro	h	3	Jn – Oc	Ag – Nv	-
Thelypteridaceae	<i>Thelypteris dentata</i> (Forssk.) St. John	413	3	pe/gro	h	2, 3	Ja – Dc	Fb	-
	<i>Thelypteris nudata</i> (Roxb.) Morton	420	2	pe/gro	h	2	Ja – Dc	Fb	-
	<i>Thelypteris parasitica</i> (L.) Fosb.	218	5	pd/gro	h	2, 3	My – Fb	Jn – Ag	-
	<i>Thelypteris valida</i> (Christ) Tag. & K. Iwats. *	419	3	pe/gro	h	2, 3	Ja – Dc	Fb	-
	<i>Thelypteris xyloides</i> (Kunze) Ching	410	3	pe/gro	h	1, 3	Ja – Dc	Fb	-

Table 4 Summary of the vascular ground flora found at Mai Muang Nao Arboretum during March 2001 – February 2002

group	families	genera	species, subspecies, varieties, and forms
Dicotyledoneae	37	109	158
Monocotyledoneae	12	59	85
Pteridophyta	10	12	19
total	59	180	262

Abbreviations used in Tables 2 and 3

Abundance

- 1 down to a few individuals
- 2 rare
- 3 medium
- 4 common
- 5 abundant

Habitat

- 1 degraded, fire-damaged areas
- 2 marshes
- 3 shaded areas, near the stream

Habit

- h herb
- s shrub
- l treelet
- v vine
- sc scandent

Phenology

- a annual
- pe perennial evergreen
- pd perennial deciduous

Life mode

- aqu aquatic
- amp amphibious
- epl epilithic
- gro ground
- nat naturalized, not native
- 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

key to major groups

1. Plants with strobili or sori.....**Pteridophytes** (p. 245)
1. Plants with flowers and fruits.....**Flowering Plants**
 2. Roots mostly arising from rhizomes, bulbs, or corms; leaves often with parallel venation, sheathing, often without petioles; flowers 3-merous**Monocotyledoneae**
 2. Roots not from rhizomes, bulbs, or corms; leaves mostly pinnately or palmately veined, not sheathing, usually with a petiole; flowers mostly 4-5-merous.....**Dicotyledoneae** (p. 97)

Monocotyledoneae

12 families

key to families

1. Ovary inferior
 2. Flowers regular (actinomorphic); corolla not lipped
 3. Perennials with corms; leaf blades > 30 cm long; perianth not winged, lobes > 50 mm long; stamens 6; ovule 1 per locule**Amaryllidaceae**
 3. Annuals, lacking corms; leaf blades < 3 cm long; perianth winged, lobes < 5 mm long; stamens 3; ovules numerous.....**Burmanniaceae**
 2. Flowers irregular (zygomorphic); corolla lipped
 4. Styles, stigmas, and stamens fused; stamens 2 or pollinia in 2-8 groups; petals present**Orchidaceae**
 4. Style, stigma, and stamen not fused; stamen 1, no pollinia; corolla 3-lobed**Zingiberaceae**
1. Ovary superior
 5. Inflorescence subtended by a spathiform bract (spathe)
 6. Flowers lacking a perianth; stamens on a spadix, numerous, anthers fused 2-4 together (synandria).....**Araceae**
 6. Flowers with sepals and petals; stamens 6, not on a spadix, anther free.....**Palmae**
 5. Inflorescence not subtended by a spathiform bract
 7. Flowers arranged in spikelets; floral parts subtended by glumes
 8. Stem terete with distinct nodes; ligule present; stigmas plumose; spikelets with glumes, lemmas, and paleas.....**Gramineae**
 8. Stem usually trigonous, rarely with nodes or ligules; stigmas not plumose; only glumes present, lacking lemmas and paleas.....**Cyperaceae**

7. Flowers not in spikelets; glumes, lemmas, and paleas absent

9. Inflorescence capitate

10. Flowers bisexual; filaments free; ovules numerous; petals yellow, > 5 mm long

.....**Xyridaceae**

10. Flowers unisexual; filaments connate; ovule one per locule; petals blackish-greyish,
< 2 mm long

Eriocaulaceae

9. Inflorescence various, not capitate

11. Sepals and petals distinct; filaments often villous, staminode anthers (if present)

lobed; leaves spiral.....**Commelinaceae**

11. Perianth present, if with sepals and petals, then the leaves whorled; staminodes
absent.....

Liliaceae

Amaryllidaceae

1 species

Crinum wattii Baker

Deciduous, glabrous, acaulescent, ground herb to c. 80 cm high. **Bulb** globose, whitish-green outside, white and fleshy inside, up to 10 cm diameter. **Leaves** mostly spiral, basal, spreading. **Blades** succulent, ensiform, apex acute, base sheathing; margins entire; venation obscure; dark green above, pale light green beneath; c. 40-70 x 4-6 cm. **Inflorescence** erect, umbellate; peduncle flattened and biconvex, light green, pale maroon or reddish-light green, c. 60 cm long. **Bracts** 2, thin, lanceolate, glabrous, light green-maroonish, c. 7 x 2 cm. **Flowers** several, sessile, regular, 3-merous, slightly fragrant. **Perianth** salverform; tube narrowly cylindric, white, c. 8-11 cm long; lobes 6, spreading, linear-lanceolate, tips acuminate, margins entire, white and greenish at the tips, c. 8-9 x 1.3-1.5 cm. **Stamens** 6, adnate to the base of perianth lobes; anthers dorsifixed, bilocular, linear, dark brown to blackish, c. 2 cm long; filaments purple-violet, whitish at base, c. 5.5 mm long. **Stigma** capitate, shallowly 3-lobed; style dark purple-violet, exerted part c. 7.5 cm from the perianth tube. **Ovary** inferior, ellipsoid, pale light green to pale maroon or reddish-green as on the peduncle, c. 15 x 8 mm; 3-loculed, each locule with one axile ovule. **Fruits** not seen.

Habitat: partly shaded, fire-damaged, degraded, shaded areas along the stream

Phenology: leafing: April-November; flowering: May-June; fruiting: June-October

Abundance: rare

Distribution: northern Thailand, Manipur (northeast India), upper Burma

Distinguishing features: acaulescent herb with globose bulb up to 10 cm diameter; leaves spirally arranged at base, blades ensiform up to c 70 cm long; inflorescence umbellate, peduncle erect up to 60 cm long; perianth white, salverform, tube up to 11 cm long, with 6 spreading lobes

Voucher specimen: 217, 23 June 2001; **Figure** 7

References: Hooker (1894) 280-284; Craib (1912) 10

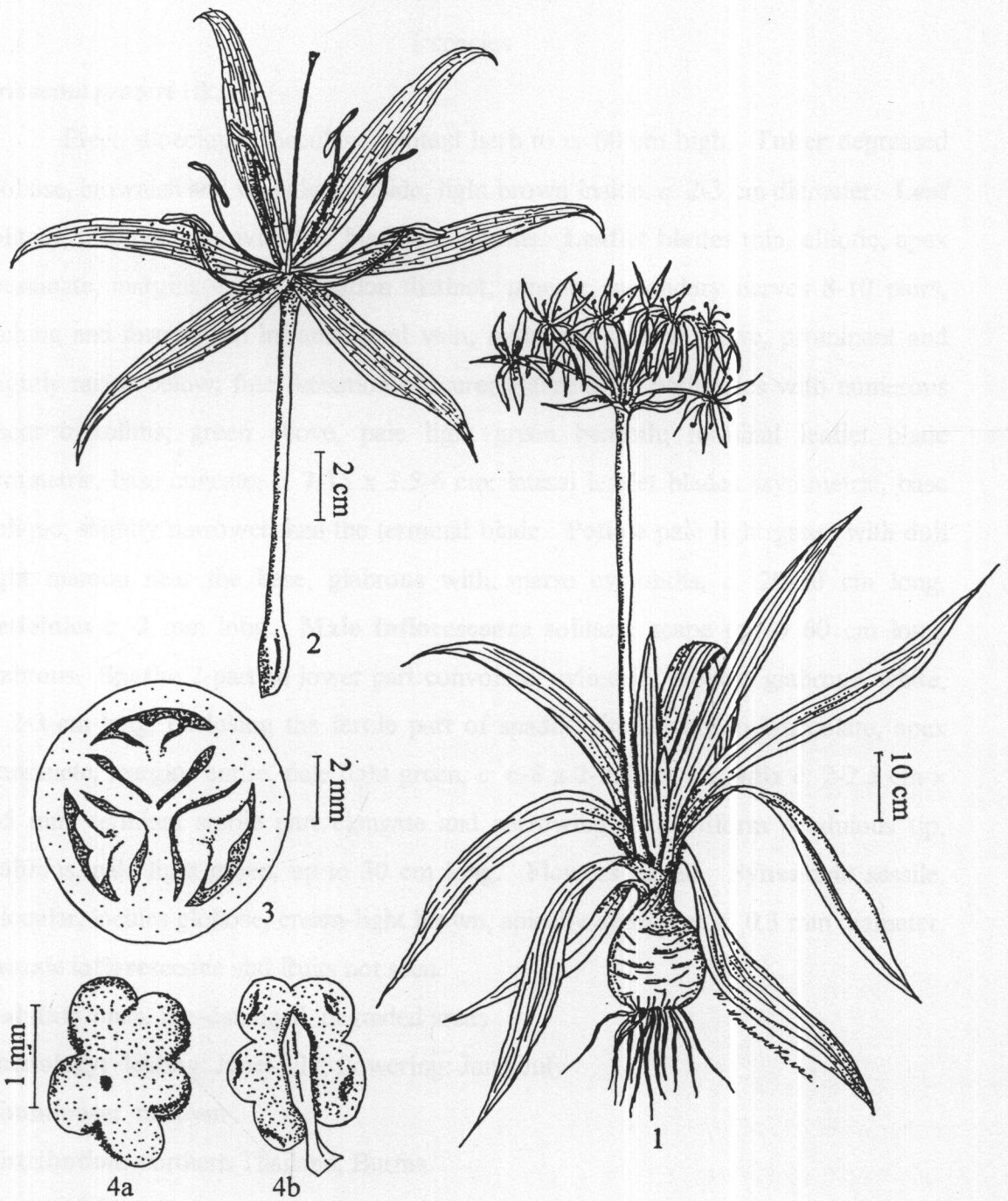


Figure 7 *Crinum wattii* Baker (#217): 1 = habit, 2 = flower, 3 = ovary (x-section),
4a = ovule (ventral side), 4b = ovule (dorsal side)

Araceae

1 species

***Arisaema prazeri* Hk. f.**

Erect, dioecious, succulent, ground herb to *c.* 60 cm high. **Tuber** depressed globose, brownish and wrinkled outside, light brown inside, *c.* 2-3 cm diameter. **Leaf** solitary, trifoliate, and with few bladeless sheaths. **Leaflet blades** thin, elliptic, apex acuminate, margins entire; venation distinct, pinnate, secondary nerves 8-10 pairs, arching and forming an intramarginal vein; midnerve sunken above, prominent and slightly raised below; finer venation obscure; glabrous on both sides with numerous linear cystoliths; green above, pale light green beneath; terminal leaflet blade symmetric, base cuneate, *c.* 7-15 x 3.5-6 cm; lateral leaflet blades asymmetric, base oblique, slightly narrower than the terminal blade. **Petiole** pale light green with dull light maroon near the base, glabrous with sparse cystoliths, *c.* 20-50 cm long. **Petiolules** *c.* 2 mm long. **Male Inflorescence** solitary; scape up to 60 cm long, glabrous. **Spathe** 2-parted; lower part convolute, cylindric, tubular, glabrous, white, *c.* 2-3 cm long, enclosing the fertile part of spadix; limb ovate to lanceolate, apex acuminate, margins entire, pale light green, *c.* 6-8 x 2-2.5 cm. **Spadix** *c.* 2-2.5 cm x 4-5 mm; terminal sterile part elongate and narrowing to a filiform pendulous tip, glabrous, pale light green, up to 30 cm long. **Flowers** naked. **Synandria** sessile, bilocular, locules globose, cream-light brown, apically dehiscent, *c.* 0.3 mm diameter. **Female inflorescence** and fruits not seen.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: June-July; flowering: June-July

Abundance: medium

Distribution: northern Thailand, Burma.

Distinguishing features: succulent herb; leaf solitary, trifoliate; inflorescence

unisexual, spadix subtended by an ovate or lanceolate spathe; spadix with a filiform tip, pendulous, *c.* 30 cm long.

Voucher specimen: 191, 6 June 2001; Plate 2A

References: Hooker (1894) 501; Hu (1968) 455

Burmanniaceae

1 species

Burmannia coelestis D. Don

Erect, delicate, annual, ground herb to c. 30 cm high. **Stem** simple, sub-terete, hollow, glabrous, light green to brownish-green. **Leaves** simple, mostly in basal rosettes, spirally arranged. **Blades** thin, glabrous, pale light green on both sides; rosette blades lanceolate, acuminate, 4-17 x 1.5-3 mm; stem blades mostly adpressed, linear to linear-lanceolate, base decurrent on the stem, c. 10 x 1.5 mm. **Peduncle** with indumentum as on the stem, 10-15 mm long. **Bracts** lanceolate, apex acuminate, glabrous, c. 3-4 x 1 mm. **Flowers** terminal solitary or in a cluster with few flowers, regular, 3-merous. **Perianth** 3-winged the entire length and decurrent on the pedicels, violet-deep blue, c. 13-16 x 2 mm; perianth tube 3 x 2.5 mm long; perianth lobes 6, unequal, outer 3 lobes ovate, tips acuminate, whitish, 2 x 1.5 mm, inner 3 lobes reduced, alternating with the larger lobes, c. 0.5 mm long. **Stamens** 3, sessile, inserted in the perianth tube, below the inner lobes; anthers bilocular, connective divergent, with a peltate crest. **Stigmas** 3, each with 2 lobes; style 1, c. 3 mm long. **Ovary** inferior, trigonous, 5-6 x 2.5-3 mm; 3-loculed, each locule with numerous axile ovules. **Capsules** not seen.

Habitat: open marshes

Phenology: flowering and fruiting from November-January

Abundance: rare

Distribution: throughout Thailand, India, Indo-China, southern China, Malaysia, Caroline Islands

Distinguishing features: delicate, erect, herb in open marshes; leaves mostly in a basal rosette, blades lanceolate; flowers solitary or few in cluster, ellipsoid in outline, 3-winged, bluish-violet

Voucher specimen: 329, 3 November 2001; Plate 2 C

Reference: Jonker (1948) 14 (fig.)-15, 17

Commelinaceae

5 genera, 11 species

key to genera

1. Ovary bilocular; inflorescence densely covered with multicellular, gland-tipped indumentum; stamens 6, all fertile..... *Floscopa*
1. Ovary trilocular; inflorescence indumentum not as above; fertile stamens 2-3 or 6
 2. Fertile stamens 6, no sterile anthers; corolla with a distinct tube; filaments with moniliform hairs; inflorescence a scorpioid cyme *Cyanotis*
 2. Fertile stamens 2-3, sterile anthers present; petals all free; filaments glabrous or pubescent, but lacking moniliform hairs; inflorescence otherwise
 3. Two petals well-developed, with 1 reduced; filaments all glabrous..... *Commelina*
 3. Three petals, all well-developed; filaments of the fertile stamens villous
 4. Fertile stamens 2, 1 reduced, 3 sterile..... *Aneilema*
 4. Fertile stamens 3, 3 sterile..... *Murdannia*

Aneilema sinicum Lindl.

Deciduous, decumbent ground herb, rooting at the lower nodes, c. 60 cm tall. **Roots** swollen, brownish outside, white and fleshy inside. **Stem** terete, glabrous, brownish-green to light green. **Leaves** simple, spirally arranged. **Blades** succulent, subcoriaceous, ensiform (linear-lanceolate) apex acute, entire, glabrous; venation parallel, midnerve obscure; dark green above, dull light green beneath; mostly 20-55 cm x 4-17 mm; sheaths villous. **Inflorescence** terminal, lax, scorpioid cymes; 8-15 x 3-5 cm. **Peduncles** glabrous, greenish-white or reddish-pink. **Bracts** thin, leaf-like, merging with reduced upper leaves, apex acuminate, glabrous, light green; 11-26 x 2-4 mm. **Flowers** many, 3-merous. **Sepals** ovate, apex obtuse, incurved, glabrous, translucent white, 4-4.5 x 2-2.5 mm. **Petals** thin, subequal, orbicular, carinate, glabrous, light blue with violet at the base; c. 6-7.5 x 5.5-7 mm. **Stamens** 6; 2 fertile anthers dorsifixed, oblong, bilocular, dark blue; c. 1.5-1.8 mm long; filaments violet and densely, medially villous, dark violet, otherwise glabrous, c. 5-5.5 mm long, widest at the base; staminodes 3, sterile anthers unequally 3-lobed, lobes globose, glabrous, yellow; filaments slender, glabrous, violet, c. 3 mm long; the sixth stamen with a reduced anther and a filaments like the fertile filaments. **Stigma** minute; style glabrous, violet, c. 4-5 mm long. **Ovary** superior, ovoid, 3 locular, each locule with 2

axile ovules. **Capsules** thin-walled, loculicidal, ellipsoid, locules unequal, tip acute, base oblique, glabrous, glossy brown, *c.* 5-6 x 3.5-4 mm. **Seeds** 2 per each locule, ovoid to subglobose, laterally compressed, somewhat 3-angular, tuberculate, greyish-brown, *c.* 2 x 1.5 mm.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: April-October; flowering and fruiting May-September

Abundance: common

Distribution: northern Thailand, Indo-China, southern China

Distinguishing features: succulent, ensiform blades; petals bluish-violet; 2 fertile and a reduced sterile filaments with violet villous; 3 sterile stamens with glabrous filaments, and one smallest sterile with villous as on the fertile ones

Voucher specimens: 178, 5 June 2001; 267, 30 August 2001; **Figure** 10-3, **Plate** 2 E

Reference: Cherfils (1937) 883-887, 902-903

Note: my two specimens were collected in different habitats and during different months. They show variation in the size of the leaf blades and period of flowering.

Commelina padulosa Bl.

Scrambling, evergreen, succulent ground herb to about 130 cm long. **Stem** terete, pilose and glabrescent, pale light green to pale maroon. **Leaves** simple, spirally arranged, well-spaced. **Sheaths** thin, densely golden-brown pilose, 7-15 mm long. **Blades** subcoriaceous, lanceolate to linear-lanceolate; apex acute, base attenuate and merging with the sheath, margins entire; finely scabrous and pilose above, sparsely sericeous below; dark green above, pale light green beneath; 30-110 x 4-24 mm. **Inflorescence** terminal, in compact cymes. **Bracts** 3-5 cucullate, marginally connate, upper margin free, truncate; finely puberulous outside, glabrous inside, pale light green; each bract usually embracing a 3-flowered cyme. **Peduncle** minutely and sparsely puberulous, *c.* 6-10 mm long. **Pedicels** erect, then reflexed, glabrous, 4-7 mm long. **Flowers** several, irregular, 3-merous. **Sepals** 3, obovate, apex obtuse to rounded, the anterior one cucullate, entire, translucent whitish, glabrous; *c.* 4-5 x 3 mm. **Petals** 3, unequal, upper two identically suborbicular, apex rounded, base tapering to the claw; glabrous, bluish, *c.* 5-7.5 x 7-8 mm; claw white,

4.5-5 mm long; the anterior petal smaller, ovate, tip acute, 2-3 x 1.5 mm. **Stamens** 6; 3 fertile, anthers bilocular, dorsifixed; 2 ovate, greyish-brown, 1 mm long; one larger, yellowish, 2 mm long; sterile anthers 3, "X"-shaped, tips of lobes globose, glabrous, yellow; all filaments glabrous, bluish; fertile filaments c. 8.5-10 mm, sterile ones, c. 4-4.5 mm long. **Stigma** terminal, minute, glabrous; style glabrous, light blue; c. 13-15 mm long. **Ovary** superior, ovoid to subglobose, glabrous; 3-loculed, each locule with one axile ovule. **Capsules** thin, glabrous, 5-5.6 x 4-5 mm. **Seeds** reniform, finely papillose; 3-3.5 x 1.5-1.8 mm.

Habitat: partly shaded areas near the seasonal stream

Phenology: leafing: January-December; flowering: July-September; fruiting:

August-November

Abundance: medium

Distribution: throughout Thailand, tropical Himalayas, Southeast Asia, Malesia

Distinguishing features: leaf blades lanceolate, scabrous and golden-brown pilose;

bracts 3-5, culcullate, top free; 2 larger and one reduced petals bluish; fertile anthers: 2 yellow and one greyish; sterile anthers 4-lobed, yellow; filaments all glabrous

Voucher specimen: 276, 30 August 2001; **Figure 8**

References: Cherfils (1937) 921-925 (fig. 88, p. 928); Backer & Bakhuizen van den Brink (1968) 12-13, 20-21

Note: A related species found in the same habitat is *C. diffusa* Burm. f. (Figure 8) which has leaf blades not as scabrous as *C. padulosa*; axillary inflorescence; a more developed ventral petal, with 2 cymes in each bract; fertile anthers all greyish

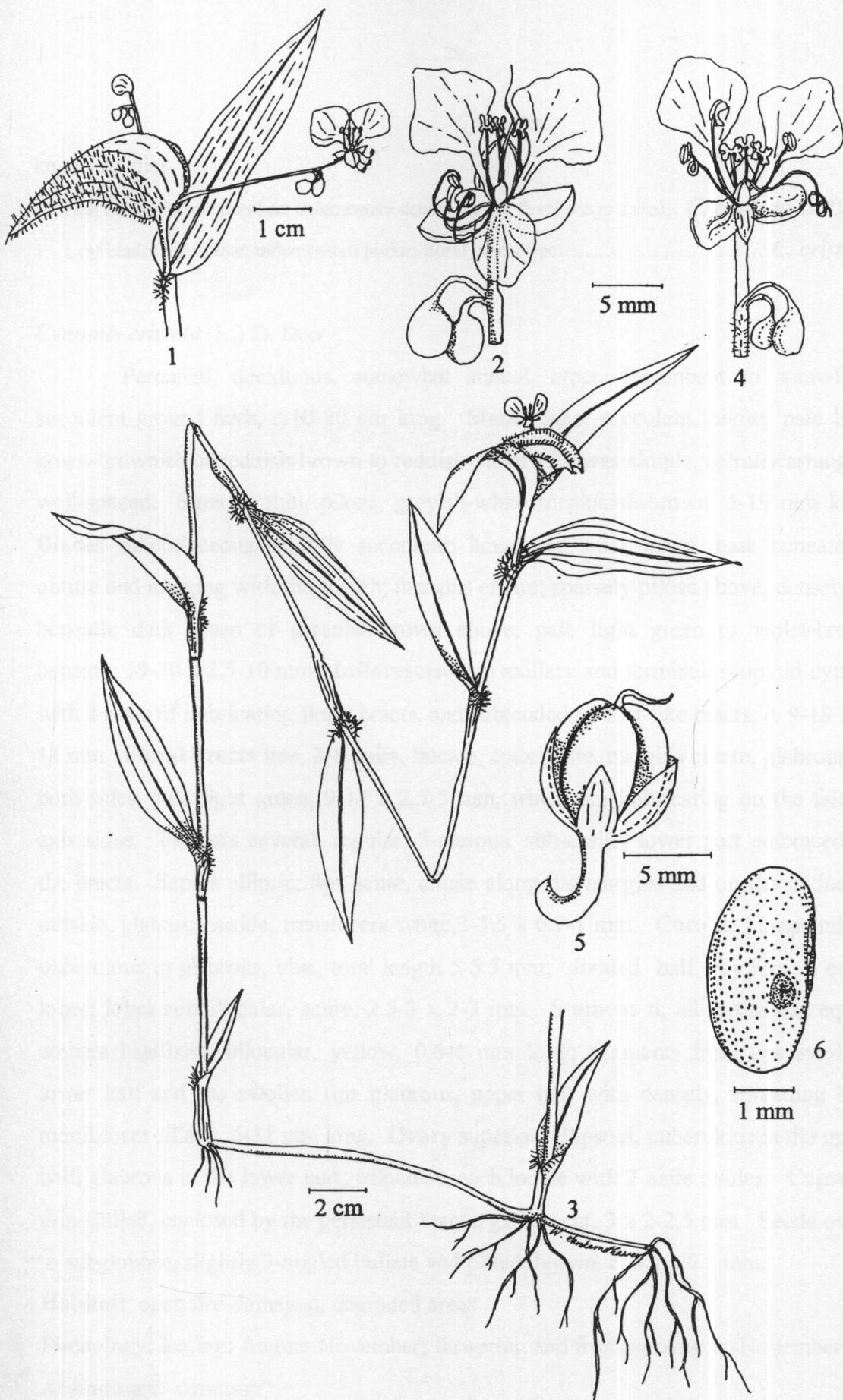


Figure 8 *Commelina diffusa* Burm. f. (#292): 1 = leaf and inflorescence, 2 = buds and open flower; *C. padulosa* Bl. (#276): 3 = habit, 4 = buds and open flower, 5 = capsule, 6 = seed

Cyanotis

key to species

1. Leaf blades linear-lanceolate; indumentum densely lanate; floral bracts united...*C. barbata* D. Don
1. Leaf blades lanceolate; indumentum pilose; floral bracts free.....*C. cristata*

Cyanotis cristata (L.) D. Don

Perennial, deciduous, somewhat annual, erect, decumbent to sprawling, succulent ground herb, c. 10-80 cm long. **Stem** terete, succulent, pilose, pale light green-brownish or reddish-brown to reddish-violet. **Leaves** simple, spirally arranged, well-spaced. **Sheaths** thin, pilose, greyish-white to pinkish-brown, 4-19 mm long. **Blades** subcoriaceous, slightly succulent; lanceolate, apex acute, base cuneate to obtuse and merging with the sheath; margins ciliate; sparsely pilose above, densely so beneath; dark green or greenish-brown above, pale light green to violet-brown beneath; 19-70 x 2.5-10 mm. **Inflorescence** in axillary and terminal, scopioid cymes, with 2 rows of imbricating floral bracts, and subtended by leaf-like bracts; c. 9-18 x 4-11 mm. **Floral bracts** free, 3-8 pairs, falcate, apex acute, margins ciliate, glabrous on both sides, pale light green, 9-17 x 2.5-5 mm, which are imbricating on the falcate axis sides. **Flowers** several, regular, 3-merous, subsessile, lower part embraced by the bracts. **Sepals** elliptic, tips acute, ciliate along the margins and on the midnerve outside, glabrous inside, translucent white, 3-3.5 x 0.7-1 mm. **Corolla** campanulate, puberulous to glabrous, blue, total length 5-5.5 mm; divided half way into 3 equal lobes; lobes suborbicular, acute, 2.5-3 x 2-3 mm. **Stamens** 6, all fertile and equal; anthers basifixed, bilocular, yellow, 0.6-1 mm long; filaments free, tips swollen, lower half and the swollen tips glabrous, upper half with densely, spreading blue moniliform cilia; c. 6-11 mm long. **Ovary** superior, ellipsoid, puberulous in the upper half, glabrous in the lower part; trilocular, each locule with 2 axile ovules. **Capsules** thin-walled, enclosed by the persistent bracts, glabrescent, 3 x 2-2.5 mm. **Seeds** ovoid to subglobose, slightly 3-angled bullate and pitted, brown, c. 0.7 x 0.5 mm.

Habitat: open fire-damaged, degraded areas

Phenology: leafing: August-November; flowering and fruiting: August-November

Abundance: common

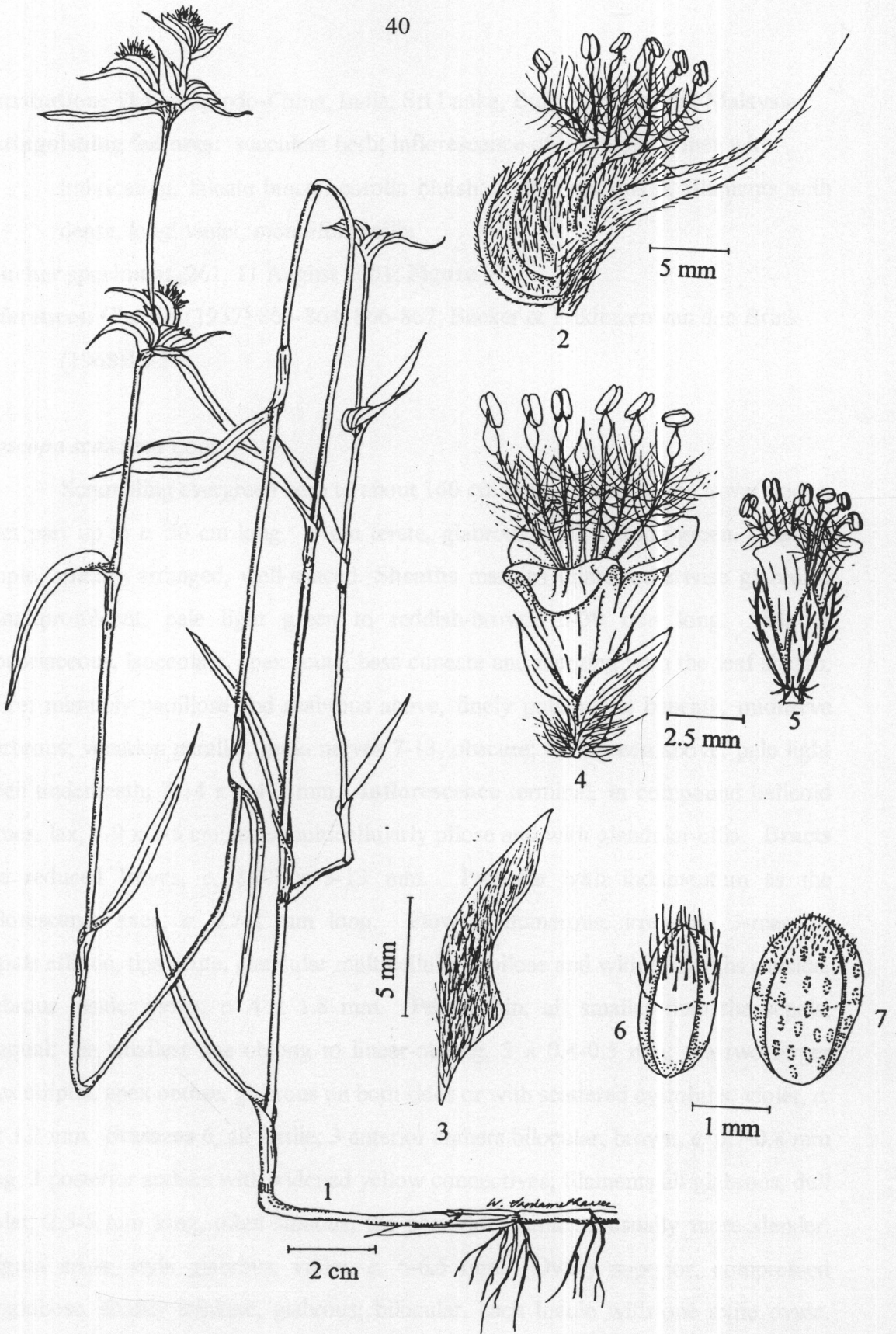


Figure 9 *Cyanotis barbata* D. Don (#306): 1 = habit, 2 = inflorescence, 3 = bract, 4 = flower, 6 = capsule; *C. cristata* (L.) D. Don (#261): 5 = flower, 7 = capsule

Distribution: Thailand, Indo-China, India, Sri Lanka, Burma, Peninsular Malaysia

Distinguishing features: succulent herb; inflorescence of scorpioid cymes with imbricating, falcate bracts; corolla bluish; fertile stamens 6, filaments with dense, long, violet, moniliform cilia

Voucher specimen: 261, 11 August 2001; **Figure 9**

References: Cherfils (1937) 863-864, 866-867; Backer & Bakhuizen van den Brink (1968) 12-14

Floscopa scandens Lour

Scrambling evergreen herb to about 160 cm long, rooting at the lower nodes; erect part up to c. 50 cm long. **Stem** terete, glabrous, dull maroon-green. **Leaves** simple, spirally arranged, well-spaced. **Sheaths** margins ciliate, otherwise glabrous, veins prominent, pale light green to reddish-brown, 5-30 mm long. **Blades** subcoriaceous, lanceolate, apex acute, base cuneate and merging with the leaf sheath, entire; minutely papillose and scabrous above, finely puberulous beneath, midnerve scabrous; venation parallel, main nerves 7-13, obscure; dark green above, pale light green underneath; 7-14 x 1.4-3 mm. **Inflorescence** terminal, in compound helicoid cymes, lax, 5-9 x 2-5 cm; axes multicellularly pilose and with glandular cilia. **Bracts** like reduced leaves, c. 8-65 x 5-13 mm. **Pedicels** with indumentum as the inflorescence axes, c. 0.7-2 mm long. **Flowers** numerous, irregular, 3-merous. **Sepals** elliptic, tips acute, glandular multicellularly pilose and with cystoliths outside, glabrous inside; violet, c. 4 x 1.8 mm. **Petals** thin, all smaller than the sepals, unequal; the smallest one oblong to linear-oblong, 3 x 0.4-0.5 mm; the two larger ones elliptic, apex obtuse, glabrous on both sides or with scattered cystoliths, violet, c. 3 x 1.2 mm. **Stamens** 6, all fertile; 3 anterior anthers bilocular, brown, c. 0.7-0.8 mm long; 3 posterior anthers with widened yellow connectives; filaments all glabrous, dull violet, 2.5-5 mm long, often sinuous, the posterior filaments usually more slender. **Stigma** acute, style glabrous, violet, c. 6-6.5 mm. **Ovary** superior, compressed subglobose, shortly stipitate, glabrous; bilocular, each locule with one axile ovule. **Capsules** compressed globose, 2-lobed; c. 2-2.3 x 2 mm. **Seeds** reniform, obtuse at both ends, aereolate, rugose wrinkled, with a longitudinal rib on the posterior side, and a circular medial groove on the anterior side; brown, c. 1.5-1.8 x 1-1.2 mm.

Habitat: partly shaded areas near seasonal streams

Phenology: flowering and fruiting October-December

Abundance: rare

Distribution: Thailand, Indo-China, India

Distinguishing features: multi-flowered helicoid cymes covered with multicellular gland-tipped indumentum; fertile stamens 6 with glabrous filaments; leaf blades subcoriaceous and scabrous; ovary bilocular

Voucher specimen: 331, 3 November 2001; **Plate 3 A**

References: Cherfils (1937) 912 (fig.), 914-915, 917-919; Backer & Bakhuizen van den Brink (1968) 20

Murdannia

key to species

1. Plants up to 2 m high when flowering; flowers more than 2.5 cm diameter
.....*M. gigantea* (Vahl) Bruck.
1. Plants usually less than 70 cm high when flowering; flowers less than 1.3 cm diameter
 2. Leaves mostly radical; roots swollen, fleshy
 3. Flowering when leafless; inflorescence up to 36 cm long, not glandular pubescent; fertile stamens 3*M. scapiflora*
 3. Flowering and leafing together; inflorescence < 10 cm long, densely glandular pubescent; fertile stamens 2.....*M. loureirii* (Hance) Rao ex Kam.
 2. Leaves mostly cauline; roots not swollen
 4. Fertile stamens 2; ovules 2 in each locule; leaf blades mostly glabrous
.....*M. nudiflora* (L.) Bren.
 4. Fertile stamens 3; ovules 5-8 in each locule, leaf blades densely velutinous
.....*M. japonica* Thunb. var. *japonica*

Murdannia scapiflora (Roxb.) Royle

Deciduous, stemless, ground herb. **Roots** swollen, fleshy, brown outside, white inside. **Leaves** simple, spirally arranged, mostly basal, appearing after flowering and fruiting. **Sheaths** glabrous, light green to reddish-brown, scarious near the margins, c. 4-9 x 1.5-2.5 cm. **Blades** succulent, linear-lanceolate, apex acuminate, base tapering to the sheath, margins entire or slightly undulate; venation parallel,

midnerve obscure; glabrous on both sides; green or dull maroon above, very pale light green beneath with dull maroon violet bands near the margins; c. 10-25 x 1-2.5 cm. **Inflorescence** axillary, racemose, 11-36 cm long; axes glabrous, dark maroon. **Bracts** ovate to lanceolate or oblong, apex acute to acuminate, glabrous, dark maroon; c. 1-4 x 0.7-1.5 cm. **Pedicels** subsessile to c. 3 mm long. **Flowers** many, regular, 3-merous. **Sepals** 3, ovate to elliptic, concave, apex acute, glabrous, dull light maroon; 5-5.5 x 2.8-3 mm. **Petals** 3, thin, suborbicular to obovate, apex rounded, light blue-violet to lilac, glabrous, c. 5 x 4.5-5 mm. **Fertile stamens** 3, anthers bilocular, locules oblong, purple, 1.5 mm long, connective pale lilac; filaments pale lilac with dense, violet, ascending cilia; c. 4 mm long. **Sterile stamens** 3, anthers 2-lobed, lobes globose, glabrous, yellow, c. 0.5 mm diameter, filaments glabrous, pale lilac to whitish, 1.5-2 mm long. **Stigma** branched; style glabrous, widened at the base and tapering to the tip, pale lilac-whitish, c. 3.5-4 mm long. **Ovary** superior, ovoid, shallowly 3-lobed, glabrous, c. 1 mm long; each locule with 4 axile ovules. **Capsules** 3-lobed, tip acute, glossy brown glabrous, loculicidal, valves reflexing when dehiscent, c. 7-8 x 3-4 mm. **Seeds** trapezoidal, smooth, greyish, c. 1.5 mm long.

Habitat: open fire-damaged, degraded areas

Phenology: leafing: May-September, flowering: March-May, fruiting: April-June

Abundance: common

Distribution: N, NE, SW Thailand, Indo-China, India

Distinguishing features: leaves mostly basal, glabrous; flowering when leafless, inflorescence relatively large compared to the other species in this genus; petals bluish-violet to lilac; fertile stamens 3 with filaments ciliate; sterile anthers 2-lobed with glabrous filaments

Voucher specimen: 137, 13 March 2001; 184, 5 June 2001; **Plate 3 D**

References: Cherfils (1937) 883-887, 908-910 (*sub Aneilema scapiflorum* Wight); Backer & Bakhuizen van den Brink (1968) 17-18; Faden (1991) 155 (*sub Murdannia edulis* (Stokes) Faden)

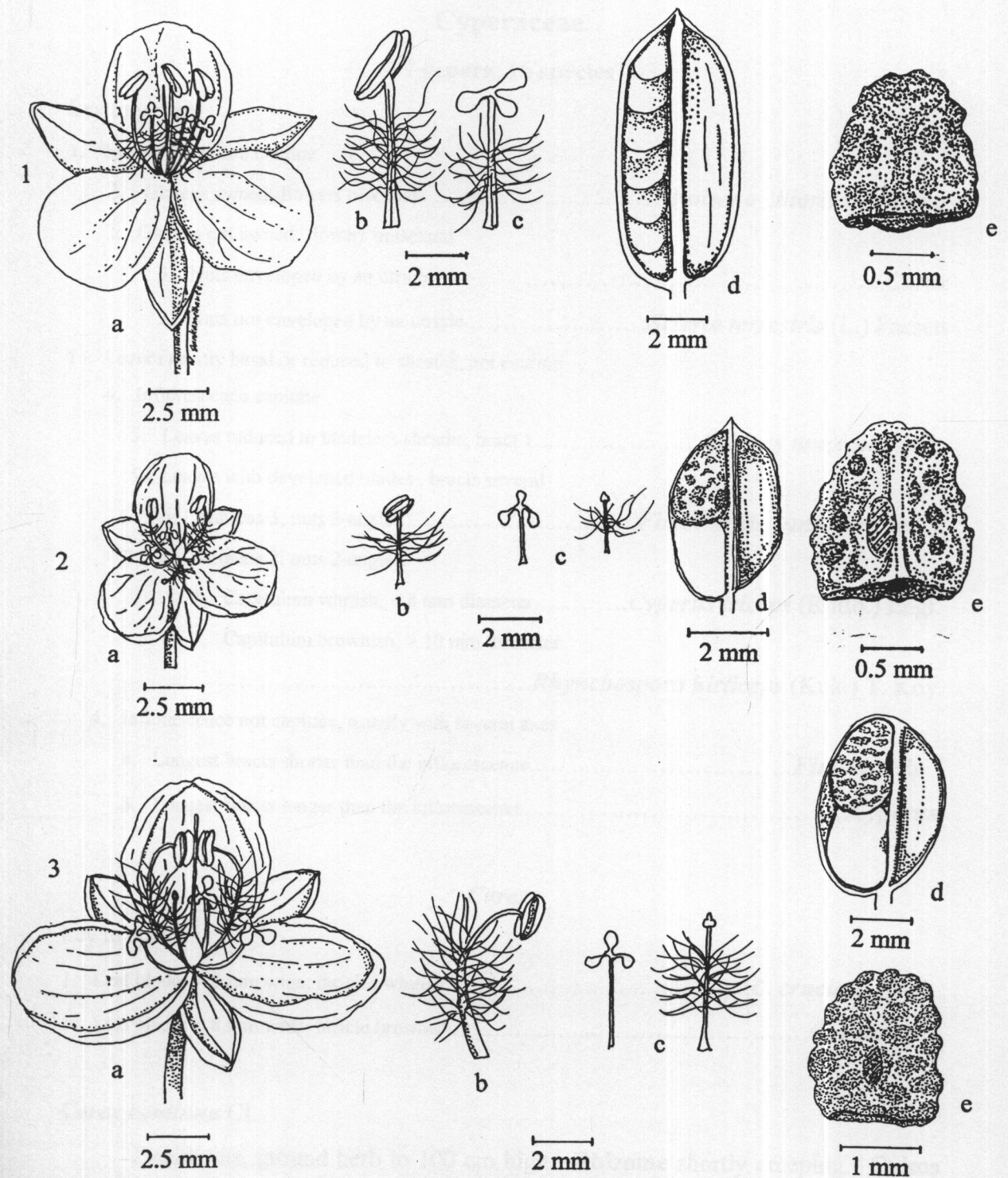


Figure 10 1 = *Murdannia japonica* (Thunb.) Faden (#266); 2 = *M. nudiflora* (L.) Bren. (#322); 3 = *Aneilema sinicum* Lindl. (#178): a = flower, b = fertile stamen, c = staminode(s), d = capsule (longitudinal section), e = seeds

Cyperaceae

7 genera, 16 species

key to genera

1. Leaves basal and cauline
 2. Glumes awned; flowers bisexual *Fuirena ciliaris* (L.) Roxb.
 2. Glumes not awned; flowers unisexual
 3. Nuts enveloped by an utricle *Carex*
 3. Nuts not enveloped by an utricle *Scleria terrestris* (L.) Fassett
1. Leaves mostly basal or reduced to sheaths, not cauline
 4. Inflorescence capitate
 5. Leaves reduced to bladeless sheaths, bract 1 *Scirpus mucronatus* L.
 5. Leaves with developed blades, bracts several
 6. Stamens 3; nuts 3-angled *Fimbristylis yunnanensis* Cl.
 6. Stamens 2; nuts 2-angled
 7. Capitulum whitish, < 8 mm diameter *Cyperus triceps* (Rottb.) Engl.
 7. Capitulum brownish, > 10 mm diameter
..... *Rhynchospora hirticeps* (Kuk.) T. Koy.
 4. Inflorescence not capitate, usually with several axes
 8. Longest bracts shorter than the inflorescence *Fimbristylis*
 8. Longest bracts longer than the inflorescence *Cyperus*

Carex

key to species

1. Leaf blades > 8 mm wide; utricles whitish *C. cruciata* Wahl.
1. Leaf blades < 8 mm wide; utricle brownish *C. continua*

Carex continua Cl.

Deciduous, ground herb to 100 cm high. **Rhizome** shortly creeping. **Culms** few-several, spreading, trigonous, smooth, glabrous, light green. **Leaves** basal and cauline, diplicate. **Blades** thin, narrowly ensiform, margins finely aculeate; venation parallel, obscure, severa-nerved, midnerve sunken above, prominent and raised below; dark green above, light green beneath; c. 20-70 cm x 1.5-5 mm. **Sheaths** up to 5 cm long. **Inflorescence** terminal, paniculate with several branches up to 10 cm

long; axes light green, scabrous. **Bracts** leaf-like up to 50 cm long. **Spikelets** numerous, each with several unisexual flowers. **Male flowers** distal on the spikelet. **Glumes** lanceolate, apex acuminate, *c.* 2.5-2.8 x 1.5 mm. **Stamens** 3, anthers basifixed, bilocular, linear, *c.* 2 mm long; filaments thin, flat, *c.* 3 mm long. **Female flowers** on the lower part of the spikelet. **Glumes** crustaceous; ovate acute to aristate, scabrous outside, glabrous inside; *c.* 2-2.5 x 1.5-1.8 mm. **Stigmas** 3, *c.* 1.3 mm long; style 1, *c.* 1.5 mm long. **Utricles** ellipsoid, brownish-green, ridges prominent, scabrous at one side, tips 2-lobed, aristate, *c.* 3 x 1.5 mm. **Nuts** ellipsoid, trigonous, shortly stipitate, whitish, *c.* 1.5-2 x 0.8 mm.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: May-February; flowering: July-October; fruiting: July-December

Abundance: common

Distribution: N, NE, SW, SE Thailand, India to southern China and Malesia

Distinguishing features: spreading herb with trigonous culms; leaves both basal and cauline, ensiform with sharply, aculeate margins; inflorescence paniculate; glumes and utricle brownish

Voucher specimen: 225, 13 July 2001

Reference: Simpson & Koyama (1998) 454-455

Cyperus

key to species

1. Inflorescence capitate.....*C. triceps* (Rottb.) Engl.
1. Inflorescence not capitate
 2. Spikelets cylindric with < 4 glumes, spirally arranged.....*C. cyperoides*
 2. Spikelets flat with > 10 glumes in 2 ranks
 3. Spikes brached with several primary axes, stigmas 3.....*C. pilosus* Vahl
 3. Spikes unbranched, stigmas 2*C. flavidus* Retz.

Cyperus cyperoides (L.) O. K.

Deciduous, glabrous, erect, ground herb to *c.* 50 cm high. **Rhizome** shortly creeping. **Culms** 1-several, trigonous, upper part green, reddish-brown near the base. **Leaves** mostly basal spiral, duplicate. **Blades** thin, narrowly ensiform, apex

acuminate, base sheathing, margins entire; venation parallel, midnerve sunken above, prominent and raised below, other venation obscure; glossy dark green above, pale green beneath; *c.* 15-30 cm x 3-8 mm. **Inflorescence** terminal spicate; axes (peduncles) several, unbranched, sessile to 12 cm long, spreading; spikes erect, compactly cylindric with numerous spikelets, *c.* 1-4 cm long. **Bracts** leaf-like, as long as the leaves, and always longer than the inflorescence. **Spikelets** linear-lanceolate, spreading, 4-7 x 0.8 mm, with 2-3 glumes. **Flowers** bisexual. **Glumes** crustaceous, spirally arranged, lanceolate, keeled, apex acute; glabrous, light green, turning brown; margins hyaline, *c.* 3.5-4 x 1-1.3 mm. **Stamens** 3, anthers basifixed, bilocular, linear, *c.* 0.5-0.6 mm long; filaments flat, *c.* 2 mm long. **Stigmas** 3, filiform, recurved, *c.* 1-1.3 mm long; style 1, glabrous, *c.* 0.8-1 mm long. **Ovary** superior. **Nuts** oblong-cylindric, trigonous, acute on both ends, smooth, brown, *c.* 2 x 0.4 mm.

Habitat: open, fire-damaged, degraded areas, often a weed

Phenology: leafing: May-September; flowering and fruiting: May-August

Abundance: medium

Distribution: throughout Thailand, tropical and subtropical Africa, Asia-Malaysia, central Japan, northern Australia

Distinguishing features: leaves basal, blades ensiform, duplicate; bracts as long as the normal leaf blades; inflorescence terminal with several spreading umbellate axes; spikes erect cylindric, with many spreading spikelets, flowers bisexual

Voucher specimen: 177, 5 June 2001

Reference: Simpson & Koyama (1998) 381-382, plate XXVIII (photo)

Fimbristylis

key to species

1. Leaf blades falcate, < 10 cm long.....*F. straminea* Turr.
1. Leaf blades straight, > 20 cm long
 2. Inflorescence capitate.....*F. yunnanensis* Cl.
 2. Inflorescence not capitate, primary axes several
 3. Ligule present, leaf blades flat (sides of equal thickness).....*F. thomsonii*

3. Ligule absent; leaf blades equitant (sides of unequal thickness)
4. Spikelets ovoid, glumes spirally arranged.....*F. miliacea* (L.) Vahl
4. Spikelets lanceolate, glumes 2-ranked
 5. Glumes > 5, scabrous, without glandular dots.....*F. fusca* (Nees) Cl.
 5. Glumes < 5, glabrous with dense glandular dots.....*F. cinnamometorum* (Vahl) Kunth

***Fimbristylis thomsonii* Boeck**

Deciduous, erect, glabrous, ground herb to c. 0 cm high. **Rhizome** shortly creeping. **Culms** few-several, flattened, smooth, green. **Leaves** basal, alternate. **Blades** chartaceous, narrowly linear, apex acute, base sheathing; flat, margins entire, sides of equal thickness; venation obscurely parallel; glossy dark green above, very pale light green beneath; c. 25-40 cm x 2-5 mm; ligule a fringe of setulose indumentum. **Sheaths** green, up to 5 cm long. **Inflorescence** terminal with several primary axes of different lengths; primary axes branched with several spikelets. **Bracts** few, leaf-like, shorter than the inflorescence and very much shorter than the leaves, c. 3-7 cm x 1.5-3 mm. **Spikelets** both sessile and pedicelled, ovoid, c. 4-6 x 1.5-2.5 mm. **Glumes** crustaceous, 5-7, spirally arranged, ovate, keeled, apex acuminate, tip cusped, base truncate, margins membranous with scattered dark brown glandular dots, c. 3.5-4 x 2 mm. **Flowers** bisexual, 3-merous. **Stamens** 3, anthers basifixed, bilocular, linear, c. 1.2-1.4 mm long; filaments flat, c. 3 mm long. **Stigmas** 3, filiform and recurved, c. 1.7-2 mm long; style 1, c. 1-1.3 mm long with a thickened base. **Ovary** superior. **Nuts** obovoid, trigonous, whitish-yellow; cancellate, base cuneate, c. 1 mm long.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: February-August; flowering and fruiting: March-August

Abundance: common

Distribution: throughout Thailand, tropical Asia

Distinguishing features: leaves basal, alternate; blades narrowly linear up to

40 cm long; midnerve obscure; inflorescence terminal, primary axes several, branched; bracts shorter than the inflorescence; spikelets ovoid, glumes brownish; stigmas 3, nuts 3-angled, base of style thickened

Voucher specimen: 156, 12 April 2001; **Figure** 11

Reference: Simpson & Koyama (1998) 296-297

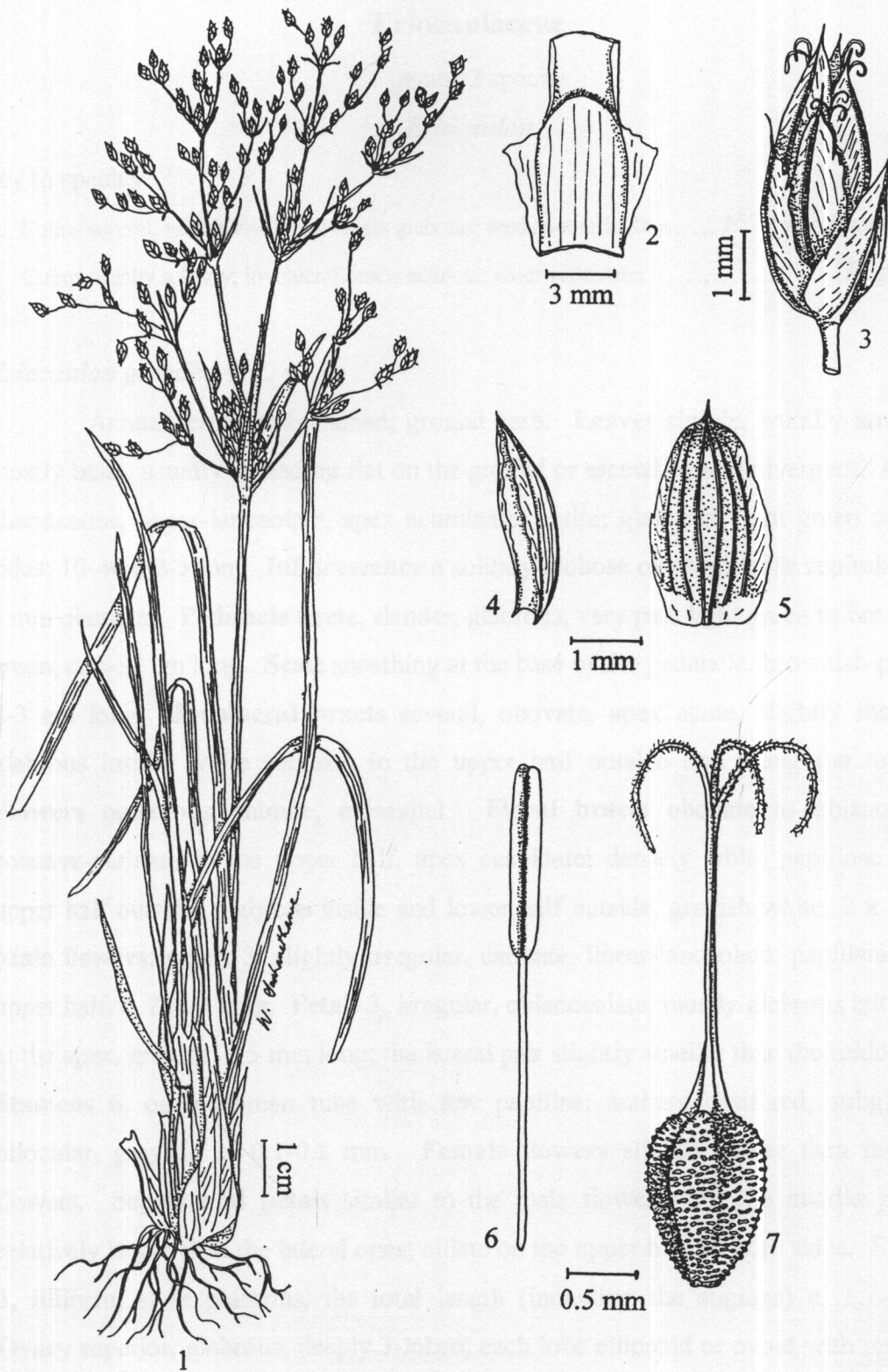


Figure 11 *Fimbristylis thimsonii* Boeck (#156): 1 = habit, 2 = ligule, 3 = spikelet, 4 = glume (ventral), 5 = glume (dorsal), 6 = stamen, 7 = nut with persistent stigmas and style

Eriocaulaceae

1 genus, 2 species

Eriocaulon

key to species

1. Culms several, tufted; involucre bracts glabrous; seeds not reticulate..... *E. oryzetorum* Mart.
1. Culms usually solitary; involucre bracts setulose; seeds reticulate.....*E. gracile*

Eriocaulon gracile Mart.

Annual, erect, unbranched, ground herb. **Leaves** simple, spirally arranged, mostly basal, usually spreading flat on the ground or ascending and divergent. **Blades** chartaceous, linear-lanceolate, apex acuminate, entire; glabrous, light green on both sides; 10-40 x 2-3 mm. **Inflorescence** a solitary globose or subglobose capitula, c. 3-5 mm diameter. **Peduncle** terete, slender, glabrous, very pale light green to brownish-green; c. 6-32 cm long. **Scale** sheathing at the base of the peduncle, brownish-pink, c. 2-3 cm long. **Involucre bracts** several, obovate, apex acute, slightly incurved, glabrous inside, white setulose in the upper half outside and along the margins. **Flowers** numerous, minute, unisexual. **Floral bracts** obovate to oblanceolate, concave-carinate in the upper half, apex cuspidate; densely white papillose in the upper half outside, glabrous inside and lower half outside, grayish-white, 2 x 1 mm. **Male flowers**: sepals 3, slightly irregular, carinate, linear-lanceolate, papillate in the upper half, c. 2 mm long. **Petals** 3, irregular, oblanceolate, mostly glabrous but ciliate at the apex, greyish; 1.5 mm long; the lateral pair slightly smaller than the middle one. **Stamens** 6, on a stamen tube with few papillae; anthers basifixed, subglobose, bilocular, greyish, c. 0.1-0.2 mm. **Female flowers** slightly larger than the male flowers. **Sepals and petals** similar to the male flowers, but the middle petal is relatively larger than the lateral ones; ciliate on the upper half on both sides. **Stigmas** 3, filiform; style glabrous, the total length (including the stigmas) c. 1.7-2 mm. **Ovary** superior, glabrous, deeply 3-lobed, each lobe ellipsoid or ovoid with one axile ovule, c. 0.7 mm long. **Capsules** ovoid, glossy black or dark brown. **Seeds** ovoid, as large as the capsules, reticulate, c. 0.5 mm long.

Habitat: open wet places, sandy-clay soil

Phenology: leafing: August-January; flowering and fruiting from September-January

Abundance: medium

Distribution: northern Thailand, Burma, Indo-China

Distinguishing features: annual, erect ground herb in marshy areas; leaves mostly in a basal rosette; blades linear; inflorescence a solitary, greyish-white, globose or subglobose capitulum

Voucher specimen: 379, 25 December 2001; **Figure 12**

References: Lecomte (1912) 1-3, 9; Hooker (1894) 577

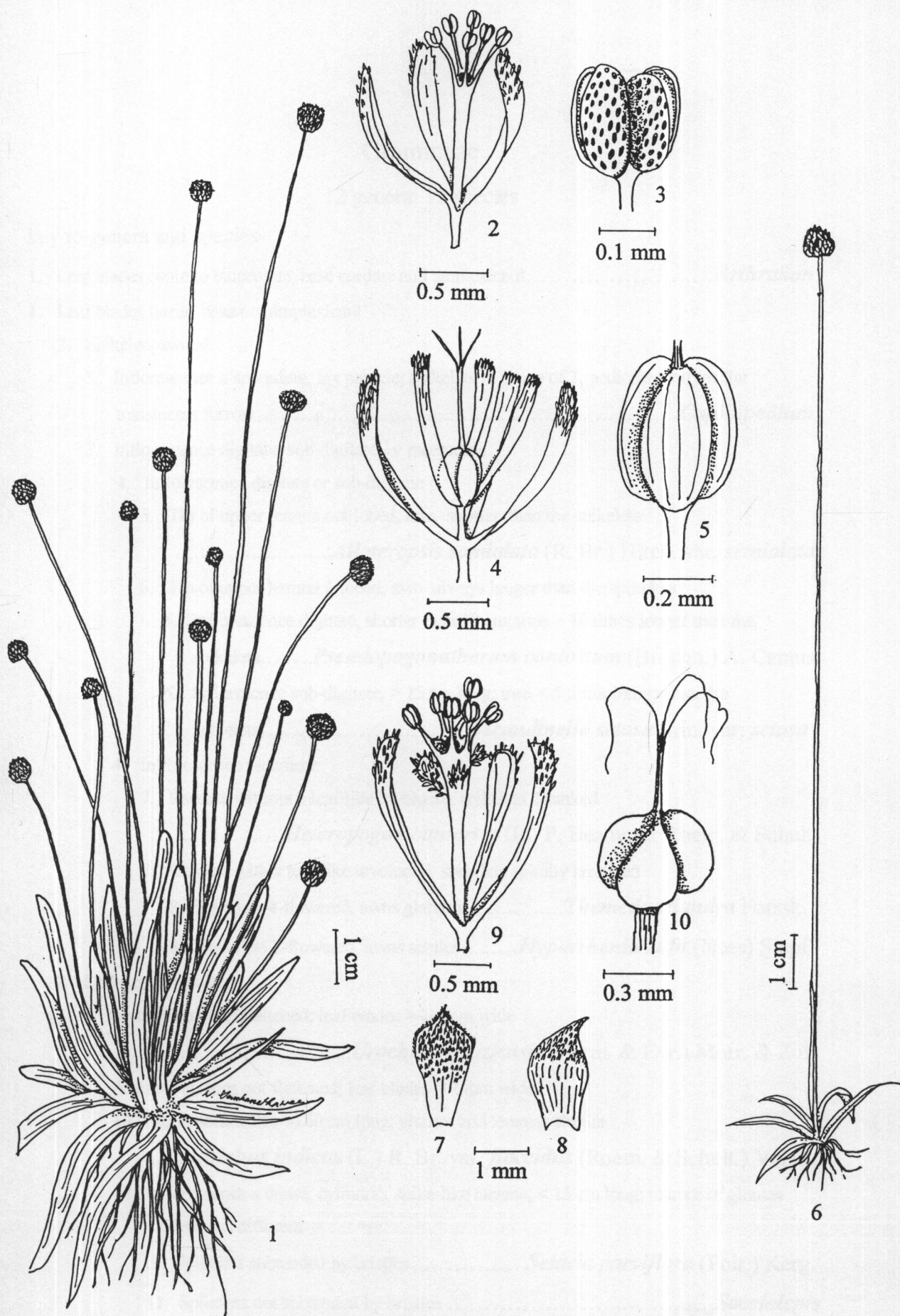


Figure 12 *Eriocaulon oryzetorum* Mart. (#255): 1 = habit, 2 = male flower, 3 = anther, 4 = female flower, 5 = capsule; *E. gracile* Mart. (#379): 6 = habit, 7 = involucre bract, 8 = flower bract, 9 = male flower, 10 = pistil

Gramineae

12 genera, 12 species

key to genera and species

1. Leaf blades ovate to lanceolate, base cordate and amplexicaul.....*Arthraxon*
1. Leaf blades linear, base not amplexicaul
 2. Spikelets awned
 3. Inflorescence a spreading, lax panicle, spikelets in group of 3, pedicels with medial translucent furrow.....*Capillipedium*
 3. Inflorescence digitate, sub-digitate, or racemeose
 4. Inflorescence digitate or sub-digitate
 5. Tip of upper lemma not lobed, awn shorter than the spikelets
.....*Alloteropsis semialata* (R. Br.) Hitch. var. *semialata*
 5. Tip of upper lemma 2-lobed, awn always longer than the spikelets
 6. Inflorescence digitate, shorter than 10 cm; awn > 10 times longer than the spikelets.....*Pseudopogonatherum contortum* (Brongn.) A. Camus
 6. Inflorescence sub-digitate, > 15 cm long; awn < 5 times longer than the spikelets.....*Arundinella setosa* Trin. var. *setosa*
 4. Inflorescence racemose
 7. Raceme without a leaf-like involucre, spikelets 2-ranked
.....*Heteropogon contortus* (L.) P. Beauv. ex Roem. & Schult.
 7. Raceme with a leaf-like involucral, spikelets spirally arranged
 8. Spikelets 4-flowered, awns glabrous.....*Themeda triandra* Forssk.
 8. Spikelets 2-flowered, awns setulose.....*Hyparrhenia rufa* (Nees) Stapf
 2. Spikelets not awned
 9. Axes of racemes flattened; leaf blades > 10 mm wide
.....*Urochloa ruziziensis* (Germ. & Evr.) Morr. & Zul.
 9. Axes of racemes not flattened; leaf blades < 7 mm wide
 10. Inflorescence lax, to 60 cm long; glumes and lemmas similar
...*Sporolobus indicus* (L.) R. Br. var. *flaccidus* (Roem. & Schult.) Veldk.
 10. Inflorescence a dense, cylindric, spike-like raceme, < 15 cm long; texture of glumes and lemmas different
 11. Spikelets subtended by bristles*Setaria parviflora* (Poir.) Kerg.
 11. Spikelets not subtended by bristles*Sacciolepis*

Arthraxon hispidus* (Thunb.) Makino var. *hispidus

Annual, ground herb, up to c. 40 cm high. Culms few to several, terete, glabrous, very pale light green to light violet-maroon; internodes elongating towards distally, c. 5 mm – 7 cm long; nodes densely setulose. **Leaves** simple, spirally arranged. **Blades** ovate to ovate-lanceolate, apex acuminate, base cordate and amplexicaul, margins long ciliate in the lower half and gradually shortening to spicules in the upper half; venation parallel with several main nerves, midnerve obscure; sparsely setose above, setulose underneath; dark green above, pale light green beneath; c. 10-20 x 3.5-8 mm. **Ligules** membranous, glabrous ring, c. 0.4 mm high. **Sheaths** setulose outside, glabrous inside, margins ciliate, pale light green, c. 8-30 mm long. **Inflorescence** of terminal, sub-digitate panicle with few to several spike-like racemes which are slightly zigzag, fragile, c. 1.5-4 cm long. **Peduncle** slender, glabrous, green, c. 8-17 cm long. **Spikelets** 5-7 per raceme, distichous; obliquely lanceolate, tips acuminate, mostly hermaphrodite, solitary, sessile, c. 3-3.5 mm long. **Lower glume** chartaceous, lanceolate, tip acuminate, nerves 7, prominent on upper half outside, scabrous outside, glabrous inside; margins membranous; maroonish-green, turning brown; as long as the spikelet. **Upper glume** membranous, lanceolate, carinate and distinctly keeled, tip acuminate, as long as the lower glume, but slightly narrower, keel rigid, otherwise glabrous. **Lower lemma** membranous, linear-lanceolate, glabrous, white, c. 1.7-1.8 x 0.5 mm. **Upper lemma** basally awned, membranous, lanceolate, tip acute, incurved, glabrous, white, c. 2-2.2 x 0.7 mm. Awn glabrous, glossy brown, 8-12 mm long; lower half thickened and twisted; upper half gradually narrowing to aristate tip which marginal spicules. **Stamens** 2, anther linear, locules linear, maroon, c. 0.8 mm long. **Stigmas** 2, plumose, maroon, c. 0.3 mm long; style c. 0.3 mm long. **Grains** cylindric, oblong, smooth, obtuse at both ends, c. 2 mm long.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: August-January; flowering and fruiting: September-January

Abundance: common

Distribution: central to eastern Africa, Madagascar, Mauritius, Caucasus, S, SE, E Asia, Japan, Malaysia, eastern Australia

Distinguishing features: leaf blades ovate-lanceolate, up to 3 cm long, base cordate

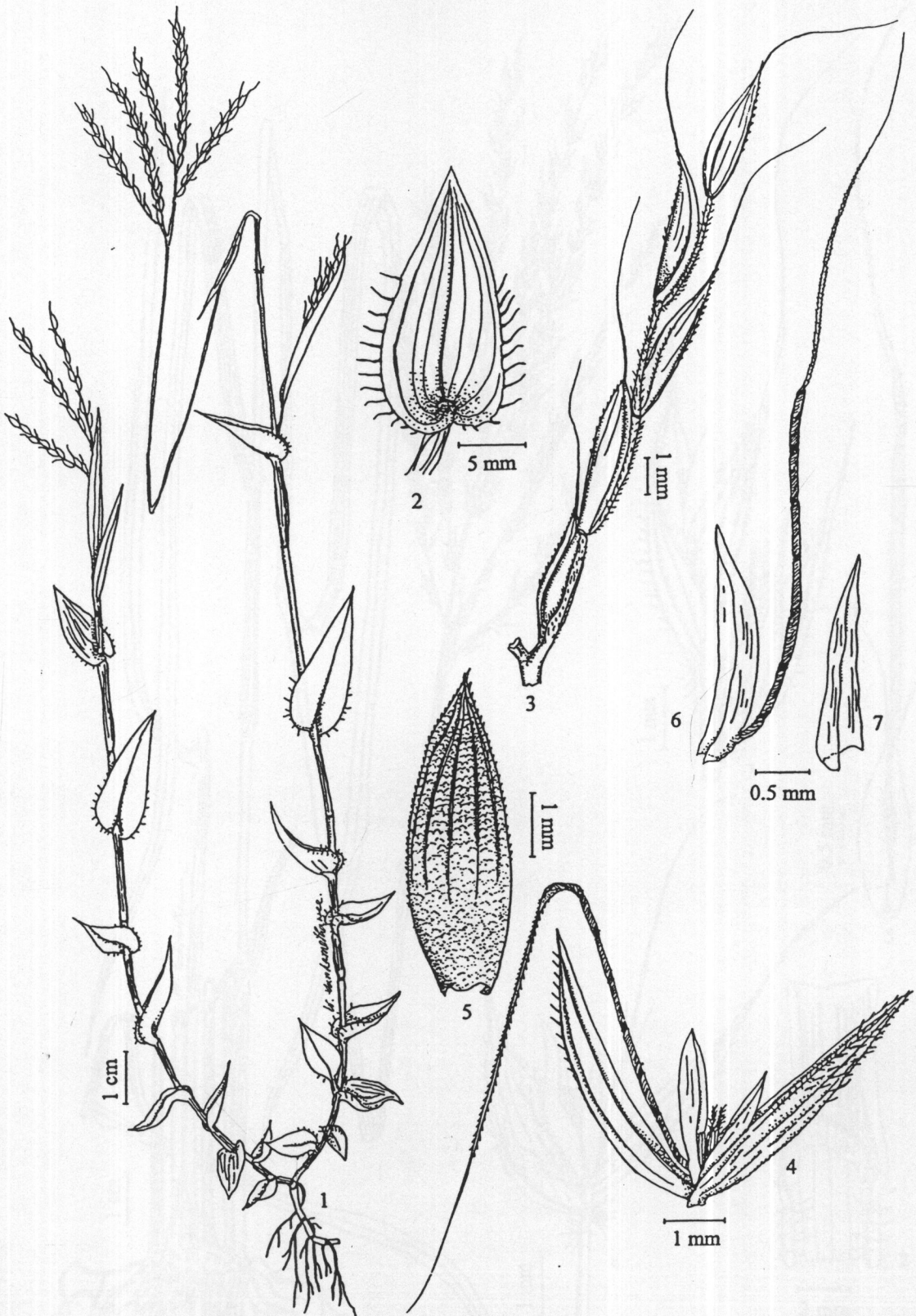


Figure 13 *Arthraxon hispidus* (Thunb.) Makino var. *hispidus* (#338): 1 = habit, 2 = leaf blade, 3 = raceme, 4 = opened spikelet, 5 = upper glume (dorsal), 6 = upper lemma and awn, 7 = lower lemma

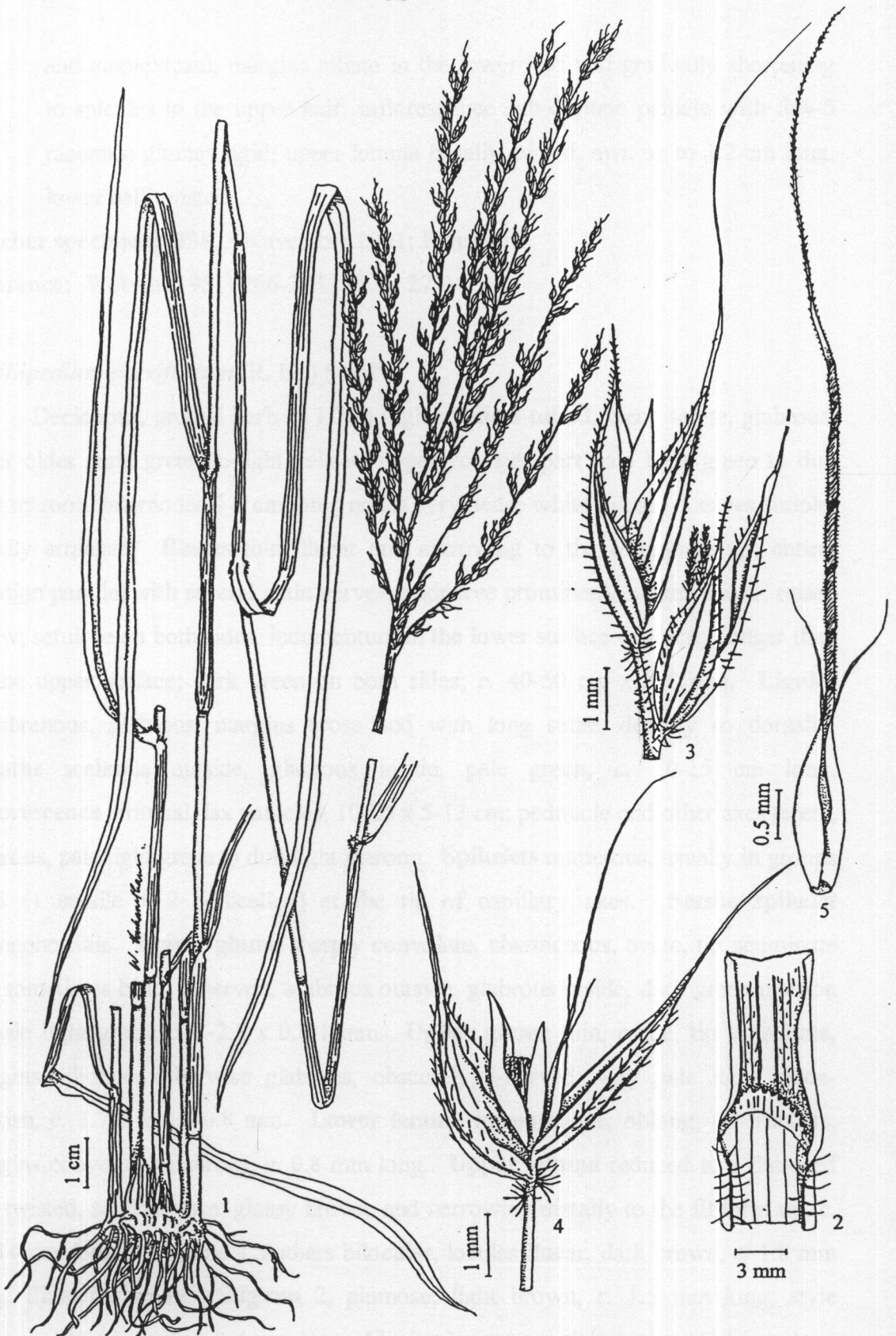


Figure 14 *Arundinella setosa* Trin. var. *setosa* (#336): 1 = habit, 2 = ligule,
3 = two of spikelets, 4 = opened spikelet, 5 = lower lemma with awn

and amplexicaul, margins ciliate in the lower half and gradually shortening to spicules in the upper half; inflorescence sub-digitate panicle with few-5 racemes; glumes rigid; upper lemma basally awned, awn up to 1.2 cm long, lower half twisted

Voucher specimen: 338, 3 November 2001; **Figure** 13

Reference: Welzen (1981) 266-274 (fig. p. 273)

***Capillipedium parviflorum* (R. Br.) Stapf**

Deciduous, ground herb to 1.7 m high. **Culms** tufted, erect, terete, glabrous; lower older parts greenish-light yellow, upper younger part pale light green to dull light maroon; internodes 4-8 cm long; nodes very dense white pilose. **Leaves** simple, spirally arranged. **Blades** thin, linear and narrowing to the acuminate tip; entire; venation parallel with several main nerves; midnerve prominent, sunken above, raised below; setulose on both sides, indumentum in the lower surface distinctly longer than on the upper surface; dark green on both sides; c. 40-50 cm x 4-8 mm. **Ligules** membranous, glabrous, margins erose and with long setae, densely so dorsally. **Sheaths** scabrous outside, glabrous inside, pale green, c. 10-15 cm long. **Inflorescence** terminal, lax panicles, 10-25 x 5-13 cm; peduncle and other axes terete, glabrous, pale light green to dull light maroon. **Spikelets** numerous, usually in groups of 3 (1 sessile + 2 pedicelled) at the tip of capillary axes. **Sessile spikelet** hermaphroditic. **Lower glume** sharply convolute, chartaceous, ovate, tip acuminate and sometimes bifid, 5-nerved, scabrous outside, glabrous inside, dark green maroon or pale light green, c. 2-2.5 x 0.8-1 mm. **Upper glume** thin, ovate, tip acuminate, margins ciliolate, otherwise glabrous, obscurely 3-nerved, very pale light green-whitish, c. 1.7-2 x 0.6-0.8 mm. **Lower lemma** membranous, oblong, tip truncate, margins convolute, glabrous, c. 0.8 mm long. **Upper lemma** reduced to a flattened and twisted, setulose awn, glossy brown, and narrowing distally to the filiform tip, c. 10-14 mm long. **Stamens** 3, anthers bilocular, locules linear, dark brown, c. 1.8 mm long; filaments white. **Stigmas** 2, plumose, light brown, c. 1.5 mm long; style glabrous, light brown, c. 3-4 mm long. **Grains** immature, glabrous, ovoid-lanceolate. **Pedicelled spikelets** male, or one reduced, slightly smaller than the sessile spikelet. **Pedicels** flattened with a medial translucent furrow, setulose on the inner margin, c. 2

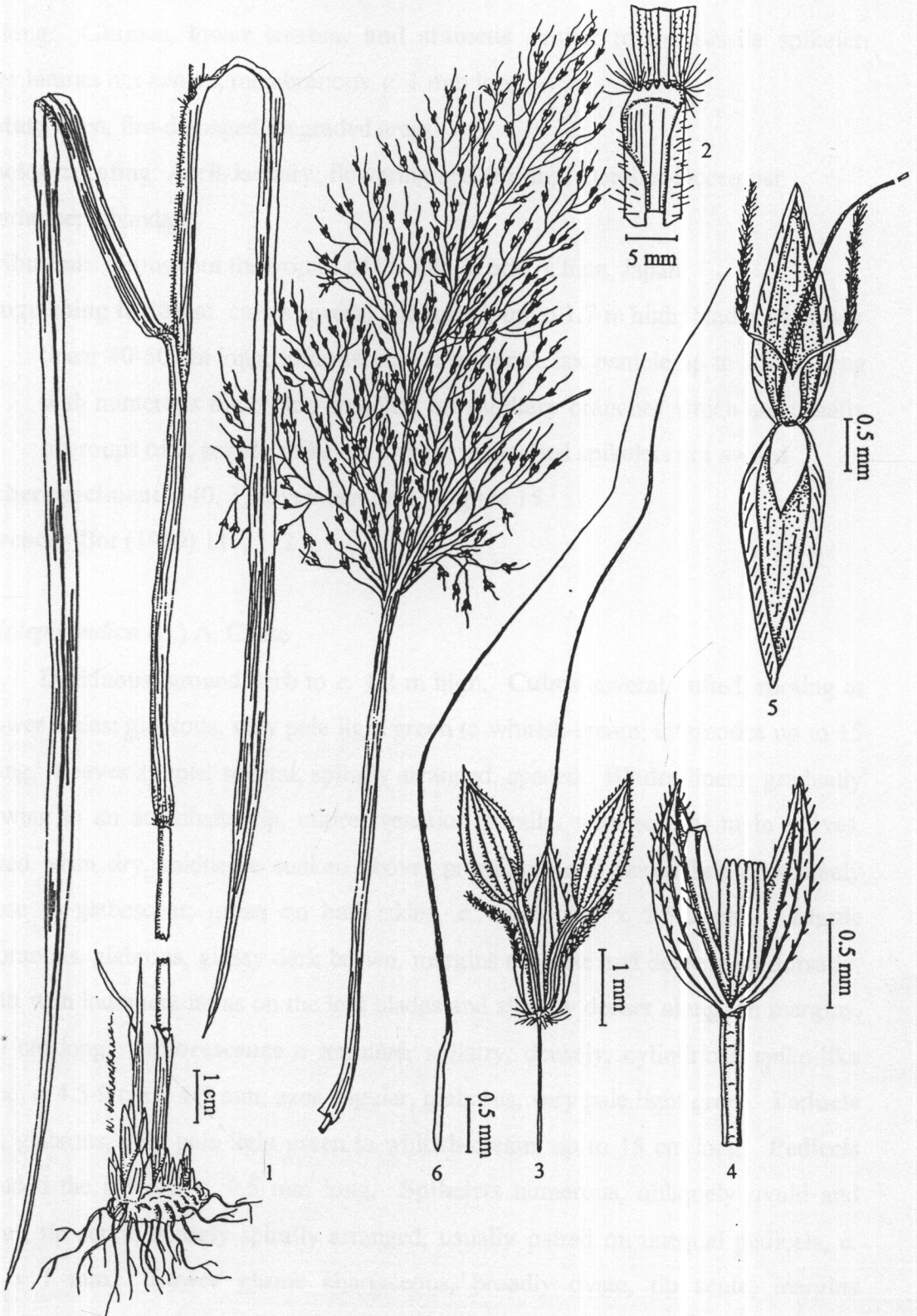


Figure 15 *Capillipedium parviflorum* (R. Br.) Stapf (#340): 1 = habit, 2 = ligule, 3 = sessile and two pedicelled spikelets, 4 = opened pedicelled spikelet, 5 = opened sessile spikelet, 6 = upper lemma of sessile spikelet with awn

mm long. **Glumes, lower lemma, and stamens** similar to the sessile spikelet.

Upper lemma not awned, membranous, *c.* 1 mm long.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: April-January; flowering and fruiting: October-December

Abundance: abundant

Distribution: throughout the tropics of the Old World, China, Japan

Distinguishing features: culms several and tufted, up to 1.7 m high; blades narrowly linear 40-50 cm long; inflorescence a terminal, lax panicle up to 25 cm long with numerous dimorphic spikelets on capillary branches which are usually in groups of 3; sessile spikelets awned; pedicelled spikelets not awned

Voucher specimen: 340, 3 November 2001; **Figure** 15

Reference: Bor (1960) 110, 112

Sacciolepis indica (L.) A. Chase

Deciduous, ground herb to *c.* 1.2 m high. **Culms** several, tufted, rooting at the lower nodes; glabrous, very pale light green to whitish-cream; internodes up to 15 cm long. **Leaves** simple, several, spirally arranged, spaced. **Blades** linear, gradually narrowing to an acuminate tip, entire; venation parallel with several main nerves, grooved when dry, midnerve sunken above, prominent and raised below; sparsely setulose to glabrescent; green on both sides, *c.* 15-26 cm x 2.5-5 mm. **Ligule** membranous, glabrous, glossy dark brown, margins ciliate and densely so dorsally. **Sheath** with indumentum as on the leaf blades and slightly denser along the margins, *c.* 4-9 cm long. **Inflorescence** a terminal, soliatry, densely, cylindrical, spike-like raceme, *c.* 4.5-9 cm x 4-5 mm; axes angular, glabrous, very pale light green. **Peduncle** terete, glabrous, very pale light green to whitish-cream, up to 15 cm long. **Pedicels** concluded the spikelet *c.* 0.5 mm long. **Spikelets** numerous, obliquely ovoid and gibbous, tip acute; densely spirally arranged, usually paired on unequal pedicels, *c.* 2.5-3 x 1 mm. **Lower glume** chartaceous, broadly ovate, tip acute, margins membranous, 3-nerved, greenish, turning light brown, *c.* 1-1.3 x 1 mm. **Upper glume** chartaceous, ovate-lanceolate, apex acute, margins membranous, slightly convolute, sparsely setulose in the upper half outside, glabrous inside, 9-nerved, *c.* 2.8-3 mm long. **Lower lemma** chartaceous, ovate, apex acute, 7-nerved, setulose in the upper

half outside, glabrous inside, light green, turning brown, about the same size as the upper glume. **Upper lemma** thin, glossy whitish-cream, elliptic, apex acute, margins incurved, distinctly 2-keeled, c. 2 x 1 mm. **Palea** thin, elliptic, texture similar to the upper lemma, c. 1.8 x 0.7-0.8 mm. **Stamens** 3, anthers bilocular, locules linear, dark maroon-violet, c. 1 mm long. **Stigmas** 2, plumose, whitish-green, exserted from the spikelet. **Grains** immature.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: May-December; flowering and fruiting: October-December

Abundance: common

Distribution: Thailand, India, Burma, Australia, Polynesia

Distinguishing features: culms tufted; inflorescence of a dense, terminal solitary

cylindrical, erect, spike-like raceme; spikelets gibbous, unawned, 2.5-3 mm long

Voucher specimen: 337, 3 November 2001; **Figure** 16

Reference: Bor (1960) 357

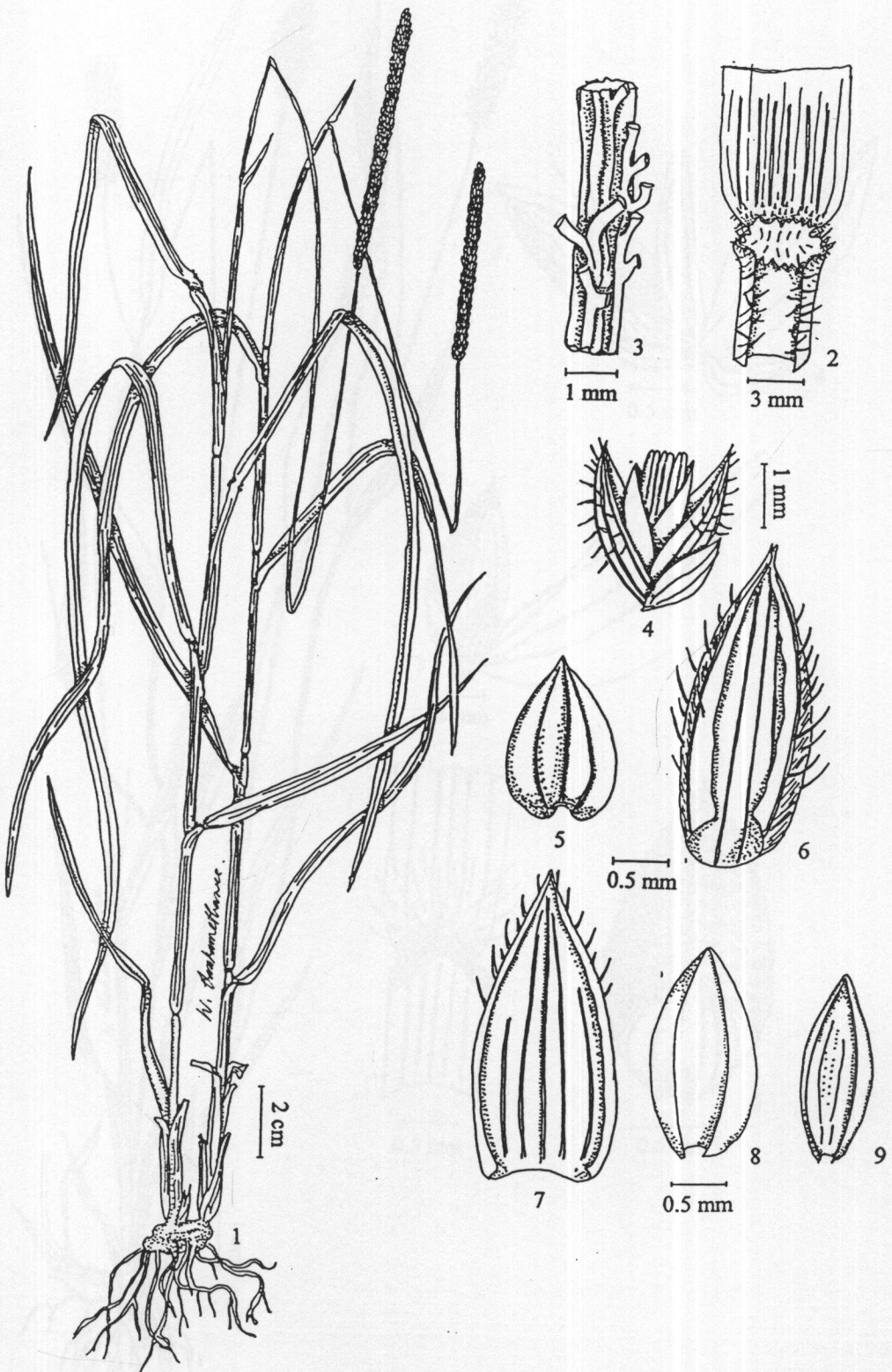


Figure 16 *Sacciolepis indica* (L.) Chase (#337): 1 = habit, 2 = ligule, 3 = part of rachilla and pedicels, 4 = opened spikelet, 5 = lower glume (dorsal), 6 = upper glume (ventral), 7 = lower lemma, 8 = upper lemma, 9 = palea

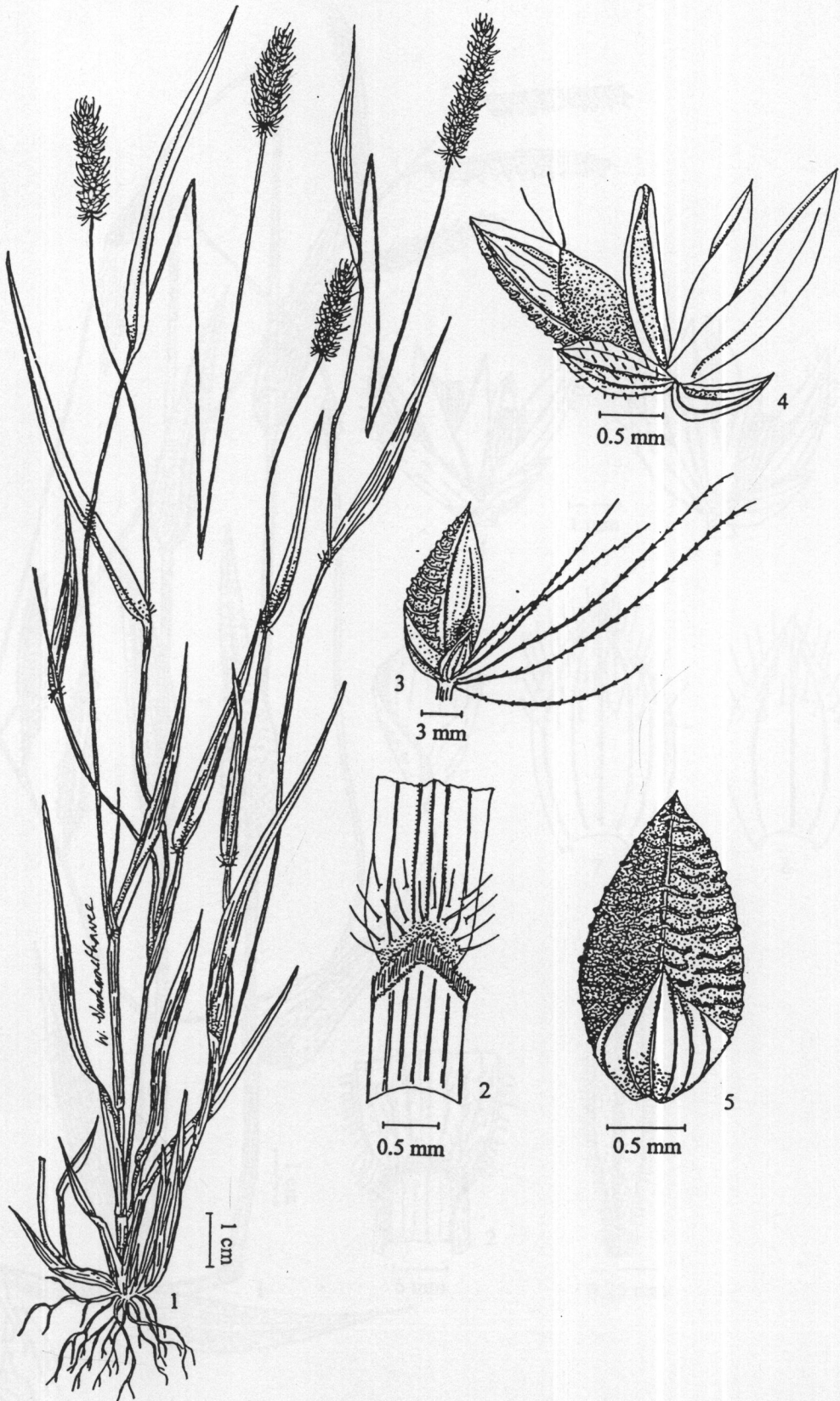


Figure 17 *Setaria parviflora* (Poir.) Kerg. (#339): 1 = habit, 2 = ligule, 3 = spikelet, 4 = opened spikelet, 5 = upper glume and upper lemma

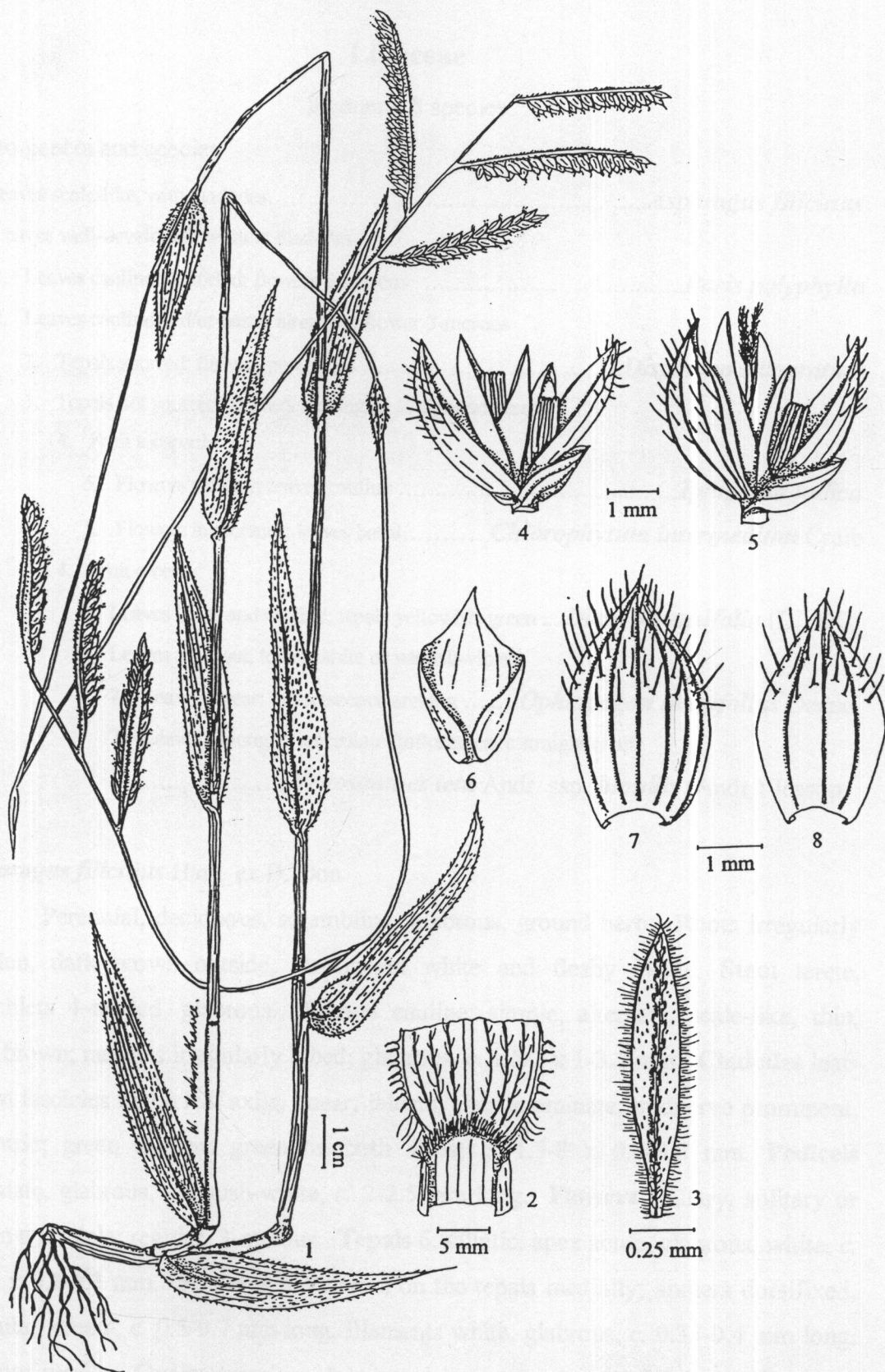


Figure 18 *Urochloa ruziziensis* (Germ. & Evr.) Morr. & Zul. (#323): 1 = habit, 2 = ligule, 3 = rachilla, 4 = opened male spikelet, 5 = opened hermaphroditic spikelet with: 6 = lower glume (ventral), 7 = upper glume (dorsal), 8 = lower lemma

Liliaceae

8 genera, 8 species

key to genera and species

1. Leaves scale-like, with cladodes..... *Asparagus filicinus*
1. Leaves well-developed, without cladodes
 2. Leaves cauline, whorled; flowers 5-merous *Paris polyphylla*
 2. Leaves cauline and/or basal, alternate; flower 3-merous
 3. Tepals spurred; flowers pendulous *Disporum calcaratum*
 3. Tepals not spurred; flowers arching or straight and erect
 4. Fruit a capsule
 5. Flowers solitary; leaves cauline *Iphigenia indica*
 5. Flowers in racemes; leaves basal..... *Chlorophytum intermedium* Craib
 4. Fruit a berry
 6. Leaves basal and cauline; tepals yellowish-green *Dianella ensifolia* (L.) DC.
 6. Leaves all basal, tepals white or whitish-violet
 7. Leaves linear; inflorescence arching *Ophiopogon longifolius* Decne.
 7. Leaves oblong to lanceolate; inflorescence straight erect
 - *Peilosanthes teta* Andr. ssp. *humilis* (Andr.) Jessop

Asparagus filicinus Ham. ex D. Don

Perennial, deciduous, scrambling, glabrous, ground herb. **Roots** irregularly swollen, dark brown outside, translucent white and fleshy inside. **Stem** terete, branchlets 4-angled, glabrous. **Leaves** cauline, simple, alternate, scale-like, thin, light brown; margins irregularly lobed; glabrous, c. 1.5-3 x 1-3.5 mm. **Cladodes** leaf-like in fascicles in the leaf axils, linear, falcate, apex acuminate; midnerve prominent, eccentric; green to dark green on both sides; c. 1.5-8 x 0.3-0.8 mm. **Pedicels** articulate, glabrous, greenish-white, c. 2-2.5 mm long. **Flowers** axillary, solitary or few in a fascicle; regular, 3-merous. **Tepals** 6, elliptic, apex acute, glabrous, white, c. 2-2.5 x 0.8-1.3 mm. **Stamens** 6, inserted on the tepals medially; anthers dorsifixed, bilocular, cream, c. 0.5-0.7 mm long, filaments white, glabrous, c. 0.35-0.4 mm long. **Stigmas** sessile. **Ovary** superior, globose, glabrous, green, c. 0.7-0.9 mm diameter; 3-loculed, each locule with one axile ovule. **Berries** not seen.

Habitat: partly shaded areas in fire-damaged, degraded areas

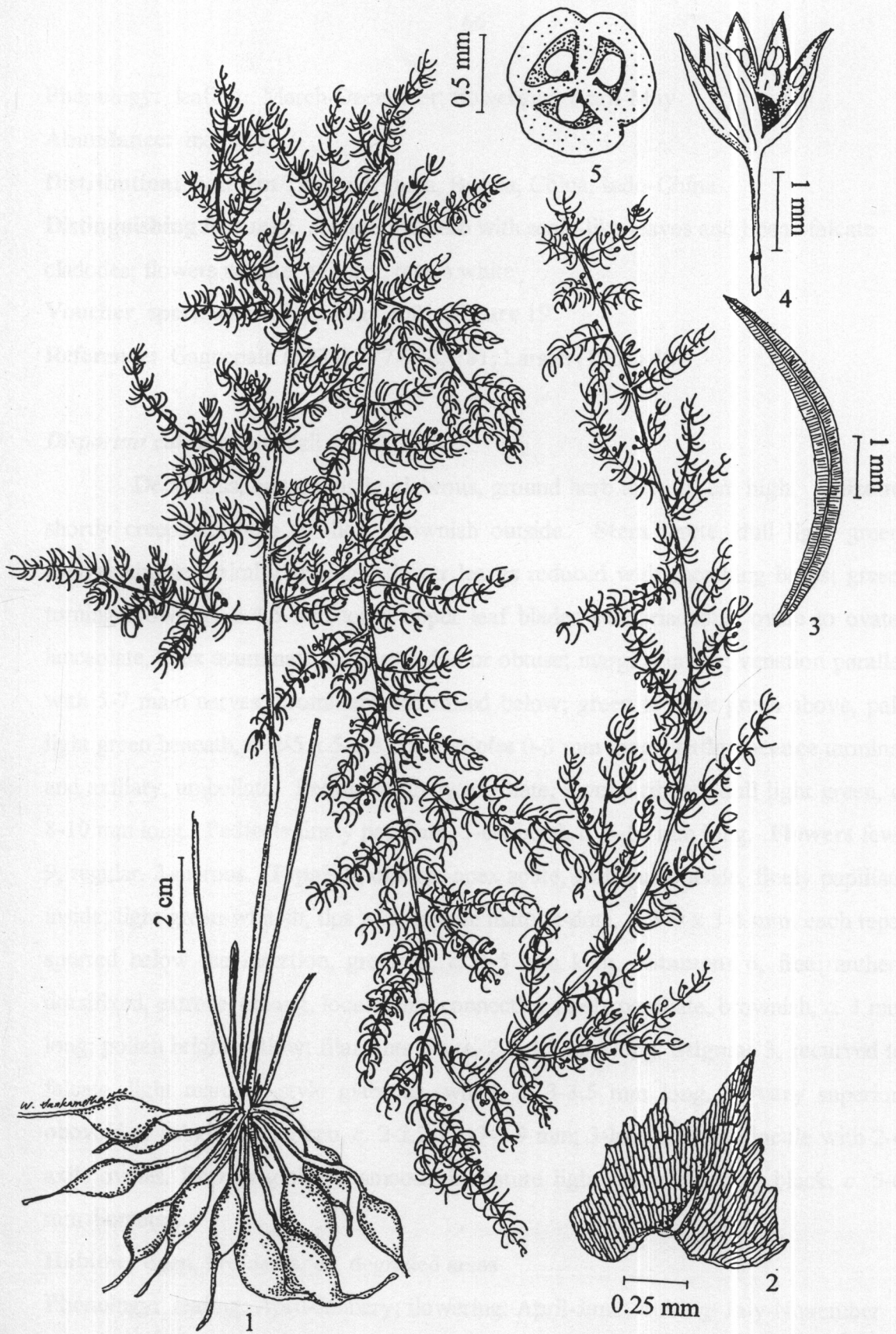


Figure 19 *Asparagus filicinus* Ham. ex D. Don (#174): 1 = habit, 2 = scale-like leaf, 3 = cladode, 4 = flower, 5 = ovary (x-section)

Phenology: leafing: March-December; flowering: April-May

Abundance: medium

Distribution: northern Thailand, India, Burma, China, Indo-China

Distinguishing features: scrambling herb with scale-like leaves and linear-falcate cladodes; flowers minute, axillary; tepals white

Voucher specimen: 174, 4 May 2001; **Figure** 19

Reference: Gagnepain (1934) 777-778, 781; Larsen (1961) 40

Disporum calcaratum Wall. ex D. Don

Deciduous, erect, mostly glabrous, ground herb to c. 70 cm high. **Rhizome** shortly creeping, roots swollen, brownish outside. **Stem** terete, dull light green. **Leaves** simple, spirally arranged; lower leaves reduced with sheathing bases; green, turning brown, c. 2-4.5 mm long; upper leaf blades subcoriaceous, ovate to ovate-lanceolate, apex acuminate, base rounded or obtuse; margins entire; venation parallel with 5-7 main nerves, prominent and raised below; green to dark green above, pale light green beneath, c. 2-5 x 5-5.8 cm. **Petioles** 0-3 mm long. **Inflorescence** terminal and axillary, umbellate. **Peduncle** finely papillate, several ribbed, dull light green, c. 8-10 mm long. **Pedicels** finely papillate, 5-6-ribbed, c. 5-10 mm long. **Flowers** few-9, regular, 3-merous. **Tepals** 6, oblong, apex acute, glabrous outside, finely papillate inside; light green-whitish, tips with minute maroon dots, c. 8-9 x 3-4 mm; each tepal spurred below the insertion, greenish, c. 4-5 mm long. **Stamens** 6, free; anthers dorsifixed, extrose, oblong, locules and connective finely papillate, brownish, c. 3 mm long; pollen bright yellow; filaments white, 2.5-4.5 mm long. **Stigmas** 3, recurved to falcate, light maroon; style glabrous, white, c. 3-3.5 mm long. **Ovary** superior, obovoid or subglobose, green, c. 2-2.2 x 1.7-1.9 mm; 3-loculed, each locule with 2-4 axile ovules. **Berries** globose, smooth, immature light green, ripening black, c. 5-6 mm diameter.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: April-January; flowering: April-June; fruiting: July-November

Abundance: medium

Distribution: northern Thailand, India, Himalayas, Yunnan, Burma, Indo-China

Distinguishing feature: mostly glabrous herb with lower nodes lacking leaf blades,

sheaths prominent; upper leaf blades ovate with parallel nerves which are prominent and raised below. Inflorescence umbellate, pendulous; tepals spurred.

Voucher specimens: 154, 11 April 2001; 241, 10 August 2001; **Plate 4 C**

References: Gagnepain (1934) 779 (fig.), 781-782; Hara (1988) 192 (fig.) 193-195, plate 42; Craib (1913) 16; Larsen (1961) 40-41.

***Iphigenis indica* (L.) Gray ex Kunth**

Deciduous, erect, mostly glabrous, ground herb to c. 40 cm high. **Corm** globose or ovoid, light brown outside, white inside, c. 10 mm diameter. **Stem** terete, dull maroon or light green. **Leaves** simple, alternate, sessile. **Blades** thin, linear; apex acuminate, base shortly sheathing; margins entire; venation parallel, midnerve sunken above, raised below; dull green above, pale light green beneath; c. 7-20 cm x 3-7 mm. **Flowers** solitary, terminal and axillary, regular, 3-merous. **Tepals** 6, oblong to linear-lanceolate, apex acuminate, dull maroon; c. 9-10 x 1.5-2 mm. **Stamens** 6, free; anthers basifixed, bilocular, dull maroon, c. 1.3-1.5 mm long; filaments finely papillate, dull light maroon, c. 2.3-2.4 mm long. **Stigmas** 3, circinate, dull maroon. **Ovary** superior, ovoid, deeply 3-lobed, dull maroon, c. 3-3.3 mm diameter; 3-loculed, rarely 4, each lobe shallowly channeled with several axile ovules. **Capsules** obovoid, 3-angled, smooth; immature green, maturing brown, 9-14 x 5-7 mm, loculicidal. **Seeds** several, arilate, irregularly rectangular, glossy dark brown, c. 2-2.3 mm long.

Habitat: open, fire-damaged, degraded area

Phenology: leafing: August-November; flowering: August-September; fruiting: August-December

Abundance: rare

Distribution: northern Thailand, India, Sri Lanka, southern China, Malaysia

Philippines, northern Sumatra, Java, Lesser Sunda Islands, New Guinea, Australia

Distinguishing features: erect, single stem herb; leaves linear, cauline; flowers solitary, tepals dull maroon, linear-lanceolate, spreading; capsules 3-angled

Voucher specimen: 250, 10 August 2001; **Figure 20**

References: Jessop (1979) 192-193, 197-198 (fig.); Craib (1913) 16; Larsen (1961) 46

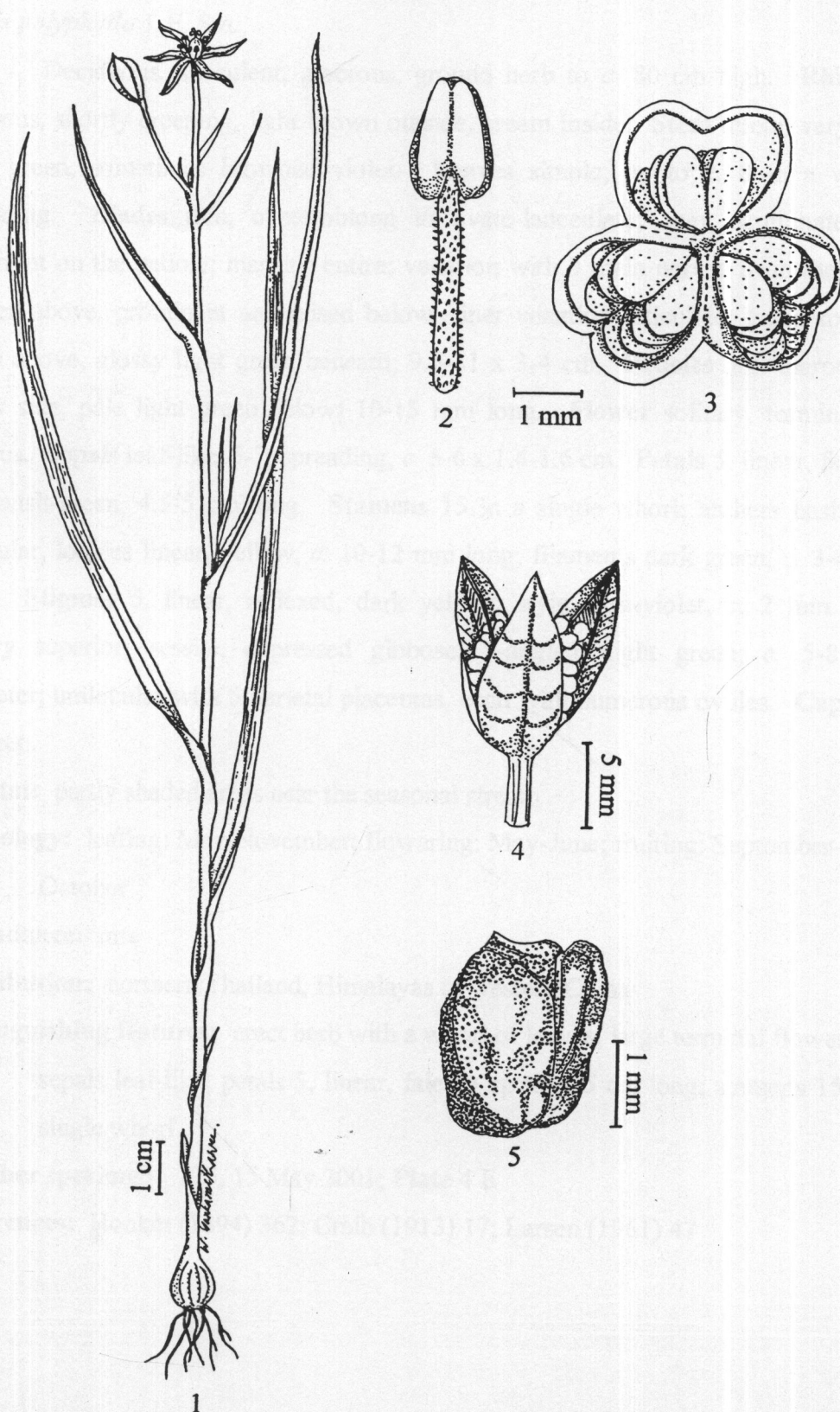


Figure 20 *Iphigenia indica* (L.) Gray ex Kunth (#250): 1 = habit, 2 = stamen, 3 = ovary (x-section), 4 = dehiscent capsule, 5 = seed

***Paris polyphylla* J. E. Sm.**

Deciduous, succulent, glabrous, ground herb to c. 80 cm high. **Rhizome** tuberous, shortly creeping, light brown outside, cream inside. **Stem** terete, very pale light green, sometimes brownish-violet. **Leaves** simple, up to c. 8 in a whorl, spreading. **Blades** thin, ovate-oblong to ovate-lanceolate; apex acuminate and decurrent on the petiole; margins entire; venation with 3 main nerves from the base; sunken above, prominent and raised below; finer venation reticulate; green to dark green above, glossy light green beneath; 9.5-11 x 3-4 cm. **Petioles** dull maroon on upper side, pale light green below; 10-15 mm long. **Flower** solitary, terminal, 5-merous. **Sepals** leaf-like, 5-7, spreading, c. 5-6 x 1.4-1.6 cm. **Petals** 5, linear, falcate, yellowish-green, 4.5-5 cm long. **Stamens** 15 in a single whorl; anthers basifixed, bilocular, locules linear, yellow, c. 10-12 mm long; filaments dark green, c. 3-4 mm long. **Stigmas** 5, linear, reflexed, dark yellow; style dark-violet, c. 2 mm long. **Ovary** superior, sessile, depressed globose, 5-angled; light green; c. 5-8 mm diameter; unilocular with 5 parietal placentas, each with numerous ovules. **Capsules** not seen.

Habitat: partly shaded areas near the seasonal stream

Phenology: leafing: May-November; flowering: May-June; fruiting: September-October

Abundance: rare

Distribution: northern Thailand, Himalayas to western China

Distinguishing features: erect herb with a whorl of leaves; large terminal flower; sepals leaf-like; petals 5, linear, falcate up to c. 5 cm long; stamens 15 in a single whorl

Voucher specimen: 175, 15 May 2001; **Plate** 4 E

References: Hooker (1894) 362; Craib (1913) 17; Larsen (1961) 47

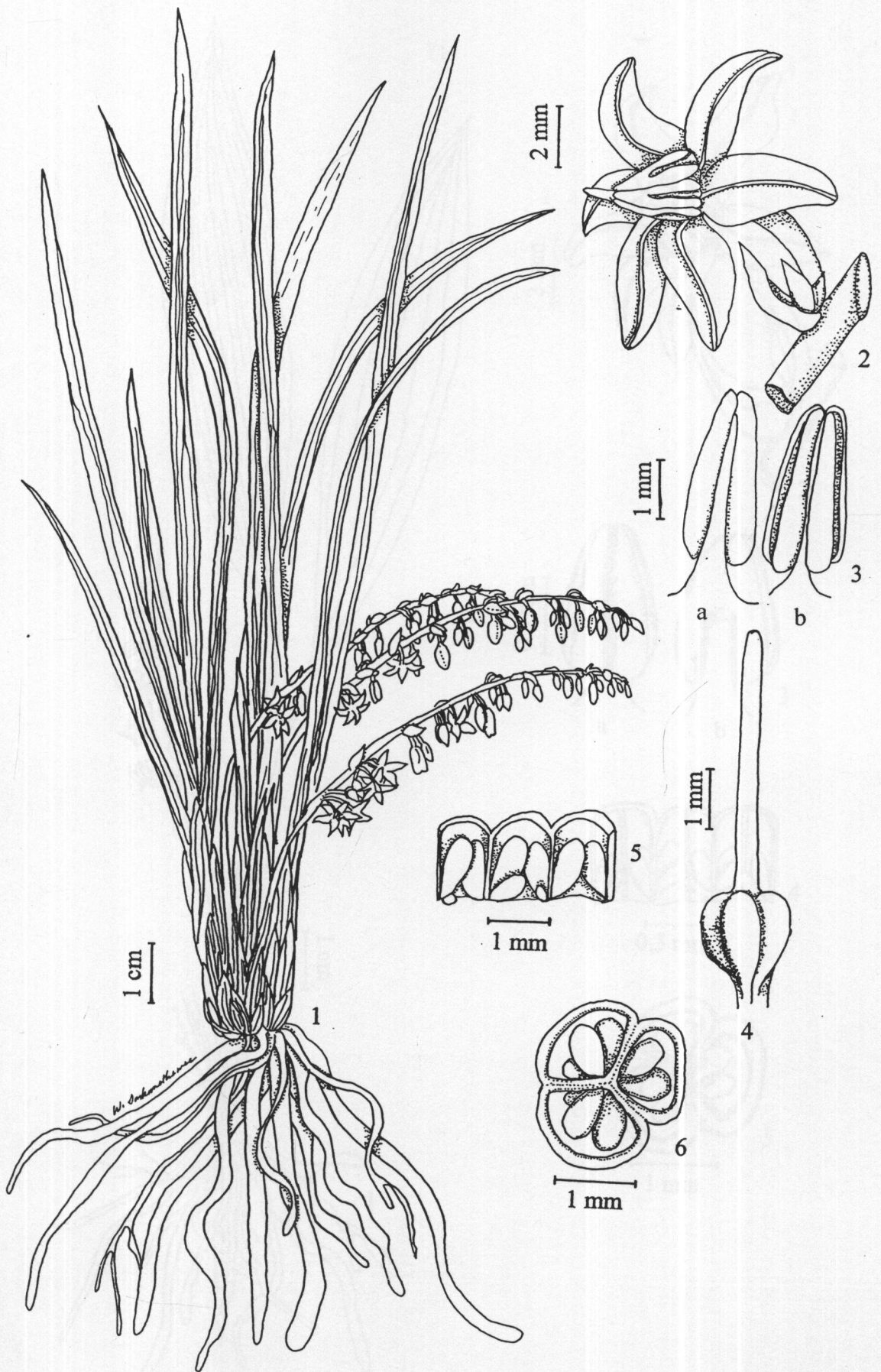


Figure 21 *Ophiopogon longifolius* Decne. (#172): 1 = habit, 2 = bracteole and flower, 3 = stamen: a = posterior, b = anterior, 4 = pistil, 5 = opened ovary, 6 = ovary (x-section)

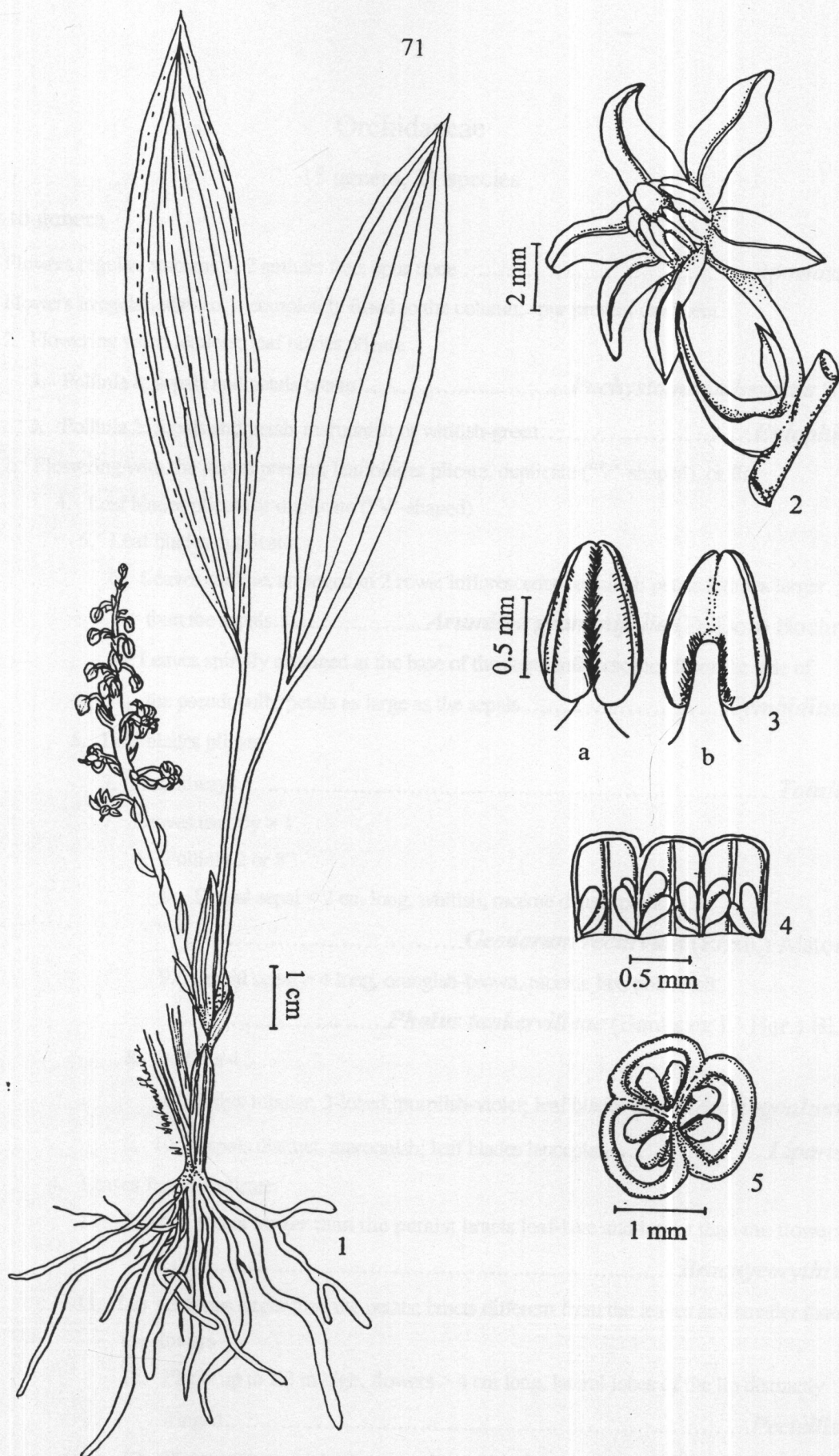


Figure 22 *Peliosanthes tetra* Andr. ssp. *humilis* (Andr.) Jessop (#204 and 244):
 1 = habit, 2 = bracteole and flower, 3 = stamen: a = anterior, b = posterior,
 4 = opened ovary, 5 = ovary (x-section)

Orchidaceae

15 genera, 21 species

key to genera

1. Flowers regular, stamens 3, 2 anthers free; spur none *Apostasia*
1. Flowers irregular, stamen 1, completely fused to the column; spur present or absent
 2. Flowering when leafless; leaf blades plicate
 3. Pollinia 8; sepals and petals cream *Pachystoma pubescens* Bl.
 3. Pollinia 2; sepals and petals maroonish or whitish-green *Eulophia*
 2. Flowering with the leaves present; leaf blades plicate, duplicate ("V"-shaped), or flat
 4. Leaf blades plicate or duplicate ("V"-shaped)
 5. Leaf blades duplicate
 6. Leaves cauline, arranged in 2 rows; inflorescence terminal; petals 2 times larger than the sepals *Arundina graminifolia* (D. Don) Hochr.
 6. Leaves spirally arranged at the base of the stem, inflorescence from the side of the pseudobulb; petals as large as the sepals *Cymbidium*
 5. Leaf blades plicate
 7. Leaf always 1 *Tainia*
 7. Leaves usually > 1
 8. Pollinia 2 or 8
 9. Dorsal sepal < 2 cm long, whitish; raceme dense, pollinia 2 *Geodorum recurvum* (Roxb.) Alston
 9. Dorsal sepal > 4 long, orangish-brown, raceme lax, pollinia 8 *Phaius tankervilleae* (Banks ex L' Her.) Bl.
 8. Pollinia 4
 10. Calyx tubular, 3-lobed, purplish-violet; leaf blades linear. *Anthogonium*
 10. Sepals distinct, maroonish; leaf blades lanceolate *Liparis*
 4. Leaves flat, not plicate
 11. Lip > 5 times larger than the petals; bracts leaf-like and larger than the flowers *Brachycorythis*
 11. Lip < 3 times larger than the petals; bracts different from the leaves and smaller than the flowers
 12. Plants up to 1.3 m high, flowers > 4 cm long, lateral lobes of the lip distinctly fringed *Pecteilis*
 12. Plants < 60 cm high, flowers < 2 cm long, lateral lobes of the lip not fringed
 13. Lip 2-lobed *Zeuxine affinis* (Lindl.) Benth. ex Hk. f.

13. Lip unlobed or 3-lobed
 14. Spur globose or ellipsoid *Peristylus*
 14. Spur elongate or none..... *Habenaria*

***Anthogonium gracile* Wall. ex Lindl.**

Deciduous, glabrous, erect, ground herb to c. 60 cm high. **Pseudobulbs** few, ovoid, white outside, cream inside, fleshy, 8-13 mm diameter. **Leaves** simple, few. **Blades** thin, linear to linear-lanceolate, plicate, apex acuminate, base attenuate to the leaf sheath, margins entire; venation parallel with 3-5 main nerves which are prominent and raised below; dark green above, pale light green beneath, c. 13-27 cm x 7-20 mm. **Inflorescence** of few to several flowered racemes, arising laterally from the pseudobulb; axes terete, light green or brownish-green. **Bracts** subulate or linear, green turning brown, c. 2-13 x 0.5-2 mm long. **Flowers** spaced, irregular, 3-merous. **Pedicels/ovary** cylindric, smooth, terete, light green or reddish-maroon, c. 10-14 mm long. **Calyx** tubular whitish-purple or violet-purplish, turning yellowish-brown, dorsally split and spathiform; tube c. 5-6 mm long; limb 3-lobed, reflexed at anthesis, 10-12 mm long; dorsal lobe ovate, tip acute, c. 6-7 x 3 mm; lateral lobes suborbicular, c. 4-5 mm diameter. **Petals** 2, limb oblong, falcate, tips obtuse, similar color as the calyx, c. 7 x 2.5 mm; claw c. 7-8 x 0.7-1 mm. **Lip** dorsal, broadly obovate, margins incurved; purple with scattered dark violet spots; hypochile 10 x 8-9 mm; epichile 3-lobed, obtuse: midlobe smallest c. 2-2.3 mm wide, lateral lobes c. 2.5 mm wide. **Column** erect and slightly curved at the top, flat, purplish to light yellow; operculum thin, purplish to light yellow, c. 1 mm diameter. **Pollinia** 4, in pairs of two. **Ovary** inferior, unilocular, with numerous parietal ovules. **Capsules** not seen.

Habitat: open, or partly shaded areas in grassy, degraded areas

Phenology: leafing: August-November; flowering: September- November

Abundance: medium

Distribution: N, NE, E Thailand, Nepal, India, Bhutan, Burma, Laos, Vietnam, China

Distinguishing features: leaves few, grass-like, blades linear-oblong up to 30 cm

long, plicate; inflorescence arising laterally from the pseudobulb, erect, few-several-flowered; flowers < 1.5 cm long; calyx tubular, violet-purplish

Voucher specimen: 303, 10 October 2001; **Plate** 5 C

References: Seidenfaden (1986) 67-68 (fig.); Schuiteman & De Vogel (2000) 27, 87 (fig.)

***Apostasia wallichii* R. Br.**

Perennial, deciduous, glabrous ground herb to c. 20 cm high. **Underground stem** erect, foetid, to c. 13 cm long with several spirally arranged, spaced cataphylls which are c. 4-6 mm long. **Leaves** simple, closely spirally arranged at the top of the stem. **Blades** thin, linear-lanceolate, apex acuminate, base attenuate into the leaf sheath, margins entire; venation parallel, with several nerves which are prominent on both sides; dark green above, green below; c. 3-11 cm x 5-8 mm. **Inflorescence** axillary, racemose up to 5 cm long; axes green. **Bracts** like reduced leaves, apex acuminate, green, c. 1.5-2 x 5-7 mm. **Flowers** several, erect, regular, 3-merous. **Pedicel/ovary** cylindric, sharply triangular, green, c. 10-15 x 1.5 mm. **Sepals** 3, oblong, carinate, tip cusped, yellow, c. 1.5-1.7 x 5-6 mm. **Petals** 3, oblong, carinate as and slightly thinner than the sepals, apex obtuse tip cusped extending from the keel. **Fertile stamens** 2, adnate to the base of the column; anthers free, cream, unequally bilocular, longer locule c. 3.5-4 mm long, shorter locule c. 3-3.5 mm long; free part of filaments c. 0.2-0.6 mm long; column white, c. 3 mm long. **Staminode** 1 entirely united to the column, c. 2 mm long. **Stigma** bilobed, free part of the style c. 0.8 mm long. **Ovary** inferior; 3-loculed, each locule with numerous axile ovules. **Capsules** not seen.

Habitat: open, fire-damaged areas

Phenology: leafing: May-February; flowering: August

Abundance: rare

Distribution: scattered throughout Thailand, Sri Lanka, Nepal, India, Burma, Cambodia, Vietnam, Malay Peninsula, Indonesia, northern Australia

Distinguishing features: erect herb; underground stem straight with cataphylls;

blades linear-lanceolate < 1.5 cm wide, nerves parallel; inflorescence racemose; flowers regular 3-merous, sepals and petals yellow; fertile stamens 2, anthers free from the column, staminode 1, united to the column; ovary inferior, cylindric, sharply triangular

Voucher specimen: 247, 10 August 2001

Reference: Larsen & De Vogel (1972) 134-137

***Brachycorythis henryi* (Schltr.) Summ.**

Deciduous, erect, ground herb to c. 30 cm high. **Tubers** subglobose, light brown outside, translucent-white and fleshy inside, c. 2 cm diameter. **Stem** terete, finely papillate, light green. **Leaves** simple, spirally arranged. **Blades** thin, elliptic, apex acute, base attenuate to the leaf sheath, margins entire; venation parallel with 3-5 main nerves, midnerve sunken above, prominent and raised below; glabrous above, finely papillate beneath; dark green above, pale light green underneath, c. 5-6.5 x 2-2.5 cm. **Inflorescence** in a terminal, erect raceme; axes light green, papillate as on the stem and blades. **Bracts** leaf-like, similar to the leaves, decreasing in size towards the inflorescence, usually larger than the flowers. **Flowers** several, irregular, 3-merous. **Pedicels/ovary** cylindric, sharply grooved, finely papillate as on the stem, light green, c. 1.5-2.2 cm long. **Sepals** 3, oblong-lanceolate, tips acute, whitish-cream with pale violet near the margins inside, purplish outside, c. 20-22 x 4-5 mm; dorsal sepal slightly smaller than the lateral ones. **Petals** 2, cream, similar to the sepals, but slightly smaller, c. 18-20 mm long. **Lip** ventral, orbicular, spreading, apex rounded or broadly emarginate, margins finely erose and undulate, pinkish-purple outside, purple-violet inside, 28-32 mm diameter. **Spur** conical, broadening at the base, shortly cylindric at the top, c. 9-10 mm long. **Column** erect, triangular in side view, pale light green to whitish-cream, c. 7 mm long; operculum thin, 2-lobed, maroon. **Pollinia** 2, yellow. **Ovary** inferior, unilocular with numerous parietal ovules. **Capsules** not seen.

Habitat: shaded area in bamboo thickets along and near a seasonal stream

Phenology: leafing: June-September; flowering: July-August

Abundance: down to few individuals

Distribution: N, NE, E, SE Thailand, Burma, China

Distinguishing features: inflorescence erect with bracts which are similar to the leaves and larger than the flowers; lip orbicular, purplish-violet, more than 5 times larger than the sepals and petals

Voucher specimen: 223, 13 July 2001; Plate 6 E

References: Seidenfaden (1977) 9-10, 12 (fig.); Schuiteman & De Vogel (2000) 31

***Cymbidium ensifolium* (L.) Sw.**

Deciduous, glabrous, ground herb to c. 50 cm high. **Roots** slightly swollen with a thickened corky epidermis, white to light brown, creeping up to c. 40 cm long. **Leaves** mostly basal, spirally arranged; lower leaves bladeless with spatheform sheaths, light green, turning brown. **Blades** coriaceous, ensiform, duplicate, linear; apex acuminate, base attenuate to the leaf sheath; entire; venation parallel with 5-7 main nerves which are prominent and raised on both sides; green above, light green below; c. 50-60 x 1-1.5 cm. **Inflorescence** of erect racemes, up to 40 cm long, arising from the side of the pseudobulb; axes terete, dull greenish to dull maroon. **Bracts** ovate-lanceolate, apex acuminate, greenish-cream, c. 7-30 x 3-6 mm. **Flowers** few-several, spaced, irregular, 3-merous. **Pedicels/ ovary** cylindric, grooved, cream-light green, c. 20-30 mm long. **Sepals** 3, spreading, oblong, tips acute, cream or whitish-green with brownish-maroon vertical lines, c. 21-32 x 6-8 mm. **Petals** 2, erect, similar to and slightly smaller than the sepals. **Lip** ventral, recurved at anthesis; hypochile orbicular with shortly raised side lobes and two medial ridges, pale yellowish-green, c. 10 x 8-10 mm; epichile ovate, apex obtuse, margins slightly undulate, whitish, c. 8 x 6 mm; spur absent. **Column** erect, thickened dorsally and concave ventrally, slightly curved at the top, cream inside with violet vertical streaks; operculum orbicular, pale light yellow, shallowly 2-lobed, c. 2 mm diameter. **Pollinia** 4, subglobose, in 2 pairs, c. 0.7 mm diameter. **Ovary** inferior, unilocular with numerous parietal ovules. **Capsules** not seen.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: May-December; flowering: April-June

Abundance: rare

Distribution: throughout Thailand, India, China, Indo-China, Japan, Sumatra, Java, Borneo, New Guinea

Distinguishing features: leaves ensiform, blades coriaceous up to 60 cm long; inflorescence racemose; sepals, petals, lip, and column mostly creamy; sepals spreading with reddish-brown or maroon streaks; spur absent

Voucher specimens: 160, 3 May 2001; Maxwell 97-722, 10 July 1997; **Plate 6 A**

Reference: Seidenfaden (1983) 65, 71-74 (fig.)

Eulophia

key to species

1. Flower > 20, dense; lip < 15 mm long.....*E. macrobulbon* (Par. & Rchb. f.) Hk. f.
 1. Flower < 15, spaced; lip > 20 mm long.....*E. spectabilis*

Eulophia spectabilis (Dennst.) Suresh

Deciduous, glabrous, ground herb to c. 60 cm high. **Rhizome** segmented, creeping in soil, to c. 15 cm long; pseudobulbs subglobose, light green outside, translucent-white, fleshy inside; roots white with thinly corky outside. **Leaves** few, simple, spirally arranged, appearing after fruiting. **Blades** thin, plicate when young, lanceolate; apex acuminate, base attenuate to the leaf sheath, margins entire; venation parallel with 9-11 main nerves which are prominent and raised below; green above, pale light green beneath; c. 20-35 x 4-5 cm. **Sheaths** very pale light green-whitish, c. 5-15 cm long; lower leaves reduced to spathiform sheaths. **Inflorescence** a terminal erect, raceme, c. 35 cm long; axes terete, pale light green. **Bracts** thin, lanceolate, apex acuminate, light green, c. 10-13 x 2-2.5 mm. **Flowers** several, irregular, 3-merous. **Pedicel/ovary** cylindric, grooved, greenish-brown, c. 20-35 mm long. **Sepals** 3, subequal, pale light green or maroon; dorsal sepal oblong-lanceolate, tip acute or obtuse, 25-27 x 5-7 mm; lateral sepals obliquely oblong or slightly curved ("C"-shaped), base united to the hypochile of the lip, c. 20-23 x 5-6 mm. **Petals** 2, obliquely lanceolate, tip obtuse, pale light green-whitish or maroon, c. 20 x 8 mm. **Lip** ventral, oblong, c. 20-22 x 8-10 mm; hypochile light yellow-green or maroon with raised sides up to 2.5 mm; epichile flat with 7-9 shallow longitudinal ridges, apex rounded to emarginate, margins undulate, whitish or maroon; spur conical, 4-5 mm long. **Column** erect and slightly curved at the top, dorsally thickened, white, c. 10-12 x 4 mm; operculum brownish, tip 3-lobed, c. 3 x 2.5 mm; stigmatic zone convex. **Pollinia** 2, sessile, ovoid, c. 1.5 x 1 mm. **Ovary** inferior, unilocular with numerous parietal ovules. **Capsules** not seen.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: May-October; flowering: April-June

Abundance: rare

Distribution: N and NE Thailand, India, Sri Lanka, Nepal, northwestern Himalayas,

Burma, China, Indo-China, west Malaysia, Sumatra, Java

Distinguishing features: deciduous ground herb with creeping segmented rhizome; young leaf blades plicate, lanceolate up to 35 cm long; flowering when leafless; sepals, petals and lip varied greenish-white and maroon, usually > 20 mm long; spur conical, 4-5 long.

Voucher specimens: 159, 3 May 2001; 231, 14 July 2001; **Plate 6 C & D**

Reference: Seidenfaden (1983) 28-29, 40, 42-46 (fig. p. 45); Seidenfaden (1992) 330 (*sub E. nuda* Lindl.)

Habenaria

key to species

1. Sepals, petals, and lip yellowish.....*H. chlorina*
1. Sepals, petals, and lip white
 2. Lip 3-lobed, spurred.....*H. dentata* (Sw.) Schltr.
 2. Lip entire, not spurred..... *H. malintana* (Blanco) Merr.

Habenaria chlorina Par. & Rchb. f.

Deciduous, erect, glabrous, ground herb to c. 45 cm high. **Roots** tuberous, brown outside, whitish inside, fleshy. **Stem** terete, light green. **Leaves** few, simple, spirally arranged, well-spaced. **Blades** subcoriaceous, lanceolate to linear-lanceolate, apex acuminate, base attenuate, margins entire; midnerve sunken above, prominent and raised below, other venation obscure; dark green above, pale light green beneath, c. 3-10.5 cm x 8-15 mm; sheath c. 1-2 cm long. **Reduced leaves** in the upper part of the stem lanceolate, apex aristate; c. 2-4 cm x 3-6 mm. **Inflorescence** a terminal raceme, erect, c. 3-8 cm long; axes light green. **Bracts** linear-lanceolate, like reduced leaves, tips aristate, c. 7-22 x 1-2 mm. **Flowers** many, irregular, 3-merous. **Pedicel/ovary** cylindric, grooved, light green-yellow, c. 14-17 mm long **Sepals** 3, subequal; dorsal sepal erect, ovate, carinate; lateral sepals spreading, ovate, tips acute, base slightly oblique, 3-nerved; light yellow-green to yellow, usually variegated with distinct dark brown patches inside; c. 5.5-6 x 3-4 mm. **Petals** 2, elliptic-oblong, tips acute, same color as the sepals, c. 5 x 2 mm. **Lip** 3-lobed; bright yellow-greenish; the midlobe linear-oblong, tip obtuse, c. 6-7 mm long; lateral lobes lanceolate, tips acute,

c. 3 mm long. **Column** erect, slightly curved at the top, cream, *c.* 4 mm long, operculum thin, cream. **Pollinia** 2, yellow, *c.* 3 mm long. **Stigmas** 2 each on a stigmaphore, extending horizontally from the column, *c.* 0.8 mm long; stylids oblong, *c.* 1 mm long. **Ovary** inferior, unilocular with numerous ovules in 3 parietal rows. **Capsules** not seen.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: August-September; flowering: August

Abundance: medium

Distribution: N and NE Thailand, Burma, Laos, Vietnam

Distinguishing features: leaves few, blades lanceolate to linear-lanceolate, < 2 cm wide; inflorescence an erect, terminal raceme; sepals, petals, and lip yellowish-green, usually variegated with dark brown patches; stigmas 2, extending and spreading, free from the column

Voucher specimen: 236, 10 August 2001; **Plate** 7 A

Reference: Seidenfaden (1977) 65-69, 105-106 (fig.)

Liparis paradoxa (Lindl.) Rchb. f.

Deciduous, glabrous, erect, ground herb to *c.* 35 cm high. **Tubers** paired, testicular, ellipsoid, whitish-green outside, translucent and white inside, fleshy, *c.* 1.5-2 cm diameter. **Pseudobulbs** inconspicuous, **Leaves** simple, 2-3, spirally arranged, basal. **Blades** thin, plicate when young, lanceolate, apex acuminate, base attenuate and sheathing, margins entire; venation parallel, 5 main nerves, distinct; green above, dull maroon beneath, *c.* 5-11 x 1.5-3 cm. **Inflorescence** an erect terminal raceme, 10-14 cm long; peduncle 4-5-angled, light green-maroon, slender, up to *c.* 20 cm long. **Bracts** thin, subulate, dull maroon, *c.* 6-9 mm long. **Flowers** several, irregular, 3-merous. **Pedicels/ovary** cylindric, grooved and slightly twisted, light green-maroon, *c.* 12-14 mm long. **Sepals** 3, unequal, dull maroon-brown: dorsal sepal oblong, apex obtuse, margins usually revolute at anthesis and the edges nearly touching, main veins 5, *c.* 10-12 x 3-3.5 mm; lateral sepals obliquely elliptic, tips acute, slightly twisted and reflexed at anthesis, main veins, 5 *c.* 10 x 5 mm. **Petals** 2, equal, dull maroon-brown, similar to the dorsal sepal, but slightly smaller and pendulous, veins 5. **Lip** broadly obovate, apex emarginate, recurved; hypochile with 2 erect raising callus, margins

entire, epichile shallowly and regularly erose; glossy dark maroon inside, sometimes with scattered, minute, white spots. **Column** erect, curved at the top, light yellow-green, c. 6 mm long; operculum thin, light yellow-green. **Pollinia** 4, light green and turning yellowish, c. 0.8 mm long without a caudicle; Stigmatic zone flat, light green. **Ovary** inferior, unilocular with numerous ovules in 3 parietal rows. **Capsules** not seen.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: May-July; flowering: June-July

Abundance: medium

Distribution: throughout Thailand, India, Himalayas, Nepal, Yunnan, Indo-China, Taiwan, Japan, Guam

Distinguishing features: leaves few, basal; young blades plicate, often dull light maroon beneath; edges of dorsal sepal and petals revolute and nearly touching; lateral sepals twisted and reflexed; lip recurved, glossy dark maroon

Voucher specimen: 187, 6 June 2001; **Plate** 7 C

Reference: Seidenfaden (1976) 9-11, 38-40, 41 (fig.)

***Pecteilis susannae* (L.) Raf.**

Deciduous, glabrous, erect, ground herb to c. 130 cm high. **Roots** tuberous; brown outside, greyish-white and fleshy inside. **Stem** terete, pale light green. **Leaves** simple, spirally arranged on the middle of the stem. **Blades** subcoriaceous, ovate to ovate-lanceolate, apex acuminate, base attenuate into the leaf sheath, margins entire; venation parallel, main nerves 5-7, obscure; midnerve distinct, sunken above and raised below; dark green above, very pale light green beneath; c. 9-15 x 3-5 cm. **Inflorescence** a terminal, erect raceme, 15-20 cm long. **Bracts** subcoriaceous, ovate to ovate-lanceolate, apex acuminate, pale light green, c. 5-8 x 2-2.5 cm. **Flowers** several, irregular, 3-merous. **Pedicels/ovary** clavate with 6-9 sharp, vertical ribs, pale light green, 5.5-6.5 cm long. **Sepals** 3, white, subequal, spreading: dorsal sepal orbicular, c. 3-3.5 mm diameter; lateral sepals ovate, apex acute, base slightly oblique, c. 3-3.2 x 2.5 cm. **Petals** 2, oblong-lanceolate, apex obtuse, white, c. 9 x 2 mm. **Lip**

3-lobed, spreading: midlobe oblong, tip obtuse margins revolute, white, *c.* 3.3-3.5 cm x 10 mm; lateral lobes obovate, *c.* 25 x 17 mm distinctly fringed. **Spur** elongate, cylindric, curved, pale light green-whitish, *c.* 11 cm long. **Column** erect, white, 9-11 mm long; operculum thin, elliptic, white. **Pollinia** 2, cream, *c.* 7-9 mm long. **Stigma** 2-lobed, divergent, cushion-shaped, white. **Ovary** inferior, unilocular with numerous parietal ovules. **Capsules** not seen.

Habitat: partly shaded, fire-damaged, degraded areas

Phenology: leafing: September-December; flowering: October

Abundance: down to a few individuals

Distribution: throughout Thailand, India, Burma, southern China, Hong Kong, Vietnam, Laos, Cambodia, West Malaysia, Borneo, Java, Timor, Celebes, Molucca, Ambon

Distinguishing features: deciduous herb up to 1.3 m high when flowering; inflorescence a terminal raceme; flowers larger than 3 cm; sepals, petals, lip, column white; lateral lobes of the lip distinctly fringed; spur > 10 cm long

Voucher specimen: 317, 17 October 2001; **Plate** 5 E

Reference: Seidenfaden (1977) 22-23 (fig.)

Peristylus

key to species

1. Leaves mostly basal, usually < 4 cm long, flowers spaced, sepals up to 3 mm long, lip unlobed.....*P. lacertiferus* (Lindl.) J. J. Sm.
1. Leaves mostly cauline, > 6 cm long; flowers dense, sepals > 3.5 mm long, lip 3-lobed
 2. Lateral lobes of the lip ovate, dorsal sepal up to 4 mm long*P. prainii*
 2. Lateral lobes of the lip linear-lanceolate, dorsal sepal 9-10 mm long
.....*P. constrictus* (Lindl.) Lindl.

Peristylus prainii (Hk. f.) Krzl.

Deciduous, erect, glabrous, ground herb to *c.* 60 cm high. **Tubers** paired, testicular; brown outside, translucent white and fleshy inside. **Stem** terete, light orangish-green. **Leaves** simple, spirally arranged at the middle of the stem. **Blades** subcoriaceous, ovate to elliptic, apex acute, base cuneate and sheathing, entire;

venation parallel with 5-7 main nerves, midnerve sunken above, prominent and raised below; dark green above, very pale light green beneath, c. 4.5-14 x 3-5 cm. **Inflorescence** a terminal, erect, dense raceme c. 4-8 cm long; axes pale light green. **Bracts** ovate-lanceolate, tips aristate, light green, c. 14-20 x 3-4 mm. **Pedicels/ovary** cylindric, shallowly grooved, pale light green, 8-10 mm long. **Flowers** numerous, irregular, 3-merous, fragrant. **Sepals** 3, light green-whitish: dorsal sepal broadly ovate, tip acute, light green c. 4 x 3 mm; lateral sepals elliptic, tips obtuse, c. 3.5-3.6 x 2-2.3 mm. **Petals** 2, suborbicular, apex slightly thickened, shallowly 2-lobed, base oblique, white, c. 5 x 4.8 mm. **Lip** ventral, white, c. 3 x 5 mm, 3-lobed; midlobe rounded, shorter than the lateral lobes which are ovate, c. 1.3 mm long; hypochile 2 ribbed. **Spur** subglobose, light green, c. 2 mm diameter. **Column** erect, slightly curved at the top, light green, c. 2.5 mm long; operculum thin, light green. **Pollinia** 2, oblong, c. 2 mm long, cream. **Stigma** 2 distinct lobes, spreading, cream, each lobe c. 1.3 mm long. **Ovary** inferior, unilocular with numerous parietal ovules in 3 rows. **Capsules** not seen.

Habitat: partly shaded areas in bamboo thickets near the seasonal stream

Phenology: leafing: May-October; flowering: June-July

Abundance: down to few individuals

Distribution: northern and central Thailand, India, upper Burma, Vietnam

Distinguishing features: leaves spirally arranged medially on the stem; blades ovate with parallel nerves, convolute when young; inflorescence an erect terminal raceme; flowers dense, fragrant; sepals, petals and lip more or less the same length, greenish-white; spur globose

Voucher specimen: 211, 23 June 2001

Reference: Seidenfaden (1976) 27-29, 48-50 (fig.)

Tainia

key to species

1. Leaf blades < 6 cm wide; lip with 5 vertical ridges...*T. angustifolia* (Lindl.) Benth. ex Hk. f.
1. Leaf blades > 10 cm wide; lip with 3 vertical ridges.....*T. viridifusca*

***Tainia viridifusca* (Hk. f.) Benth. & Hk.f.**

Deciduous, glabrous, erect, ground herb. **Pseudobulbs** few, creeping, subglobose, light green outside, translucent-light green and fleshy inside, c. 5 cm diameter. **Leaf** always one. **Blades** thin, plicate when young, elliptic-oblong, apex acuminate, base cuneate, margins entire; venation parallel with 8 main nerves which are sunken above, prominent and raised below; dark green above, pale light green beneath, c. 70-15 cm. **Petiole** green, c. 70 cm long. **Sheath** dry, up to 25 cm long. **Inflorescence** a solitary, erect raceme, raising laterally from the pseudobulb, c. 130 cm long; axes terete, light green. **Bracts** thin, linear-lanceolate, green, turning brown, c. 10-15 x 2-3 mm. **Flowers** several, spaced, irregular, 3-merous. **Pedicel/ovary** cylindric, grooved, pale light green, c. 15-30 mm long. **Sepals** 3, thin, brownish-light green, tips acuminate; dorsal sepals oblong, c. 20-25 x 5-6 mm; lateral sepals obliquely oblong, spreading, brownish-green, c. 24-26 x 5-6 mm. **Petals** 2, similar to the lateral sepals, but slightly smaller, brownish-green. **Lip** ventral, oblong, incurved and embracing the ventral side of the column, cream; hypochile with raised sides and 3 vertical ridges; epichile thin, orbicular with 5 vertical ribs, c. 4 mm diameter, brownish-green. **Column** slightly curved at the top, margins incurved, cream, c. 10 mm long; operculum triangular, apex shallowly 2-lobed, violet, c. 2 mm long. **Pollinia** 8, yellow, c. 0.7 mm long. **Ovary** inferior, unilocular with numerous parietal ovules. **Capsules** not seen.

Habitat: shaded area near the seasonal stream

Phenology: leafing: June-December; flowering: January-February

Abundance: down to few individuals

Distribution: N and NE Thailand, northern India, Burma, Vietnam, China

Distinguishing features: only one leaf, blade plicate when young, elliptic-oblong

up to 70 cm long; inflorescence erect up to 130 cm long; sepals, petals, and lip brownish-green

Voucher specimen: 412, 7 February 2002

Reference: Seidenfaden (1986) 27-31 (fig. pp. 29,31)

Palmae

1 species

Phoenix loureiri Kunth var. *loureiri*

Perennial, dioecious, evergreen, glabrous, fire-tolerant, ground herb. **Stem** c. 0-60 cm tall, basal diameter c. 10-20 cm; roughened and charred with persistent, burned leaf bases. **Leaves** impinnately compound, spirally arranged, crowded at the top of the stem; leaf axes quadrangular, narrowing and laterally flattening to the tip, pale light green to yellowish. **Leaflets** 14-19 groups (including the terminals), each group with 4-8 sessile leaflets. **Blades** coriaceous, linear, duplicate, apex acuminate, base truncate, entire; venation parallel, distinct with several main nerves, midnerve sunken above, prominent and raised below; dark green above, very pale light green underneath, c. 25-40 x 1-2 cm; lower leaflets reduced to sharp spines, channeled dorsally, c. 2-11 cm long. **Petiole** c. 19-44 cm long. **Inflorescence** terminal, an irregular branching, compact panicle of erect spikes, 13-25 cm long; axes undulate, glabrous, cream, turning pale light yellow; peduncle flattened, up to c. 50 cm long, 8-16 mm wide; spike axes c. 10-15 cm long. **Spathe** flattened, 2-lobed, orange-yellow on both sides, c. 25 x 8 cm in male inflorescence; 15 x 2-4 mm in female inflorescence. **Flowers** unisexual, numerous, regular, 3-merous, sessile. **Male flowers:** **calyx** campanulate, margin truncate or shallowly 3-lobed, cream, c. 1.5-1.7 mm long. **Petals** 3, valvate, elliptic to oblong, slightly oblique, carinate, tips acute, cream, c. 4-5 x 3 mm. **Stamens** 6; anthers inserted on the receptacle, subsessile, basifixed, bilocular, linear, cream, c. 2.5 mm long. **Female flowers:** **calyx** campanulate, distinctly 3-lobed, cream, lobes suborbicular, c. 2.5-3 x 2.5 mm. **Petals** 3, imbricate, orbicular, incurved, thickened at the base, margins membranous, c. 3 mm diameter. **Stigmas/style** 3, recurved, c. 0.6 mm long. **Ovary** superior with 3 separate carpels of 2 sterile locules and one fertile locule; fertile locule with one axile ovule. **Drupe** ellipsoid to oblong; pericarp thin, glossy light green, ripening blackish, c. 10-14 x 7-8 mm; calyx and petals persistent. **Seeds** ellipsoid, smooth, channeled at one side, c. 8-11 x 6 mm.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: January-December; flowering: March-April; fruiting: April-June

Abundance: common

Distribution: northern Thailand, Burma, China, Indo-China

Distinguishing features: fire tolerant, dioecious; stem roughened and charred with persistent, burnt leaf bases; leaves pinnate, leaflets in 14-19 groups, each group with 4-8 leaflets which are linear, duplicate; lower leaflets spinescent; inflorescence a terminal compact panicle of erect spikes; spikes axes undulate; calyx, petals, and anthers cream; drupes ellipsoid, ripening black, and edible

Voucher specimens: 133, 13 March 2001 (flowers); Maxwell & Sankamethawee 00-255, 6 May 2000 (fruits); **Plate 2 D**

Reference: Gagnepain (1937) 977-978 (*sub P. humilis* Royle var. *loureiri* Becc.)

Xyridaceae

1 species

Xyris capensis Thunb.

Annual, erect, stemless ground herb to about 80 cm tall. **Leaves** simple, mostly basal. **Blades** ensiform or linear, thickened on one margin, apex bluntly oblique; muricate; green on both sides; 100-260 x 1-3.4 mm. **Ligules** glabrous, reddish-brown. **Sheaths** sides reddish-brown, greenish medially. **Inflorescence** terminal, dense, solitary, capitate, c. 4-10 mm diameter. **Peduncle** terete and grooved, glabrous, lower part red-brown, upper part dark green, to c. 80 cm long. **Bracts** convex, crustaceous, broadly ovate, margins scarious, convex, apex and upper part of midnerve thickened, acute, glabrous, brown, c. 7-7.5 x 4-5 mm. **Median bracts** each enclosing one flower; ovate, convex, thickened below the tip, margins entire, glabrous, brownish, somewhat brownish-green, about the same size or slightly smaller than the lower bracts. **Flowers** numerous, regular, 3-merous. **Lateral sepals** membranous, conduplicate, ovate, tip acute, entire, glabrous, light brown, c. 5 x 1.5 mm. **Petals** 3, thin, obovate, apex erose, base narrow and tapering into a claw, c. 6 mm long; blades yellow, c. 4 mm diameter. **Staminodes** 3, alternipetalous, each with terminal braches 2 with a tuft of numerous hairs, yellow; total length c. 6-6.5 mm. **Stamens** 3, oppositipetalous, adnate to the petal claws; anthers basifixed, bilocular, ovate, yellow, c. 1.8 mm long; filaments flat, glabrous, yellow, c. 1-1.2 mm long. **Stigmas** 3, each 2-lobed, papillate, yellow; style glabrous, yellow, c. 3-3.3 mm long. **Ovary** superior, ovoid to compressed ellipsoid, glabrous, c. 3.5-4 mm long; 3-loculed, each locule with numerous parietal ovules. **Capsules** laterally compressed, ovoid or obovoid, smooth, embraced by the persistent sepals and bracts, tip shortly cuspidate, glabrous, dark brown; 5-6 x 3-3.2 mm. **Seeds** numerous, ellipsoid with an oblique base, finely reticulate and ribbed, brown, c. 0.7-0.2 mm.

Habitat: open wet areas

Phenology: leafing: July-November; flowering: August-November; fruiting:

August-December

Abundance: medium

Distribution: N and NE Thailand; India, Indo-China, China, Malesia, South Africa, South America

Distinguishing features: stemless herb; leaves in basal rosettes, blades ensiform or linear; inflorescence terminal, dense solitary capitate; bracts glossy brownish, median bract subtending one flower; petals 3, bright yellow; staminodes 3, 2-branched

Voucher specimen: 277, 31 August 2001; **Figure** 23

References: Hansen (1987) 130-131, 132 (fig.), 135-136; Royen (1954) 366 (fig.) 368, 374-375 (fig.)

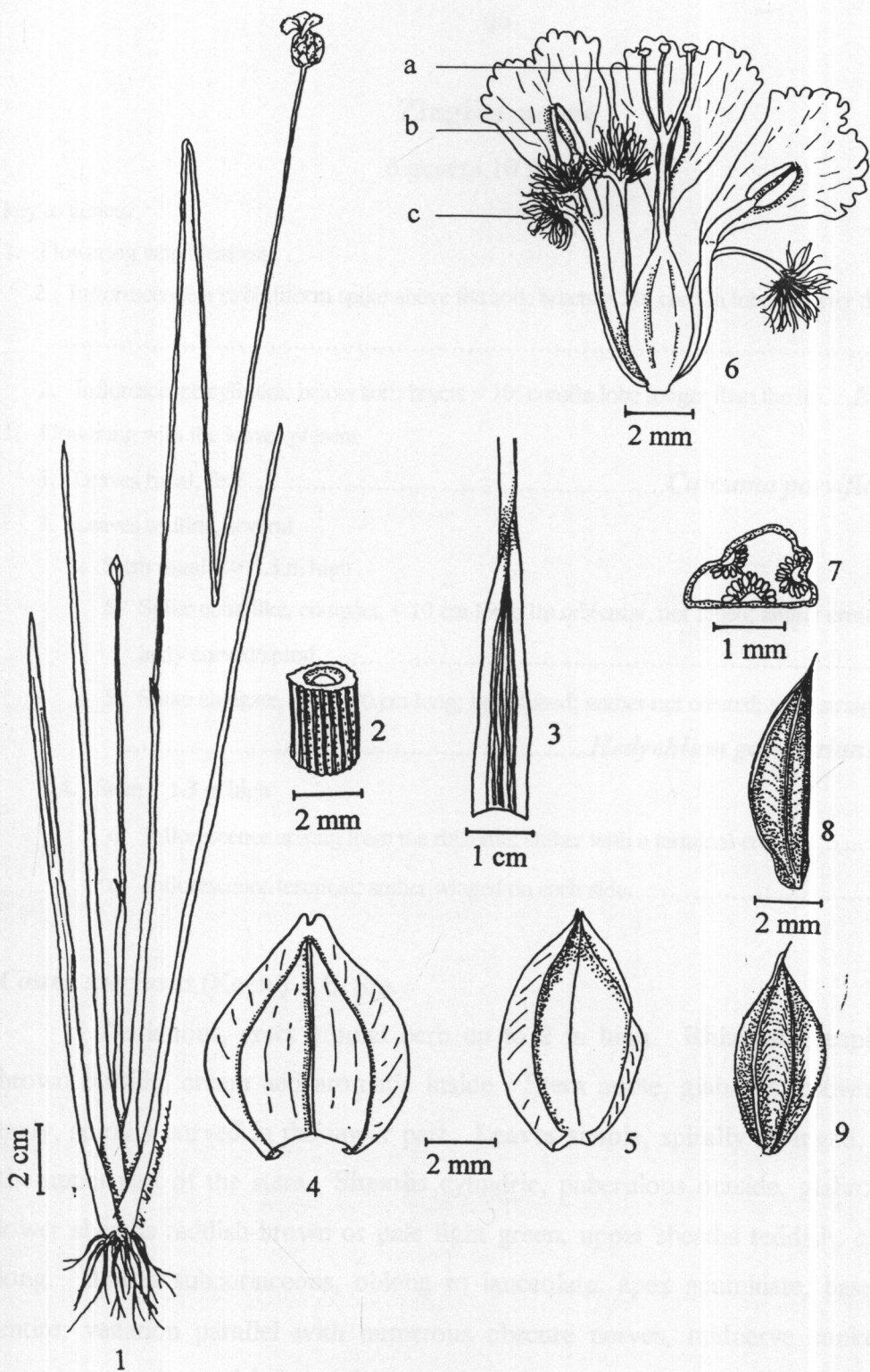


Figure 23 *Xyris capensis* Thunb. (#277): 1 = habit, 2 = peduncle (x-section), 3 = leaf sheath, 4 = medial bract (dorsal), 5 = medial bract (ventral), 6 = flower with: a = stigma, b = fertile stamen, c = staminode, 7 = ovary (x-section), 8 = capsule (side view), 9 = capsule (dorsal)

Zingiberaceae

6 genera, 10 species

key to genera

1. Flowering when leafless
 2. Inflorescence a strobiliform spike above the soil; bracts > 20; corolla lobes shorter than the lip
.....*Curcuma*
 2. Inflorescence cylindric below soil; bracts < 10; corolla lobe longer than the lip....*Kaempferia*
1. Flowering with the leaves present
 3. Leaves basal, few*Curcuma parviflora* Wall.
 3. Leaves cauline, several
 4. Stem usually > 1.5 m high
 5. Spike cone-like, compact, < 10 cm long; lip orbicular, not lobed; anther crested; stem laxly curved/spiral.....*Costus*
 5. Spike elongate, lax, > 20 cm long; lip 2-lobed; anther not crested; stem straight
.....*Hedychium gardnerianum* Rosc.
 4. Stem < 1.3 m high
 6. Inflorescence arising from the rhizome; anther with a terminal crested.....*Zingiber*
 6. Inflorescence terminal; anther winged on each side.....*Globba*

Costus speciosus (Koeh.) J. E. Sm.

Deciduous, erect ground herb up to 2 m high. **Rhizome** creeping, stout, brown outside, cream and aromatic inside. **Stem** terete, glabrous, brownish-green, laxly, spirally curved in the upper part. **Leaves** simple, spirally arranged, mostly in the upper part of the stem. **Sheaths** cylindric, puberulous outside, glabrous inside, lower sheaths reddish-brown or pale light green, upper sheaths reddish, c. 4-12 cm long. **Blades** subcoriaceous, oblong to lanceolate, apex acuminate, base cuneate, entire; venation parallel with numerous obscure nerves, midnerve sunken above, prominent and raised below; glabrous above, very dense grey sericeous underneath; dark green above, pale light green underneath, c. 14-20 x 3.5-6 cm. **Inflorescence** of terminal, cone-like spike, c. 5-8 x 3.5-4 cm. **Bracts** coriaceous, several, spirally arranged, ovate, elliptic to oblong, shallowly carinate, apex acute and cusped, entire, reddish outside, light greenish-brown inside, very densely sericeous outside, glabrous inside, c. 2-3 x 1-2 cm. **Bracteoles** subcoriaceous, carinate, sharply keeled, tips acute,

sericeous and greenish-brown outside, inside sericeous on upper half and glabrous on lower half. **Flowers** several, gradually opening at intervals in the inflorescence, irregular, 3-merous. **Calyx** tubular, coriaceous; tube unequally 3-angled, sericeous outside, glabrous inside, cream, *c.* 2-2.5 cm long; lobes 3, the anterior lobe ovate, *c.* 7-9 x 4 mm, posterior 2 lobes 3-4 x 3 mm. **Corolla** tube cylindric, glabrous, white, *c.* 1 cm long; lobes 3, elliptic, apex acuminate, finely sericeous outside, glabrous inside, whitish-cream, *c.* 5-5.2 x 1.8-2 cm, dorsal lobe symmetric, 2 ventral lobes asymmetric; all thickened at the tip. **Lip** thin, suborbicular, puberulous outside, inside glabrous on upper half and gradually denser pilose toward the base, white, *c.* 6-8 x 6-7 cm. **Staminodes** none. **Stamens** 1; anther bilocular, linear, cream, *c.* 10-12 mm long; crest expanded, lanceolate, glabrous, yellowish, *c.* 20 x 8 mm; filament oblong, flat, ascending, glabrous, white, *c.* 25 x 10-12 mm. **Stigma** capitate with 2 flattened lobes, *c.* 1.5 x 3 mm; style glabrous, white, extending through the embracing anther locules. **Ovary** inferior, compressed ovoid, sharply 3-angled, sericeous, *c.* 4-6 x 4 mm; 3-loculed, each locule with numerous axile ovules. **Capsules** immature, ovoid, 3-angled, crowned with the persistent calyx, *c.* 1.6-2 x 1 cm.

Habitat: open and partly shaded areas near the seasonal stream

Phenology: leafing: May-January; flowering: August-September; fruiting: August-December

Abundance: medium

Distribution: throughout Thailand, India, Himalayas, Sri Lanka, Malaysia

Distinguishing features: erect, deciduous herb up to 2 m high, stem laxly spirally curved in the upper part; leaves spirally arranged, blades elliptic to oblong, grey sericeous below; inflorescence a terminal, cone-like spike; bracts several, coriaceous, reddish; flowers gradually appearing each for one day throughout the inflorescence; lip orbicular up to 8 cm diameter, white

Voucher specimen: 246, 10 August 2001

Reference: Gagnepain (1932) 118, 120; **Plate 8 C**

Curcuma

key to species

1. Flowering when leaves present; coma white.....*C. parviflora* Wall.
1. Flowering when leafless, coma reddish-violet or absent
 2. Coma reddish-violet; fertile bracts green-reddish; leaf blades oblong to lanceolate, < 5-6 cm wide.....*C. zedoaria*
 2. Coma absent; fertile bracts pinkish; blades broadly elliptic, > 10 cm wide...*C. ecomata* Craib

Curcuma zedoaria (Berg.) Rosc.

Deciduous, acaulescent, ground herb. **Rhizome** shortly creeping, segments several, globose or ovoid, brown outside, cream-yellowish, and very aromatic inside, up to c. 3 cm diameter. **Leaves** simple, few, appearing after fruiting period. **Blades** subcoriaceous, oblong to linear-lanceolate, apex acute, base attenuate and decurrent on the petiole, entire; venation parallel with numerous nerves, midnerve often dull reddish, sunken above, prominent and raised below; glabrous; dark green above, pale light green beneath, c. 17-35 x 4-5 cm. **Petiole** sheathing, puberulous outside, glabrous inside, margins ciliolate, light green, up to c. 20 cm long. **Inflorescence** a solitary, compact spike, cone-like, arising laterally on the rhizome, c. 8-13 x 2.5-4 cm. **Peduncle** usually underground, erect, terete, succulent, puberulous, white, 2-11 cm long. **Peduncle bracts** coriaceous, 1-few, oblong, embracing sides adnate to axis, apex acute to obtuse, margins ciliolate, puberulous outside, glabrous inside, white, c. 7-11 x 2.5-3.2 cm. **Flower bracts** several, coriaceous, base united, upper free part broadly ovate to elliptic, gradually becoming smaller distally on the inflorescence; apex acute, obtuse or rounded, reflexed and spreading, glabrous on both sides, lower bracts greenish, upper ones reddish-violet in the upper half, c. 1.5-3 x 1.3-2.8 cm; terminal infertile bracts (coma) 5-6, spreading, oblong, dark violet, c. 2.5-2.8 x 1-1.2 cm. **Bracteoles** thin, oblong, apex acute, glabrous, white, c. 10-13 x 4 mm. **Flowers** 3 in each bract, irregular, 3-merous, open one at a time. **Calyx** tubular, margin truncate to shallowly obtusely 3-lobed, translucent white, c. 6-8 mm long. **Corolla** tubular, 3-lobed: tube narrowly cylindric, glabrous, white, c. 1.5-2 cm long; upper part of the tube expanded c. 5-6 mm long; lobes whitish-pale light yellow to pinkish, tips reddish; posterior lobe largest, broadly ovate, tip acute and slightly incurved, cusped,

c. 9-11 x 6-7 mm; anterior 2 lobes equal, ovate, tips obtuse, 4-5 mm wide. **Lip** ventral, suborbicular, glabrous, yellow medially inside, otherwise pale light yellow; *c.* 13 x 10-12 mm, apex shallowly emarginate, lobes *c.* 3 mm long. **Staminodes** 2, petaloid, asymmetrically obovate, apex rounded, glabrous, pale light yellow-cream, *c.* 11 x 6 mm. **Stamens** 1, anther bilocular, locules compressed ellipsoid, cream, *c.* 3 mm long, base subulately spurred, *c.* 2-2.5 mm long; filament ovate, flat, glabrous, white, *c.* 4 x 3.5 mm. **Stigma** capitate, unequally 2-lobed, dorsal lobe thickened, ventral lobe flat, *c.* 0.8 mm diameter; style glabrous, filiform, white, extending between the anther locules. **Ovary** inferior, sparsely pilose, *c.* 2-2.5 mm long; 3-loculed, each locule with numerous axile ovules. **Capsules** not seen.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: May-October; flowering: March-May

Abundance: abundant

Distribution: northern Thailand, Burma, Laos, Cambodia, eastern Himalaya, Indo-China, Malay Islands, cultivated in India

Distinguishing features: flowering when leafless, peduncle underground;

inflorescence erect, cone-like; coma dark violet-reddish; flower bracts several, curved and spreading, greenish and reddish; lip pale light yellow with a vertical yellow band medially; leafing after fruiting, blades oblong to oblong-lanceolate up to 35 cm long, midnerve with dull reddish dorsally

Voucher specimens: 194, 6 June 2001; Maxwell & Sankamethawee 00-250, 5 May 2000

References: Baker (1890) 210-211; Gagnepain (1908) 67-68; Craib (1913) 6

Note: rhizome aromatic inside; flesh inflorescences also edible

Globba

key to species

1. Lowest bract lanceolate < 20 mm long, light green; leaf blade base cuneate.....*G. reflexa*
1. Lowest bract broadly elliptic, > 20 mm long, pink or white; leaf blade base cordate.....*Globba* sp.

Globba reflexa Craib

Deciduous, erect, ground herb to c. 60 cm high. **Rhizome** shortly creeping, segments few, globose, light green outside, dull yellow and aromatic inside, c. 1-1.5 cm diameter. **Stem** glabrous, light green, terete. **Bladeless sheaths** on the lower part of the stem, glabrous, pale light green, c. 4-10 cm long. **Leaves** (immature) simple, up to about 5, alternate, distichous. **Blades** thin, oblong to linear-lanceolate, apex acuminate, base cuneate, entire; venation parallel with several obscure nerves, midnerve sunken above, prominent and raised below; glabrous above, puberulous beneath; green above, pale light green beneath; c. 5-15 x 0.8-2 cm. **Ligule** a ring of densely pilose. **Sheaths** mostly glabrous, margins ciliolate, pale light green, c. 4-10 cm long. **Inflorescence** a lax terminal panicle, several-branched, nodding, 5-11 cm long; axes terete, puberulous, light green; peduncle c. 4-7 cm long; branches 1-1.5 cm long with few to several flowers at the tip. **Bracts** thin, lanceolate, gradually smaller to the top, tips acute and ciliate, glabrescent, light green, reflexed, c. 7-16 x 3-5 mm; bracteoles thin, broadly ovate, duplicate, tips acute, yellowish-light green, c. 5-7 x 4-5 mm. **Flowers** several, irregular, 3-merous. **Calyx** tubular, 3-lobed, yellowish-green, turning yellow, glabrous; tube c. 4 mm long; lobes carinate, equal, c. 1.5 mm long. **Corolla** tube narrowly cylindric, puberulous, orange, reflexed medially, c. 15 mm long; lobes 3, carinate, unequal, light orange, puberulous outside, glabrous inside; dorsal lobe c. 8 x 5 mm; 2 ventral lobes c. 6 x 3 mm. **Lip** 2-parted, orange; lower 1/3 united to the filament, c. 6 mm long; upper 2/3 reflexed, 2-lobed, united part c. 6 mm long, free parts spreading, oblong, tips obtuse, c. 3 x 1.2-1.5 mm. **Staminodes** 2, petaloid, thin, pale light orange, asymmetrically oblanceolate, shallowly unequal 2-lobed, c. 10 x 3.5 mm. **Stamen** 1; anthers bilocular, each locule oblong, orange, c. 2 mm long; anther wings unequally 2-lobed, spreading, lanceolate, tips acuminate, lower lobes slightly smaller, light orange, c. 3.8-4 x 0.7-1 mm; filament glabrous, light orange, curved near the tip, c. 2.5 cm long. **Stigma** capitate, 2-lobed, c. 0.3 mm long; style filiform, white, extending between the anther locules. **Ovary** inferior, ovoid, tuberculate, light green, c. 2.5 mm long; unilocular with numerous parietal ovules. **Capsules** immature, globose, light green, tuberculate, c. 7-8 mm diameter, crowned with the persistent calyx.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: April-September; flowering: April-May; fruiting: May-August

Abundance: common

Distribution: northern Thailand

Distinguishing features: leaf blades linear-lanceolate; inflorescence paniculate, nodding; bracts light green; most parts of the flower orangish; anther locules winged; immature capsules fleshy, globose, tuberculate

Voucher specimens: 169, 4 May 2001; Maxwell 00-244, 5 May 2000

Reference: Craib (1913) 3

***Kaempferia rotunda* L.**

Deciduous, acaulescent, ground herb. **Rhizome** 1-few-segmented, each segment globose, yellow-brown outside, yellow and fleshy inside, c. 2-3 cm diameter. **Roots** swollen, translucent white and fleshy inside. **Leaves** appearing after fruiting, simple, few, erect. **Blades** subcoriaceous, oblong to lanceolate, apex acute, base attenuate and decurrent on the petiole; venation parallel with obscurely 5-7 main nerves on each side of the midnerve which is sunken above, prominent and raised below; glabrous above, finely sericeous beneath; dull green above, very pale light green, and sometimes dull light violet underneath; c. 25-30 x 6-8 cm. **Petiole** vaginate with indumentum as on undersurface of leaf blades, dull green-maroonish to pale light green-violet, c. 16-28 cm long. **Inflorescence** arising laterally from the rhizome when leafless, erect; upper part of bracts and flower emerging above the soil. **Bracts** few to several, chartaceous, ovate to lanceolate, apex acute; glabrous, white, c. 2-4.5 x 1.5-3.5 cm; bracteoles thin, sheathing, oblong, margins convolute and nearly touching, glabrous, white 13-15 mm long; apex equally 2-lobed; lobes lanceolate, keeled, tip acuminate, c. 5 mm long. **Flowers** few-several, usually open one at a time, irregular, 3-merous. **Calyx** thin, glabrous, white, 5-6 cm long; tube flattened and shallowly split on one side to c. 13-15 mm, tip 2-cusped. **Corolla** thin, tube narrowly cylindric, white, c. 6-6.5 cm long; lobes unequal, linear, white, spreading, tips acuminate: posterior lobe largest c. 50-55 x 6-8 mm; lateral lobes 40-43 x 4-5 mm. **Staminodes** 2, petaloid, thin, spreading, tips acute, pink, c. 3.3-3.8 x 1.5-1.7 cm. **Lip** ventral, broadly obovate, 2-lobed, c. 3-3.4 cm long, lobes elliptic, tips rounded, purple and with violet medially, c. 15 x 11 mm. **Stamen** 1, sessile; anther bilocular, locules

linear, cream, *c.* 7-8 mm long; anther crest oblong, *c.* 8 mm long, 3-lobed: midlobe rounded, *c.* 0.8 mm long; lateral lobes lanceolate, *c.* 3 mm long. **Stigma** capitate, concave, margin ciliate, white, embracing the anther locules, *c.* 1.3 mm diameter; style filiform, white, extending between the anther locules. **Ovary** inferior, oblong, glabrous, *c.* 5.5 x 3 mm; 3-loculed, each locule with numerous axile ovules. **Capsules** not seen.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: May-September; flowering: April-May

Abundance: common

Distribution: N, NE, C, SE, SW Thailand; India, Sri Lanka, Indo-China, Malay-Peninsula, Java

Distinguishing features: flowering when leafless, inflorescence axes usually below soil, only one flower opening at a time; lip 2 deeply-lobed, pinkish; staminodes petaloid, purple; leaves produced after fruiting, erect, petiolate, blades lanceolate, sericeous beneath

Voucher specimens: 149, 11 April 2001; 240, 10 August 2001; **Plate 8 E**

References: Sirirugsa (1992) 2-3, 7-8; Baker (1890) 223

Zingiber

key to species

1. Inflorescence on an erect peduncle well above ground level; bracts yellowish-green; leaf blades glabrous.....*Z. parishii*
1. Inflorescence on a procumbent peduncle at ground level; bracts reddish-brown; leaf blades tomentose below.....*Zingiber* sp.

Zingiber parishii Hk. f.

Deciduous, erect, glabrous, ground herb to *c.* 1 m high. **Rhizome** shortly creeping, yellow-brown outside, cream and aromatic inside. **Sheaths** on lower part of the stem bladeless, reddish-green to pale light green. **Leaves** simple, alternate, distichous. **Blades** subcoriaceous, linear-lanceolate, apex acuminate, base obtuse, entire; venation parallel with several nerves, midnerve sunken above, prominent and raised below; dark green above, very dull light green beneath; *c.* 20-25 x 1.8-3 cm.

Ligule 2-lobed, glabrous, very pale light green. **Leaf sheaths** light green, *c.* 3-10 cm long. **Inflorescence** a compact spike on an erect peduncle, arising from the rhizome, *c.* 12 x 3 cm; peduncle up to 24 cm long. **Bracts** several, imbricating, pale light green, *c.* 4-5 cm long. **Inflorescence bracts** many, adpressed imbricate, coriaceous, broadly ovate, apex rounded or shortly cuspidate, margins slightly concave; glossy light yellow-green, *c.* 3-4 x 1.5-2.5 cm; bracteoles chartaceous, obovate, apex obtuse, puberulous, white, *c.* 2.5-3 x 1.3-1.8 cm. **Flowers** 1 in each bract, usually one open at a time, irregular, 3-merous. **Calyx** tubular, split on one side, apex truncate or shallowly 2-lobed, puberulous to glabrescent, white, *c.* 8-10 cm long. **Corolla** bilabiate; tube narrowly cylindric, glabrous, white, *c.* 2.8-3 cm long; upper lip elliptic or lanceolate, apex acute and slightly incurved, glabrous, light yellow-cream, *c.* 3.4-3.7 x 1.5-1.6 cm; lower lip *c.* 2.6-2.8 cm long, 2-lobed, each lobe lanceolate, tips acute, *c.* 1.5-1.9 x 0.8 cm. **Lip** anterior, thin, 3-lobed, glabrous, light yellow-cream, *c.* 3 cm long; midlobe largest, orbicular, speckled with numerous light violet spots, *c.* 2 cm diameter; lateral lobes obliquely elliptic, tips obtuse, base with a circular reddish-violet patch. **Stamen** 1; anther sessile, adnate to the base of upper corolla lobe, bilocular, locules linear, margins undulate, pinkish-cream, *c.* 1.5 cm long; anther crest lanceolate, apex acuminate, margins incurved and touching, enveloping the style, yellowish-cream, *c.* 1.7-1.8 cm long. **Stigma** tubular, curved, margins ciliate, white; style filiform, exceeding the anthers and reaching the apex of the anther crest. **Ovary** inferior, ovoid, densely sericeous, *c.* 3-4 mm long; 3-loculed, each locule with numerous axile ovules. **Capsules** not seen.

Habitat: open and shaded areas in bamboo thickets and along the seasonal stream

Phenology: leafing: July-October; flowering: August-September

Abundance: rare

Distribution: northern and central Thailand, Burma

Distinguishing features: erect herb with several, distichous leaves, blades linear-lanceolate; inflorescence strobiliiform spike, on an erect peduncle up to 24 cm long, arising from the rhizome; bracts glossy light yellow-green; lip 3-lobed, variegated with violet

Voucher specimen: 243, 10 August 2001; Plate 9 E

Reference: Theilade (1999) 391, 401

Dicotyledoneae

37 families

key to families

1. Ovary inferior
 2. Leaves opposite or whorled
 3. Inflorescence a capitulum of many, often bimorphic flowers on a receptacle; pappus present; fruit an achene.....**Compositae**
 3. Inflorescence not in a capitulum, with a receptacle; flowers monomorphic; pappus none; fruits not achenes
 4. Stipules present, interpetiolar; corolla present; fruits as capsules or drupes.....**Rubiaceae**
 4. Stipules absent; petals present; fruit a berry (baccate).....**Melastomataceae**
 2. Leaves spirally arranged
 5. Inflorescence umbellate; fruit a schizocarp.....**Umbelliferae**
 5. Inflorescence not umbellate; fruit an achene or capsule
 6. Inflorescence a capitulum; flowers bimorphic.....**Compositae**
 6. Inflorescence not a capitulum; flowers monomorphic
 7. Perianth present; ovary 6-locular; stamens 6.....**Aristolochiaceae**
 7. Calyx and corolla present; ovary 2-locular; stamens 5**Campanulaceae**
1. Ovary superior
 8. Leaves opposite or whorled
 9. Flowers regular
 10. Flowers unisexual; tepals/perianth present in 1 whorl.....**Urticaceae**
 10. Flowers bisexual; sepals/calyx and petals/corolla present in 2 whorls
 11. Stipulate; inflorescence with sticky glandular indumentum.....**Caryophyllaceae**
 11. Exstipulate; inflorescence lax with sticky glandular indumentum
 12. Stamens numerous (> 10).....**Guttiferae (Hypericeae)**
 12. Stamens as many as the corolla lobes or petals (4-5)
 13. Pollinia attached to a translator; corona present; milky sap present
.....**Asclepiadaceae**
 13. Pollinia, translators, corona, and milky sap absent
 14. Ovary 4-locular; plant amphibious**Lythraceae**
 14. Ovary 1-2-locular; plant terrestrial
 15. Shrub with stellate indumentum.....**Loganiaceae**
 15. Herb without stellate indumentum.....**Gentianaceae**
 9. Flowers irregular
 16. Sepals present, lower sepal spurred; petals unequally bilobed.....**Balsaminaceae**
 16. Calyx and corolla present, no spur
 17. Ovary unilocular; ovules parietal.....**Gentianaceae (Canscora)**

- 17. Ovary 2-4-locular; ovules basal or axile
 - 18. Ovary 2-locular
 - 19. Cystoliths present; placentae with 2-10 ovules.....**Acanthaceae**
 - 19. Cystoliths absent; placentae with > 15 ovules.....**Scrophulariaceae**
 - 18. Ovary 4-locular
 - 20. Ovary deeply 4-lobed; fruit as nutlets.....**Labiatae**
 - 20. Ovary not lobed; fruit as drupes.....**Verbenaceae**
- 8. Leaves spirally arranged, reduced, or absent
 - 21. Stamens more than the number of petals or corolla lobes
 - 22. Stamens 8-10
 - 23. Filaments free
 - 24. Stamens 8; leaves simple, or pinnate with alternated leaflets
 - 25. Leaves simple lacking aromatic glands; petals 3; ovary bilocular
.....**Polygalaceae**
 - 25. Leaves pinnate with aromatic punctate glands; petals 4; ovary 4 locular
.....**Rutaceae**
 - 24. Stamens 10; leaves pinnate with opposite leaflets
 - 26. Flowers irregular; petals present; ovary unilocular
.....**Leguminosae (Caesalpinioideae)**
 - 26. Flower regular; corolla present; ovary 5 locular.....**Oxalidaceae**
 - 23. Filaments connate, rarely free
 - 27. Ovary 5 locular; fruit a capsule..... **Sterculiaceae**
 - 27. Ovary unilocular; fruit a pod.....**Leguminosae (Papilionoideae)**
 - 22. Stamens > 15
 - 28. Filaments free
 - 29. Receptacle absent; indumentum stellate..... **Tiliaceae**
 - 29. Receptacle present; indumentum not stellate
 - 30. Herbaceous; leaves trifoliate, or deeply lobed; fruits follicular or achenes.....**Ranunculaceae**
 - 30. Woody; leaves simple, not lobed; fruits as drupes.....**Ochnaceae**
 - 28. Filaments connate, or stamens grouped on an androphore
 - 31. Flowers unisexual, 2-merous; filaments free on an androphore
.....**Begoniaceae**
 - 31. Flowers bisexual, 5-merous; filaments connate, androphore none
.....**Malvaceae**
 - 21. Stamens as many as or less than the number of petals or corolla lobes
 - 32. Flowers irregular
 - 33. Stamens 4; calyx spathiform; corolla not spurred

- 34. Leaves absent; upper corolla lip not galeate; lacking green colour
.....**Orobanchaceae**
- 34. Leaves present; upper corolla lip galeate; green colour present
.....**Scrophulariaceae** (*Pedicularis*)
- 33. Stamens 2 or 5; calyx not spathiform; corolla or petals spurred
 - 35. Stamens 2; leaves microscopic; corolla bilabiate; roots with utricles
.....**Lentibulariaceae**
 - 35. Stamens 5; leaves well-developed; petals free; roots lacking utricles
.....**Violaceae**
- 32. Flowers regular
 - 36. Leaves 1-2-x compound; stipules petiolar.....**Leeaceae**
 - 36. Leaves simple; stipules, when present, not petiolar
 - 37. Stipulate
 - 38. Stipules sheathing (ochea); flowers bisexual; ovary unilocular
.....**Polygonaceae**
 - 38. Stipules not sheathing; flowers unisexual; ovary 3-locular..**Euphorbiaceae**
 - 37. Exstipulate
 - 39. Leaves glandular ciliate; petals free.....**Droseraceae**
 - 39. Leaves not glandular ciliate; corolla present
 - 40. Plants with milky sap; corolla margin truncate or shallowly lobed;
ovary bilocular; ovules basal**Convolvulaceae**
 - 40. Plants without milky sap; corolla deeply 5-lobed; ovary unilocular;
ovules on a free central placenta.....**Myrsinaceae**

Acanthaceae

8 genera, 10 species

key to genera

1. Corolla campanulate or funnelform
 2. Vine; calyx denticulate; corolla white..... *Thunbergia similis* Craib
 2. Erect or ascending herb; calyx not denticulate; corolla bluish to violet
 3. Leaf blade margins serrulate, often dull dark violet*Sericocalyx*
 3. Leaf blade margins entire, always green
 4. Leaf blades base sagittate or hastate..... *Perilepta*
 4. Leaf blades base cuneate..... *Strobilanthes*
1. Corolla bilabiate
 5. Stamens 4
 6. Upper lip of corolla 4-lobed, 5-6 cm long; bracts and calyx pectinate..... *Barleria*
 6. Upper lip of corolla 2-lobed; bracts and calyx not pectinate..... *Hygrophila*
 5. Stamens 2
 7. Calyx 4-lobed; bracts lanceolate; ovules axile *Justicia*
 7. Calyx 5-lobed; bracts obovate; ovules basal*Rungia parviflora* (Retz.) Nees

Barleria cristata L.

Deciduous, erect ground herb to *c.* 1.3 m tall, basal diameter *c.* 3-5 mm. **Stem** and branches bluntly quadrangular, with scattered cystoliths and densely multicellularly hirsute. **Leaves** simple, opposite, decussate. **Blades** thin, oblong, apex acuminate, base cuneate and decurrent on the petiole, margins entire; venation distinct, pinnate, secondary nerves 4-6 on each side of the midnerve, sunken above, prominent and raised below; finer venation reticulate; with cystoliths and sparsely sericeous on both sides; dark green above, pale light green beneath; 40-80 x 13-28 mm. **Petiole** with indumentum as on the stem and blades, *c.* 3-8 mm long. **Inflorescence** of dense, compact, terminal and axillary cymes, peduncle subsessile to 3 mm long. **Bracts** sericeous, narrowly elliptic, pectinate, sparsely hispid, very pale green with reddish nerves, *c.* 0.5-2.3 cm long; bracteoles linear-lanceolate, apex acuminate, margins sharply pectinate, long hispid outside, glabrous inside; 11-20 x 1.2-1.5 mm. **Calyx** 4-lobed, 2-seriate, external pair ovate, tips acuminate, margins

pectinate, glabrous inside, sparsely hispid outside, pigmented as the bracts and bracteoles, *c.* 22-25 x 6-7 mm; the interior (lateral) pair much smaller, tips acute to acuminate, keeled, glabrous on both sides, margins pubescent, *c.* 7-8 x 3 mm. **Flowers** several, irregular, 5-merous. **Corolla** tube densely glandular hairy outside, glabrous inside, narrow part white, 2-3 cm long; expanded part and lobes purple-violet; *c.* 2 cm long; 2-lipped: upper lip (posterior) equally 4-lobed, obovate, apex rounded, glabrous inside and minutely glandular hairy outside, *c.* 15 x 10 mm; lower lip 1-lobed, slightly longer than the upper lip, *c.* 21 x 15 mm. **Stamens** 5, inserted in the corolla tube, the posterior (longest) pair exceeding the corolla lobes; anthers dark blue, bilocular, 2.5-3 mm long, filaments pubescent at base, bluish, *c.* 2.3-2.7 cm long; the other 2 anterior (shorter) stamens included in the corolla tube; filaments 4-5 mm long; one reduced filament *c.* 0.7 mm long; anther none. **Stigma** capitate, purple; style glabrous, purple, *c.* 3.5-4 cm long. **Ovary** superior, ovoid, bilocular, each locule with 2 axile ovules. **Capsules** laterally compressed ovoid or clavate, tip acute, glabrous, glossy brown, 17-20 x 4-5 mm, loculicidal. **Seeds** not seen.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: May-February; flowering: September-November; fruiting:
September:February

Abundance: common

Distribution: N and SW Thailand, Indo-China, India

Distinguishing features: pectinate bracts, compact inflorescence, showy blue-violet corolla with the upper lip 4-lobed, and lower lip 1-lobed

Vouchers specimen: 294, 29 September 2001; **Plate** 10 A

References: Bremekamp (1961) 65; Bremekamp (1965) 202; Benoist (1935) 684-688 (fig. p. 685).

Hygrophylla phomoides Nees

Annual herb to *c.* 50 cm high. **Stem** quadrangular, green, with densely multicellular hirsute indumentum. **Leaves** simple, opposite, decussate. **Blades** subcoriaceous, lanceolate, apex acute, base cuneate and decurrent on the petiole, margins entire; venation pinnate, midnerve distinct, other venation obscure; with cystoliths and multicellular strigose indumentum on both sides; dark green above,

pale light green beneath; 25-80 x 5-12 mm; aromatic when crushed. **Petiole** hirsute, *c.* 4-10 mm long. **Inflorescence** solitary, axillary, densely racemose, 10-12 mm long. **Pedicels** more or *c.* 0.5 mm. **Bracts** imbricate, linear-lanceolate, apex obtuse, densely pilose outside, glabrous inside, light green, *c.* 5-11 x 1-1.2 mm. **Flowers** up to 8, irregular, 5-merous. **Calyx** campanulate, pilose outside, glabrous inside; 8-11 mm long; tube whitish, divided half way into 5 subequal, linear-lanceolate, green lobes. **Corolla** bilabiate; tube cylindric, glabrous, white, *c.* 6-7 mm long; upper lip ovate, shallowly 2-lobed, glandular hairy outside, glabrous inside, violet, *c.* 8-9 x 6-7 mm; lower lip ovate, equally 3-lobed, apex obtuse, glandular hairy outside and with scattered villous indumentum above the throat, violet; palate white and variegated with minute violet spots. **Stamens** 4, didynamous, inserted on the posterior side of the corolla throat and included in the corolla; anthers dorsifixed, bilocular; filaments glabrous; the posterior (longer) pair *c.* 4 mm long, the anterior (shorter) pair *c.* 1.5 mm long. **Stigma** capitate, white; style shortly glandular hairy, white, *c.* 10-11 mm long. **Ovary** superior, ellipsoid to cylindric, glabrous, *c.* 1.5 x 1 mm, bilocular, each locule with 8-10 axile ovules. **Capsules** compressed oblong, brownish, *c.* 10-12 x 2 mm, loculicidal. **Seeds** asymmetrically ovoid, glabrous, smooth, dark brown; 1-1.3 mm long.

Habitat: open marshes

Phenology: leafing: May- January; flowering: August-September; fruiting:
October-January

Abundance: medium

Distribution: central and northern Thailand, India, Indo-China

Distinguishing features: marsh plant; stem quadrangular; leaf blades lanceolate;
aromatic when crashed; inflorescence solitary, axillary, in dense racemes;
corolla bilabiate, violet

Voucher specimens: 275, 31 August 2001; 396, 16 January 2002

References: Bremekamp (1965) 202; Benoist (1935) 640, 642

Note: *H. intermedia* Imlay (1939) has thyrsoid inflorescences with longer pedicels;
indumentum of denser and longer glandular sticky hairs, and is found in
seasonally dry stream beds

Justicia procumbens L.

Annual, erect herb to c. 50 cm tall. **Stem** quadrangular with cystoliths and finely strigose angles, dull green and sometimes reddish-maroon. **Leaves** simple, opposite, decussate. **Blades** thin, linear-lanceolate, apex acute, base cuneate and decurrent on the petiole, margins entire; venation distinct, pinnate, secondary nerves 4-6 pairs, cystoliths conspicuous and with scattered multicellular strigose indumentum on the main nerves on both surfaces, c. 20-59 x 5-11 mm. **Petioles** strigose, 2-6 mm long. **Inflorescence** of terminal strobiliiform spikes, c. 10-60 x 6-8 mm; peduncle strigose, 3-4 mm long. **Bracts** linear, with cystoliths, scattered strigose outside, glabrous inside, dark green; 5-6.5 x 0.8-1 mm. **Flowers** numerous, irregular, 5-merous. **Calyx** 4-lobed almost to the base, light green with hyaline margins, densely setulose, c. 5-7 x 1 mm. **Corolla** bilabiate; tube narrow, glabrous, light pink, 2 mm long; upper lip 3 mm long, shallowly 2-lobed, tips acute, light pink; lower lip suborbicular, shallowly 3-lobed, c. 5 mm long; lateral lobes obtuse, the midlobe acute, pinkish outside, purple inside. **Stamens** 2, free and inserted below the corolla throat; anthers bilocular, oblique, upper locule spurred at the base, the lower locule apiculate; filaments glabrous, 3 mm long. **Stigma** shallowly 2-lobed; style setulose at the base, otherwise glabrous, c. 6 mm long. **Ovary** superior, ovoid, bilocular, each locule with 2 axile ovules. **Disc** cupular, glabrous. **Capsules** slightly inflated, ellipsoid, enclosed by the persistent bracts and calyx, top hirsute. **Seeds** biconvex, orbicular, rugose.

Habitat: open and partly shaded areas near streams and marshes

Phenology: leafing: July-December; flowering: August-January; fruiting:

September-January

Abundance: common

Distribution: N, NE, SE Thailand; India, Sri Lanka, Indo-China, Malay Peninsula, northern Australia

Distinguishing features: linear-lanceolate blades; inflorescence of terminal, strobiliiform spikes; corolla with broad lower lip; stamens 2, locules free, the upper ones obliquely spurred at the base

Voucher specimens: 264, 30 August 2001; **Figure** 24

References: Benoist (1935) 732-733; Bremekamp (1961) 84-87

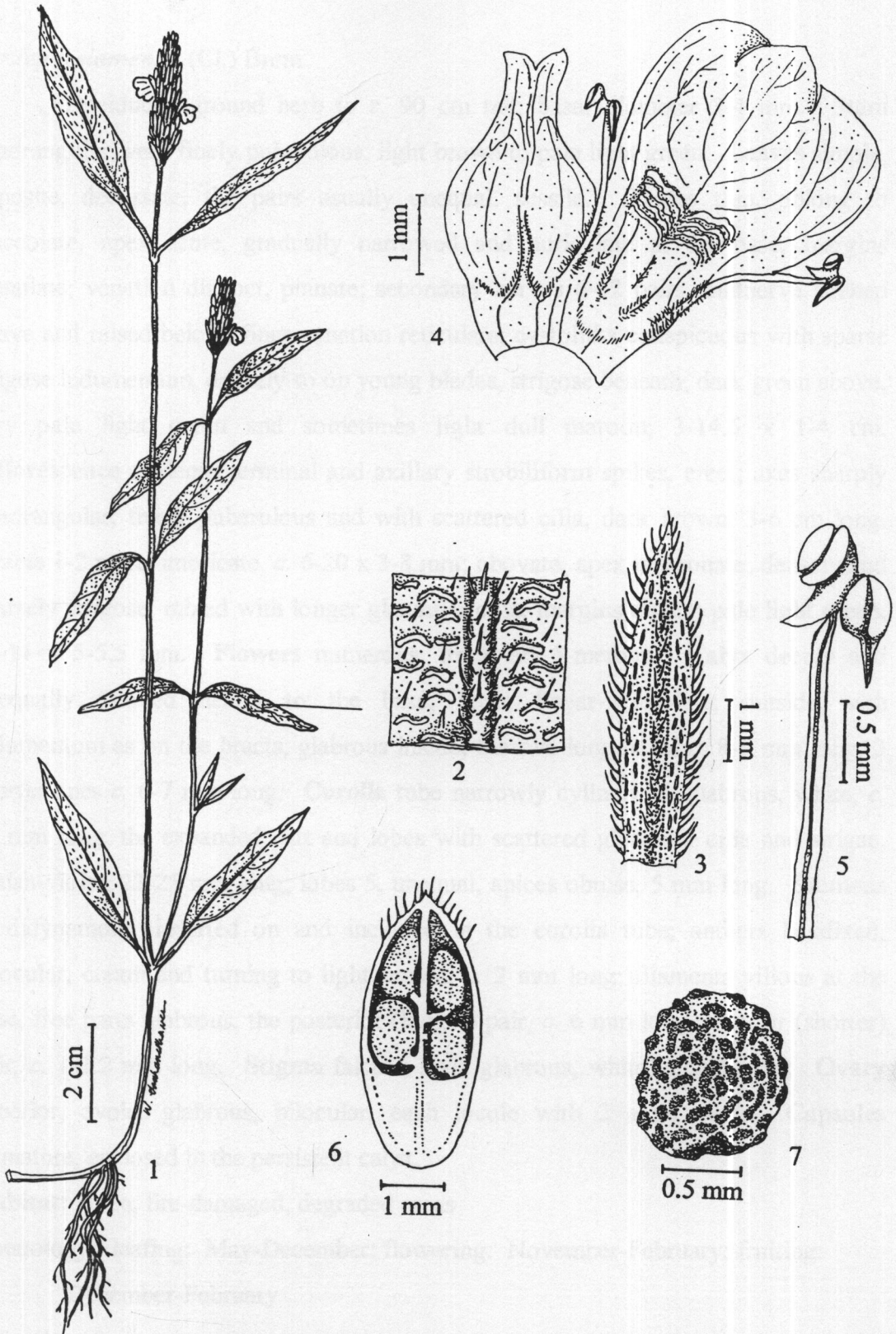


Figure 24 *Justicia procumbens* L. (#264): 1 = habit, 2 = lower surface of leaf blade, 3 = bract, 4 = opened corolla, 5 = stamen, 6 = capsule (longitudinal section), 7 = seed

***Perilepta siamensis* (Cl.) Brem.**

Deciduous ground herb to c. 90 cm tall; basal diameter 3-4 mm. **Stem** quadrangular, very finely puberulous, light brown to pale light green. **Leaves** simple, opposite, decussate, the pairs usually unequal, sessile. **Blades** thin, oblong to lanceolate, apex acute, gradually narrowed and auriculate at the base, margins crenulate; venation distinct, pinnate; secondary nerves 6-12 pairs, midnerve sunken above and raised below; finer venation reticulate; cystoliths conspicuous with sparse strigose indumentum, densely so on young blades, strigose beneath; dark green above, very pale light green and sometimes light dull maroon; 3-14.5 x 1-4 cm. **Inflorescence** of dense terminal and axillary strobiliform spikes, erect; axes sharply quadrangular, finely puberulous and with scattered cilia, dark brown, 3-6 cm long. **Bracts** 1-2 pairs, imbricate, c. 6-20 x 3-8 mm; obovate, apex mucronate; densely and sparsely strigose, mixed with longer glandular cilia, margins ciliate; pale light green, 10-11 x 5-5.5 mm. **Flowers** numerous, irregular, 5-merous. **Calyx** deeply and unequally 5-lobed nearly to the base; lobes linear-lanceolate; outside with indumentum as on the bracts, glabrous inside; the two longest lobes 8-9 mm long, 3 shorter ones c. 6-7 mm long. **Corolla** tube narrowly cylindrical, glabrous, white, c. 10 mm long, the expanded part and lobes with scattered glandular cilia and strigae, bluish-violet; 22-25 mm long; lobes 5, unequal, apices obtuse, 5 mm long. **Stamens** 4, didynamous, inserted on and included in the corolla tube; anthers basifixed, bilocular, cream and turning to light brown, c. 2 mm long; filaments villous at the base, free parts glabrous, the posterior (longer) pair, c. 6 mm long, anterior (shorter) pair, c. 1-1.2 mm long. **Stigma** falcate; style glabrous, white, c. 2-2.3 cm. **Ovary** superior, ovoid, glabrous, bilocular, each locule with 2 axile ovules. **Capsules** immature, enclosed in the persistent calyx.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: May-December; flowering: November-February; fruiting:

December-February

Abundance: common

Distribution: northern Thailand

Distinguishing features: leaves opposite, blades usually auriculate at base, sessile

Voucher specimen: 366, 3 December 2001; **Plate** 10 B

References: Bremekamp (1961) 70; Benoist (1935) 673-674 (*sub Strobilanthes auriculatus* Nees var. *siamensis* Cl.)

Sericocalyx quadrifarius (Wall. ex Nees) Brem.

Deciduous ground herb to 40 cm tall. **Stem** quadrangular with swollen nodes, densely hirsute. **Leaves** simple, opposite, decussate. **Blades** thin ovate, apex acute, base shortly cuneate to obtuse, margins serrulate; venation distinct, pinnate, 5-10 secondary nerves on each side; midnerve sunken above, raised below; finer venation scalariform and prominent below with dense cystoliths and scattered multicellular strigose indumentum and densely so on the midnerve above, strigose underneath; dark green or dull dark violet above, pale light green or pale violet beneath; 4-9.8 x 2-5.4 cm. **Petiole** with indumentum as on the stem, 1-2 cm long. **Inflorescence** terminal, strobiliform c. 2-3 x 1.5-2 cm. **Bracts** leaf-like, arranged in 4 ranks, decreasing in size distally, ovate to elliptic, apex acute; the lowest pair largest, 2.6-3 x 1-1.2 cm; distal ones 11 x 3 mm; all densely white hirsute. **Flowers** numerous, irregular, 5-merous, sessile. **Calyx** regularly 5-lobed nearly to the base; lobes linear-lanceolate, apex acute; densely hirsute as the bracts; whitish, 10-11 x 0.9-1 mm. **Corolla** funnelform; tube narrowly cylindric, glabrous, white, 1.3-1.5 cm long; the expanded part with minute glandular puberulence, purple-pink outside, inside pilose only below the midlobe, 1.5-2 cm long; lobes 5, subequal, orbicular, apices obtuse or rounded, shallowly emarginate with scattered ciliolate indumentum along the margins; c. 5-5.5 mm in diam. **Stamens** 4, didynamous; anthers bilocular, dorsifixed, 2.5-2.8 mm long; filaments hirsute on the lower connate part, glabrous on the upper free part; white; the posterior (longer) filaments 5.5 mm long, and the anterior (shorter) ones glabrous, 2 mm long. **Stigma** 1, rugose inside, linear, c. 3 mm long; style exceeding the anthers, hirsute, white. **Ovary** superior, ovoid, densely hirsute on the top, bilocular, each locule with numerous axile ovules. **Disc** annular, glabrous. **Capsules** not seen.

Habitat: shaded area in bamboo thickets near the stream

Phenology: leafing: July-February; flowering: September-November; fruiting:

November-February

Abundance: medium

Distribution: northern Thailand, Burma

Distinguishing features: blades often dull violet; inflorescence strobiliiform with 4-ranked bracts; corolla funnelform, almost regular, purple-pink; only found in bamboo thickets near the stream

Voucher specimen: 288, 29 September 2001

References: Bremekamp (1961) 68; Benoist (1935) 655 (*sub Hemigraphis quadrifaria* (Nees) T. And.)

Strobilanthes apricus (Hance) T. And. var. *pedunculatus* (Craib) Ben.

Deciduous, erect, ground herb to about 80 cm tall, basal diameter 3-4 mm. **Stem** bluntly quadrangular, sparsely scabrellous; pale light green to light brown. **Leaves** simple, opposite, decussate. **Blades** subcoriaceous, oblong, apex acute, base cuneate, margins entire; venation pinnate, with 6-9 secondary nerves on each side of the midnerve, sunken above, prominent and raised beneath; finer venation scalariform, cystoliths dense and with scabrellous indumentum above, minutely sericeous and scabrellous below, densely so on the main nerves below; dark green above, very pale light green beneath; 2.5-8 x 1-3.5 cm. **Petiole** sparsely strigose, c. 5-7 mm long. **Inflorescence** terminal and axillary in dense strobiliiform spikes. **Peduncle** with indumentum as on the stem, 0.3-2.5 cm long. **Bracts** with 1 or 2 reduced leaves near the tip, imbricate, subcoriaceous, ovate-lanceolate, apex acute, scabrous outside, glabrous inside, dark green, c. 4 x 1.5-1.7 cm; bracteoles paired, linear-lanceolate, margins multicellularly ciliate, glabrous, greenish-white, 14-16 x 1.8-2 mm. **Flowers** numerous, irregular, 5-merous. **Calyx** tube narrowly cylindric, c. 17 mm long; 5-lobed, lanceolate, cystolithic, margins ciliate. **Corolla** funnelform; narrow cylindrical part of the tube glabrous outside, hirsute along the 2 ridges inside, white; 1.5-1.8 cm long; expanded part of the tube glabrous, c. 1 cm long; lobes 5, subequal, suborbicular, tips emarginate; purple-light blue; c. 5-6 x 5.7 mm. **Stamens** 2, free, inserted on the base of the expanded part of and included in the corolla tube; anthers bilocular dorsifixed; filaments glabrous, 12-13 mm long. **Stigma** linear, curved; style glabrous, as high as the anthers, c. 2.5 mm long. **Ovary** superior, ovoid; bilocular, each locule with 2 axile ovules. **Capsules** enclosed in the persistent bracts, oblong, apex acute, glabrous, loculicidal, c. 10-13 x 3-3.5 mm. **Seeds** not seen.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing July-February; flowering: November-January; fruiting:
November-February

Abundance: rare

Distribution: northern Thailand, southern China

Distinguishing features: coarse, scabrous plant, blades entire; inflorescence of
strobiliform spikes; corolla purple-light blue

Voucher specimen: 364, 15 November 2001

Reference: Benoist (1935) 666

Notes: *Strobilanthes anfractuosus* Cl. ex Hoss. is a related species which is mostly
glabrous, has a pinkish-lilac corolla, and is usually found only in the
seasonally dry stream

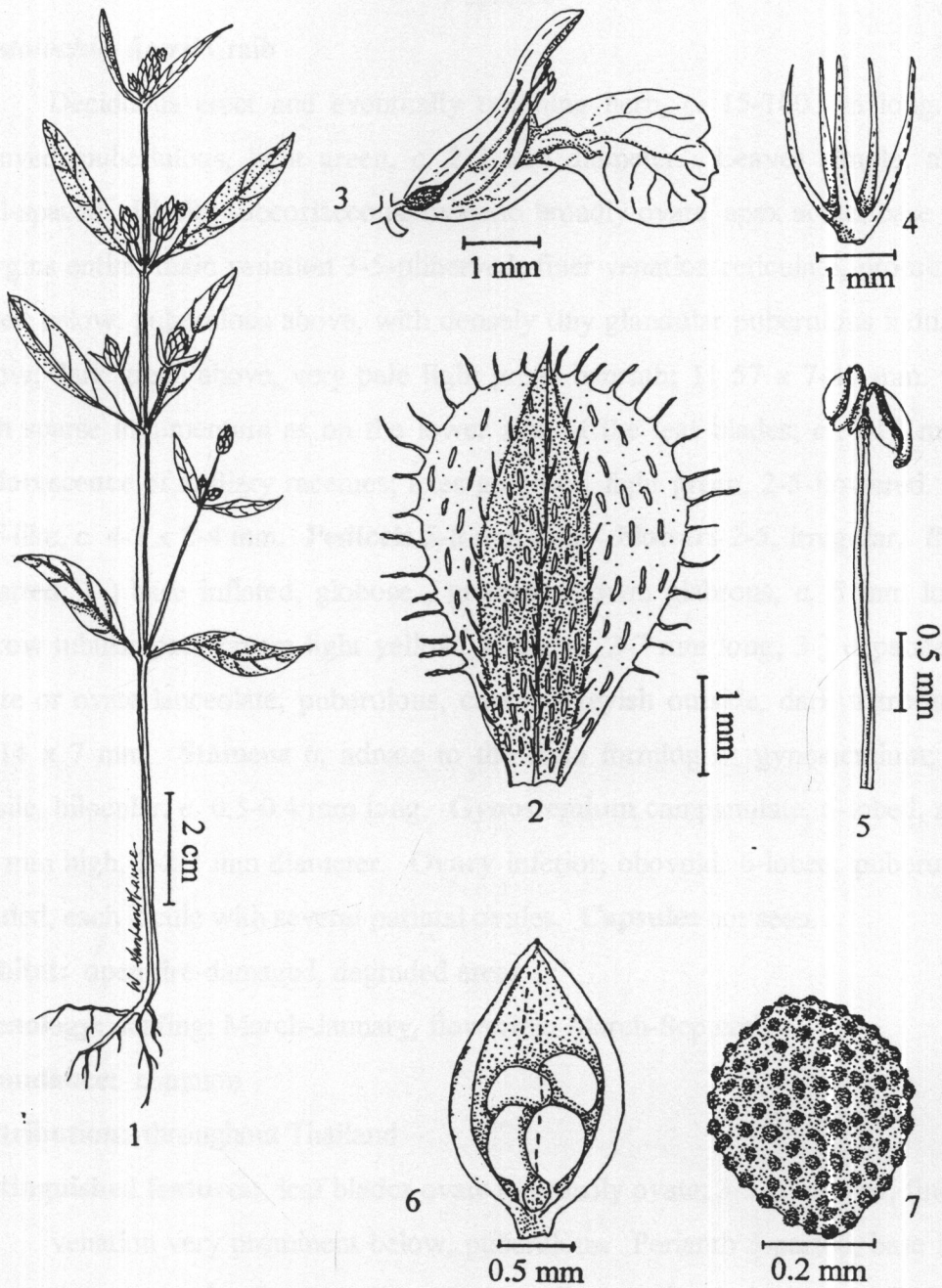


Figure 25 *Rungia parviflora* (Retz.) Nees (#283): 1 = habit, 2 = bract, 3 = flower (calyx removed), 4 = calyx, 5 = stamen, 6 = ovary (longitudinal section), 7 = seed

Aristolochiaceae

1 species

Aristolochia kerrii Craib

Deciduous erect and eventually twinning herb, c. 15-100 cm long. **Stem** grooved, puberulous, light green, c. 2-3 mm diameter. **Leaves** simple, alternate, well-spaced. **Blades** subcoriaceous, ovate to broadly ovate, apex acute, base cordate, margins entire; main venation 3-5-plinerved; finer venation reticulate, prominent and raised below; puberulous above, with densely tiny glandular puberulous indumentum below; dark green above, very pale light green beneath; 11-57 x 7-40 mm. **Petiole** with sparse indumentum as on the lower side of the leaf blades; c. 6-17 mm long. **Inflorescence** of axillary racemes; axes glabrous, light green, 2-5-flowered. **Bracts** leaf-like, c. 4-7 x 2-4 mm. **Pedicels** 5-8 mm long. **Flowers** 2-5, irregular. **Perianth** 3-parted: 1) base inflated, globose, greenish-brown, glabrous, c. 5 mm long; 2) narrow tubular part, cream-light yellow, glabrous, 2-7 mm long; 3) expanded limb, ovate or ovate lanceolate, puberulous, creamy-greyish outside, dark maroon inside, 12-14 x 7 mm. **Stamens** 6, adnate to the style forming a gynostemium; anthers sessile, bilocular, c. 0.3-0.4 mm long. **Gynostemium** campanulate, 6-lobed, acute, c. 1.5 mm high, 2-2.2 mm diameter. **Ovary** inferior, obovoid, 6-lobed, puberulous; 6-loculed, each locule with several parietal ovules. **Capsules** not seen.

Habitat: open fire-damaged, degraded areas

Phenology: leafing: March-January, flowering: March-September

Abundance: common

Distribution: throughout Thailand

Distinguished features: leaf blades ovate to broadly ovate; 3-5-plinerved, finer venation very prominent below, puberulous. Perianth 3-parted, base inflated, then narrowing into a tube and expanding to the dark maroon limb; ovary inferior

Voucher specimen: 163, 4 May 2001; **Figure** 26

Reference: Phupathanaphong (1987) 1-5 (fig. p. 4-5), 18-19 (fig.)

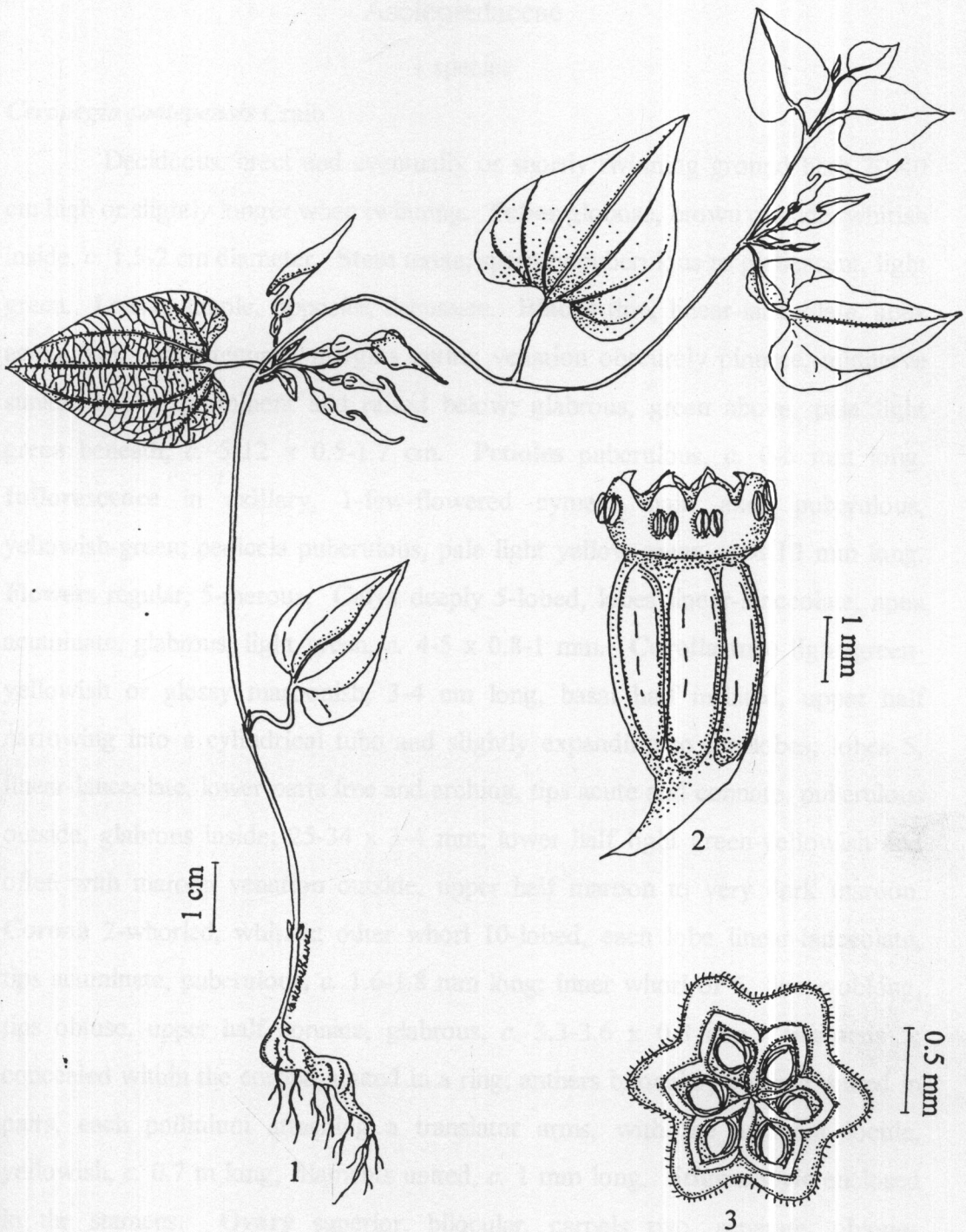


Figure 26 *Aristolochia kerrii* Craib (#163): 1 = habit, 2 = ovary and gynostemium, 3 = ovary (x-section)

Asclepiadaceae

1 species

Ceropegia sootepensis Craib

Deciduous, erect and eventually or shortly twinning ground herb 20-40 cm high or slightly longer when twinning. **Tuber** globose, brown outside, whitish inside, c. 1.5-2 cm diameter. **Stem** terete, sparsely puberulous to glabrescent, light green. **Leaves** simple, opposite, decussate. **Blades** thin, linear-lanceolate, apex acuminate, base attenuate, margins entire; venation obscurely pinnate, midnerve sunken above, prominent and raised below; glabrous, green above, pale light green beneath; c. 5-12 x 0.5-1.7 cm. **Petioles** puberulous, c. 0-6 mm long. **Inflorescence** in axillary, 1-few-flowered cymes; main axes puberulous, yellowish-green; pedicels puberulous, pale light yellow-green, c. 8-12 mm long. **Flowers** regular, 5-merous. **Calyx** deeply 5-lobed, lobes linear-lanceolate, apex acuminate, glabrous, light green, c. 4-5 x 0.8-1 mm. **Corolla** tube light green-yellowish or glossy maroonish, 3-4 cm long, basal half inflated, upper half narrowing into a cylindrical tube and slightly expanding to the lobes; lobes 5, linear-lanceolate, lower parts free and arching, tips acute and connate, puberulous outside, glabrous inside; 25-34 x 3-4 mm; lower half light green-yellowish and often with maroon venation outside, upper half maroon to very dark maroon. **Corona** 2-whorled, whitish; outer whorl 10-lobed, each lobe linear-lanceolate, tips acuminate, puberulous, c. 1.6-1.8 mm long; inner whorl of 5, linear-oblong, tips obtuse, upper half connate, glabrous, c. 3.3-3.6 x 0.8 mm. **Stamens** 5, concealed within the corona, united in a ring; anthers bilocular, pollinia united in pairs, each pollinium attaching a translator arms, with the adjacent locule, yellowish, c. 0.7 mm long; filaments united, c. 1 mm long. **Stigma/style** enclosed in the stamens. **Ovary** superior, bilocular, carpels two, separate, oblong-lanceolate, each locule with numerous parietal ovules. **Fruits** not seen.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: April-September; flowering: May-June; fruiting: July-September

Abundance: rare

Distribution: northern Thailand

Distinguishing features: deciduous vine with a globose tuber; leaves opposite, blades linear-lanceolate; basal half of the corolla tube inflated, upper half narrowing into a cylindrical tube, lobes free and arching in lower parts, tips connate; maroonish

Voucher specimens: 195, 6 June 2001; Maxwell & Sankamethawee 00-240, 5 May 2000; **Plate** 10 E

Reference: Costantin (1912) 150-153

Balsaminaceae

1 genus, 2 species

Impatiens craddockii Hk. f.

Annual, erect, glabrous ground herb, c. 35-70 cm high. **Stem** slightly succulent, terete, glabrous, lower older parts red-brown, upper younger parts light green. **Leaves** simple, opposite, decussate, sessile. **Blades** subcoriaceous, linear-lanceolate, apex acuminate, base cuneate, margins remotely and finely serrate; venation obscurely pinnate, midnerve prominent and raised below; dark green above, very pale light green beneath; 4-13.5 cm x 5-13 mm. **Flowers** axillary, solitary, irregularly 5-merous. **Pedicels** glabrous, reddish-brown, 21-43 mm long. **Bracts** lanceolate, reddish, c. 3 mm long. **Lateral sepals** 2, obliquely ovate, apex acute, reddish, c. 10-12 x 4.5-5 mm. **Lower sepal** reddish, sac-like, c. 20 x 6 mm and prolonged backward into a tubular spur, c. 25 mm long. **Petals** 5, appearing as a standard and 2 lateral pairs united into 2 wings, purple. **Upper petal** (standard) suborbicular, apex deeply emarginate, c. 20 x 24-25 mm. **Wings** 2, each with 2 unequal imbricate lobes; distal lobes obliquely ovate, apex rounded, 18-21 mm; basal lobes much smaller than the distal ones, apex emarginate, c. 14 mm diameter. **Stamens** 5; anthers bilocular, pale yellow, laterally connate; filaments connate in the upper half, light green, c. 1.5-2.5 mm long. **Ovary** superior, embraced by the stamens, ellipsoid, 3 x 1.5 mm; 5-loculed, each with several axile ovules. **Capsules** not seen.

Habitat: open, fire-damaged areas

Phenology: leafing: July-November; flowering: July-October

Abundance: medium

Distribution: northern Thailand, Upper Burma

Distinguishing features: glabrous and slightly succulent herb; leaf blades linear-lanceolate, opposite and decussate; flowers irregular, petals purple, lower sepal with a sac-like spur

Voucher specimen: 221, 13 July 2001; Plate 11 B

Reference: Shimizu (1970) 187-192

Note: a related species is *I. chinensis* L. (Plate 11 A) which is found in wet areas. This species has narrower and scabrous leaf blades. The lower lobe of the wing petals is very much reduced and the standard is keeled; the pedicels and spur are puberulous

Begoniaceae

1 species

Begonia integrifolia Dalz.

Deciduous, succulent, ground herb to c. 10 cm high. **Stem** terete, glabrous, reddish-brown. **Leaves** simple, usually 1-2, alternate. **Blades** subcoriaceous, obliquely ovate, flat on the ground; apex rounded to broadly acute, base obliquely cordate, margins finely serrulate; venation 5-7-plinerved, main veins sunken above, prominent and raised below; finer venation reticulate; scattered scabrous above, scarcer below; dull green-brownish, sometimes variegated with white bands on both sides of the midnerve, reddish beneath; 6-9 x 4.5-7 cm. **Petioles** puberulous, 0.8-3.5 cm long. **Inflorescence** a terminal, few-flowered raceme; axes glabrous, reddish-brown, c. 5-7 cm long. **Bracts** obliquely ovate to suborbicular, glabrous, translucent white with reddish nerves, c. 5-6 x 3-5 mm. **Pedicels** c. 5 mm long. **Flowers** few, unequal, 2-merous. **Sepals** 2, thin, suborbicular, shallowly concave, pinkish-white with reddish nerves, c. 5 mm diameter. **Petals** 3 times larger than the sepals, obovate-oblong, apex rounded to truncate, glabrous, white, c. 15 x 8 mm. **Stamens** numerous, clustered in a globose head; anthers basifixed, bilocular, obovate, apex truncate, yellow, c. 0.5 mm long; filaments free, 0.5 mm long; androphore glabrous, c. 1.5-2 mm long. **Female flowers** and capsules not seen.

Habitat: shaded areas in bamboo thickets along the seasonally wet stream

Phenology: leafing: July-September; flowering: July-August

Abundance: rare

Distribution: northern Thailand, India, Burma, Indo-China

Distinguishing features: succulent herb with 1-2 leaves, often flat on the ground, blades obliquely ovate and usually variegated with white bands above, lower surface reddish; stamens numerous in a globose cluster on an androphore

Voucher specimen: 245, 10 August 2001; **Figure** 27

Reference: Gagnepain (1921) 1095-1099, 1113-1114

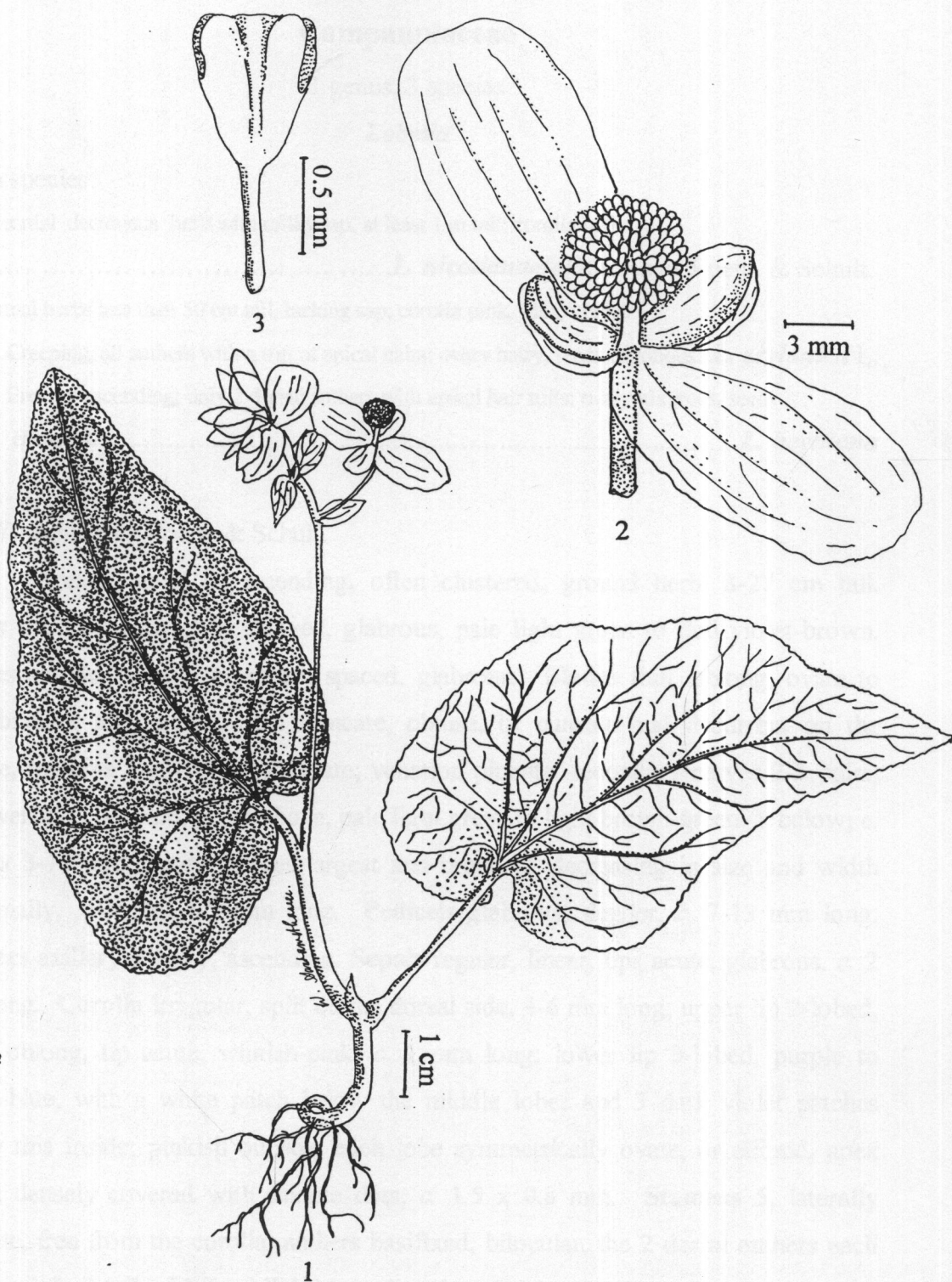


Figure 27 *Begonia integrifolia* Dalz. (#245): 1 = habit, 2 = male flower, 3 = stamen

Campanulaceae

1 genus, 3 species

Lobelia

key to species

1. Perennial deciduous herb with milky sap, at least 1 m tall; corolla white
.....*L. nicotianaefolia* Roth ex Roem. & Schult.
1. Annual herbs less than 50 cm tall, lacking sap; corolla pink, lilac, to violet
 2. Creeping, all anthers with a tuft of apical hairs; ovary hairy, seeds trigonous...*L. zeylanica* L.
 2. Erect or ascending; only 2 dorsal anthers with apical hair tufts; ovary glabrous, seeds ellipsoid.....*L. heyniana*

Lobelia heyniana Roem. & Schult.

Annual, erect or ascending, often clustered, ground herb, 8-27 cm tall. **Stems** trigonous, narrowly winged, glabrous, pale light green to dull violet-brown. **Leaves** simple, spirally arranged, spaced, glabrous. **Blades** thin, oblong, ovate to suborbicular, apex acute, base truncate, obtuse, or cuneate and decurrent on the petiole, margins finely doubly serrate; venation pinnate, secondary nerves 2-3 pairs; finer venation obscure; green above, pale light green to light brown-greenish below; *c.* 8-25 x 3-18 mm; lowest blades largest and broadest, decreasing in size and width proximally. **Petioles** 1-7 mm long. **Pedicels** glabrous, slender, *c.* 7-13 mm long. **Flowers** axillary solitary, ascending. **Sepals** regular, linear, tips acute, glabrous, *c.* 2 mm long. **Corolla** irregular, split on the dorsal side, 4-6 mm long; upper lip 2-lobed, lobes oblong, tip acute, whitish-pink, *c.* 1 mm long; lower lip 3-lobed, purple to violet-blue, with a white patch below the middle lobes and 3 dark violet patches below this inside; pinkish outside; each lobe symmetrically ovate, or elliptic, apex acute; densely covered with minute dots, *c.* 1.5 x 0.8 mm. **Stamens** 5, laterally connate, free from the corolla; anthers basifixed, bilocular, the 2 dorsal anthers each with an apical tuft of hairs, slightly smaller than the 3 ventral ones; *c.* 0.5-0.7 mm; filaments glabrous, *c.* 3-3.5 mm long. **Stigma** bilobed, surrounded by a row of hairs; style glabrous, free part *c.* 2 mm long and the lower half united to the corolla. **Ovary** inferior, obovoid, 8-ribbed, glabrous; bilocular, each locule with numerous axile ovules. **Capsules** obconical, 8-ridged, with persistent sepals at the apex, glabrous, *c.*

4-5 x 2-2.5 mm. **Seeds** numerous, laterally compressed ovoid or ellipsoid, glabrous, brown, c. 0.3 x 0.2 mm.

Habitat: open fire-damaged, degraded areas

Phenology: leafing: August-December; flowering and fruiting October-December

Abundance: common

Distribution: throughout Thailand, East Africa, India, Sri Lanka to South China, Southeast Asia, Malaysia, Sumatra to Timor, northern Philippines

Distinguishing features: annual herb, stem triangular; leaves spirally arranged, blade margins doubly serrate, glabrous; corolla dorsally split, violet; ovary inferior and ribbed. Resembling *L. alsinoides* Lmk. which has trigonous seeds

Voucher specimen: 325, 2 November 2001; **Figure** 28

Reference: Moeliono & Tuyn (1960) 129-130

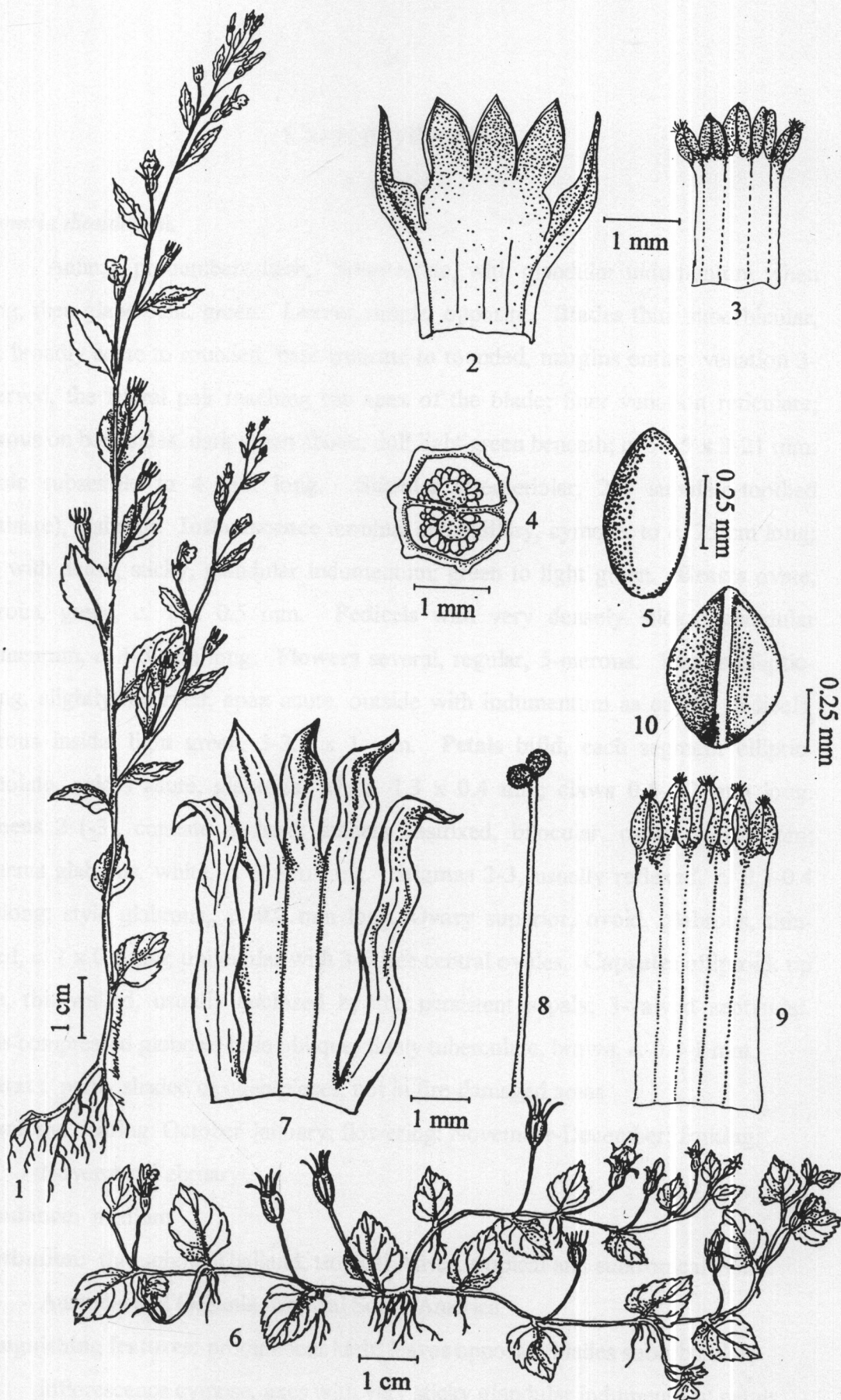


Figure 28 *Lobelia heyneana* Roem. & Schult. (#325): 1 = habit, 2 = opened corolla, 3 = opened stamen tube, 4 = ovary (x-section), 5 = seed;
L. zeylanica L. (#274): 6 = habit, 7 = opened corolla, 8 = stigmas and style, 9 = opened stamen tube, 10 = seed

Caryophyllaceae

1 species

Drymaria diandra Bl.

Annual, procumbent herb. **Stem** terete, with glandular indumentum when young, then glabrescent, green. **Leaves** simple, opposite. **Blades** thin, suborbicular, apex broadly acute to rounded, base truncate to rounded, margins entire; venation 3-plinerved, the lateral pair reaching the apex of the blade; finer venation reticulate; glabrous on both sides, dark green above, dull light green beneath; *c.* 5-15 x 3-21 mm. **Petiole** subsessile to 4 mm long. **Stipules** interpetiolar, 2-4 subulate-toothed (pectinate), glabrous. **Inflorescence** terminal and axillary, cymose, to *c.* 25 cm long; axes with dense, sticky, glandular indumentum; green to light green. **Bracts** ovate, glabrous, green, *c.* 1 x 0.5 mm. **Pedicels** with very densely sticky, glandular indumentum, *c.* 1-3 mm long. **Flowers** several, regular, 5-merous. **Sepals** elliptic-oblong, slightly incurved, apex acute, outside with indumentum as on the pedicels, glabrous inside, light green, 3-3.5 x 1 mm. **Petals** bifid, each segment elliptic-lanceolate, apices acute, glabrous, white, 1.3 x 0.4 mm; claws 0.5-0.7 mm long. **Stamens** 2 (-3), connate at base; anthers basifixed, bilocular, ovate, *c.* 0.2 mm; filaments glabrous, white, *c.* 1 mm long. **Stigmas** 2-3, usually reflexed, *c.* 0.3-0.4 mm long; style glabrous, *c.* 0.2 mm long. **Ovary** superior, ovoid, glabrous, thin-walled, *c.* 1 x 0.8 mm; unilocular with 3-6 free central ovules. **Capsules** ellipsoid, tip acute, thin-walled, usually enclosed by the persistent sepals; 3-valved septicidal. **Seeds** compressed globose, base oblique, finely tuberculate, brown, *c.* 0.8-1 mm.

Habitat : partly shaded or open places, not in fire-damaged areas

Phenology: leafing: October-January; flowering: November-December; fruiting:
November-February

Abundance: medium

Distribution: throughout Thailand, tropical Africa, tropical and subtropical Asia,
Australia and Oceania, tropical South America

Distinguishing features: procumbent herb; leaves opposite, blades suborbicular;
inflorescence cymose, axes with very sticky glandular indumentum; petals
bifid, white

Voucher specimen: 391, 25 December 2001; **Figure** 29

Reference: Larsen (1992) 413-415 (fig.)

Note: similar to *Canscora diffusa* (Vahl) G. Don (Gentianaceae) in general features, but *C. diffusa* has sessile leaves, without sticky glandular indumentum; corolla tubular and pinkish, and is mostly found on damp rocks near and in the seasonally dry stream bed.

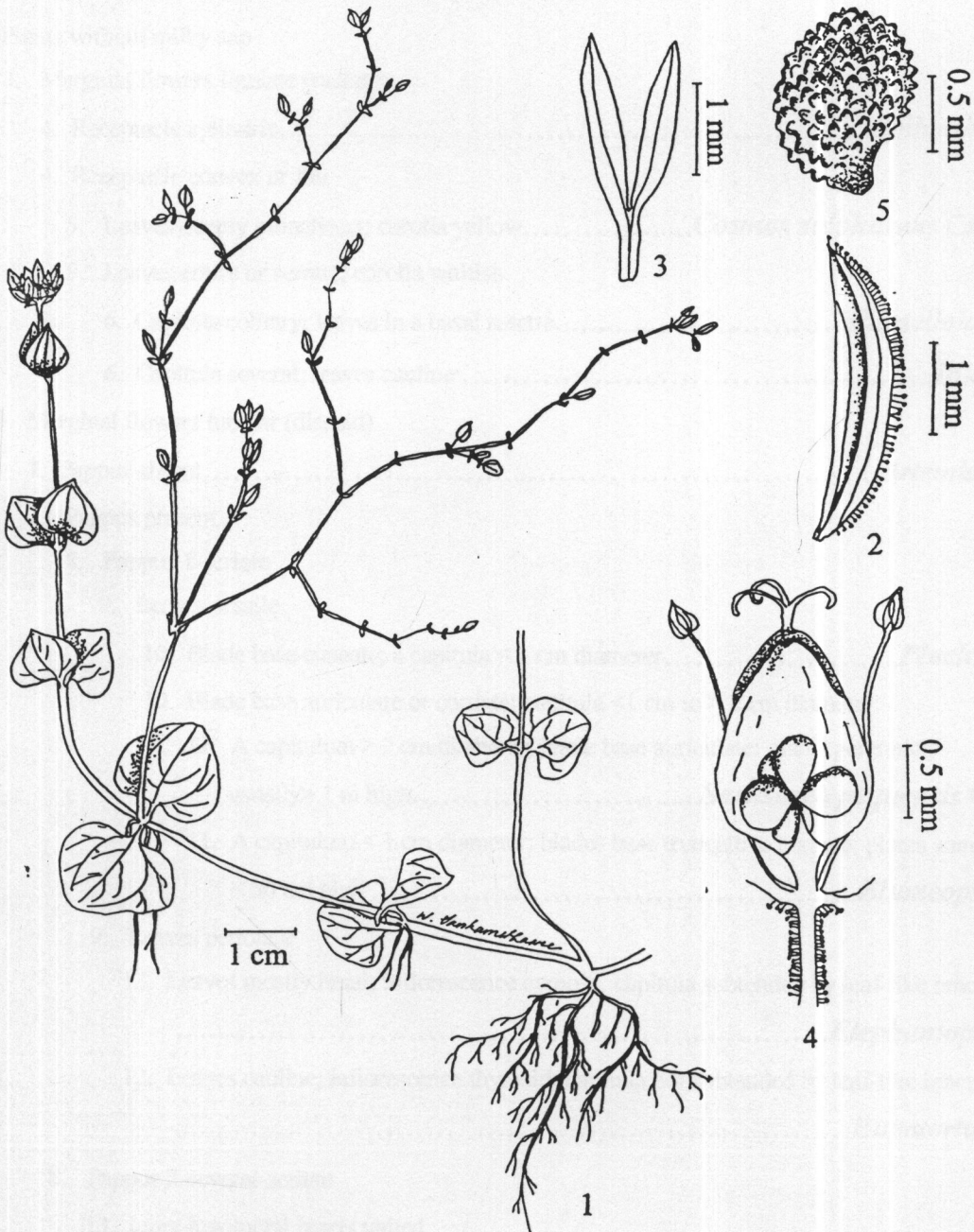


Figure 29 *Drymaria diandra* Bl. (#391): 1 = habit, 2 = sepal, 3 = petal, 4 = stamens and pistil (part of ovary wall removed), 5 = seed

Compositae

20 genera, 30 species

key to genera

1. Plants with milky sap
 2. Leaf blades linear, < 1 cm wide, sessile; corolla yellow.....*Crepis*
 2. Leaf blades broadly ovate, > 4 cm wide; petiole winged; corolla white.....*Lactuca*
1. Plants without milky sap
 3. Marginal flowers ligulate (radiate)
 4. Receptacle cylindric.....*Spilanthes*
 4. Receptacle convex or flat
 5. Leaves deeply pinnatisect; corolla yellow.....*Cosmos sulphureus* Cav.
 5. Leaves entire or serrate; corolla whitish
 6. Capitula solitary; leaves in a basal rosette.....*Piloselloides*
 6. Capitula several; leaves cauline*Inula*
 3. Marginal flowers tubular (discoid)
 7. Pappus absent.....*Artemisia*
 7. Pappus present
 8. Pappus 1-seriate
 9. Leaves sessile
 10. Blade base cuneate; a capitula < 1 cm diameter.....*Pluchea*
 10. Blade base auriculate or cordate; capitula <1 cm to > 2 cm diameter
 11. A capitulum > 2 cm diameter; blade base auriculate; plants perennial; usually > 1 m high.....*Saussurea pequensis* Cl.
 11. A capitulum < 1 cm diameter; blades base truncate to cordate; plants annual, < 50 cm high*Blumeopsis*
 9. Leaves petiolate
 12. Leaves mostly basal; inflorescence cymose; capitula subtended by leaf-like bracts*Elephantopus*
 12. Leaves cauline; inflorescence thyrsoid; capitula not subtended by leaf-like bracts*Eupatorium*
 8. Pappus 2-several-seriate
 13. Inner involucre bracts united
 14. Blades lyrate lobed, annual.....*Crassocephalum*
 14. Blades pinnatifid or denticulate, deciduous, perennial*Gynura*

13. Involucral bracts free

15. Plant with white woolly indumentum *Anaphalis adnata* DC.

15. Plant without woolly indumentum

16. Stem winged..... *Laggera*

16. Stem not winged

17. Blades bipinnatisect... *Cyathocline purpurea* (Ham. ex D. Don) O.K.

17. Blades not divided

18. Flowers all hermaphrodite.. *Vernonia*18. Marginal flowers female..... *Conyza**Artemisia japonica* Thunb.

Deciduous, erect ground herb, 0.5-1.5 m tall. **Stem** tomentose, densely so on younger parts, light green, brownish-greenish on older parts. **Leaves** simple, closely spirally arranged, sessile. **Blades** thin, oblanceolate, apex erose incised irregularly, entire, finely tomentose on both sides; venation 3-nerved, obscure above, slightly raised beneath; finer venation obscure; dark green above, light green beneath, sometimes dull violet on lower old blades; 12-70 x 3-10 mm. **Inflorescence** terminal, paniculate to c. 60 cm long; axes glabrous, light green turning red-brown; distal axes pale light green. **Capitula** numerous, globose, c. 2 mm diameter. **Involucral bracts** 2-3-seriate, glabrous; light green with white margins, increasing in size internally; outer bracts crustaceous, broadly ovate, obtuse, margins white; 1 mm long; inner bracts thin, ovate, slightly incurved, tip obtuse to rounded; c. 2 x 1.5 mm. **Flowers** all tubular, bimorphic. **Marginal flowers** female; corolla tube urceolate, mostly glabrous, finely papillate on the throat outside, apex shallowly and irregularly 4-5-lobed, white, c. 0.8-1 mm long. **Stigmas** 2, cream, c. 0.5-0.6 mm long and exceeding the corolla; style as long as or slightly longer than the corolla. **Ovary** inferior, cylindric, glabrous; unilocular with one basal ovule, c. 0.5 mm long. **Achenes** ellipsoid, slightly curved at base, papillate at apex, dark brown, c. 1 mm long. **Central flowers** male; corolla campanulate, glabrous, whitish, total length c. 1.5 mm, apex divided into 5 regular, acute lobes with scattered papillae. **Stamens** 5, laterally connate, inserted on and included in the corolla; anthers bilocular, linear-oblong, apex

acuminate, base shortly sagittate; c. 1 mm long; filaments glabrous, c. 0.4-0.5 mm long. **Stigma** 1, discoid; style c. 1 mm long. **Ovary** none.

Habitat: open areas near and along wet places

Phenology: leafing: September-February, flowering and fruiting: October-March

Abundance: common

Distribution: Thailand, Indo-China

Distinguishing features: globose capitula, bimorphic tubular flowers, without pappus; leaves closely, spirally arranged, sessile, blades oblanceolate

Voucher specimen: 139, 14 March 2001

References: Gagnepain (1924) 449, 452-453, 584-586; Kerr (1936) 285; Koyama (1989) 106-107

Blumea

key to species

1. Capitula sessile in glomerate clusters; leaf blades elliptic.....*B. fistulosa*
1. Capitula stipitate, not in glomerate clusters; leaf blades ovate, obovate to orbicular
 2. Plants tomentose; leaf blade margins dentate; corolla purplish.....*B. mollis* (D. Don) Merr.
 2. Plants glabrescent; leaf blade margins serrate; corolla yellowish.....*B. napifolia* DC.

Blumea fistulosa (Roxb.) Kurz

Annual, erect, ground herb, 10-70 cm high. **Stem** terete, simple or branched, puberulous to glabrescent, violet-brownish or light green. **Leaves** simple, spirally arranged, well-spaced. **Blades** elliptic, apex acute, base cuneate and decurrent on the petiole; margins sharp, irregularly dentate; venation pinnate, distinct with secondary nerves 3-5 pairs; finer venation obscurely reticulate; puberulous and slightly scabrous on both sides; green above, dull light green beneath; c. 18-70 x 4-22 mm. **Petioles** c. 0-12 mm long. **Inflorescence** terminal, spicate, and merging with few branches from the upper leaf axils, up to c. 25 cm long. Capitula several, usually sessile in groups and spaced along the main axes; inflorescence axes light green with indumentum as on the stem and branches. **Involucral bracts** 2-4 seriate, linear, increasing in size distally, purplish; outer bracts recurved, tomentose outside, glabrous inside; c. 2-4 x 0.5 mm; inner bracts c. 4.5-5 x 0.5 mm. **Receptacle** flat, pilose. **Flowers** all tubular,

herteromorphic, regular, 5-merous. **Marginal flowers** female; corolla tube cylindric, shallowly 4-5-lobed, glabrous, purple-violet, total length c. 2.5-3 mm long. **Stigmas** 2, recurved, c. 0.4 mm long, usually exceeding the corolla lobes; style glabrous, c. 0.2 mm long. **Pappus** a single whorl of white bristled hairs, c. 3 mm long, caducous. **Ovary** inferior, cylindric, puberulous, c. 0.8 mm long. **Central flowers** hermaphroditic; corolla tube cylindric, slightly expanding to the lobes, 3-3.2 mm long; lobes 5, apex acute, ciliolate, c. 0.2 mm long, purple-violet. **Stamens** 5, inserted on the base of, and included in the corolla tube; anthers linear, bilocular, base sagittate, laterally connate. **Stigmas**, style and pappus similar as in the marginal flowers. **Ovary** slightly larger than the marginal flowers. **Achenes** ellipsoid, puberulous, brownish, crowned with the attachment of fallen pappus, c. 0.5 x 0.2 mm. **Habitat**: open fire-damaged, degraded areas

Phenology: leafing: November-April; flowering: December-March; fruiting: March-May

Abundance: abundant

Distribution: Thailand, India, Burma, Indo-China

Distinguishing features: stem and branches violet-brown; involucre bracts 2-4- seriate, purplish; capitula sessile in dense clusters along the spike axis; flowers all tubular, the marginal female, central ones hermaphroditic; corolla purplish-violet; pappus usually < 3 mm long, caducous

Voucher specimen: 146, 11 March 2001; **Figure 30, Plate 12 A**

Reference: Randeria (1960) 255-257

***Blumeopsis flava* Gagnep.**

Annual, erect, mostly glabrous, ground herb to about 80 cm tall. **Stem** terete; lower part dark maroon, upper stem light green. **Leaves** simple, spirally arranged, sessile. **Blades** thin, ovate, elliptic to obovate, apex acute, base truncate to auriculate, margins sharply and irregularly doubly serrate; venation pinnate, distinct on both surfaces, secondary nerves 4-8 on each side of the midnerve; finer venation laxly reticulate with remote, minute multicellular caducous pilose above on young blades, dark green and usually light brown-violet on the lower leaf blades, glabrous, pale light green beneath; 1.5-10 x 1-5 cm. **Inflorescences** cymose and with merging branches from the upper leaf axils, c. 27 cm long. **Axes** glabrous, light green.

Peduncle 0.5- 3 mm long. **Capitula** numerous, ovoid, 5-7 x 3-4 mm. **Involucral bracts** 2-3 seriate, scarious; outer bracts ovate, acute, incurved, glabrous inside and puberulous at the apex outside; light green–yellow, *c.* 1-1.5 x 1 mm; inner bracts much longer than the outer ones, linear to lanceolate, concave at the base and straight, apex acute, glabrous, yellowish 4-5 x 1 mm. **Flowers** numerous, all tubular, bimorphic, regular, 5-merous. **Pappus** in a single whorl of many erect white hairs, as long as the corolla in female flowers, and shorter than the corolla in hermaphroditic flowers, *c.* 3.2 - 3.5 mm. **Marginal flowers** female, corolla tube filiform, shallowly 5 lobed, glabrous, yellow, total length about 2.5 – 2.8 mm. **Stigmas** 2, exceeding the corolla, yellow, *c.* 0.5 mm long; style glabrous, 3 mm long. **Ovary** inferior, cylindric, glabrous, unilocular with one basal ovule, *c.* 0.4 mm long. **Central flowers** hermaphroditic; corolla slightly larger than the female flowers, glabrous, yellow, *c.* 0.4 mm long including the 5 papillate lobes. **Stamens** 5, inserted on and included in the lower half of the corolla tube; anthers laterally connate, linear–elliptic, base obtuse or acute, bilocular, yellow, *c.* 1 mm long; filaments glabrous, white, *c.* 1.3–1.5 mm long. **Stigma** and style similar to the female flowers, but slightly larger and longer. **Ovary** ellipsoid, glabrous, *c.* 0.3 mm long. **Achenes** immature.

Habitat: common in open fire – damaged, degraded areas

Phenology: leafing: October–January, flowering: December–January, fruiting: January

Abundance: common

Distribution: throughout Thailand, India, Nepal, Indo–China, Penang

Distinguishing features: annual herb, sessile leaves with sharply doubly serrate margins, stramineous involucral bracts; corolla yellow

Voucher specimen: 375, 24 December 2001; **Figure** 30

Note: this species is similar to *Blumea napifolia* DC. which has much more coriaceous leaf blades with sharper margins and acute base; anther base not sagittate

References: Gagnepain (1924) 449, 452, 567-569 (fig.); Craib (1936) 265 (*sub Laggera falcata* (D. Don) O. K.); Koyama (1984) 115-116

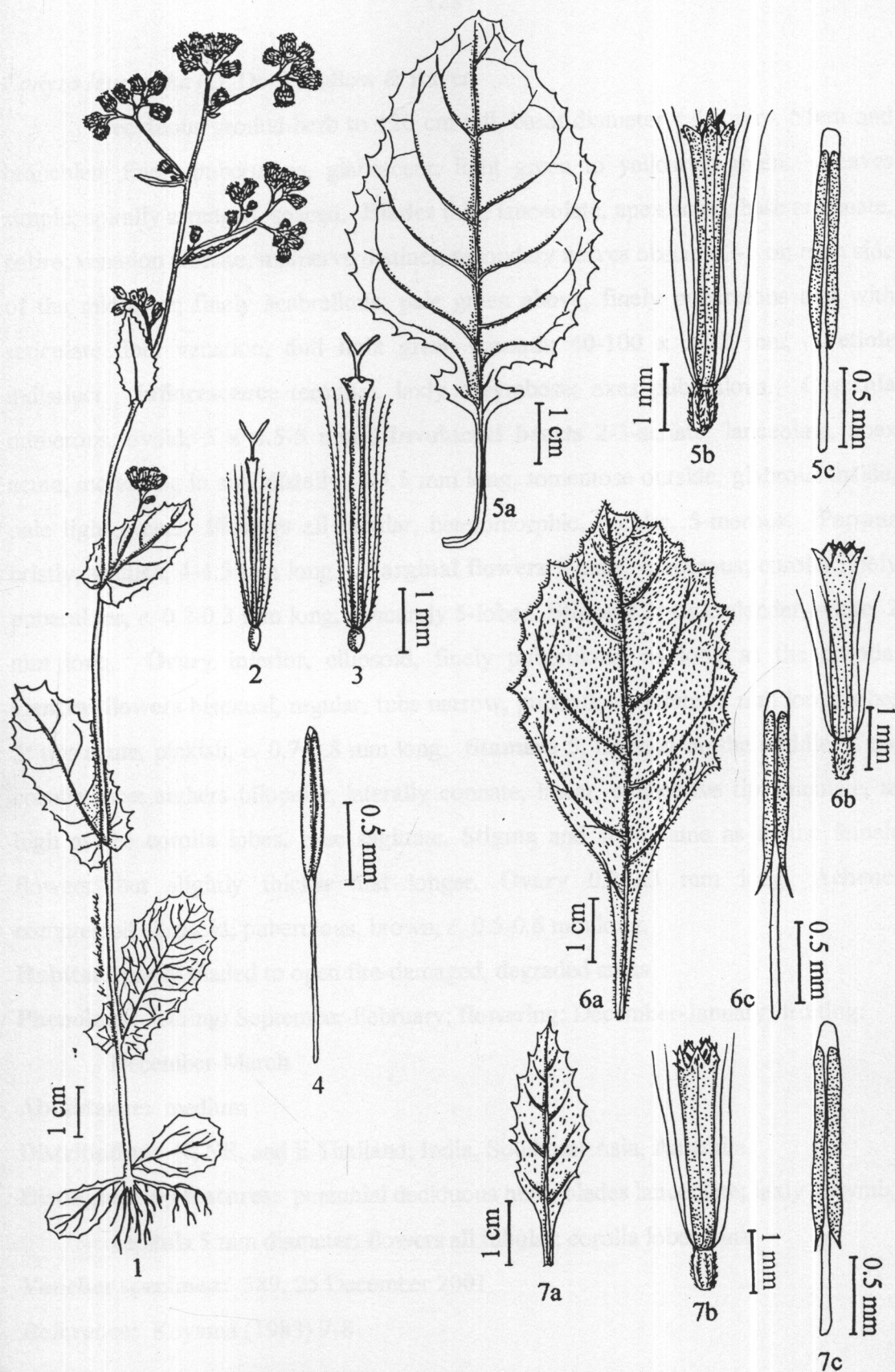


Figure 30 *Blumeopsis flava* (DC.) Gagnep. (#375): 1 = habit, 2 = marginal (female) flower, 3 = central (hermaphroditic) flower, 4 = stamen; 5 = *Blumea napifolia* L. (#403), 6 = *B. mollis* (D. Don) Merr. (#416), 7 = *B. fistulosa* (Roxb.) Kurz (#146): a = leaf, b = disc flower, c = stamen

Conyza leucantha (D. Don) Ludlow & Raven

Deciduous ground herb to 120 cm tall, basal diameter c. 4-8 mm. **Stem** and branchlets finely puberulous, glabrescent; light green to yellowish-green. **Leaves** simple, spirally arranged, spaced. **Blades** thin, lanceolate, apex acute, base attenuate, entire; venation pinnate, midnerve distinct, secondary nerves obscure 2-5 on each side of the midnerve; finely scabrellous; pale green above, finely puberulous and with reticulate finer venation, dull light green beneath; 40-100 x 5-22 mm. **Petiole** indistinct. **Inflorescence** terminal, laxly corymbose; axes puberulous. **Capitula** numerous, ovoid, 5 x 4.5-5 mm. **Involucral bracts** 2-3-seriate, lanceolate, apex acute, increasing in size distally; 4-4.5 mm long, tomentose outside, glabrous inside, pale light green. **Flowers** all tubular, heteromorphic, regular, 5-merous. **Pappus** bristly, whitish, 4-4.5 mm long. **Marginal flowers** female, numerous; corolla finely puberulous, c. 0.2-0.3 mm long, obscurely 5-lobed. **Stigmas** 2; style slender, white, 2 mm long. **Ovary** inferior, ellipsoid, finely puberulous, as long as the corolla. **Central flowers** bisexual, regular, tube narrow, puberulous, white, 2 mm long; lobes 5; tips acute, pinkish, c. 0.7-0.8 mm long. **Stamens** 5, inserted on the middle of the corolla tube; anthers bilocular, laterally connate, linear, connective tip apiculate, as high as the corolla lobes, base sagittate. **Stigma** and style same as in the female flowers, but slightly thicker and longer. **Ovary** 0.2-0.3 mm long. **Achenes** compressed ellipsoid, puberulous, brown, c. 0.5-0.6 mm long.

Habitat: partly shaded to open fire-damaged, degraded areas

Phenology: leafing: September-February; flowering: December-January; fruiting:

December-March

Abundance: medium

Distribution: N, NE, and E Thailand; India, Southeast Asia, Australia

Distinguishing features: perennial deciduous herb; blades lanceolate; laxly corymb, capitula 5 mm diameter; flowers all tubular; corolla lobes pink

Voucher specimen: 389, 25 December 2001

Reference: Koyama (1983) 7-8

***Crassocephalum crepidioides* (Benth.) S. Moore**

Annual, erect herb to 80 cm tall. **Stem** terete, slightly succulent, finely puberulous, light green with scattered violet spots and lines. **Leaves** simple, spirally arranged, spaced. **Blades** thin, ovate-lanceolate, often irregularly lyrate lobed in the lower part; apex rounded, base acute, margins irregular serrate; venation distinct, pinnate, with 6-14 secondary nerves on each side of the midnerve; finer venation laxly reticulate; finely and sparsely puberulous; dark green above, mostly glabrous and pale light green underneath; main nerves and margins maroon; 3-8 x 1-5 cm. **Petiole** finely puberulous, c. 10-30 mm long. **Inflorescence** cymes, terminal and from upper leaf axils, often cernuous, main axes puberulous and pigmented as on the stem, c. 16 cm long. **Peduncles** 5-20 mm long; pedicels with a bulbulate to linear bracts in the upper part, 3-6 mm long. **Capitula** several, ellipsoid, 16 x 6 mm. **Involucral bracts** 2-seriate; outer bracts several, subulate, free, minutely multicellularly puberulous, green, 2-3.5 mm long; inner bracts thin, united in a tube, finely and sparsely puberulous with a few multicellular pilose, light green outside, glabrous inside; apex divided to c. 1/5 the length of the bracts into c. 20 lobes, dark green, c. 9-12 mm long. **Flowers** numerous, all tubular, hermaphroditic; glabrous. **Pappus** of numerous, erect, very fine soft, white hairs, as long as or longer than the corolla. **Corolla** tube whitish, lobes yellowish-orange; total length c. 12 mm long; apex acutely 5-lobed, papillate, c. 0.5 mm long. **Stamens** 5, inserted on and included in the corolla tube; anthers bilocular, linear, apex acuminate, connective acute, base obtuse, laterally connate, c. 1 mm long; filaments glabrous, c. 2 mm long. **Stigmas** 2, violet, c. 1 mm long, exceeding the corolla; style glabrous, whitish-violet, c. 9-10 mm long. **Ovary** inferior, cylindric, ribbed and grooved, finely ciliate along the ridges, c. 2 x 0.5 mm. **Achenes** not seen.

Habitat: open, disturbed sandy wet, weedy areas

Phenology: leafing: July-February; flowering: October-January; fruiting: November-March

Abundance: medium

Distribution: throughout Thailand, native to tropical Africa

Distinguishing features: inner involucral bracts united into a tube, capitula often nodding; blades irregularly lyrate

Voucher specimen: 385, 25 December 2001; Plate 13 B

Reference: Koyama (1986) 112

Note: young parts and inflorescence are edible

***Crepis lignea* (Vant.) Bab.**

Erect, deciduous, ground herb to about 70 cm tall. **Tap root** tuberous, light brown outside, white, with milky sap inside. **Stem** 4 angled, glabrous, green. **Leaves** simple, spirally arranged, sessile. **Blades** linear to linear-lanceolate, apex acute, base cuneate, margins entire; glabrous on both sides; dark green above, light green beneath; 10-35 x 1-2 mm. **Inflorescences** terminal, laxly corymbose, c. 10-30 cm long. **Capitula** many, cylidric, c. 14 mm long; axes slender, terete, glabrous, 3-30 mm long. **Involucral bracts** 2-seriate; outer bracts much shorter than the inner ones, elliptic to lanceolate, acute, glabrous inside, glandular hairy outside, margins ciliate; 1-3 x 0.6-0.8 mm; inner bracts in a single whorl, subequal, linear-lanceolate to linear, apex obtuse; glabrous inside with fine gland-tipped pilose outside; light green with cream margins, apex usually reddish; 6-8 x 1-1.8 mm. **Flowers** all ligulate, hermaphroditic, c.10 flowers in each capitulum. **Pappus** a single whorl of many erect, white hairs, 4-5 mm long. **Corolla** tube narrow, 2-3 mm long; limb oblanceolate, subequally 5-lobed, glabrous, dull yellow outside, bright yellow inside; 7-9 x 3 mm. **Stamens** 5, inserted on and included in the corolla tube; anthers laterally connate, bilocular, linear, tip acute, base sagittate, c. 3.5-4 mm long; filaments free glabrous, 2 mm long. **Stigmas** 2, puberulous, 1 mm long; style glabrous in the lower half, puberulous in the upper half, yellowish, 6-8 mm long. **Ovary** inferior, ovoid, glabrous, unilocular with one basal ovule, c.1 mm long. **Achenes** fusiform, glabrous, dark brown, 5-7.3 x 0.7-0.8 mm; pappus persistent.

Habitat: open, fire – damaged, degraded areas

Phenology: leafing: June–September; flowering: April–June; fruiting: May –June

Abundance: common abundant

Distribution: northern Thailand, upper Burma, Yunnan, Indo–China

Distinguishing features: perennial deciduous herb with milky sap; tap root tuberous; flowering when leafless, c. 10 flowers in each capitulum, all ligulate and hermaphroditic; corolla bright yellow

Voucher specimens: 182, 5 June 2001; Maxwell 00-248, 5 May 2000; **Plate** 12 B

References: Koyama (2001) 143-144; Gagnepain (1924) 449, 455, 642; Craib (1936) 296

Elephantopus scaber* L. ssp. *scaber* var. *scaber

Evergreen, erect ground herb to about 40 cm tall. **Stem** terete, densely sericeous, dull green-maroon. **Leaves** simple, spirally arranged mostly in a basal rosette and usually flat on the ground. **Blades** subcoriaceous, oblanceolate, apex acute to obtuse, base attenuate and decurrent on the petiole, margins serrate with scattered sericeous indumentum and shortly scabrous on both sides, densely so on the main nerves underneath; venation pinnate, midnerve prominent, with 7-13 secondary nerves on each side; finer venation reticulate, obscure above, raised below; dark green above, pale light green beneath; 5-15 x 1.3-4 cm. **Petiole** 1-3 cm long, grooved above, green and clasping at the base, pinkish-violet. **Inflorescence** terminal, cymose, subtended by 3 conspicuous bracts which are broadly ovate, apex acute to acuminate, sericeous, 4-18 x 5-12 mm; axes sericeous. **Pedicels** each with 1 capitulum which consists of several groups of 4 flowers. **Capitula** sessile, lanceolate to ellipsoid. **Involucral bracts** 2-seriate, crustaceous; outer bracts lanceolate, keeled, glabrous inside, sericeous at base and apex outside; 5-5.5 x 1 mm; inner bracts linear-lanceolate, acute, glabrous inside, sericeous in the upper half along the midrib and apex, dark green, 8-10 x 1.5-2 mm. **Flowers** all tubular, hermaphroditic, glabrous. **Pappus** a single whorl of several white bristles, as long as the corolla tube. **Corolla** tube white, 4-4.3 mm long; limb 5-lobed; lobes linear to oblong, apex acute, margins thickened, purple, 3-3.5 mm long. **Stamens** 5, inserted at the base of and shorter than the corolla tube; anthers bilocular, linear, base sagittate, laterally connate, connective crested, c.1 mm long; filaments glabrous, pale light green, c.1 mm long. **Stigmas** 2, finely pilose, white, c.1-1.2 mm long; style finely pilose, white, 6 mm long. **Ovary** inferior cylindric, unilocular with one basal ovule; finely pilose along the 10 longitudinal ridges, 2 x 0.4 mm. **Achenes** obovoid, finely pilose along the 10 prominent ridges, brown, 3.5-4 x 1 mm; pappus persistent.

Habitat: open, degraded areas

Phenology: leafing: January–December; flowering: September–October; fruiting:
September–December

Abundance: common

Distribution: throughout Thailand, Indo-China, Malesia, Taiwan, southern China,
Australia, tropical Africa

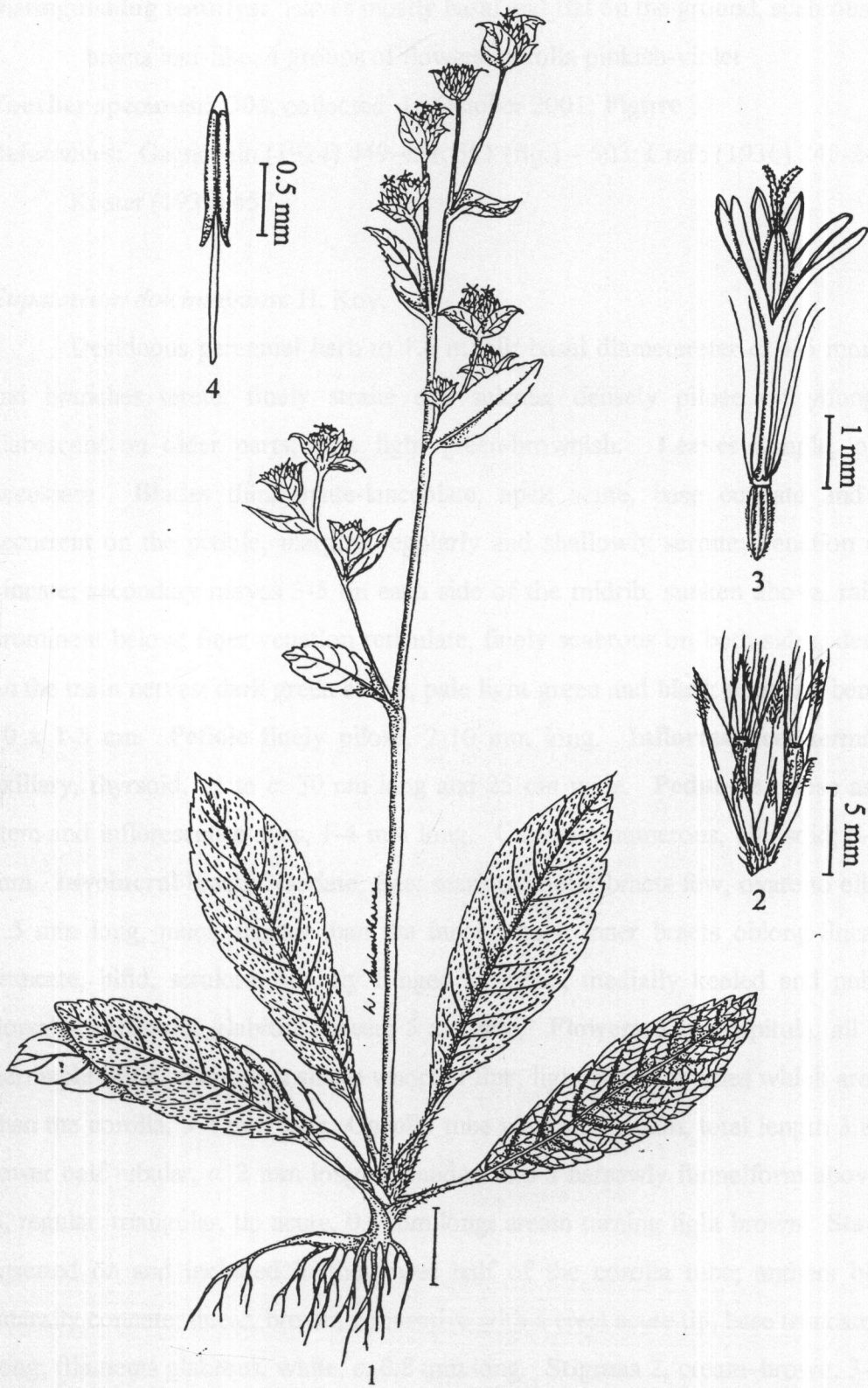


Figure 31 *Elephantopus scaber* L. ssp. *scaber* var. *scaber*: 1 = habit, 2 = capitulum with achenes, 3 = disc flower, 4 = stamen

Distinguishing features: leaves mostly basal and flat on the ground, scabrous;

bracts leaf-like; 4 groups of flowers; corolla pinkish-violet

Voucher specimen: 304, collected 16 October 2001; **Figure** 31

References: Gagnepain (1924) 449-451, 501 (fig.) – 503; Craib (1936) 245-246;

Koster (1935) 457

***Eupatorium doichangense* H. Koy.**

Deciduous perennial herb to 1.6 m tall; basal diameter c. 4-6 mm. **Stem** and branches terete, finely striate and sulcate, densely pilose on young parts, glabrescent on older parts; pale light green-brownish. **Leaves** simple, opposite, decussate. **Blades** thin, ovate-lanceolate, apex acute, base cuneate and shortly decurrent on the petiole, margins regularly and shallowly serrate; venation distinct, pinnate; secondary nerves 3-5 on each side of the midrib, sunken above, raised and prominent below; finer venation reticulate, finely scabrous on both sides, densely so on the main nerves; dark green above, pale light green and black punctate beneath; 2-10 x 1-5 cm. **Petiole** finely pilose, 2-10 mm long. **Inflorescences** terminal and axillary, thyrsoïd, up to c. 30 cm long and 25 cm wide. **Peduncle** pilose as on the stem and inflorescence axes, 1-4 mm long. **Capitula** numerous, ellipsoid; 5-6 x 4-5 mm. **Involucral** bracts 2-seriate, free, scarious; outer bracts few, ovate to elliptic, 1-1.5 mm long, much shorter than the inner whorl; inner bracts oblong-linear, apex truncate, bifid, setulose, slightly fringed or lobed, medially keeled and puberulous dorsally, otherwise glabrous, green; 5 x 1 mm. **Flowers** 5 per capitula, all tubular, hermaphroditic. **Pappus** a single whorl of fine, light brown bristles which are shorter than the corolla, 3-4 mm long. **Corolla** tube glabrous, cream, total length 3.8-4 mm; lower half tubular, c. 2 mm long, expanded into a narrowly funnelform above; lobes 5, regular, triangular, tip acute, 0.5 mm long; cream turning light brown. **Stamens** 5, inserted on and included in the lower half of the corolla tube; anthers bilocular, laterally connate; linear, brown, connective with a crest acute tip, base truncate, c. 1 mm long; filaments glabrous, white, c. 0.8 mm long. **Stigmas** 2, cream-brown, 3-3.5 mm long, exerted from the corolla; style glabrous, 3 mm long. **Ovary** inferior, cylindric, prominently angled, pilose; unilocular with one basal ovule, c. 2 mm long. **Achenes**

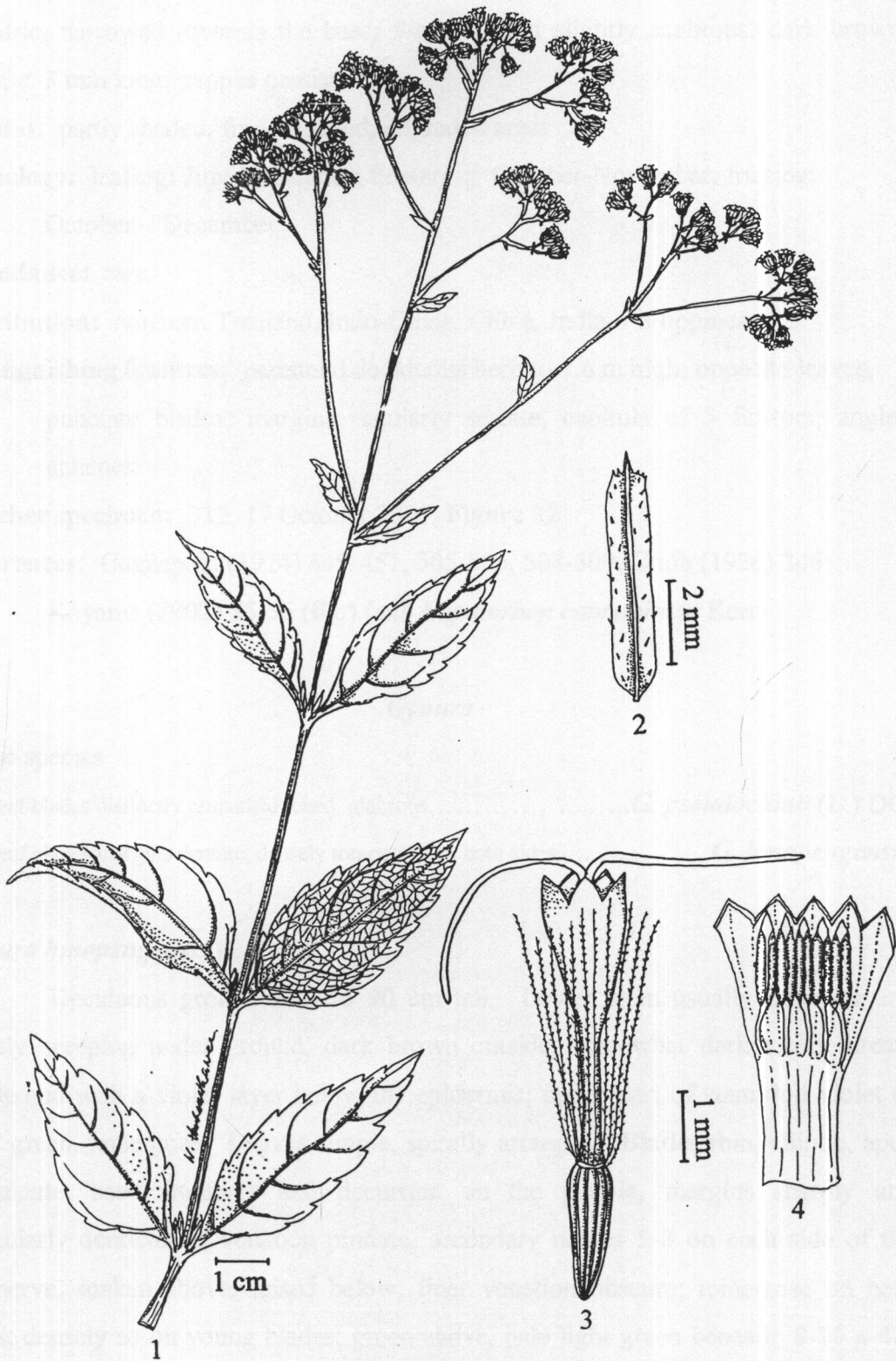


Figure 32 *Eupatorium doichangense* H. Koy.: 1 = upper part of plant, 2 = involucre bract, 3 = disc flower, 4 = opened corolla with stamens

cylindric, narrowed towards the base, 5-angled and slightly scabrous, dark brown-black, c. 3 mm long; pappus persistent.

Habitat: partly shaded, fire-damaged, degraded areas

Phenology: leafing: July-December; flowering: October-November; fruiting:
October – December

Abundance: rare

Distribution: northern Thailand, Indo-China, China, India, Philippines

Distinguishing features: perennial deciduous herb to 1.6 m high; opposite leaves, punctate blades; margins regularly serrate, capitula of 5 flowers; angled achenes

Voucher specimen: 312, 17 October 2001; **Figure** 32

References: Gagnepain (1924) 449-451, 505-506, 508-509; Craib (1936) 248;

Koyama (2002) 55-56 (fig.) (*sub Eupatorium cannabinum* Kerr)

Gynura

key to species

1. Leaf blades distinctly pinnatifid lobed, glabrous.....*G. pseudochina* (L.) DC.
1. Leaf blades margins dentate, densely tomentose on both sides.....*G. hmopengensis*

Gynura hmopengensis H. Koy.

Deciduous ground herb to 90 cm tall. Lower stem usually tuberous and shortly creeping under ground, dark brown outside, somewhat dark violet, cream inside and with a violet layer below the epidermis; upper part of stem dull violet to light green, tomentose. **Leaves** simple, spirally arranged. **Blades** thin, elliptic, apex acuminate, base attenuate and decurrent on the petiole, margins sharply and irregularly denticulate; venation pinnate, secondary nerves 5-8 on each side of the midnerve, sunken above, raised below; finer venation obscure; tomentose on both sides; densely so on young blades; green above, pale light green beneath; 8-20 x 4-7 cm. **Petioles** tomentose as on the stem and leaves; 15-50 mm. **Inflorescence** terminal, cymose, and merging with cymules from the upper leaf axils, c. 35 cm long. **Capitula** several, ellipsoid to campanulate; c. 9-15 x 4-6 mm. **Peduncle** with indumentum as on the stem and inflorescence axes, 4-36 mm long. **Involucral bracts**

2-seriate; outer bracts few, free on the peduncle and with about 10 bracts at the base of the capitula, linear-lanceolate, subequal, margins ciliate; inner bracts united into a tube, pilose and dark green outside, glabrous inside; 12-14 mm long, apex divided to c. 13 lobes to about 1/5 of total length. **Flowers** numerous, all tubular, hermaphroditic, very foetid. **Pappus** several, erect, white hairs, usually shorter than the corolla tube; c. 8-12 mm long. **Corolla** tube narrow, glabrous, light yellow, c. 13 mm long; divided to regular 5-lobed, acute and papillate, bright yellow-orange; c. 1 mm long. **Stamens** 5, adnate to the upper half of the corolla tube; anthers bilocular, linear-oblong, apex acute, base obtuse, laterally connate, bright yellow, c. 2 mm long, reaching the level of the corolla lobes or slightly longer; filaments glabrous, yellow, 3 mm long, usually swollen below the anthers. **Stigmas** 2, lanceolate, papillate, bright yellow-orange, 4-4.2 mm long and exceeding the corolla; style glabrous, light yellow. **Ovary** inferior, cylindric, glabrous, ribbed, c. 1 mm long; unilocular with one basal ovule. **Achenes** not seen.

Habitat: partly shaded areas in bamboo thickets near the seasonal stream

Phenology: leafing: October-March; flowering: January-February; fruiting: February

Abundance: rare

Distribution: northern Thailand

Distinguishing features: lower stem tuberous and shortly creeping; blades elliptic and tomentose on both sides; peduncle slender; inflorescence very foetid; corollas all tubular, bright yellow-orange

Voucher specimen: 399, 17 January 2002

Note: this species is related to *G. pseudochina* (L.) DC. (Plate 13 A), which is less foetid and found in degraded, fire-damaged areas

Reference: Koyama (1988) 151-154 (fig. P. 153)

Inula

key to species

1. Flowers all tubular; plants very densely golden villous
.....*I. cappa* (Ham. ex D. Don) DC. *forma cappa*
1. Flowers both tubular and ligulate; marginal flowers ligulate, indumentum not golden villous
2. Ligulate corolla white and central disc corolla yellow, capitula 2.5-3 cm diameter...*I. nervosa*

2. Ligulate corolla yellow and capitula always less than 2.5 cm diameter
3. Leaf blades linear-lanceolate, less than 15 mm wide, scabrous above; inflorescence laxly cymose, capitula few < 10.....*L. indica* L.
3. Leaf blades broadly elliptic, 4-8 cm wide; lower surface with white-grey floccose; inflorescence dense, capitula numerous > 10
.....*I. wismanniana* Hand.-Mzt. *forma wismanniana*

***Inula nervosa* Wall. ex DC.**

Deciduous, erect ground herb, 30-100 cm tall. **Stem** with long golden setulose and multicellular pilose indumentum, densely so on the young branches; dull maroon to violet on lower older parts and pinkish-light green above. **Leaves** simple, spirally arranged, sessile. **Blades** slightly succulent, elliptic, lanceolate, apex acute, base cuneate, margins entire to shallowly irregularly denticulate; venation pinnate, secondary nerves 3-4 on each side of the midnerve, sunken above, raised below; finer venation obscure; setulose and pilose as on the stem and branches on both sides and densely so on young blades; dark green above, very pale light green beneath; 2.7-14 x 1-3.5 cm. **Inflorescence** in terminal and axillary panicles to c. 23 x 15 cm. **Peduncle** 1-7 mm long, with indumentum as on the stem but longer and denser. **Capitula** several, campanulate 1 x 1.4 cm, and to c. 3 cm diameter at anthesis. **Involucral bracts** 3-4-seriate, the outermost whorl shortest and gradually increasing in size to the innermost whorl; outer bracts ovate-oblong, acute, margins ciliate and setulose outside; light green with violet tips, 2-3.5 x 1-1.2 mm; inner bracts linear-oblong to linear-lanceolate, glabrous on both sides, pale light green, 7-8 x 1-1.3 mm. **Flowers** numerous, both ligulate and tubular. **Marginal flowers** female, ligulate. **Pappus** a single whorl of light brown hairs, as long as the corolla tube. **Corolla** tube narrow c. 2-3 mm long; limb spreading, oblanceolate, glabrous, white, c. 10-13 x 2-3 mm with 3 acute lobes, c. 0.3-0.5 mm. **Stigmas** 2, reflexed, yellow, c. 0.8-1 mm long; style 5.5-6.5 mm long. **Ovary** inferior, cylindric, c. 1 mm long, tomentose; unilocular with one basal ovule. **Central flowers** hermaphroditic, corollas tubular, total length c. 5.5-6.5 mm, apex divided into 5, equal acute lobes, c. 0.3-0.5 mm, glabrous, yellow. **Stamens** 5, inserted on and included in the corolla tube; anthers linear, laterally connate, bilocular, apex obtuse, base distinctly sagittate, 3 mm long; filaments free,

glabrous, light yellow, c. 2 mm long. **Stigmas**, style, and ovary similar to the female flowers. **Pappus** similar to the ligulate flowers. **Achenes** not seen.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: September-January; flowering: November-December; fruiting:
December-January

Abundance: common

Distribution: northern Thailand, Assam

Distinguishing features: white ligulate corolls, blades slightly succulent with long setulose and pilose indumentum; stem and inflorescence axes usually maroon to violet

Voucher specimen: 363, 15 November 2001; **Plate** 13 F

References: Koyama (1984) 118; Kerr (1936) 271

***Lactuca parishii* Craib ex Hoss.**

Deciduous, erect, tap-rooted ground herb with milky sap. **Stem** terete, unbranched, glabrous, brown-green, 1-2 mm long. **Leaves** simple, spirally arranged. **Blades** chartaceous, ovate, apex acute; base sagittate, broadly decurrent and winged up to 5 mm on each side of the upper 1/3 of the petiole, lower 2/3 of the petiole narrowly winged upto 2.5 mm wide on each side, glabrous, green and dull maroon-violet at base, total length 8-25 cm; margins appearing entire with fine, remote denticulate, extensions of the main nerves which are c.1 mm long; venation distinct, 3-5 plinerved; finer venation reticulate; glabrescent on both sides; dark green above, light green beneath; 7-18 x 4-10 cm. **Inflorescences** a terminal panicle to c. 60 cm long with a few reduced leaf-like bracts; axes glabrous, green; peduncle 10-15 mm long. **Capitula** numerous, cylindric-campanulate, c.15 x 5 mm. **Involucral bracts** all free, glabrous, dull green, sometimes with violet margins, 3-seriate; outer bracts very much smaller than the inner ones, lanceolate, c.1-2.5 x 0.4-0.7 mm; medial bracts lanceolate, 4-5 x 1 mm; inner bracts linear-lanceolate, 12-14 x 1.5 mm. **Flowers** all ligulate, hermaphroditic, 10-12 per capitula. **Pappus** of fine, erect hairs on several unequal whorls, white, 1-8 mm long. **Corolla** tube c. 6 mm long; limb oblong, glabrous, white, 6 x 2.5-2.7 mm, divided in 5 regular acute lobes, c. 0.3 mm long. **Stamens** 5, inserted slightly below the corolla throat; anthers bilocular, laterally

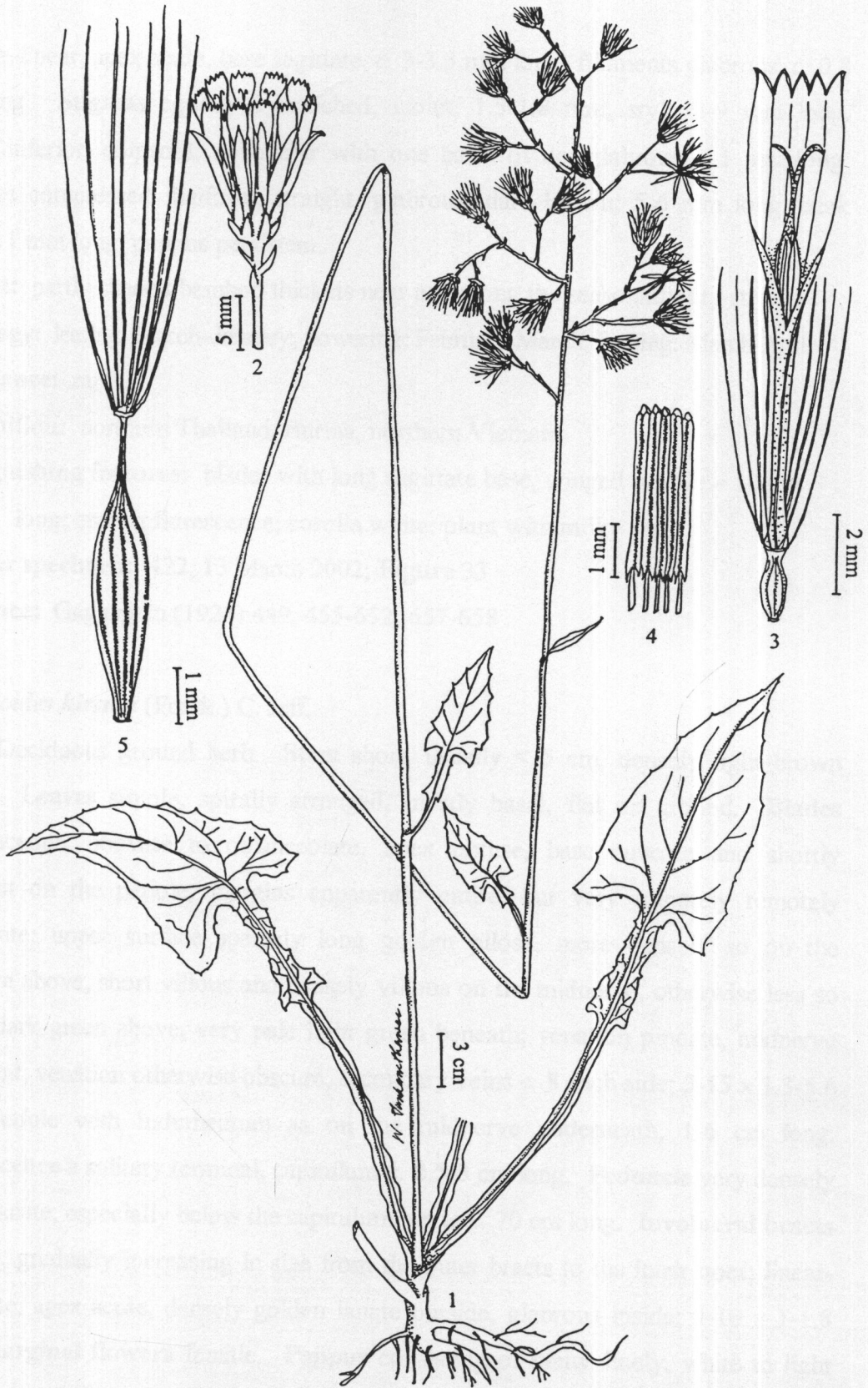


Figure 33 *Lactuca parishii* Craib ex Hoss.: 1 = habit, 2 = capitulum, 3 = ray flower, 4 = opened stamens, 5 = achene with pappus

connate, linear, apex acute, base sagittate, *c.* 3-3.3 mm long; filaments glabrous, *c.* 0.8 mm long. **Stigmas** equally 2-branched, violet, 1.5-1.8 mm; style 8-9 mm long. **Ovary** inferior, ellipsoid, unilocular with one basal ovule; glabrous, *c.* 1 mm long. **Achenes** compressed fusiform, straight, glabrous, dark brown; 5-6 mm long, beak slender 1 mm long; pappus persistent.

Habitat: partly shaded bamboo thickets near and along the seasonally dry stream

Phenology: leafing: March–January; flowering: February–March; fruiting: March–April

Abundance: rare

Distribution: northern Thailand, Burma, northern Vietnam

Distinguishing features: blades with long sagittate base, winged petiole > 10 cm long; erect inflorescence; corolla white; plant with milky sap

Voucher specimen: 422, 13 March 2002; **Figure** 33

Reference: Gagnepain (1924) 449, 455-652, 657-658

***Piloselloides hirsuta* (Forsk.) C. Jeff.**

Deciduous ground herb. **Stem** short, usually < 5 cm, densely light brown villous. **Leaves** simple, spirally arranged, mostly basal, flat on ground. **Blades** subcoriaceous, obovate to oblanceolate, apex obtuse, base cuneate and shortly decurrent on the petiole, margins apparently entire, but very minutely remotely denticulate; upper surface sparsely long golden pilose, more densely so on the midnerve above, short villous and densely villous on the midnerve, otherwise less so below, dark green above, very pale light green beneath; venation pinnate, midnerve prominent, venation otherwise obscure, secondary veins *c.* 8 each side; 3-15 x 1.3-5.6 cm. **Petiole** with indumentum as on the midnerve underneath, 1-6 cm long. **Inflorescence** a solitary terminal, capitulum *c.* 2.5-3 cm long. **Peduncle** very densely golden lanate, especially below the capitulum, up to *c.* 70 cm long. **Involucral bracts** 3-seriate, gradually increasing in size from the outer bracts to the inner ones; linear-lanceolate, apex acute, densely golden lanate outside, glabrous inside; 4-10 x 1-1.8 mm. **Marginal flowers** female. **Pappus** consisting of many finely, white to light brown hairs, 8-12 mm long. **Corolla** ligulate, tube narrow, glabrous, 4-5 mm long; anterior limb linear-oblong to oblanceolate, apex obtuse and shallowly 3-lobed, glabrous; white, cream, or somewhat pale blue-violet; 7-15 x 1.5-2 mm; posterior

limb linear, divided to about 1.5-2 mm, c. 2-3 mm long. **Stigmas** 2, oblong, obtuse, white; 0.5-1 mm long; style glabrous, white, 7-10 mm long. **Ovary** inferior, cylindric, papilose, unicellular, with one basal ovule, c. 2 x 0.7-0.8 mm. **Central flowers** tubular, hermaphroditic, numerous. **Corolla** tube narrow, 9-13 mm long, divided into 3 irregular lobes; 2 dorsal lobes linear, curved at the apex, white, 2 mm long; ventral lobe ovate-oblong, shallowly 3-toothed, 3-3.5 x 1-1.2 mm. **Stamens** 5, inserted just below the corolla throat; anthers bilocular, laterally connate, apex obtuse, base sagittate, brown, c. 3 mm long; filaments free glabrous, c. 1 mm long. **Stigmas** 2, similar to the female flowers, but slightly larger and more slender; style, ovary and pappus similar to the female flowers. **Achenes** laterally compressed, fusiform, puberulous; dark brown; 4-5 x 1.3-2 mm, and with a 3-10 mm long beak; pappus persistent.

Habitat: usually found in fire-damaged, degraded areas

Phenology: leafing: March-September; flowering: April-June; fruiting: May-July

Abundance: common abundant

Distribution: north and northeastern Thailand, Indo-China, Burma, southern China, Himalayas, Africa, Asia Minor

Distinguishing features: solitary capitulum; ligulate corollas white, cream, or blue-violet, spreading; white pappus; long, slender peduncle; indumentum densely lanate on all parts; stem < 5 cm long; obovate blades flat on the ground

Voucher specimen: 170, 4 May 2001; **Plate** 12 C

References: Gagnepain (1924) 449, 455-456, 647 (fig.) 658-660 (*sub Gerbera piloselloides* (L.) Cass.); Koyama (1981) 57-58

***Pluchea polygonata* (DC.) Gagnep.**

Erect, deciduous herb to about 1 m tall. **Stem** winged, densely white lanate. **Leaves** simple, spirally arranged, spaced, sessile. **Blades** subcoriaceous, elliptic, lanceolate to obovate-lanceolate, apex acute, base cuneate, margins finely denticulate; venation pinnate, obscure above, distinct on the lower surface; 5-7 secondary nerves on each side of the midnerve; finer venation reticulate; green above, white-cream beneath. **Inflorescences** terminal compactly, cymose; axes with indumentum as on the stem and young blades. **Capitula** several, subglobose, c. 6-8 mm diameter.

Peduncle subsessile to 15 mm long. **Involucral bracts** 2-4-seriate, crustaceous, lanate outside; outer bracts linear, slightly convex at base, 5-7 x 1 mm, green; inner bracts less lanate and smaller than the outer ones, with violet tips, c. 4 x 0.75 mm. **Pappus** a single whorl of erect, white hairs as long as the corolla. **Marginal flowers** female; corolla tube gradually narrowing distally, top 5-lobed. **Stigmas** 2, exceeding the corolla, subulate, glabrous, c. 0.5 mm long; style glabrous, c. 2 mm long. **Ovary** inferior, slightly longer and narrower than the bisexual flowers, c. 0.8-1 mm long. **Central flowers** hermaphroditic, all tubular; corolla tube narrow, total length c. 4 mm long, tip with 5 equal lobes, glabrous; lobes scaly and finely setulose outside, violet, c. 0.5 mm long. **Stamens** 5, inserted on and included in the corolla tube; anthers bilocular, free, linear, apex obtuse, base sagittate, violet, c. 1 mm long; filaments free, glabrous, c. 1 mm long. **Stigmas** 2, papillate, dark violet; style glabrous, violet, c. 2 mm long. **Ovary** inferior, cylindric, c. 0.5-1 mm long; unilocular with one basal ovule. **Achenes** cylindric, truncate at both ends, densely long setulose at base, pappus caducous.

Habitat: open fire- damaged, degraded areas

Phenology: leafing: October-April; flowering: December-March; fruiting: March- April

Abundance: medium

Distribution: N, NE, SW, E Thailand, Indo-China, Burma

Distinguishing feature: winged stem, inflorescence densely white lanate; leaves sessile; inflorescence compactly cymose; all flowers as high as the involucral bracts, appearing flat-topped; flowers all tubular, marginal flowers female, central flowers hermaphroditic

Voucher specimens: 144, 14 March 2001; Maxwell 00-93, 25 February; **Plate** 13 C

References: Gagnepain (1924) 449, 451, 523 (fig.) – 525; Koyama (1984) 122-123; Craib (1936) 271-272 (*sub Inula polygonata* DC.)

***Spilanthes iabadicensis* A. H. Moore**

Annual, ascending or decumbent herb, often rooting at the lower nodes.

Stem terete with minute scattered multicellular puberulous indumentum, reddish-pink and pale light green. **Leaves** simple, opposite, spaced, decussate. **Blades** thin, ovate, ovate-oblong, apex acute, base cuneate and decurrent on the petiole, margins irregularly serrate to shallowly dentate, somewhat finely dentate; main venation 3-

plinerved, sunken above, prominent and raised below; finer venation reticulate; mostly glabrous and with scattered multicellular hispid indumentum on the margins above; dark green above, very pale light green beneath; 15-70 x 5-35 mm. **Petiole** with indumentum as on the stem, 2-18 mm long. **Inflorescence** terminal and axillary, capitula solitary, rarely paired. **Peduncle** with same indumentum as on the stem, light green or reddish-pink, up to c.10.5 cm long. **Capitula** conical, 7-11 x 4-6 mm. **Involucral bracts** crustaceous, 2-seriate, ovate-oblong to elliptic, apex acute, margins ciliolate, glabrous on both sides, light green; c.3-3.5 x 1-2 mm. **Flowers** numerous, bimorphic; pappus none. **Marginal flowers** ligulate, female. **Corolla** tube pale yellow, finely ciliolate, c.1 mm long; limb obovate, apex broadly truncate and shallowly 2-3-lobed, glabrous, yellow, turning cream; c. 2-2.5 x 1.2-1.5 mm. **Stigmas** 2, recurved, papillate, yellow, c. 0.5 mm long; style glabrous, light yellow, c.1.3 mm long. **Ovary** inferior, oblanceolate with sharply 3-angled, finely ciliolate on the posterior side and setulose along the angles; 1.7-2 x 0.6 mm. **Central flowers** hermaphroditic, discoid, each embraced by an incurved, glabrous, keeled chaff; corolla funnellform; tube c.1.2 mm long, margin with 4-5 equal acute lobes; the posterior 2-3 lobes usually reflexed, the anterior 2 lobes erect, papillate, yellow, c. 0.3 mm long. **Stamens** 5, inserted on and included in the corolla tube; anthers bilocular, linear, apex with an extension of the connective, base sagittate, laterally connate, brown, c. 0.8 mm long; filaments glabrous, 0.4 mm long. **Stigmas** and style similar to the female flowers, but slightly shorter. **Ovary** laterally compressed and slightly longer than the female flowers with the same indumentum. **Achenes** obovate, laterally compressed, setulose, margins ciliolate, black, c. 2-2.2 x 1 mm.

Habitat: open, wet areas

Phenology: leafing, flowering, and fruiting throughout the year

Abundance: medium

Distribution: throughout Thailand, India, southern China, Southeast Asia

Distinguishing features: capitula conical, solitary, long-peduncled; yellow ray corollas; ovary and achenes embraced with chaff; leaves opposite

Voucher specimen: 390, 25 December 2001

References: Koyama (1985) 65-66; Kerr (1936) 277 (*sub S. acmella* Murr.); Radanachales & Maxwell (1994) 214-215 (fig.)

Vernonia

key to species

1. Capitula mostly solitary, sessile, axillary; involucre bracts crustaceous; blades very scabrous above *V. squarosa* (D. Don) Less. var. *orientalis* Kit.
1. Capitula in cymes or panicles, several, terminal or axillary; involucre bracts not crustaceous; blades not scabrous
 2. Capitula usually more than 13 mm long; blades, c. 9-23 x 4-9 cm, margins serrate
..... *V. sutepensis*
 2. Capitula less than 8 mm long; blades 1.5-3 x 3-6 cm, margins crenate
..... *V. cinerea* (L.) Less. var. *cinerea*

Vernonia sutepensis Kerr

Deciduous ground herb to c. 1 m tall, basal diameter c. 5-8 mm. **Stem** terete, light green, with multicellular hirsute indumentum. **Leaves** simple, spirally arranged, spaced. **Blades** subcoriaceous, elliptic to oblong, apex acute, base cuneate, margins sharply and shallowly serrate; venation distinct, pinnate, secondary nerves 7-9 on each side of the midnerve, sunken above, prominent and raised below; finer venation reticulate, prominent beneath; sparsely covered with multicellular pilose indumentum on both sides, finely punctate below; dark green above, pale light green underneath. **Petioles** hirsute, 4-7 mm long, indumentum as on the stem. **Inflorescence** in lax terminal and axillary thyrses. **Peduncle** hirsute and with densely multicellular indumentum, the central capitulum of each cymule sessile, and the lateral ones with peduncles 5-25 mm long. **Capitula** several, campanulate, 10-15 x 8-12 mm. **Involucre bracts** many-seriate, free, increasing in size from the outside to inside, ovate, all with a thickened midnerve and subulate tip; finely floccose outside, glabrous inside whitish-green, c. 3-4 x 1-1.2 mm; innermost bracts crustaceous oblong-lanceolate, sharply acute, glabrous on both sides, c. 9-10 x 1.4-1.6 mm. **Pappus** 2-seriate of many erect, white bristles; outer whorl much shorter, c. 1-2 mm long; inner whorl c. 7 mm long and shorter than the corolla. **Corollas** all tubular, hermaphroditic, glabrous, purple then turning white, total length c. 9-11 mm, apex divided to c. 3 mm into 5 equal, acute and usually reflexed lobes. **Stamens** 5, inserted below the corolla throat; anthers bilocular, linear-lanceolate, apex acute, base sagittate, laterally connate, c. 3 mm long; filaments glabrous, c. 1-1.5 mm. **Stigmas**

2, each slightly circinate, *c.* 2-2.4 mm long, purple then turning white; style glabrous, 7 mm. **Ovary** inferior, cylindric-obovate, 10-grooved, glabrous; unilocular with one basal ovule; *c.* 3 mm long. **Achenes** laterally compressed, glabrous, dark brown with 10 distinct ribs, *c.* 4-5 mm long; pappus persistent, *c.* 10 mm long.

Habitat: partly shaded areas in bamboo thickets along the seasonal stream

Phenology: leafing: May-February; flowering: November-December; fruiting:

November-January

Abundance: rare, down to a few individuals

Distribution: northern Thailand

Distinguishing features: leaf blades margins sharply and regularly serrate, all parts covered with multicellular indumentum; thyrsoid inflorescence; flowers all tubular, hermaphroditic, corolla purple-white; pappus 2-seriate of different lengths

Voucher specimen: 356, 15 November 2001; **Figure** 34

Reference: Kerr (1936) 244

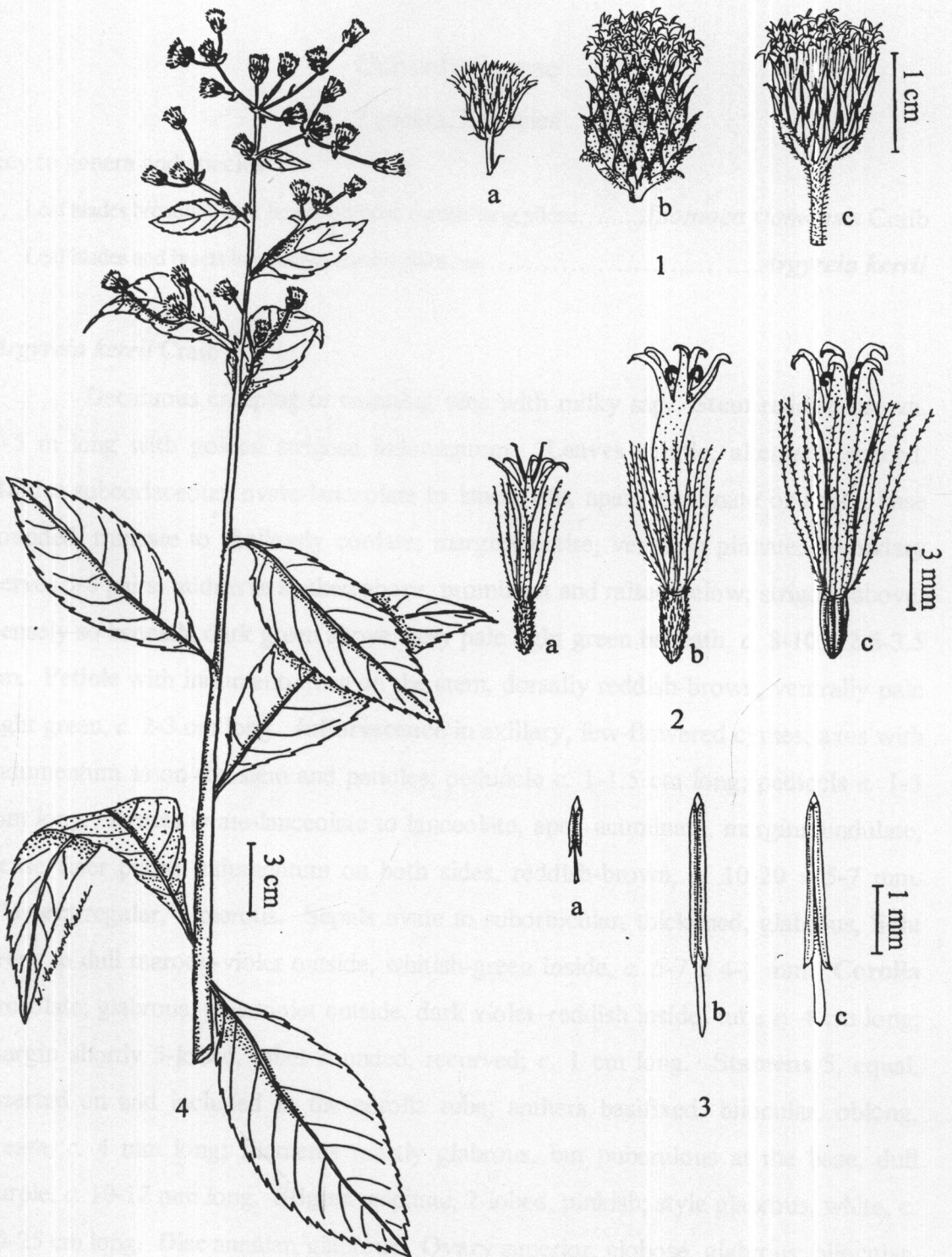


Figure 34 a = *Vernonia cinerea* (L.) Less. var. *cinerea* (#145); b = *V. squarrosa* (D. Don) Less. var. *orientalis* Kit. (#271); c = *V. sutepensis* Kerr (#356); 1 = capitula, 2 = disc flowers, 3 = stamens, 4 = upper part of c

Convolvulaceae

2 genera, 2 species

key to genera and species

1. Leaf blades broadly ovate; bracts filiform; corolla long pilose.....*Ipomoea siamensis* Craib
1. Leaf blades and bracts lanceolate; corolla glabrous.....*Argyreia kerrii*

Argyreia kerrii Craib

Deciduous creeping or twinning vine with milky sap. **Stem** reddish-brown, 4-5 m long with golden strigose indumentum. **Leaves** simple, alternate, spaced. **Blades** subcoriaceous, ovate-lanceolate to lanceolate, apex acuminate or acute, base rounded, truncate to shallowly cordate; margins entire; venation pinnate, secondary nerves 5-8 pairs, midnerve sunken above, prominent and raised below; strigose above, densely so beneath; dark green above, very pale light green beneath, *c.* 8-10 x 2.6-3.5 cm. **Petiole** with indumentum as on the stem, dorsally reddish-brown, ventrally pale light green, *c.* 2-3 cm long. **Inflorescence** in axillary, few-flowered cymes; axes with indumentum as on the stem and petioles; peduncle *c.* 1-1.5 cm long; pedicels *c.* 1-3 mm long. **Bracts** ovate-lanceolate to lanceolate, apex acuminate, margins undulate, dense finer pilose indumentum on both sides, reddish-brown, *c.* 10-20 x 5-7 mm. **Flowers** regular, 5-merous. **Sepals** ovate to suborbicular, thickened, glabrous, light green to dull maroon-violet outside, whitish-green inside, *c.* 5-7 x 4-6 mm. **Corolla** urceolate; glabrous, pale violet outside, dark violet-reddish inside; tube *c.* 4 cm long; margin shortly 5-lobed, lobes rounded, recurved; *c.* 1 cm long. **Stamens** 5, equal, inserted on and included in the corolla tube; anthers basifixed, bilocular, oblong, cream, *c.* 4 mm long; filaments mostly glabrous, but puberulous at the base, dull purple, *c.* 10-12 mm long. **Stigma** capitate, 2-lobed, pinkish; style glabrous, white, *c.* 20-25 cm long. **Disc** annular, glabrous. **Ovary** superior, globose, glabrous; bilocular, each locule with 2 basal ovules. **Fruits** not seen.

Habitat: open fire-damaged, degraded areas

Phenology: leafing: June-December; flowering: July-August; fruiting: July-

December

Abundance: rare

Distribution: northern Thailand

Distinguishing features: deciduous vine with milky sap; blades lanceolate with golden strigose indumentum; corolla urceolate, up to 5 cm long, margin shortly 5-lobed and recurved, dark violet-reddish

Voucher specimen: 230, 13 July 2001; **Plate** 11 C

References: Gagnepain & Courchet (1915) 272-274, 281; Craib (1912) 139; Kerr (1951) 133 (*sub Lettsomia kerrii* (Craib) Kerr)

Droseraceae

1 genus, 2 species

Drosera

key to species

1. Leaves cauline, peltate; sepals fimbriate, styles 3.....*D. peltata*
1. Leaves in a basal rosulate; sepals not fimbriate; styles 5.....*D. burmannii* Vahl

Drosera pelata J.E. Sm. ex Willd.

Deciduous, perennial, erect, carnivorous, ground herb to *c.* 30 cm tall. Base of taproot tuberous, globose, reddish-brown outside, *c.* 5 mm diameter. **Stem** simple or sometimes with few branches, glabrous, lower (older) parts reddish, upper (younger) parts light green. **Leaves** simple, spirally arranged, peltate. **Blades** succulent, lunate, apex rounded, base truncate and slightly curved, margins with long mucilage glandular ciliate, which secretion at the apex; venation obscure; sparsely, reddish mucilage glandular ciliate and light green above, glabrous and light green beneath; *c.* 2 x 3 mm. **Petiole** glabrous, light green or brownish, *c.* 8-12 mm long. **Inflorescence** a terminal cyme, 2-3 cm long. **Pedicels** glabrous, light green, 5-9 mm long. **Flowers** few, regular, 5-merous. **Sepal** 5(-6), ovate, apex acute, margins irregularly fimbriate; sparsely reddish gland-tipped ciliate outside, light green and glabrous inside, *c.* 2 x 1 mm. **Petals** 5, thin, obovate, apex truncate, rounded or shallowly 2-3 irregularly lobed, glabrous, white, *c.* 3-3.5 x 2-2.7 mm. **Stamens** 5, alternipetalous, free; anthers dorsifixed, bilocular, orbicular, *c.* 0.4 mm; filaments glabrous, gradually narrowing to the tip; white, *c.* 2 mm long. **Stigmas** fimbriate, 4-5-lobed, papillate; styles 3, *c.* 0.6 mm long. **Ovary** superior, globose, shallowly 6-lobed, light green, glabrous, *c.* 1-1.2 mm diameter, 3-carpeled, unilocular with numerous parietal ovules. **Capsules** globose, 3-valved, *c.* 2.5 mm long, loculicidal. **Seeds** numerous, ellipsoid, papillate, greyish, *c.* 0.2 mm long.

Habitat: open fire-damaged, degraded grassy areas

Phenology: leafing, flowering, and fruiting June –August

Abundance: very common, abundant

Distribution: N, NE, SW Thailand, Sri Lanka, Philippines, Japan, southern China, Australia, and Tasmania

Distinguishing features: erect herb up to 30 cm high; basal part of taproot tuberous; plants with numerous glandular-sticky cilia; leaves cauline, peltate; petals white; styles 3

Voucher specimen: 197, 22 June 2001; **Figure 35**

References: Larsen (1987) 67-69 (fig.); Craib (1931) 590

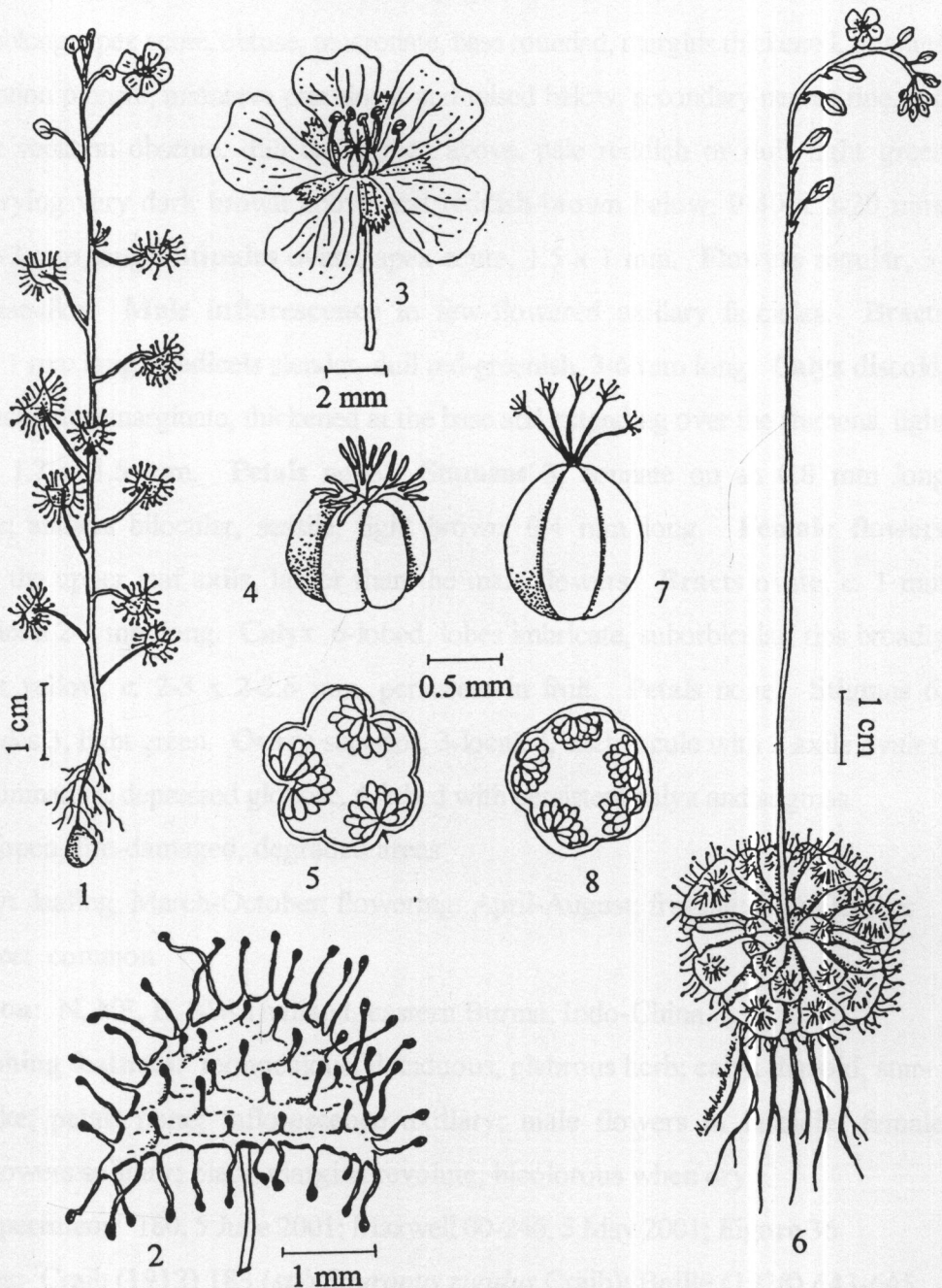


Figure 35 *Drosera peltata* J. E. Sm. ex Willd. (#197): 1 = habit, 2 = upper surface of leaf blade, 3 = flower, 4 = pistil, 5 = ovary (x-section); *D. burmannii* Vahl (#392): 6 = habit, 7 = pistil, 8 = ovary (x-section)

Euphorbiaceae

1 species

***Sauropus bicolor* Craib**

Deciduous, erect or ascending, glabrous, monoecious ground herb to c. 55 cm high, lacking sap. **Rootstock** woody. **Stem** and branches terete, glaucous, green to reddish-green or dull light maroon. **Leaves** simple, alternate. **Blades** subcoriaceous, ovate, elliptic to oblong; apex acute, obtuse, mucronate, base rounded, margins thickened, revolute entire; venation pinnate, midnerve prominent and raised below, secondary nerves fine, 3-6 pairs; finer venation obscure; dull dark green above, pale reddish or dull light green beneath; drying very dark brown above and reddish-brown below; 9-40 x 6-20 mm. **Petioles** 2-3 mm long. **Stipules** ovate, apex acute, 1.5 x 1 mm. **Flowers** regular, 3-merous, star-like. **Male inflorescence** in few-flowered axillary fascicles. **Bracts** subulate, c. 1 mm long. **Pedicels** slender, dull red-greenish, 3-6 mm long. **Calyx** discoid, 6-lobed, each lobe emarginate, thickened at the base and extending over the stamens, light yellow, c. 1.7 x 1.5 mm. **Petals** none. **Stamens** 3, connate on an 0.8 mm long androphore; anthers bilocular, sessile, light brown, 0.4 mm long. **Female flowers** solitary in the upper leaf axils, larger than the male flowers. **Bracts** ovate, c. 1 mm long. **Pedicels** 2-3 mm long. **Calyx** 6-lobed, lobes imbricate, suborbicular, tips broadly acute, light yellow, c. 2-3 x 2-2.5 mm, persistent in fruit. **Petals** none. **Stigmas** 6, hooked, styles 3, light green. **Ovary** superior, 3-loculed, each locule with 2 axile ovules. **Capsules** immature, depressed globose, 6-lobed with persistent calyx and stigmas.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: March-October; flowering: April-August; fruiting: July-October

Abundance: common

Distribution: N, NE, E, SW Thailand, eastern Burma, Indo-China

Distinguishing features: monoecious, deciduous, glabrous herb; calyx discoid, star-like; petals none; inflorescence axillary; male flowers in fascicle; female flowers solitary; blade margins revolute, bicolourous when dry

Voucher specimens: 180, 5 June 2001; Maxwell 00-246, 5 May 2001; **Figure** 36

References: Craib (1912) 183 (*sub Sauropus rigidus* Craib); Beille (1928) 643-645, 654-655; Airy Shaw (1972) 330-334; Welzen (1998) 1-11

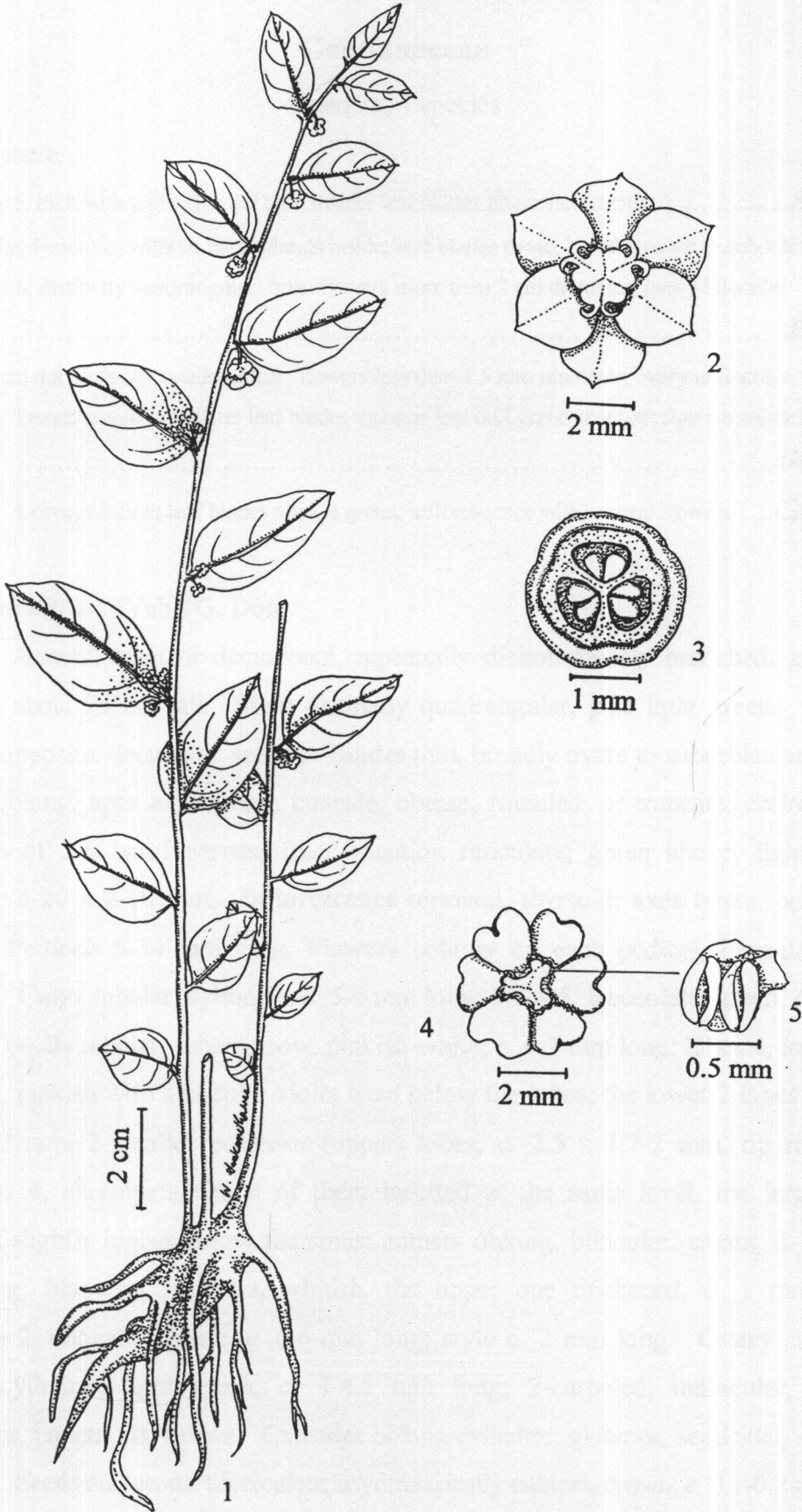


Figure 36 *Sauropus bicolor* Craib: 1 = habit, 2 = female flower, 3 = ovary (x-section), 4 = male flower, 5 = stamen

Gentianaceae

4 genera, 4 species

key to genera

1. Petals 5, each with a gland at the base inside; leaf blades linear-lanceolate.....*Swertia*
1. Corollas 4-merous, without basal glands inside; leaf blades ovate, broadly ovate to suborbicular
 2. Stem, distinctly quadrangular; open flowers more than 2 cm diameter; ovary bilocular
*Exacum*
 2. Stem not distinctly quadrangular; flowers less than 1.5 mm diameter; ovary unilocular
 3. Leaves usually rosulate; leaf blades more or less dull green-maroon; flowers solitary
*Gentiana*
 3. Leaves cauline; leaf blades always green, inflorescence with several flowers.....*Canscora*

Canscora diffusa (Vahl) G. Don

Annual, erect or decumbent, repeatedly dichotomously branched, glabrous herb, to about 25 cm tall. **Stem** distinctly quadrangular, pale light green. **Leaves** simple, opposite, decussate, sessile. **Blades** thin, broadly ovate to suborbicular, lower blades oblong, apex acute, base cuneate, obtuse, rounded, or truncate; entire; main venation of 3-5 basal nerves; finer venation reticulate; green above, light green beneath; 4-20 x 2-10 mm. **Inflorescence** terminal, thyrsoid; axes terete, pale light green. **Pedicels** 5-14 mm long. **Flowers** solitary on each pedicel, irregular, 4-5-merous. **Calyx** tubular, cylindric, c. 5-6 mm long; lobes 5, lanceolate, green, c. 1 mm long. **Corolla** tubular; tube narrow, pinkish-white, c. 6-7 mm long; lobes 4, irregular, obovate, pinkish with a circular violet band below the lobes; the lower 2 lobes longer, c. 3 x 2 mm; 2 smaller posterior (upper) lobes, c. 2.5 x 1.7-2 mm, tip rounded. **Stamens** 4, alternipetalous, 3 of them inserted at the same level, the larger one inserted slightly higher below the sinus; anthers oblong, bilocular, cream, c. 0.8-0.9 mm long; filaments glabrous, whitish, the upper one thickened, c. 1 mm long. **Stigmas** 2, obovate, obtuse, c. 0.6 mm long; style c. 2 mm long. **Ovary** superior, oblong-cylindric, light green, c. 4-4.5 mm long; 2-carpeled, unilocular, ovules numerous, parietal, in 4 rows. **Capsules** oblong-cylindric, glabrous, septicidal, c. 4-6 x 1.5 mm. **Seeds** numerous, tuberculate, asymmetrically cubical, brown; c. 0.1-0.2 mm.

Habitat: in shallow soil or on damp rocks near and in the seasonally dry stream bed

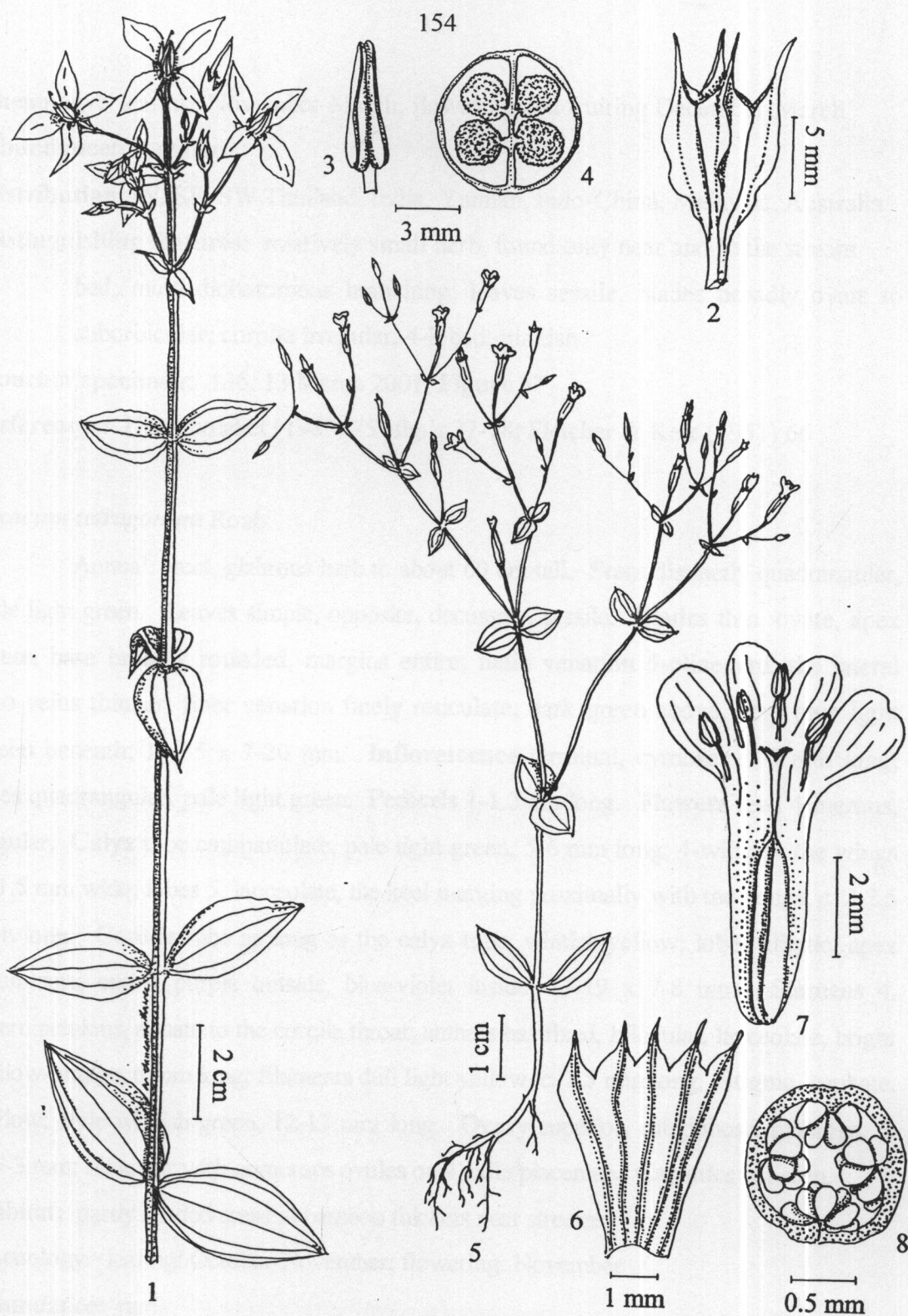


Figure 37 *Exacum tetragonum* Roxb. (#334): 1 = upper part of plant, 2 = calyx, 3 = stamen, 4 = ovary (x-section); *Canscora diffusa* (Vahl) G. Don (#136): 5 = habit, 6 = opened calyx, 7 = opened corolla with stamens and pistil; 8 = ovary (x- section)

Phenology: leafing: November-March; flowering and fruiting December-March

Abundance: common

Distribution: N, SE, SW Thailand, India, Yunnan, Indo-China, Malaysia, Australia

Distinguishing features: relatively small herb, found only near and in the stream bed; multi-dichotomous branching; leaves sessile, blades broadly ovate to suborbicular; corolla irregular, 4-lobed, pinkish

Voucher specimen: 136, 13 March 2001; **Figure** 37

References: Ubolcholaket (1987) 75 (fig.), 77-78; Fletcher & Kerr (1951) 66

Exacum tetragonum Roxb.

Annual, erect, glabrous herb to about 60 cm tall. **Stem** distinctly quadrangular, pale light green. **Leaves** simple, opposite, decussate, sessile. **Blades** thin, ovate, apex acute, base broadly rounded, margins entire; main venation 5-plineverd, the lateral two veins thinner; finer venation finely reticulate; dark green above, very pale light green beneath; 15-35 x 7-20 mm. **Inflorescence** terminal, cymose, c. 5 mm long; axes quadrangular, pale light green. **Pedicels** 1-1.3 cm long. **Flowers** few, 4-merous, regular. **Calyx** tube campanulate, pale light green, 5-6 mm long; 4-winged, the wings 1-1.5 mm wide; lobes 5, lanceolate, the keel merging proximally with the wings, c. 2-2.5 mm long. **Corolla** tube as long as the calyx tube, whitish-yellow; lobes elliptic, apex acuminate, entire, purple outside, blue-violet inside; 17-19 x 7-8 mm. **Stamens** 4, alternipetalous, adnate to the corolla throat; anthers basifixed, bilocular, lanceolate, bright yellow-orange, 6 mm long; filaments dull light yellow, c. 1.5 mm long. **Stigma** capitate, yellow; style whitish-green, 12-13 mm long. **Ovary** superior, subglobose, glabrous, c. 2.5-3 mm; bilocular with numerous ovules on 4 axile placentae. **Capsules** not seen.

Habitat: partly shaded areas in bamboo thickets near streams

Phenology: leafing: October-November; flowering: November

Abundance: rare

Distribution: throughout Thailand, India, Southeast Asia, China

Distinguishing features: leaves sessile, blades ovate; flowers 4-merous, calyx winged, corolla bright violet; anthers bright yellow-orange

Voucher specimen: 334, 3 November 2001; **Plate** 37

References: Ubolcholaket (1987) 72-73, 75 (fig.), 79-80; Fletcher & Kerr (1951) 65

Gentiana timida Kerr

Deciduous, nearly glabrous ground herb. **Taproots** swollen, tan to white outside, c. 7 cm long. **Leaves** dimorphic, appearing in different seasons. **Vegetative leaves** (dry season) rosulate, clustered at the tip of the stem which is underground, sessile; blades thin, obovate-lanceolate, apex acuminate, base attenuate, deccurrent, margins finely ciliate; venation 3-nerved, inconspicuous, papillate and dull dark green or dull green-maroon above, dull light maroon or light green beneath; c. 20-30 x 4-9 mm. **Flowering** stems slender, terete, violet; branches few to many, up to c. 7 cm tall. **Flowering leaves** opposite, decussate; blades thin, oblong to broadly ovate, apex acute to acuminate, base acute, connate with the opposite leaf in the lower half, blades surfaces and margins similar to the rosette leaves; midnerve obscure; other veins invisible; dull dark green above, light green below; 3-6 x 1.5-4 mm. **Flowers** terminal, solitary, 5-merous, regular. **Pedicels** 4 mm long, dull maroon. **Calyx** tube campanulate, reddish-green or dull dark violet, 4-5 mm long; lobes linear-lanceolate, thickened, tip acuminate, green, c. 2 mm long. **Corolla** tube campanulate, greenish-orangish or blue outside, white inside; 7-9 mm long; lobes blue, ovate, tips acute, c. 2.5-3 mm long, with a thin, blue obtuse or acute-tipped alternipetalous membrane inside. Corolla closing in mid-afternoon. **Stamens** 5, inserted on the middle of and included in the corolla tube; anthers oblong, bilocular, cream-yellow, c. 2 mm long; filaments white, c. 3-4 mm long. **Stigmas** 2, reflexed and circinate. **Ovary** superior, stipitate, slightly compressed, oblanceolate to fusiform, apex tapering to the style, c. 5 mm long; 2-carpeled, unilocular with numerous parietal ovules. **Capsules** not seen.

Habitat: open grassy, degraded, fire-damaged areas

Phenology: leafing: October-January; flowering: March-June

Abundance: common

Distribution: northern Thailand

Distinguishing features: deciduous herb, usually < 5 cm high; leaves dimorphic, vegetative leaves rosulate, flat on the ground, maroon; corollas blue-violet, closing in mid-afternoon

Voucher specimens: 173, 4 May 2001; Maxwell & Sankamethawee 00-249, 5 May 2000; Plate 11 D

References: Uboncholaket (1987) 72-73, 82-83, 85 (fig.), 88-89; Fletcher & Kerr (1951) 71.

***Swertia angustifolia* Ham. ex D. Don**

Annual, glabrous herb to about 80 cm tall. **Stem** erect, unbranched, quadrangular with narrowly winged angles, dull maroon to light brown-greenish. **Leaves** simple, opposite, decussate, sessile. **Blades** chartaceous, linear-lanceolate to lanceolate, apex acuminate, base cuneate, margins entire; main venation of 3 basal nerves, sunken above, prominent and raised below; finer venation finely reticulate; dark green to dull maroon above, pale light green to dull maroon beneath; 20-70 x 1.5-9 mm. **Inflorescence** of terminal cymes; axes quadrangular, pale light green, *c.* 10 cm long. **Pedicels** 5-20 mm long. **Bracts** linear-lanceolate, glabrous, green, *c.* 1-1.5 mm. **Flowers** several per cyme, 4-merous, regular. **Sepals** elliptic, glabrous, light green; 6-8 x 1-1.5 mm. **Petals** apex acute, entire, each with a distinct yellowish-green gland at the base inside; white and variegated with violet-blue lines and spots inside; 6-9 x 2.5-4 mm. **Stamens** 4, free, alternipetalous; anthers dorsifixed, bilocular, oblong, light brown and turning reddish, *c.* 1.2 mm; filaments glabrous, cream to light yellow, narrowing distally, *c.* 3 mm long. **Stigmas** 2, suborbicular, yellowish-green. **Ovary** superior, sessile, ovate-lanceolate or fusiform, tapering to the style, pale light yellow, *c.* 3 mm long; unilocular, ovules numerous; placentation parietal in 4 rows. **Capsules** 2-valved; ovoid-lanceolate or fusiform, light brown; usually embraced by the persistent dry petals, septicidal, 5-6 x 3 mm. **Seeds** numerous, subglobose with many irregular sides, pitted; brown, *c.* 0.3 mm.

Habitat: open fire-damaged, degraded areas

Phenology: leafing: August-December; flowering: September-December; fruiting:

October-February

Abundance: common

Distribution: N, NE, E Thailand, India, Nepal, Bhutan, Burma, Cambodia, Laos, west and central China

Distinguishing features: glabrous herb, stem quadrangular; leaf blades linear-lanceolate; petals 4, white and variegated with violet-blue lines and spots, with a yellowish gland at the base of each petal inside

Voucher specimen: 309, 17 October 2001

References: Uboncholaket (1987) 72-73, 90-91; Craib (1912) 138, Fletcher & Kerr (1951) 71

Guttiferae, Hypericeae

1 species

Hypericum japonicum Thunb. ex Murr.

Annual, erect ground herb about 7-20 cm tall. **Stem** slender, quadrangular, glabrous, green. **Leaves** simple, opposite, decussate, sessile. **Blades** thin, ovate to elliptic, apex obtuse, base cuneate, margins entire; venation 3-5-plinerved, midnerve the most prominent on the lower surface; green above, very pale light green and with distinct scattered punctate glands beneath; 3-7 x 1.5-4 mm. **Inflorescences** terminal and axillary, racemose, 1.5-5 cm long, 1-many-flowered; axes quadrangular and green as the stem. **Bracts** paired, leaf-like, gradually decreasing in size to the distal part of the inflorescence. **Flowers** 5-merous, regular, odorless. **Sepals** ovate to elliptic, subequal, apex acute, glabrous on both sides, green; 2.5-4 x 1.5-2.5 mm. **Petals** membranous, valvate in bud, obovate, apex rounded, more or less same size as the sepals, 5-6-nerved from the base, yellowish-orange. **Stamens** 16-25, free, equal, in a single whorl; anthers bilocular, rounded, longitudinally dehiscent, yellow; filaments glabrous, yellow, 1.5-2 mm long. **Stigmas** 3, capitat; styles 0.5 mm long. **Ovary** superior, ovoid, glabrous, 1-1.5 x 1 mm; unilocular with numerous parietal ovules. **Capsules** ovoid, tip acute, septicidal, c. 3-3.5 x 2-2.5 mm, style persistent. **Seeds** many, ovoid-oblong or shortly cylindric, obtuse at both ends, light yellow-brown, 0.3-0.5 mm long.

Habitat: open wet marshy areas

Phenology: leafing, flowering, and fruiting all year round

Abundance: medium

Distribution: northern Thailand, Japan, South Korea, southeastern China to Sri

Lanka, Australia, New Zealand, Hawaii, throughout Malesia

Distinguishing features: erect herb, usually < 25 cm high; opposite leaves, blades with punctate glands; petals yellowish-orange

Voucher specimen: 157, 12 April 2001

Reference: Robson (1974) 14-16, 27

Labiatae

10 genera, 13 species

key to genera

1. Corolla seemingly unilabiate, lower lip unequally 5-lobed *Teucrium*
1. Corolla bilabiate, lower lip 1-3-lobed; or subequally 4-5-lobed
 2. Inflorescence of solitary or branched spikes; flowers 1-3 mm long
 3. Inflorescence a branched spike; corolla 5-merous, bilabiate, whitish; filaments without moniliform hairs..... *Elscholtzia*
 3. Inflorescence an unbranched spike; corolla subequally 4-lobed; filaments with long moniliform, gland-tipped hairs..... *Pogostemon*
 2. Inflorescence of verticillate cymes, racemes, or thyrses; flowers more than 4 mm long
 4. Plants glandular-sticky
 5. Fertile stamens 2, each with 1 fertile locule; connective filament-like, separating the fertile and sterile locules; calyx lobes not spinescent.....*Salvia*
 5. Fertile stamens 4, locules 2; connective not separating the locules, calyx with spine-like lobes..... *Hyptis suaveolens* (L.) Poit.
 4. Plants not glandular-sticky
 6. Plants with stellate hairs.....*Gomphostemma*
 6. Plants without stellate hairs
 7. Lower lip of corolla 2-lobed, bluish to violet; calyx with a dorsal crest; stamens not didynamous *Scutellaria*
 7. Lower lip of corolla 1-lobed, whitish-pink; calyx without a crest; stamens didynamous
 8. Inflorescence a terminal thyrse *Isodon*
 8. Inflorescence a terminal raceme or axillary cyme
 9. Cymes axillary; plants densely villous; leaf blades ovate.....*Leucas*
 9. Racemes terminal; plants mostly glabrous; leaf blades oblanceolate to obovate-lanceolate..... *Orthosiphon*

Elscholtzia winitiana Craib

Aromatic, deciduous, erect herb to 1 m tall. **Stem** quadrangular, with dense greyish multicellular setulose and slender, thickened unicellular scarbrous indumentum; dull light green to dull light maroon. **Leaves** simple, opposite, decussate. **Blades** subcoriaceous, oblong; apex acute, base cuneate, margins shallowly bluntly serrate; venation distinct, pinnate, midnerve sunken above, raised

below; secondary nerves 6-8 on each side of the midnerve; finer venation reticulate; sparsely scabrellous above, densely pilose beneath; green above, very pale light green beneath; 10-70 x 7-23 mm. **Petiole** pilose, *c.* 2-9 mm long. **Inflorescence** terminal, ascending, in spike-like racemes, *c.* 20-80 x 3-5 mm. **Bracts** obovate to oblanceolate, apex aristate, densely setulose outside and glabrous inside. **Flowers** dense, irregular, 5-merous, *c.* 1.5 mm long, subsessile. **Calyx** campanulate, *c.* 1 mm long, irregularly 5-lobed, posterior segment the largest, then decreasing in size from the lateral to the anterior ones, outside densely pilose and very pale light green. **Corolla** bilabiate, puberulous outside, white, narrow, *c.* 1 mm long; upper lip orbicular, 3-lobed, the midlobe twice as long as the lateral ones, *c.* 0.4 x 0.7 mm; lower lip 1-lobed, incurved boat-shaped with shortly fimbriate margins, about the same size as the midlobe of the upper lip. **Stamens** 4, didynamous, inserted on and near the corolla throat; anthers dorsifixed, bilocular, orbicular, brownish-black, *c.* 0.2 mm diameter; filaments glabrous, white, *c.* 2 mm long. **Disc** cupular, with a distinct ligular lobe on the anterior side. **Stigmas** 2, subulate, white, *c.* 0.4 mm long; style glabrous, white, *c.* 2 mm long. **Ovary** superior, deeply 4-lobed, ovoid, each locule with one basal ovule. **Nutlets** 2-4, ovoid, greyish-black, *c.* 0.4 mm.

Habitat : open, fire-damaged, degraded areas

Phenology: leafing: November-February; flowering: December-January; fruiting: December-March

Abundance: medium

Distribution: northern Thailand, southern Vietnam, Laos

Distinguishing features: inflorescence ascending, spiciform racemes, flowers numerous, dense, minute, corolla white; leaves aromatic

Voucher specimen: 381, 24 December 2001; **Plate** 14 E

References: Doan (1936) 980-981 (fig.); Murata (1971) 497

Gomphostemma strobilinum Wall. ex Benth. var. *acaulis* (Kurz ex Hk. f.) Prain

Deciduous ground herb. **Rootstock** woody. **Stem** up to 5 cm long. **Leaves** simple, several, closely decussate at the top of the stem, usually flat on the ground. **Blades** subcoriaceous, broadly elliptic; apex rounded, base cuneate and decurrent on

the petiole; margins regularly crenulate; venation distinct, pinnate, midnerve sunken above, raised below; secondary nerves 4-6 on each side of the midnerve; finer venation reticulate; upper surface covered with fine bifid and trifid indumentum, densely so on the main nerves and young blades which also have simple multicellular pilose indumentum, lower surface densely stellate pilose; dark green above, pale light green beneath; 5-19 x 3-11 cm. **Petiole** finely stellately pilose, 4-30 mm long. **Inflorescence** terminal, compactly racemose (appearing strobiliform), c. 5 cm long. **Flowers** several, irregular, 5-merous. **Bracts** prominent, leaf-like, suborbicular or obovate, margins sharply denticulate, 3-nerved; very densely stellate pilose and light green on both surfaces; bracteoles linear, light green, c. 5 mm long. **Calyx** campanulate, total length c. 7-10 mm; apex divided to half way into 5 regular lobes, tips acuminate; densely stellate pilose outside, inside with pilose hairs on the lobes and glabrous on the tube, pale light green. **Corolla** bilabiate, tube curved, narrow and broadening distally with stellate and fine simple multicellular, gland-tipped indumentum outside, glabrous in the upper half and papillose in the lower half inside; violet-maroon, c. 12-14 mm long; upper lip 1-lobed, ovate, apex emarginate, curved, c. 8-10 x 6-7 mm; lower lip 3-lobed, tips obtuse and slightly undulate, 2-keeled below the sinus; glabrous inside and finely bullate at and above the throat; mostly covered with fine multicellular gland-tipped and scattered stellate indumentum outside; the expanded part of the tube and lobes yellow-cream, 3-4 mm long. **Stamens** 4, didynamous, included in the corolla, embraced by the upper lip; anthers dorsifixed, elliptic, bilocular, greyish-brown, c. 2 x 1.3 mm; the shorter filaments adnate to the upper half of the posterior side of the tube, c. 8 mm long; the longer pair adnate to the anterior side, c. 9-9.5 mm long; all slightly compressed; with scattered unicellular, gland-tipped indumentum, light yellow. **Disc** glabrous, gibbous on the anterior side. **Stigma** shortly bifid; style glabrous, whitish, 22-24 mm long. **Ovary** superior, deeply 4-lobed, each locule (lobe) ovoid or ellipsoid, c. 0.7 mm long, tips rounded, with one basal ovule. **Nutlets** not seen.

Habitat: partly shaded areas in bamboo thickets near and along the seasonal stream

Phenology: leafing: August-December; flowering: September-November;

fruiting: November-December

Abundance: rare

Distribution: northern Thailand, Burma

Distinguishing features: short stem, seemingly stemless with leaves flat on the ground, leaf blades with dense stellate indumentum; inflorescence strobiliform; corolla bilabiate, yellowish-cream

Voucher specimen: 287, 28 September 2001; **Plate** 14 F

References: Doan (1936) 915-916, 918, 1030-1032; Murata (1971) 501

Note: a related species is *G. wallichii* Prain, found in the same habitat which has a stem up to 1.5 m tall and blades with fine strigose indumentum dorsally

Isodon lophanthoides (Buch.-Ham. ex D. Don) H. Hara var. *lophanthoides*

Annual, aromatic, ground herb, 20-80 cm tall. **Stem** quadrangular, scabrous and sometimes with scattered multicellular puberulence; light green, light violet-brown, to maroon. **Leaves** simple, opposite, decussate. **Blades** thin, ovate to broadly ovate; apex acute, base broadly acute, rounded or truncate, margins dentate; venation pinnate, midnerve sunken above, raised below; secondary nerves 3-6 on each side of the midnerve; finer venation reticulate; upper surface densely puberulous, less so beneath; which is densely covered with minute violet glands; dark green above, dull light green beneath; 10-75 x 7-50 mm. **Petiole** with indumentum as on the stem and the blades, c. 2-40 mm long. **Inflorescence** a terminal thyrse, sometimes with basal branches from the upper leaf axils; 8-20 x 3-5 cm; axes with indumentum as on the stem, violet-brown to dull maroon. **Bracts** elliptic to ovate, apex acute to acuminate, margins entire to widely serrate or lobed; unlobed margins usually ciliate; greenish-violet, hairy as on the blades; 3-4.5 x 2-3 mm. **Pedicels** 3-6 mm long. **Flowers** several, irregular, 5-merous. **Calyx** campanulate, total length c. 1.5-2.2 mm, densely glandular puberulous and with long multicellular pilose outside, glabrous inside; pale light green to light violet-brown to maroon; divided to c. 1/3 of its length into 5 irregular lobes, tips acute. **Corolla** bilabiate, mostly glabrous, scattered hirsute on the outside of the lobes; whitish with minute violet spots inside; tube narrowly campanulate, c. 3-4 x 1-1.5 mm; upper lip 4-lobed, lobes oblong, the inner 2 lobes slightly smaller, c. 1-1.5 x 0.8-1 mm, the lateral 2 lobes slightly larger; lower lip 1-lobed, suborbicular, 2-2.6 mm diameter. **Stamens** 4, didynamous; the posterior pair shorter, inserted on the base of the corolla tube, puberulous near the base, c. 4-6 mm

long; the longer pair inserted on and adnate to the anterior side of the tube, free part *c.* 4 mm long; anthers dorsifixed, unilocular, elliptic; greyish-black or dark violet; *c.* 0.2-0.3 mm long. **Disc** symmetrically cupular. **Stigma** equally 2-lobed, acute; style glabrous, white, *c.* 6-8 mm long. **Ovary** superior, deeply 4-lobed, ovoid, glabrous, each lobe with one basal ovule. **Nutlets** ellipsoid, rounded at both ends, smooth to finely rugose, brown; *c.* 0.8-1 x 0.5 mm, the persistent accrescent calyx, bilabiate, and curved.

Habitat: open fire-damaged, degraded area and bamboo thickets near the stream

Phenology: leafing: October-February; flowering: December-January; fruiting: December-February

Abundance: abundant in open areas, but rare in shaded areas near the stream

Distribution: northern Thailand, Himalayas, Burma, Laos, Vietnam, China

Distinguishing features: leaf blades ovate with dentate margins, petiole usually long; inflorescence a thyrse, corolla bilabiate, white

Voucher specimens: 377, 24 December 2001; 388, 25 December 2001; **Plate** 15 A

Reference: Murata (1971) 504 (*sub Plectranthus striatus* Benth.)

Note: Somran Suddee (BKF) has changed the name on CMU specimens for this thesis.

My two specimens are different in sizes of the leaf blades and flowers, and have different indumentum. Specimen 377 has entire bracts and the stamens are included in or as long as the corolla lobes, while specimen 388 has lobed or serrate blades and stamens distinctly exserted from the corolla

Leucas decemdentata (Willd.) J. Sm.

Deciduous, ascending, scrambling or decumbent to diffuse ground herb. **Roots** thick. **Stem** quadrangular, densely sericeous, very pale light green. **Leaves** simple, opposite, decussate. **Blades** subcoriaceous; apex acute, base acute, rounded, or somewhat oblique; margins regularly serrate; venation obscure, covered by the indumentum, midnerve indistinct; secondary venation pinnate; finer venation invisible; densely sericeous above, lanate below; green above, very pale light green beneath; 13-40 x 8-25 mm. **Petioles** sericeous, 2-4 mm. **Inflorescences** axillary, in spaced verticillate cymes, internodes 5-10 cm long. **Bracts** linear, acuminate, villous, green, *c.* 2-5 mm long. **Flowers** several, irregular, 5-merous. **Calyx** tubular, 10-ridged, 4.5-5.5 mm long, lobes subulate, 5 short alternating with 5 long, *c.* 0.4 and 0.8

mm long, respectively, the lobe and all outside sericeous, glabrous inside. **Corolla** bilabiate, white; tube narrow, 8-9 mm long, upper 1/4 villous, lower 3/4 glabrous outside, glabrous inside with a ciliolate ring medially; upper lip 3-lobed, c. 9 mm long, the midlobe largest, broadly obovate, apex shallowly emarginate, glabrous, the lateral lobes obtuse, 1/2 as long as the middle one, villous outside, glabrous inside; lower lip 1-lobed, concave to boat-shape, densely sericeous outside glabrous inside, c. 5 mm long. **Stamens** 4, didynamous, all inclinate and embraced in the upper lip; anthers dorsifixed, unilocular, ellipsoid, reddish, c. 0.8 mm long; filaments all puberulous, white; the shorter pair inserted on the corolla throat, c. 4 mm long; the longer pair 5 mm long. **Disc** glabrous, ligulate on the posterior side. **Stigma** unequally 2-lobed; style glabrous, white, c. 10 mm long. **Ovary** superior, deeply 4-lobed, tips truncate, sides straight, c. 1 mm long, each lobe with one basal ovule. **Nutlets** not seen.

Habitat: open fire-damaged, degraded areas

Phenology: leafing: May-December, flowering: August-October, fruiting:
August-December

Abundance: common

Distribution: northern Thailand, Burma, Malay peninsula, Philippines, Lesser Sunda Islands, Celebes, New Guinea, Northern Australia

Distinguishing features: mostly scrambling or diffuse herb; thick roots, most parts densely whitish villous; flowers in axillary verticillasters, corolla white

Voucher specimen: 257, 10 August 2001

References: Murata (1971) 506; Keng (1978) 340-341; Keng (1969) 100, 107-108;
van Steenis (1982) 567 (*sub Leucas flaccida* R. Br.)

***Orthosiphon rubicundus* (D. Don) Benth.**

Deciduous, erect ground herb to c. 60 cm tall. **Roots** tuberous, brown, and hard outside; light brown and fleshy inside. **Stem** quadrangular, glabrous, dull violet. **Leaves** simple, opposite, decussate. **Blades** thin, oblanceolate to obovate-lanceolate; apex acute to acute, base attenuate, margins serrate on young blades and nearly entire on old lower blades; venation pinnate; midnerve sunken above, raised below, with 4-6 pairs of ascending secondary nerves; finer venation laxly reticulate; with fine, scattered, multicellular pilose indumentum on the midnerve of young blades and

glabrescent; green above, dull light green beneath; 25-70 x 4-20 m; sessile or with a petiole up to 4 mm long. **Inflorescence** terminal, laxly racemose, erect, to c. 40 cm long, verticillasters 3-6-flowered; axes quadrangular, densely glandular indumentum and with multicellular pilose, reddish-violet to maroon. **Pedicels** reflexed at the tip, 3 mm long. **Bracts** ovate, margins ciliate, otherwise glabrous, reddish-violet, 1.6-1.9 x 2-2.3 mm. **Flowers** numerous, irregular, 5-merous, c. 11 mm long, fragrant. **Calyx** cylindric, slightly curved, tube c. 6-7 mm long; anterior side with 4 irregular, subulate lobes, 2-3 mm long, pale light green with violet lines, densely glandular and finely pilose; posterior side with one suborbicular lobe, apex cuspidate, margins scabrous, mostly covered with glandular and scattered pilose indumentum on the ridges, dull violet. **Corolla** bilabiate, densely pilose outside, finely glandular and puberulous on the lobes and upper half of the tube inside; white to pinkish-white; upper lip irregularly 4-lobed, or 3-lobed with an emarginate midlobe; lower lip 1-lobed, apex obtuse, margins undulated. **Stamens** 4, didynamous, inserted on the upper half of the anterior side of the tube, included in the corolla tube, glabrous; anthers reniform, bilocular, divergent, brownish-dark maroon, c. 0.5 mm; posterior pair with filaments, c. 1.5 mm long, whitish; anterior pair c. 2 mm long. **Disc** gibbous on the anterior side. **Stigma** capitate, shallowly lobed; style with sparse glandular hairs, white, c. 7-8.5 mm long. **Ovary** superior, deeply 4-lobed, glabrous, each locule ovoid and with one basal ovule. **Nutlets** 2-4, compressed globose, all included in the persistent calyx, greyish-brown with dense dark tiny glands, c. 1.5-1.8 mm diameter.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: April-September, flowering: April-May, fruiting: May-August

Abundance: common

Distribution: northern Thailand, Burma, Himalayas, Indochina, southern China

Distinguishing features: glabrous herb; blades oblanceolate; inflorescence an erect terminal verticillate raceme; axes and calyx reddish-violet; corolla white, lobes bilabiate, upper lip 3-4-lobed, lower lip 1-lobed

Voucher specimen: 148, 11 April 2001

References: Murata (1971) 510-511; Doan (1936) 933, 935

Pogostemon

key to species

1. Leaves opposite, blades more than 10 mm wide.....*P. auricularius* (L.) Haask.
1. Leaves whorled, blades less than 5 mm wide
 2. Plants mostly glabrous.....*P. pentagonus* (C. B. Clark ex Hk. f.) Kuntz
 2. Plants densely pilose.....*P. cruciatus*

Pogostemon cruciatus (Benth.) Kuntz

Deciduous, erect and sometimes scrambling herb to c. 1.2 m tall. **Stem** quadrangular, densely greyish pilose, green with scattered tiny violet spots. **Leaves** in whorls of 3-4, sessile. **Blades** thin, lanceolate to linear-lanceolate; apex acute, base cuneate; margins remotely serrate and revolute; densely pilose on both sides; venation pinnate, midnerve sunken above, prominently raised below; secondary nerves c. 5 pairs, finer venation obscure; light green above, very pale light green underneath; 15-30 x 1.5-4 mm. **Inflorescence** a very dense, terminal, solitary spike. **Peduncle** densely pilose, pinkish, 1-4 cm long. **Flowers** numerous in each whorl, almost regular, 4-merous. **Bracts** leaf-like, sharply serrate, violet, c. 5 x 1.5 mm; Bracteoles linear, c. 3-3.5 mm long. **Calyx** campanulate, 3-4 mm long, densely pilose, and with scattered glandular indumentum, 5-lobed to 1/3 the length of the tube; tips acuminate, violet. **Corolla** finely pilose in the upper half of each lobe outside, otherwise glabrous, whitish-pink; tube c. 2 mm long; lobes 4, subequal, suborbicular, apex obtuse or rounded, c. 1-1.1 x 0.8-0.9 mm. **Stamens** 4; anthers dorsifixed, unilocular, reniform, brown, c. 0.2-0.25 mm, exserted from the corolla; filaments all equal, each with dense, moniliform pilose up to c. 1.5 mm long in groups medially, purple; c. 6 mm long. **Disc** symmetrically cupular. **Stigmas** 2, capitate, divergent, glabrous, pinkish, c. 1.7-2 mm long; style glabrous, pink, c. 4-4.5 mm long. **Ovary** superior, deeply 4-lobed, ovoid, glabrous, each lobe with one basal ovule. **Nutlets** 2-4, slightly compressed ovoid, glabrous, all included in the persistent calyx, c. 0.5 x 0.4 mm.

Habitat: open, wet, marshy areas

Phenology: leafing: October-February; flowering: December-January; Fruiting:

December-February

Abundance: rare

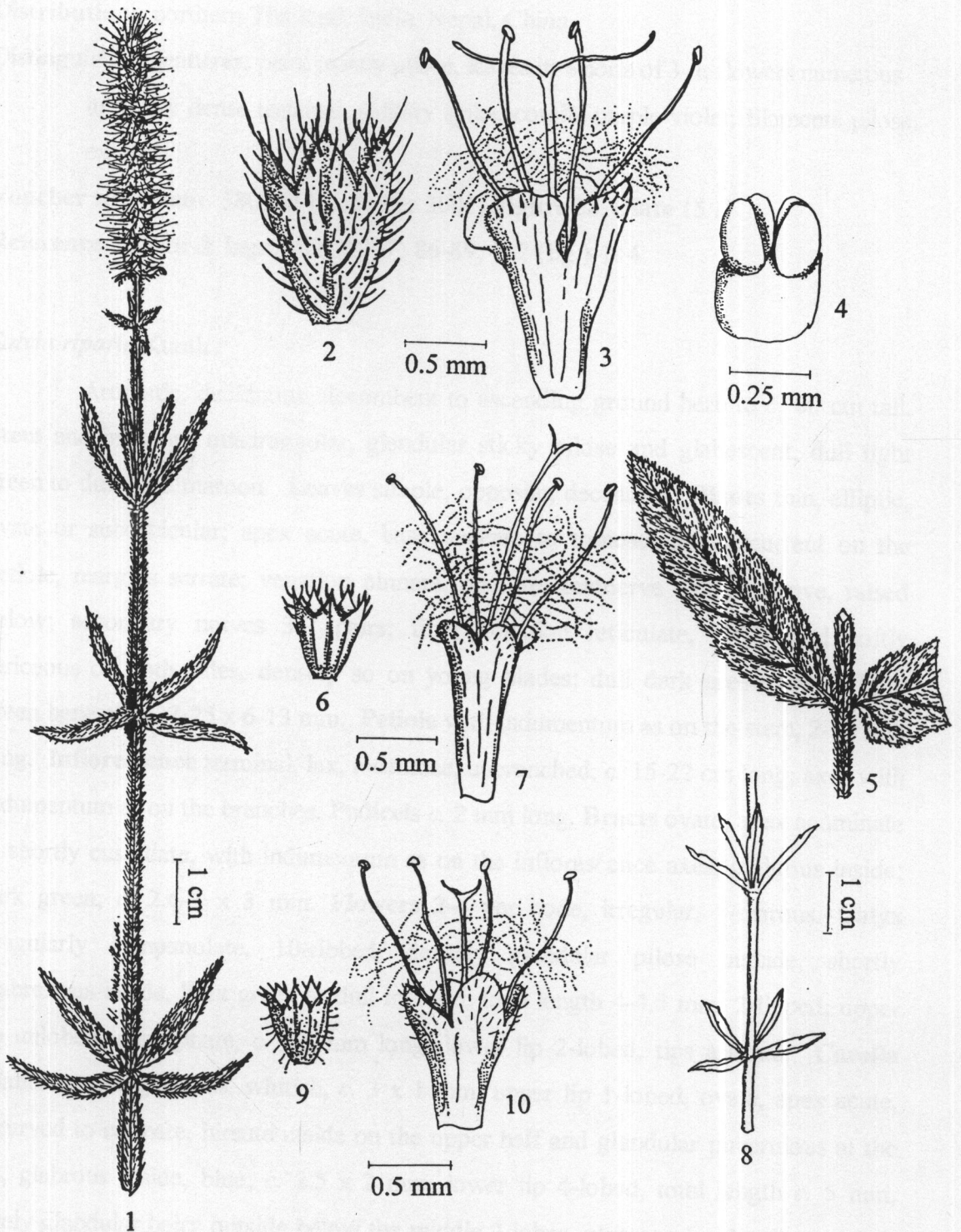


Figure 38 *Pogostemon cruciatus* (Benth.) Kuntz (#380): 1 = upper part of plant, 2 = calyx, 3 = corolla with stamens, stigmas and style, 4 = disc and nutlets; *P. auricularius* (L.) Hassk. (#253): 5 = stem and leaves, 6 = calyx, 7 = corolla with stamens, stigmas and style; *P. pentagonus* (C. B. Clark ex Hk. f.) Kuntz (#203): 8 = stem and leaves, 9 = calyx, 10 = corolla with stamens, stigmas and style

Distribution: northern Thailand, India, Nepal, China

Distinguishing features: plant mostly pilose, leaves in whorls of 3-4; flowers numerous in a very dense terminal, solitary spike, corolla purple-violet; filaments pilose, exerted

Voucher specimen: 380, 25 December 2001; **Figure 38, Plate 15 D**

Reference: Bhatti & Ingrouille (1997) 86-89, 112 (fig.)-114

Salvia riparia Kunth

Aromatic, deciduous, decumbent to ascending ground herb to c. 80 cm tall. **Stem** and branches quadrangular, glandular sticky pilose and glabrescent, dull light green to dull dark maroon. **Leaves** simple, opposite, decussate. **Blades** thin, elliptic, ovate or suborbicular; apex acute, base cuneate to truncate and decurrent on the petiole, margins serrate; venation pinnate, obscure; midnerve sunken above, raised below; secondary nerves 3-7 pairs; finer venation reticulate, finely and softly sericeous on both sides, densely so on young blades; dull dark green above, light green beneath, c. 7-25 x 6-13 mm. **Petiole** with indumentum as on the stem, 2-12 mm long. **Inflorescence** terminal, lax, racemose, unbranched, c. 15-22 cm long; axes with indumentum as on the branches. **Pedicels** c. 2 mm long. **Bracts** ovate, apex acuminate to shortly cuspidate, with indumentum as on the inflorescence axes, glabrous inside; dark green, c. 2.6-3 x 3 mm. **Flowers** 2-4 per node, irregular, 5-merous. **Calyx** irregularly campanulate, 10-ribbed, densely glandular pilose outside, shortly scabrellous inside, light green or dull maroon; total length 4-4.5 mm; 2-lipped; upper lip unlobed, emarginate, c. 1.5 mm long, lower lip 2-lobed, tips aristate. **Corolla** bilabiate; tube glabrous, whitish, c. 3 x 1 mm; upper lip 1-lobed, ovate, apex acute, incurved to carinate, hirsute outside on the upper half and glandular puberulous at the tip, glabrous inside, blue, c. 2.5 x 2 mm; lower lip 4-lobed, total length c. 5 mm, finely glandular hairy outside below the middle 2 lobes, glabrous inside, tip rounded, c. 2-3 mm wide, the lateral 2 lobes divided below the middle ones and much smaller, apices acute, 1 x 0.3 mm; pale blue outside, blue inside and variegated with radiating white bands and lines from the corolla throat. **Stamens** 2, inserted on the posterior side of the throat and ascending to the upper lip; filaments articulating with the filament-like connective; connective transverse; anthers bilocular of one fertile and

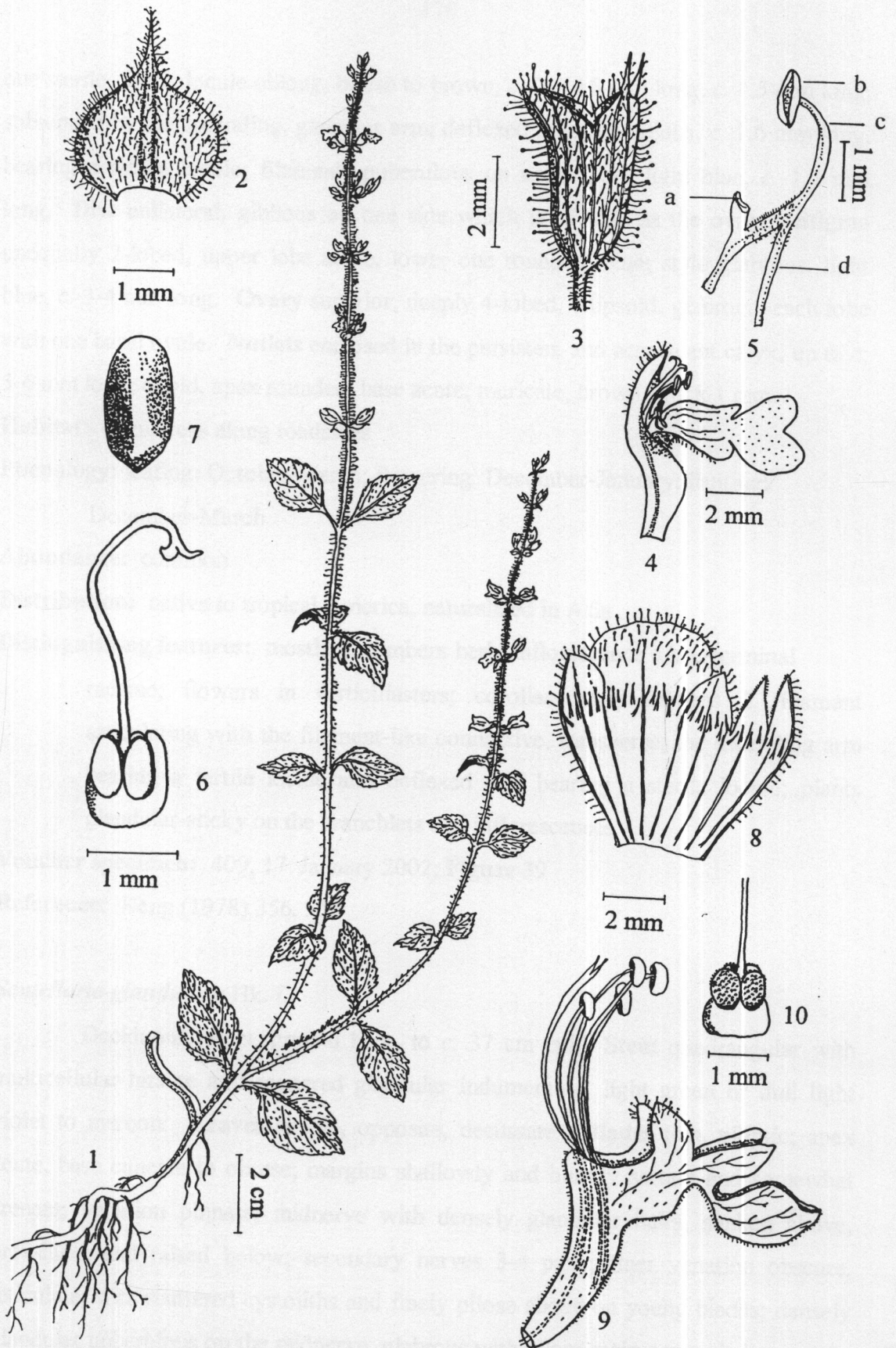


Figure 39 *Salvia riparia* Kunth (# 409): 1 = habit, 2 = bract, 3 = calyx, 4 = corolla, 5 = stamen: a = sterile anther, b = fertile anther, c = connective, d = filament; 6 = disc and pistil, 7 = nutlet; *Teucrium quadrifarium* Buch.-Ham. ex D. Don (#332): 8 = opened calyx, 9 = corolla with stamens, stigma and style, 10 = disc, ovary and style

one sterile; fertile locule oblong, bluish to brown, c. 0.7-0.8 mm long, c. 1.5 mm long, subtended by the ascending, glabrous arm; deflexed arm puberulous, c. 1.6 mm long, bearing a sterile locule; filaments puberulous on upper part, light blue, c. 1.2 mm long. **Disc** unilateral, gibbous on one side which is as high as the ovary. **Stigma** unequally 2-lobed, upper lobe acute, lower one rounded, blue; style glabrous, light blue, c. 3-4 mm long. **Ovary** superior, deeply 4-lobed, ellipsoid, glabrous, each lobe with one basal ovule. **Nutlets** enclosed in the persistent and accrescent calyx, up to c. 5-6 mm long; ovoid, apex rounded, base acute, muricate, brown, c. 2 x 1 mm.

Habitat: open areas along roadsides

Phenology: leafing: October-March; flowering: December-January; fruiting: December-March

Abundance: common

Distribution: native to tropical America, naturalized in Asia

Distinguishing features: mostly decumbent herb; inflorescence a lax, terminal raceme; flowers in verticillasters; corollas blue; stamens 2, filament articulating with the filament-like connective, transverse; the ascending arm bearing a fertile locule and deflexed arm bearing a sterile locule; plants glandular-sticky on the branchlets and inflorescences

Voucher specimen: 409, 17 January 2002; **Figure** 39

Reference: Keng (1978) 356, 359

Scutellaria glandulosa Hk. f.

Deciduous, erect, ground herb, to c. 37 cm tall. **Stem** quadrangular with multicellular hirsute and scattered glandular indumentum, light green or dull light violet to maroon. **Leaves** simple, opposite, decussate. **Blades** thin, elliptic; apex acute, base cuneate to obtuse; margins shallowly and bluntly serrate and somewhat crenate; venation pinnate, midnerve with densely glandular hairs, sunken above, prominent and raised below; secondary nerves 3-4 pairs; finer venation obscure, reticulate, with scattered cystoliths and finely pilose above on young blades; densely glandular puberulous on the midnerve, glabrous with pilose main nerves below; green or dull dark green above, dull light green and sometimes dull maroon underneath; 20-60 x 5-20 mm. **Petiole** 0 to c. 2 mm long. **Inflorescence** a terminal, lax, raceme, c.

18 x 2 cm; axes similar to the stem. **Pedicels** 4-6 mm long. **Flowers** opposite, decussate, irregular, 5-merous. **Bracts** ovate-lanceolate, apex acute, finely puberulous on both sides and densely glandular pilose along the margins, green, c. 5-7 x 2 mm. **Calyx** campanulate, margin shallowly 2-lobed (lips), dull light green, turning to dark violet to reddish; densely pilose as on the inflorescence axes, total length c. 2-2.5 mm; upper lip with an orbicular and usually reflexed crest, c. 4-4.5 mm diameter. **Corolla** bilabiate, with indumentum as on the calyx outside, glabrous inside; tube narrow, curved and wider at the base; white, c. 7-8 mm long; upper lip equally 2-lobed, tips obtuse, embracing the stamens, and with finely glandular hairs, violet or pale blue outside, glabrous and bright violet or blue inside, 10 x 5 mm; lower lip 2-lobed, spreading, tips rounded, light violet or pale blue outside, violet or blue inside with a white medial band or a white patch near and above the throat, c. 8 x 9 mm. **Stamens** 4, ascending on the upper lip of the corolla; anthers dorsifixed, bilocular, divergent, cream and turning violet, dehiscence margins brownish and densely pilose, c. 0.5 mm long; filaments glabrous in upper half, lower half puberulous, white, c. 12-15 mm long. **Disc** unilateral, cupular. **Stigma** irregularly 2-lobed, lobes subulate, glabrous; style curved, as long as the filaments. **Ovary** superior, deeply 4-lobed; locules 4, subglobose, glabrous, each with one basal ovule. **Nutlets** 2-4, enclosed in the accrescent calyx, glabrous; nutlets globose, tuberculate and sparsely pilose, grey, c. 1-1.2 mm diameter.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: April-November; flowering: May-September; fruiting: May-September

Abundance: abundant

Distribution: northern Thailand, Burma, Cambodia

Distinguishing features: upper lip of the calyx broadly and distinctly crested, corolla blue or violet; leaf blades elliptic, margins serrate or crenate

Voucher specimens: 153, 12 April 2001, Maxwell & Sankamethawee 00-247, 5 May 2000; Plate 15 E

References: Murata (1971) 515-516; Doan (1936) 999-1000, 1003-1004

***Teucrium quadrifarium* Buch.-Ham. ex D. Don**

Deciduous, ground herb to c. 90 cm tall. **Stem** quadrangular, densely multicellular golden pilose and light green on young parts, indumentum scarcer and brownish on old parts. **Leaves** simple, opposite, decussate. **Blades** subcoriaceous; ovate, ovate-oblong to oblong, apex acute, base slightly oblique obtuse or truncate; margins denticulate; venation distinct, pinnate, midnerve sunken above, prominent and raised below; secondary nerves 4-8 pairs; finer venation reticulate; hirsute above, densely so beneath; dull green above, pale light green beneath; 2.5-10 x 2-6.5 cm. **Petioles** hairy as on the stem, 4-17 mm long. **Inflorescence** terminal, racemose, and sometimes from the upper leaf axils; 5-20 x 1.5-2 cm; axes similar to the stem, with fine multicellular gland-tipped pilose. **Pedicels** 2-3 mm long. **Flowers** numerous, usually in opposite pairs, decussate, irregular, 5-merous. **Calyx** shallowly bilabiate, densely gland-tipped and hirsute outside, mostly glabrous inside and long pilose around the throat, very pale light green; upper lip 3-lobed, midlobe longest, orbicular, tip acute, c. 2.5 x 2 mm, lateral lobes obtuse, c. 1 mm long; lower lip equally 2-lobed, lanceolate, c. 3 x 1 mm. **Corolla** unilabiate; tube puberulous, white-pinkish, c. 5 mm long; upper lip indistinct, lower lip 5-lobed; terminal lobe the largest, orbicular and incurved, c. 3 mm diameter; lateral lobes consisting of 2 pairs of obliquely elliptic, c. 2 x 1.2 mm; finely gland-tipped pilose outside, sparsely so inside; purple-pink. **Stamens** inserted on the corolla tube, exserted; anthers dorsifixed, bilocular, reniform, reddish, c. 0.3-0.6 mm long; filaments glabrous, subequal, white, 12-14 mm long. **Disc** cupular, glabrous. **Stigma** shallowly 2-lobed, tips acute; style glabrous, white, 14-15 mm long. **Ovary** superior, deeply 4-lobed, globose, papillate, each lobe with one basal ovule. **Nutlets** globose, shallowly tuberculate, brownish-grey, c. 1 mm diameter, enclosed by the persistent calyx.

Habitat: partly shaded areas near the bamboo thickets and the stream

Phenology: leafing: June-December; flowering: October-November; fruiting:

October-December

Abundance: rare

Distribution: northern Thailand, northern Burma, India, Nepal, China, Indo-China, Sumatra

Distinguishing features: corolla seemingly unilabiate, 5-lobed, white-pinkish, with dense golden multicellular indumentum on most vegetation parts

Voucher specimen: 332, 3 November 2001; **Figure 3**

References: Doan (1936) 1037-1039; Li & Hedge (1994) 59

Leeaceae

1 species

Leea indica (Burm. f.) Merr.

Evergreen or deciduous, erect, ground herb to c. 1.5 m high, basal diameter 11 mm. **Stem** and branches grooved, puberulous, brownish. **Leaves** spiral, imparipinnate 1-2x compound, leaflets 3-5, opposite, rachis channeled above, puberulous, reddish-brown, 20-50 mm long, intrajugal part c. 12-23 mm long. **Leaflet blades** subcoriaceous, elliptic to oblong, apex acuminate, base acute to rounded, margins serrate to doubly serrate; venation distinct, pinnate, secondary nerves 8-13 opposite pairs, ascending, sunken above, prominent and raised below, especially in young blades; finer venation scalariform, finest venation reticulate; glabrous above, densely finely tomentose beneath; dark green above, very pale light green beneath; 45-110 x 25-60 mm. **Petioles** channeled above, puberulous with reddish-brown glands, c. 15-40 mm long. **Petiolules** 0- 8 mm long. **Petiole stipules** oblong, lower 3/4 attached to the petiole, upper 1/4 part free, apex obtuse, margins finely ciliate puberulous with scattered reddish-brown glands outside, glabrous inside; very pale light green, and sometimes red-brown; 10-65 x 7-25 mm, caducous. **Inflorescence** in terminal, leaf-opposed cymes, spreading, c. 15-70 x 20-50 mm; axes puberulous, light green. **Flowers** numerous, 5-merous, regular. **Pedicels** c. 1 mm long. **Bracts** lanceolate, puberulous, 1-1.2 x 0.3-0.5 mm. **Calyx** funnelform, shallowly and obtusely 5-lobed, puberulous outside, glabrous inside, light green, c. 10-13 mm long. **Corolla** glabrous, greenish-white; tube c. 2 mm long; lobes ovate-lanceolate, apex acute, c. 2.5-3 x 1-1.5 mm. **Stamens** 5, filament tube with 5 fertile stamens, alternating with 5, bifid, white staminodes, glabrous, c. 1 mm long; anthers alternating with the staminodes, dorsifixed, introrse, bilocular, greyish outside, white inside, c. 1 mm long; free filaments glabrous, white, c. 1-1.2 mm long. **Stigma** capitate; style ribbed, glabrous, c. 0.8-1 mm long. **Ovary** superior, depressed globose, 5-loculed, each locule with one basal ovule. **Fruit** a depressed globose berry, shallowly lobed, with scattered brownish caducous scales, glabrescent, immature dark green, ripening black, c. 7-9 mm diameter. Fruiting calyx and infrutescence axes reddish, narrowly winged.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: flowering: June-July; fruiting: January-November

Abundance: common

Distribution: throughout Thailand, Sri Lanka, India, Nepal, Bangladesh, Andaman and Nicobar Islands, Burma, Indo-China, southern China throughout Malesia, northernmost Australia, Solomon Islands, Santa Cruz Islands, New Hebrides, Fiji

Distinguishing features: 1-2 x imparipinnate leaves, prominent opposite secondary nerves; large petiolar stipules, embracing each new leaf; berries ripening black

Voucher specimen: 192, 6 June 2001; **Plate** 14 A

References: Ridsdale (1974) 64-66 (fig.) 73-79, 95-96; Ridsdale (1976) 758 (fig.), 779-781 (fig. p. 780)

Leguminosae

key to subfamilies

1. All petals free, a standard petal innermost; filaments free.....**Caesalpinioideae**
1. Corolla papilionaceous, 2 anterior petals connate, a standard petal outermost; filaments united
.....**Papilionoideae**

Subfamily Caesalpinioideae

1 species

Chamecrista leschenaultiana (DC.) Degener

Annual ascending ground herb. **Stem** terete, pilose, reddish-light brown. **Leaves** paripinnate, alternate; rachis canaliculate, pilose, 15-45 mm long with sessile foliar gland at c. 2 mm from base. **Leaflets** opposite, 7-24 pairs, sessile, decreasing in size distally; leaflet blades obliquely linear-oblong, apex acuminate, base obliquely obtuse to truncate, margins finely ciliate; venation pinnate at one side, finer venation obscure; glabrous on both sides; dark green above, pale light green beneath; c. 3-9 x 1-2 mm. **Stipules** obliquely lanceolate, c. 1.7-1.8 x 5-6 mm. **Inflorescence** axillary, raceme; axes pilose, reddish-light brown. **Bracts** subulate, light green, c. 2-4 mm long. **Pedicels** 10-15 mm long. **Flower** few or solitary, irregular, 5-merous. **Sepals** 5, unequally lanceolate, glabrous, greenish-white to pale light yellow, c. 6-7 x 2-3 mm. **Petals** 5 unequal, glabrous, yellow; upper 3 petals the largest, obliquely ovate, 14-15.5 x 10-11.5 mm; claw c. 1 mm long; the lower 2 petals slightly smaller, obovate, c. 14-14.5 x 6 mm. **Stamens** 9, free; anthers yellow, unequal, 4 longer ones 7 mm long and the 5 shorter ones, c. 7 mm long; filaments light green, 0.5 mm long. **Stigma** acute; style quadrangular, curved, glabrous, light green, c. 4-6 mm long. **Ovary** superior, flattened, oblong, densely adpressed pilose, whitish-green, c. 5-6 x 1 mm, unilocular with several parietal ovules. **Pods** not seen.

Habitat: open fire-damaged, degraded areas

Phenology: leafing: August-November; flowering: September-October; fruiting:

September-November

Abundance: rare

Distribution: throughout Thailand, SE Asia

Distinguishing features: ascending herb; leaves paripinnate; leaflets opposite, usually more than 15 pairs; rachis canaliculate above; inflorescence in axillary, lax racemes with few-flowers, or solitary; petals yellow; stamens 9, free, dimorphic with 4 larger and 5 smaller anthers

Voucher specimen: 295, 29 September 2001; **Plate** 16 A

References: Larsen, Larsen, & Vidal (1984) 123, (fig. 121); Hou, Larsen, & Larsen (1996) 566-567

Subfamily Papilionoideae

10 genera, 29 species

key to genera

1. Leaves simple (unifoliate)
 2. Stamens monadelphous, bimorphic; pods turgid.....*Crotalaria*
 2. Stamens diadelphous (9+1), monomorphic; pods turgid or flat
 3. Pods inflated with one seed; leaf blades linear*Eriosema*
 3. Pods flat or cylindric with several seeds; leaf blades not linear
 4. Pods not articulated; plants with "T"-shaped hairs.....*Indigofera*
 4. Pods articulated or incised; plants without "T"-shaped hairs.*Desmodium*
1. Leaves compound
 5. Leaves pinnately compound with > 3 leaflets
 6. Stipules basifixed; plants with bifid or "T"-shaped hairs.....*Indigofera*
 6. Stipules peltate; plants without bifid or "T"-shaped hairs
 7. Leaflets up to 6 pairs; pods twisted.....*Smithia*
 7. Leaflets more than 10 pairs; pods not twisted.....*Aeschynomene*
 5. Leaves trifoliate
 8. Leaves digitately trifoliate.....*Flemingia*
 8. Leaves pinnately trifoliate
 9. Pods articulated; standard < 10 mm long.....*Desmodium*
 9. Pods not articulated; standard > 10 mm long
 10. Inflorescence up to 30 cm long; flowers numerous, petals brownish-maroon
.....*Dunbaria*
 10. Inflorescence up to 5 cm long; few-flowered, petals white.....*Clitoria*

***Clitoria macrophylla* Wall. ex Benth.**

Deciduous, erect to twinning ground herb to c. 1 m long. **Roots** with swollen subglobose tubers, light brown outside, white inside. **Stem** terete, adpressed pilose and mixed with puberulous indumentum; light green. **Leaves** alternate, pinnately trifoliate. **Petiole** with indumentum as on the stem, c. 3-6.5 cm long. **Leaflet blades** coriaceous, ovate, the terminal one the largest, apex acute, base broadly acute or obtuse, margins entire; venation distinct, pinnate; secondary nerves 8-14 pairs, prominent and raised below; finer venation reticulate; glabrous above, very densely appressed pilose below; dark green above, pale light green beneath; 4-10.5 x 2.5-5 cm. **Petiolules** with dense indumentum as on the blades, c. 2-3 mm long; ultrajugal part of the rachis similar to the petiole, 2-3.5 cm long. **Stipules** thin, ovate, tip acute, with similar indumentum as on the blades, c. 10 x 5 mm. **Inflorescence** in axillary racemes, c. 4-5.5 cm long, axes setulose, light green. **Bracts** thin, ovate-lanceolate, glabrescent; margins ciliate, c. 5-10 x 2-4 mm. **Pedicels** c. 2-4 mm long. **Flowers** few, irregular, 5-merous. **Calyx** campanulate, pubescent outside and mixed with scattered long pilose along the margins, glabrous inside, very pale light green; tube 10-ribbed, c. 12-14 mm long; lobes 5, irregular, lanceolate, apices acuminate, c. 12-14 x 3.5-4 mm. **Petals** puberulous on both sides, white; standard ventral, symmetrically orbicular with a shallowly emarginate apex and usually incurved margins, usually yellowish-cream, c. 3.4-3.6 cm; wings obliquely obovate, apex acute, c. 13-18 x 10-12 mm, base narrowing into a claw c. 8-10 mm long; keel petals 2, united in the upper half of the dorsal side, obliquely elliptic, tip acute, c. 10-12 x 5-6 mm, base narrowing into a slender claw c. 10-12 mm long. **Stamens** 10, diadelphous (9 + 1); anthers elliptic, greyish-cream, c. 1.5 x 1 mm; filaments falcate, glabrous, whitish, tube c. 20-23 mm long; free parts with 5 longer ones c. 5-6 mm long, with basifixed anthers alternating with 4 shorter ones, c. 3 mm long and with dorsifixed anthers. **Stigma** acute; style flattened straight, glabrous, c. 9-11 mm long, then reflexed c. 7 mm long, puberulous on the ventral side. **Ovary** superior, flattened cylindric and enclosed in the filament tube, puberulous, c. 8-10 x 1.6 mm; unilocular with c. 5 parietal ovules on the dorsal suture. **Pods** cylindric, glabrous, brown, 40 x 4-5 mm; splitting and twisting on both sutures. **Seeds** globose, dark brown to black, c. 2 mm diameter.

Habitat: open fire-damaged, degraded areas

Phenology: leafing: July-November; flowering: August-September; fruiting: August-November

Abundance: medium

Distribution: N, SE, SW Thailand, Burma, Indo-China

Distinguishing features: swollen roots; leaves pinnately trifoliate; petals white, standard usually > 3 cm long, and very much larger than the keel and wings; pods cylindric, to c. 4 cm long, splitting and twisting when mature

Voucher specimen: 321, 17 October 2001; **Plate** 16 B

References: Craib (1928) 436; Gagnepain (1916) 309-310, 315; Thuan (1979) 43-44, 48; Niyomdham (1994) 76 (fig.)

Crotalaria

key to species

1. Stem winged.....*C. alata* D. Don
1. Stem not winged
 2. Leaf blades linear-oblong or linear-lanceolate
 3. Plants mostly glabrous, leaf blades linear-lanceolate.....*C. neriifolia* Wall. ex Benth.
 3. Plants densely sericeous, leaf blades linear-oblong
 4. Calyx > 2 cm long; petals pale yellow-cream.....*C. calycina*
 4. Calyx < 1.5 cm long; petals bluish*C. sessilifolia* L.
 2. Leaf blades not as above
 5. Racemes terminal or axillary
 6. Leaf blades lanceolate; pods always longer than the fruiting calyx
.....*C. albida* Heyne ex Roth
 6. Leaf blades oblanceolate or obovate; pods mostly enclosed in the fruiting calyx
 7. Racemes elongate, petals bright yellow; plant up to 1 m high; leaf blades oblanceolate.....*C. montana* Heyne ex Roth.
 7. Racemes short and dense, petals light yellow or greenish-white; plant < 50 cm tall; leaf blades obovate.....*C. dubia* Grah. ex Benth.
 5. Racemes leaf-opposed
 8. Calyx 12-15 mm long.....*C. ferruginea* Grah. ex Benth.
 8. Calyx c. 5 mm long
 9. Prostrate herb; leaf blades broadly ovate, obovate or orbicular; pods < 1 cm long.....*C. auricularis* Ham. ex Benth.

9. Erect or ascending herb; leaf blades oblong; pods c. 1.5 cm long

..... *C. melanocarpa* Wall. ex Benth.

***Crotalaria calycina* Schrank**

Annual erect, or ascending ground herb to c. 50 cm tall. **Stem** terete, densely golden-brown, adpressed sericeous. **Leaves** simple, spirally arranged. **Blades** subcoriaceous, linear-lanceolate, apex acuminate, base obtuse, margins entire; venation pinnate, secondary nerves 9-18 pairs, obscure; midnerve sunken above, raised below; glabrous above with long brown sericeous, densely indumentum as on the stem but slightly scarcer below; dark green above, pale light green beneath; 30-130 x 6-15 mm. **Petiole** with longer indumentum than on the stem and blades up to c. 3 mm long. **Inflorescence** a terminal raceme and occasionally with solitary flowers in the upper leaf axils, c. 3-7 mm long. **Bracts** lanceolate, apex acuminate, c. 14-20 x 3.5-5 mm. **Calyx** campanulate, deeply bilabiate, divided nearly to the base, glabrous inside, densely long maroon-brown sericeous; pale light green; upper lip 2-lobed, lobes elliptic, c. 20-24 x 7-11 mm; lower lip 3-lobed, lobes lanceolate, with the medial lobe narrower, c. 19-21 x 3-5 mm. **Petals** glabrous, pale light yellow-cream; standard obovate, tip rounded or shallowly emarginate, 20-22 x 14-16 mm; wings, obliquely oblong, tips obtuse, base oblique and twisted, c. 16-18 x 5.5-7 mm; keel petals united in the upper half on the ventral margin, each obliquely ovate, tips acuminate; whitish, c. 20 x 8 mm. **Stamens** 10, monadelphous; anthers bilocular, cream, bimorphic with 5 globose and dorsifixed, c. 0.3 mm diameter, alternating with 5 lanceolate, basifixed, c. 3 mm long; filaments glabrous, whitish, united part c. 5-7 mm long, free parts c. 6-10 mm long. **Stigma** capitate; style white, glabrous, 13-15 mm long. **Ovary** superior, sessile, flattened, oblong, glabrous, light green; unilocular with many parietal ovules. **Pods** immature completely enclosed by the persistent calyx, obliquely compressed obovate, glabrous. **Seeds** many, immature, reniform.

Habitat: partly shaded, degraded, fire-damaged areas

Phenology: leafing: August-December; flowering and fruiting: September-November

Abundance: medium

Distribution: N, E, SE, and peninsular Thailand, tropical Asia to northern Australia, tropical Africa

Distinguishing features: plant densely golden sericeous; blades linear-lanceolate; calyx more than 2 cm long; petals pale yellow-cream

Voucher specimen: 297, 29 September 2001; **Plate** 16 C

Reference: Niyomdham (1978) 113-114, 126-127

Note: flowers usually open in the afternoon

Desmodium

key to species

1. Leaves unifoliate, or the lateral pair of leaflets very much reduced
 2. Leaf blades broadly ovate to suborbicular, densely velutinous.....*D. velutinum*
 2. Leaf blades oblong, lanceolate, sparsely short hispid or nearly glabrous
 3. Blades oblong, scabrous above, venation very prominent and raised underneath
.....*D. oblongum* Wall. ex Benth.
 3. Blades lanceolate, glabrous above, venation inconspicuous
.....*D. motorium* (Houtt.) Merr.
1. Leaves trifoliate, all leaflets similar
 4. Terminal leaflet blade ovate, usually more than 6 cm long
 5. Flowers in elongate racemes, not subtended by foliaceous bracts; pods linear, sections rectangular, straight on both margins*D. laxiflorum* DC. ssp. *laxiflorum*
 5. Flowers usually in clusters and subtended by orbicular foliaceous bracts; pod sections suborbicular
 6. Plant glabrous; inflorescence of axillary racemes.....*D. pulchellum* (L.) Benth.
 6. Plant very dense golden-brown velutinous; inflorescence a terminal panicle
.....*D. kurzianum* (Kuntze) Ohashi
 4. Terminal leaflet obovate or oblong-elliptic, usually less than 3 cm long
 7. Terminal leaflet obovate, c. 15-30 mm long; pods incised ventrally
.....*D. heterocarpon* (L.) DC. ssp. *heterocarpon* var. *heterocarpon*
 7. Terminal leaflet obovate-oblong to elliptic-oblong, less than 10 mm long; pods incised on both margins*D. microphyllum* (Thunb. ex Murry) DC.

Desmodium velutinum (Willd.) DC. ssp. *velutinum* var. *velutinum*

Deciduous ascending, ground herb to c. 1 m high; basal diameter c. 4 mm. Stem terete, with dense strigose indumentum more densely so on younger parts; brown to dull maroon. Leaves unifoliate, simple, alternate; lateral leaflets reduced, opposite, subulate, c. 3-4 mm long. Blades subcoriaceous, broadly ovate to

suborbicular, apex obtuse or rounded, base obtuse to truncate, margins entire; venation pinnate, prominent and raised below, secondary nerves 6-7 on each side of the midnerve; finer venation scalariform; velutinous above and densely so beneath; dark green above, pale light green beneath; 4-8 x 3-7 cm. **Petiole** 5-20 mm; ultrajugal axis *c.* 1-4 mm long. **Stipules** deltoid *c.* 1-2 x 1.5-3 mm, apex long caudate to *c.* 6 mm. **Inflorescence** in terminal and axillary racemes, *c.* 2-12 x 1.3-1.5 cm; axes with straight and hooked velutinous indumentum; flowers numerous. **Pedicels** 2-3 mm long. **Calyx** campanulate, irregularly 4-lobed, velutinous outside, glabrous inside, whitish; tube 1.7-2 mm long; posterior lobe widest, ovate, 1.5 x 1.2 mm; lateral pair and anterior lobe lanceolate, *c.* 2-2.5 x 0.8 mm. **Petals** 5, glabrous; standard suborbicular, apex shallowly emarginate, base acute, purple, *c.* 4-4.3 x 4.8-5 mm; wings obliquely oblong, apex obtuse, purple *c.* 3.5-3.8 x 1.6-1.7 mm, base shortly clawed, *c.* 0.8 mm long; keel obliquely elliptic, medially connate, tips acute, dark purple, *c.* 3-3.2 x 1.5 mm, base clawed, *c.* 1 mm long. **Stamens** 10, diadelphous (9 + 1); anthers basifixed, orbicular, bilocular, gray, *c.* 0.3 mm diameter; filaments glabrous, whitish; the vexillary filament 2.8-3 mm long; filament tube *c.* 3 mm long, free parts of 5 longer *c.* 0.8 mm, and alternating with 4 shorter ones, *c.* 0.3-0.4 mm long. **Stigma** minute, capitate, green; style curved, glabrous, whitish, *c.* 1-1.2 mm long. **Ovary** superior, sessile, inflated, linear-oblong, velutinous, *c.* 2 x 0.3 mm; unilocular with several parietal ovules. **Pods** immature, flattened linear, shallowly articulated with 5-8 sections, densely hooked velutinous, *c.* 10-15 x 1-1.5 mm. **Immature seeds** obliquely reniform, smooth and glabrous.

Habitat: open, fire-damaged, degrade areas

Phenology: leafing: June-January; flowering: September-October; fruiting:
September-January

Abundance: rare

Distribution: throughout Thailand, India, Sri Lanka, Himalayas, China, Indo-China, Burma, Malay peninsula

Distinguishing features: densely velutinous in most vegetative parts; unifoliate, leaf blade broadly ovate, finer venation scalariform; petals purple; pods flattened linear, articulated with 5-8 sections; inflorescence axes and pods densely hooked velutinous

Voucher specimen: 315, 17 October 2001; **Plate** 16 F

References: Phon, Ohashi, & Vidal (1994) 62-67, 85 (fig.), 117-120; Craib (1928) 421-422

Dunbaria bella Prain

Deciduous vine to about 4 m long. **Stem** tomentose on young parts, then glabrescent, reddish-brown. **Leaves** alternate, pinnately trifoliate; petiole pulvinus at base, channeled or flat above, c. 2-3.5 cm long; ultrajugal axis similar to the petiole, c. 1.5-2.4 cm long. **Leaflet blades** coriaceous, ovate-oblong, lateral pair slightly asymmetric, apex acute, base obtuse to broadly acute, margins entire and slightly revolute, with 3 main nerves from the base; finer venation reticulate, prominent on both sides and raised below; scabrous above, very densely hirsute below; dark green above, pale light green beneath; 5-9.5 x 2-3.7 cm. **Petirolules** with denser indumentum, 2-3 mm long. **Stipules** caducous. **Inflorescence** of axillary racemes, 16-30 x 3-4 cm with many flowers; axes with indumentum as on the stem and petiole. **Pedicels** puberulous, 3-4 mm long. **Calyx** obliquely urceolate, shortly puberulous on both sides, densely hispid on the lobes inside, base brown, medially light green, upper part and lobes dull dark red; tube 5-6 mm long; lobes 4, irregular, posterior lobe widest and shortest with emarginate apex, c. 3 x 7 mm, anterior lobe longest, lanceolate, apex acute, c. 7 x 2 mm. **Petals** 5, glabrous; standard obliquely broadly obcordate, base shortly claw, conduplicate, very glossy dark maroon outside, dull dark maroon inside, c. 11 x 19 mm; wings obliquely oblong, apex obtuse, base auriculate and narrowing in to a claw on one side, yellow, c. 11-12 x 4-5 mm, claws c. 4 mm long; keel petals united in the upper half of the ventral side, obliquely ovate, apex falcate, obtuse, c. 12-12.5 x 7.5-8 mm, claw c. 5.5-6.5 mm long. **Stamens** 10, diadelphous (9 + 1), curved and enclosed in the keel petals; anthers 5 basifixed and alternating with 4 dorsifixed ones, ovate-oblong, dull greenish, c. 0.7 x 1 mm; filament tube glabrous, very pale light green, c. 13-16 mm long, free part c. 5-7 mm long, vexillary filament c. 21 mm long. **Stigma** 2-lobed; style glabrous in the upper half, hirsute below, c. 15-17 mm long. **Ovary** superior, compressed, linear-oblong, densely hirsute and mixed with dense, minutely glands, light green, c. 7 x 1.5 mm long; unilocular with 6-8 parietal ovules on the dorsal side. **Pods** immature, inflated oblong with cuspidate tip, densely hirsute, light green.

Habitat: open fire-damaged, degraded areas

Phenology: leafing: May- March, flowering: October-February; fruiting: December-March

Abundance: abundant

Distribution: N, NE, and SW Thailand, Indo-China

Distinguished features: deciduous vine; trifoliate with scabrous and densely hirsute below, lateral leaflet blades asymmetric with 3 main nerves from the base; standard dark maroon, wings yellowish. Pods flated oblong, densely hirsute

Voucher specimen: 141, 14 March 2001

Reference: Thuan (1979) 115-116, 128 (*sub D. longeracemosa* Craib, = synonym)

Note: inflorescences are eaten as a vegetable

Eriosema chinensis Vogel

Perennial, deciduous, erect, ground herb to 80 cm high; tuber subglobose, smooth, brown outside, medial layer with red sap, inner part white, 2-3 cm diameter with basal tap root. **Stem** unbranched, brown, covered with brown strigose. **Leaves** simple, spirally arranged. **Blades** subcoriaceous, linear, apex acute, base cuneate, margins entire; scattered puberulous near the margins and along the midnerve above; minute grayish-yellow glands and densely light brown lanate below; venation pinnate, obscure; midnerve distinct, sunken above, raised below, with dense brown strigose; dark green above, pale light green beneath, *c.* 0.3-0.6 x 7-9 cm. **Petiole** with indumentum as on the stem and blades, *c.* 1-3 mm long. **Stipules** subulate to narrowly linear, light green, *c.* 5-10 mm long, caducous. **Inflorescence** axillary, cymose, with 1-3 flowers. **Calyx** tube green, *c.* 2 mm long, irregularly 5-lobed, anterior lobe the longest, apex acuminate, 5 mm long; the other 4 posterior ones with acute apices, setaceous outside, glabrous inside; pale light green, *c.* 3 mm long. **Petals** 5; standard suborbicular, broadly rounded, emarginate, setaceous outside, glabrous inside, yellow with radiating red lines from above the claw, 6-7 x 7-8 mm; wings oblong, apices obtuse, glabrescent on both surfaces, yellow, 3-4 x 6 mm; keel lanceolate, glabrous, light yellow-green with radiating red lines at the apex, 6 mm long. **Stamens** 10, diadelphous (9 + 1); anthers bilocular, cream; filament tube glabrous, white, 5-6 mm long, vexillary filament widest at the base, glabrous, 5 mm long. **Ovary** superior, oblong, flattened, densely pilose, *c.* 3 mm long; unilocular with

1-2 parietal ovules. **Stigma** capitate; style tapering to the apex. **Pods** slightly oblique, flattened, ovate to oblong, brown, hirsute outside, dull yellow turning brownish-black, 5-7 x 9-10 mm. **Seed** 1, ovoid, glossy brown, variegated with grayish hues; aril orange-brown.

Habitat: open fire-damaged, degraded areas

Phenology: leafing: April-December; flowering: April-August; fruiting: May-December

Abundance: medium

Distribution: N, SW, and central Thailand, Indo-China, India to China, Australia

Distinguishing features: swollen, globose tuber; stem unbranched, erect; leaves simple; blades linear with long brown indumentum; inflorescence axillary cymose with 1-3 flowers; petals yellowish; pods ovate to oblong with indumentum as on the vegetative parts, 1-seeded

Voucher specimen: 155, 12 April 2001

References: Thuan (1979) 136-139 (fig.); Craib (1928) 467-468

***Flemingia sootepensis* Craib**

Deciduous, erect ground herb to c. 80 cm tall. **Stem** terete on lower parts and angled in upper young parts, very densely sericeous; greenish-brown. **Leaves** alternate, digitately trifoliate. **Petiole** flat, with indumentum as on the stem; c. 1.5-4 cm long. **Leaflet blades** coriaceous, irregular; the terminal leaflet elliptic to elliptic-oblong, base symmetrically acute to obtuse; the lateral pair lanceolate, base obliquely obtuse, tips acute to acuminate, margins entire; with 3 main nerves from the base, sunken above, very prominent and raised below; finer venation reticulate, scabrous on both sides, and long villous along the main nerves below; dark green above, very pale light green with red-violet dots beneath, c. 3-9.5 x 1-2.8 cm. **Petiolules** 1-2 mm long with denser indumentum. **Stipules** thin, basifixed, lanceolate, apex long aristate, glabrous, light green, c. 15-27 x 2-2.5 mm. **Inflorescence** axillary in densely racemes, 1-1.5 x 1.5-4 cm; axes densely villous. **Pedicels** c. 2 mm long. **Calyx** campanulate, deeply lobed, densely villous, with tiny red-violet dots outside, glabrous inside; very pale light green; irregularly 5-lobed, lobes linear-lanceolate, slightly curved, the midlobe longest, c. 7.5-8 x 1 mm, usually falcate and longer than the petals, then decreasing in size to the dorsal lobe. **Petals** 4, glabrous; standard elliptic,

clawed, apex rounded, base shortly hastate, c. 4 x 3 mm, duplicate, claw c. 2 mm long, caducous; wings subequal oblong, apex obtuse, base shortly hastate, c. 4.5-5 x 1.2 mm, narrowing into a claw, c. 2 mm long; keel, whitish-green, united in the upper half on the ventral side; obliquely oblong, apex acute, base truncate, c. 5 x 2 mm, clawed on one side, c. 2 mm long. **Stamens** 10, diadelphous (9 + 1); anthers basifixed, equal, suborbicular, cream, c. 0.25 mm; filaments glabrous, whitish-green, tube 3.5-4 mm long, free part c. 1-2 mm long; the vexillary filament 5 mm long. **Stigma** capitate, light green; style glabrous, whitish-green, narrow at base and swollen medially, then narrowing to the stigma, all enclosed in the filament tube. **Ovary** superior, obliquely inflated, ovoid, densely villous, c. 1.5 x 1 mm; unilocular with 2 parietal ovules. **Pods** ovoid, tip shortly aristate, tomentose, c. 7-8 x 5 mm. **Seeds** subglobose, smooth or finely wrinkled, dark brown, c. 1-1.2 mm diameter.

Habitat: open or partly shaded places, not in fire-damaged areas

Phenology: flowering October-December; fruiting: November-January

Abundance: medium

Distribution: northern Thailand, Indo-China, southern China

Distinguishing features: leaves digitately trifoliate, lateral leaflet bases oblique; inflorescence axillary, in densely racemes; indumentum densely villous; calyx lobes longer than the petals; petals whitish; pods ovoid, < 1 cm long

Voucher specimen: 342, 14 November 2001

References: Thuan (1979) 138-141, 149-151 (fig.); Craib (1928) 472; Gagnepain (1916) 294-295, 300

Indigofera

key to species

1. Leaves unifoliate
 2. Shrub > 1 m tall; leaf blades ovate; petals whitish.....*I. caloneura* Kurz
 2. Herb < 70 cm tall; leaf blades oblanceolate; petals reddish.....*I. squalida* Prain
1. Leaves imparipinnate
 3. Erect or ascending herb; leaflets opposite, with both of sticky glandular and irregularly bifid indumentum.....*I. colutea* (Burm. f.) Merr.
 3. Creeping herb; leaflets alternate; blades with "T"-shaped indumentum only.....*I. spicata*

Indigofera spicata Forsk. var. *spicata*

Deciduous creeping herb, to c. 50 cm long, rooting at the lower nodes. **Stem** terete, glabrous, reddish-brown to pale light green. **Leaves** imparipinnate, alternate; rachis channeled above, sparse "T"-shaped indumentum, 10-23 mm long; leaflets 7-9, alternate, increasing in size distally. **Leaflet blades** subcoriaceous, obovate to oblanceolate, apex rounded, minutely mucronate, base acute to obtuse, margins entire; venation pinnate, midnerve sunken above and raised below; secondary nerves 4-7 pairs, obscure, glabrous above, "T"-shaped indumentum dense below; dark green above, dull light green beneath; c. 4-17 x 1.5-6 mm. **Petiolules** c. 1 mm long. **Stipules** thin, lanceolate, tip acuminate, basifixed, glabrous, persistent; c. 3-5 x 1-1.5 mm. **Inflorescence** of axillary racemes, c. 30-50 x 10-15 mm; axes sparsely covered with "T"-shaped indumentum as on the leaf axes; flowers numerous. **Pedicels** curved, with indumentum as on the inflorescence axes, c. 0.5-0.8 mm long. **Calyx** irregularly, deeply 5-lobed, lobes lanceolate, tips acuminate, with scattered sessile "T"-shaped indumentum outside, glabrous inside; pale light green; c. 1.5-1.8 mm long. **Petals** 5, glabrous; reddish pink inside, pinkish outside; standard orbicular, c. 5 mm diameter; wings obliquely ovate, tips obtuse, base shortly clawed, c. 5 x 2-2.2 mm; keel united in the upper half of the ventral side, dorsal margins ciliate; each lobe spurred; c. 5.5-1.8 mm. **Stamens** 10, diadelphous (9 + 1); anthers equal, basifixed, orbicular, tip acute crested, greyish, c. 0.3 mm diameter; filaments glabrous, whitish-green, c. 4 mm long, free parts increasing in length from the lateral ones to the middle one, 0.8-1.2 mm long; vexillary filament 4 mm long. **Stigma** capitate, light green; style geniculate, whitish-green, c. 1 mm long. **Ovary** superior, cylindric, enclosed by and as long as the filament tube, with indumentum similar as on the calyx; unilocular with 5-10 parietal ovules. **Pods** reflexed, cylindric and slightly inflated, straight, tip cuspidate; immature pods dull maroon to brownish-green, sparsely covered with "T"-shaped indumentum, turning dark brown and glabrescent when mature. **Seeds** 5-8, flattened cubical, truncate at both ends, glabrous, light brown, c. 2 x 1 mm.

Habitat: open, degraded, and along roadsides, not in fire-damaged areas,

Phenology: leafing: April-January; flowering: August-October; fruiting:

September-December

Abundance: common

Distribution: northern Thailand, tropical and South Africa to India, Sri Lanka, Burma, Indo-China, Luzon & Mindanao, Malay peninsula, Sumatra, Java, Bali, Celebes

Distinguishing features: creeping herb; leaf imparipinnate with 7-9 alternate leaflets; inflorescence of axillary racemes; petals reddish-pink; pods reflexed, cylindric

Voucher specimen: 305, 16 October 2001

References: Tuan, Phon, & Niyomdham (1987) 65-67, 80-81; Kort & Thijsse (1984) 104-109, 132-133

***Smithia ciliata* Roy.**

Annual, ascending or decumbent ground herb to about 50 cm tall. **Stem** terete, glabrous, reddish-brown to light green. **Leaves** alternate, paripinnate with 3-6 pairs of opposite leaflets; rachis trigonal with scattered setulose indumentum, light green, c. 3-20 mm long, sensitive. **Leaflet blades** thin, obovate, oblanceolate to oblong, apex obtuse, base oblique, margins ciliate; venation obscure, only the midnerve prominent below; glabrous on both sides and only sparsely setulose along the midnerve below; dark green above, pale light green beneath; c. 2-10 x 1.5-3 mm. **Stipules** dorsifixed, equally peltate, each lobe lanceolate, tips acuminate to aristate, glabrous c. 3-3.5 x 1 mm. **Inflorescence** in terminal and axillary racemes, 2-4 x 1.5-2 cm; peduncles slender, glabrous, reddish-brown to light green, c. 10-25 mm long; pedicels c. 1-2 mm long. **Sepals** 4, all free and irregular, yellowish-pale light green; dorsal sepal broadly ovate, tip acute, scattered hirsute outside, glabrous inside, c. 6.5-7 x 4.5-5 mm; lateral pair the smallest, ovate and carinate, c. 4 x 2 mm; ventral sepal lanceolate and carinate, c. 6.5 x 2 mm. **Petals** 5, glabrous, yellow; standard orbicular, apex shallowly emarginate, c. 6.5-7 mm diameter; wings obliquely oblanceolate, c. 7 x 3 mm, apex rounded, base shortly hastate on one side, clawed c. 1.5-1.8 mm long on the other side; keel united in the upper half on the ventral side, similar to the wings, but with a slightly longer hastate base. **Stamens** 10, diadelphous (9 + 1); anthers equal, dorsifixed, ovate, greenish-yellow, c. 0.3 mm long; filaments glabrous, white, tube c. 6.5-7 mm long, free parts c. 2-3 mm long, the vexillary filament c. 7.5

mm long. **Stigma** acute; style glabrous, whitish-green, *c.* 4-4.5 mm long. **Disc** cupular, glabrous. **Ovary** superior, linear, straight on the dorsal side and several curves on the ventral side, glabrous, whitish-green, 3-3.5 x 0.4 mm; unilocular with several parietal ovule on the dorsal side. **Pods** completely enclosed in the persistent sepals; linear deeply incised on the dorsal side and articulated, twisted, depressed, sections 5-7, sections orbicular, *c.* 1.6-2 mm diameter. **Seeds** reniform, smooth, glabrous, *c.* 1 x 0.8 mm.

Habitat: partly shaded places, not in fire-damaged areas

Phenology: leafing: August-November, flowering: September-October, fruiting:
September-November

Abundance: medium

Distribution: northern Thailand, southern China, northern Vietnam to Philippines

Distinguishing features: leaves sensitive, paripinnate with opposite leaflets; sepals
4, free; petals yellow; pods articulated with several orbicular twisted sections

Voucher specimen: 298, 29 September 2001

Reference: Thuan, Phon, & Niyomdham (1987) 168-169, 171 (fig.), 173-174

Lentibulariaceae

1 genus, 3 species

Utricularia

Key to species

- 1. Stem twinning; corolla yellow, *U. scandens* Benj.
- 1. Stem erect; corolla purplish-blue,
 - 2. Plant glabrous..... *U. minutissima* Vahl
 - 2. Plant hirsute..... *U. hirta*

Utricularia hirta Klein ex Link

Annual, delicate leafless, ground herb to c. 15 cm high. **Stem** simple or few-branched, slender, with multicellular, greyish hirsute, dull dark green. **Utricles** inflated suborbicular, c. 0.15 mm diameter, laterally mouthed, upper part with a short subulate appendage; stipe c. 0.25-3 mm long. **Inflorescence** a lax, terminal raceme; axes with the indumentum as the stem. **Bracts** basifixed, lanceolate, apex acuminate, with indumentum as on the stem and inflorescence axes, c. 0.7-0.8 mm long. **Pedicels** c. 1-1.2 mm long. **Flowers** few, well-spaced, irregular 2-merous. **Calyx** deeply 2-lobed, lobes ovate, apex acute, outside with indumentum as on the stem, etc., glabrous inside; dull light maroon, c. 1.8-2 x 1.4-1.6 mm. **Corolla** bilabiate, purplish-blue; upper lip obovate, shallowly emarginate, glabrescent, c. 3 x 1.7 mm; lower lip suborbicular, 3-lobed, with minutely scattered puberulous outside, glabrous inside, palate and variegated with two yellowish patches, c. 4-4.5 diameter. **Spur** subulate, tip acute and shortly curved, densely hirsute and less so at the base, c. 5-6 mm long. **Stamens** 2, inserted on and included near the base of the spur; anthers dorsifixed, bilocular, divergent, cream, c. 0.8-1 mm long; filaments glabrous, white, c. 0.5 mm long. **Stigma** unequally 2-lobed, the upper lobe 2-3 times larger than the lower lobe; style glabrous, c. 0.3 mm long. **Ovary** superior, ovoid, glabrous, c. 0.7-0.8 mm long; unilocular with numerous free central ovules. **Capsules** subglobose with persistent calyx and stigma, smooth, c. 1.4-1.6 mm diameter. **Seeds** numerous, brownish, irregularly obovoid to ellipsoid, c. 0.15 mm long.

Habitat: open wet areas

Phenology: flowering and fruiting: November-December

Abundance: rare

Distribution: throughout Thailand, India (Assam), Laos, Cambodia, Vietnam, Sarawak

Distinguishing features: leafless, delicate herb in wet marsh areas, with greyish
indumentum; corolla bilabiate, purplish-blue

Voucher specimens: 370, 3 December 2001; Maxwell 96-1593, 3 December 1996;

Figure 40

Reference: Maxwell (1985) 410-412, 417-418

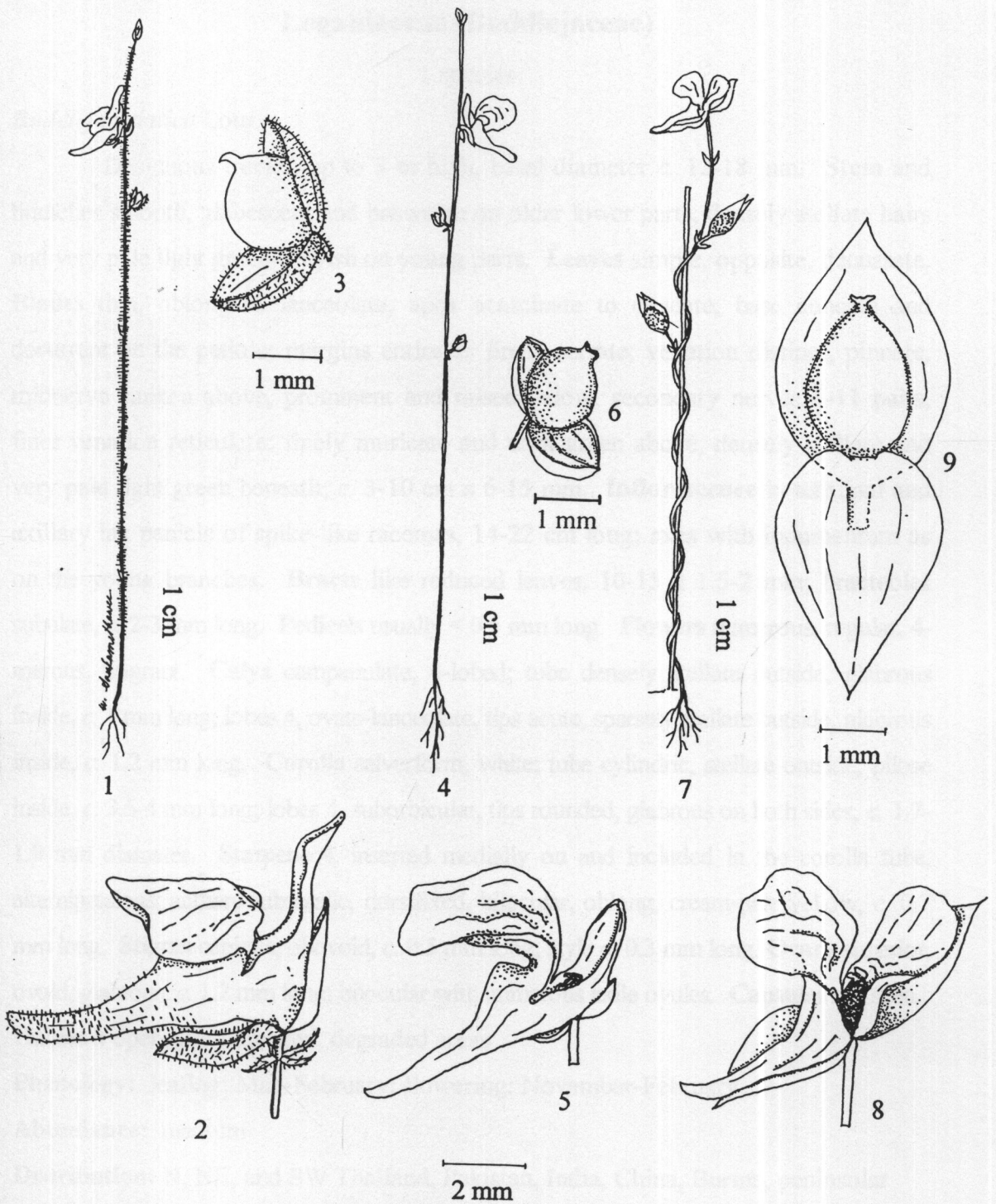


Figure 40 *Utricularia hirta* Klein ex Link (#370): 1 = habit, 2 = flower, 3 = calyx and capsule; *U. minutissima* Vahl (#278): 4 = habit, 5 = flower, 6 = calyx and capsule; *U. scandens* Benj. (#279): 7 = habit, 8 = flower, 9 = opened calyx and capsule

Loganiaceae (Buddlejaceae)

1 species

***Buddleja asiatica* Lour.**

Deciduous treelet, up to 3 m high, basal diameter c. 12-18 mm. **Stem** and branches smooth, glabrescent and brownish on older lower parts, densely stellate hairs and very pale light green-greyish on young parts. **Leaves** simple, opposite, decussate. **Blades** thin, oblong to lanceolate, apex acuminate to caudate, base cuneate and decurrent on the petiole; margins entire or finely serrate; venation distinct, pinnate, midnerve sunken above, prominent and raised below, secondary nerves 6-11 pairs, finer venation reticulate; finely muricate and dark green above, densely stellate and very pale light green beneath; c. 3-10 cm x 6-15 mm. **Inflorescence** in terminal and axillary lax panicle of spike-like racemes, 14-22 cm long; axes with indumentum as on the young branches. **Bracts** like reduced leaves, 10-15 x 1.5-2 mm; bracteoles subulate, c. 2-3 mm long. **Pedicels** usually < 0.5 mm long. **Flowers** numerous, regular, 4-merous, fragrant. **Calyx** campanulate, 4-lobed; tube densely stellate outside, glabrous inside, c. 1 mm long; lobes 4, ovate-lanceolate, tips acute, sparsely stellate outside, glabrous inside, c. 1.2 mm long. **Corolla** salverform, white; tube cylindric, stellate outside, pilose inside, c. 3.5-4 mm long; lobes 4, suborbicular, tips rounded, glabrous on both sides, c. 1.7-1.9 mm diameter. **Stamens** 4, inserted medially on and included in the corolla tube, alternipetalous; anthers subsessile, dorsifixed, bilocular, oblong, cream-pale yellow, c. 0.7 mm long. **Stigma** capitate, obovoid, c. 0.5 mm long; style c. 0.3 mm long. **Ovary** superior, ovoid, glabrous, c. 1.2 mm long; bilocular with numerous axile ovules. **Capsules** not seen.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: May-February; flowering: November-February

Abundance: medium

Distribution: N, NE, and SW Thailand, Pakistan, India, China, Burma, peninsular Malaysia, Java, Philippines

Distinguishing features: deciduous treelet up to c. 3 m high; leaf blades with densely greyish-brown stellate underneath; inflorescence a lax panicle of spike-like racemes with numerous 4-merous flowers; corolla white

Voucher specimen: 406, 17 January 2002

Reference: Leeuwenberg & Vidal (1972) 92-93, 95 (fig.); Opie & Parnell (2002) 655-657

Lythraceae

1 species

Rotala rotundifolia (Ham. ex Roxb.) Koeh.

Evergreen, decumbent, amphibious, glabrous, succulent herb, *c.* 50 cm long, erect part *c.* 20-25 cm high. **Stem** violet-brown, rooting at the lower nodes. **Leaves** simple, opposite, decussate. **Blades** coriaceous, suborbicular or broadly ovate; apex obtuse, base broadly cuneate to truncate, margins entire; venation pinnate with 4-6 pairs of secondary nerves; midnerve sunken above, prominent and raised below; main nerves red-violet underneath; dark green above, light green with distinct minutely reddish-brown dots beneath; *c.* 6-11 x 5-10 mm. **Petiole** to *c.* 1.5 mm long. **Inflorescence** terminal, a lax panicle of racemes, 3-8 cm long. **Axes** quadrangular, violet-brown as the stem. **Bracts** leaf-like, broadly ovate, apex acute, base obtuse to truncate, green-violet; 0.5-0.8 mm long. **Flowers** numerous, regular, 4-merous. **Calyx** violet; tube campanulate, 1.5 mm long; lobes triangular, 0.8 mm long. **Petals** thin, orbicular to broadly obovate; apex obtuse, base cuneate, gradually narrowing into a short claw, light violet-purple, 1-1.2 x 1 mm. **Stamens** free alternipetalous; anthers basifixed, bilocular, longitudinally dehiscent, dull light violet, *c.* 0.25 mm long; filaments 1 mm long. **Ovary** superior, obscurely 4-lobed, *c.* 1 mm long included style and stigma; stigma capitate; locules 4, each locule with numerous axile ovules. **Capsules** globose, septicidal dehiscent, *c.* 1.5 mm long. **Seeds** many, elliptic, obtuse at both ends, smooth, *c.* 0.5 mm long.

Habitat: open wet places

Phenology: leafing all year round, flowering and fruiting January – June

Abundance: common

Distribution: northern Thailand, India, China, Indo-China

Distinguishing features: succulent amphibious herb in marsh areas, rooting at the lower nodes; leaves opposite, blades rounded; inflorescence a panicle of racemes; bracts leaf-like; petals violet-purple

Voucher specimen: 135, 13 March 2001

Reference: Gagnepain (1921) 970-971, 973, 975 (fig.)

Malvaceae

3 genera, 3 species

key to genera and species

1. Stem and braches with simple pilose indumentum; leaf blades often deeply lobed, base sagittate or hastate; flowers > 6 cm diameter *Abelmoschus*
1. Stem and blades with fine, soft stellate hairs; leaf blades entire or shallowly lobed, base cordate or truncate; flowers < 4 cm diameter
 2. Ovary and schizocarps glabrous *Pavonia*
 2. Ovary and schizocarps spinulose *Urena lobata* L. ssp. *lobata* var. *lobata*

Abelmoschus moschatus Medic. ssp. *tuberosus* (Span.) Borss.

Deciduous, erect or decumbent ground herb to c. 70 cm tall.. **Tap root** tuberous. **Stem** and branches terete, densely long golden pilose, light green-brownish. **Leaves** simple, alternate. **Blades** thin ovate, entire or lobed; apex acute, base sagittate or hastate, margins serrate, with 5-7 basal nerves, each main nerve with pinnate venation, sunken above and prominently raised below; finer venation reticulate; strigose above, stellate indumentum and with scattered strigae underneath; dark green above, very pale light green beneath; c. 25-60 x 15-50 mm; basal lobes lanceolate to oblong, tips acute to obtuse; c. 6-25 x 3-12 mm. **Petioles** with indumentum as on the stem and branches, c. 1-6 cm long. **Stipules** linear, pilose, green, c. 3-8 mm long. **Flowers** axillary, solitary, regular, 5-merous. **Pedicels** slender, densely golden pilose, light green-brownish, c. 1.5-4.5 cm long, accrescent to c. 10 cm long in fruit. **Epicalyx** segments 10, linear, pilose, green, c. 8-14 x 1 mm. **Calyx** spatheform, tip minutely and shallowly 5-lobed, with simple pilose and stellate indumentum outside, pilose inside, light green, c. 20-23 x 20 mm. **Petals** 5, thin, symmetrically obovate, apex rounded, sparsely covered with minute simple and bifid indumentum, pinkish, light orangish-pink with dark red radiating nerves; petal bases glossy red appearing as a solid ring inside the flower; c. 35-40 x 25-30 mm. **Stamens** numerous, monadelphous; filament tube glabrous, white, 20 mm long; anthers dorsifixed, bilocular, yellow, c. 1 mm long; free part of filaments c. 0.7-1 mm long. **Stigmas** 5, discoid, c. 2.8-3 mm long, dark red; style solitary, glabrous, reddish-pink, c. 7-8 mm long and exceeding the filament tube. **Ovary** superior, ovoid, 5-loculed,

each locule with several axile ovules. **Capsules** immature, ovoid, tip acute, light green, densely golden pilose, c. 2 mm long. **Seeds** reniform, brownish-black, obtuse at both ends with several longitudinal ribs, c. 3-3.5 x 2-2.8 mm.

Habitat: open fire-damaged, degraded areas

Phenology: leafing: March-October; flowering: April-August; fruiting: April-October

Abundance: medium

Distribution: N and E Thailand, Burma, Indo-China, Hainan, Malesia, north Australia

Distinguishing features: tap roots tuberous; leaf blade base sagittate or hastate; showy flower > 6 cm diameter, pinkish-orangish petals

Voucher specimen: 162, 3 May 2001; **Figure** 14 B

References: Borssum Waalkes (1966) 89-95; Craib (1925) 159 (*sub Hibiscus sagittifolius* Kurz)

Pavonia repanda (Roxb. ex J. E. Sm.) Spreng.

Perennial deciduous shrub to c. 1 m high, basal diameter 7-8 mm. **Stem** terete, epidermis greyish-brown; young branches maroon-green with densely stellate indumentum and more adpressed on old parts. **Leaves** simple, alternate. **Blades** subcoriaceous, orbicular, ovate, elliptic to oblong, 3-lobed; apex acute, base cordate, margins finely and remote serrulate; venation with 3-5 basal nerves, each of which is pinnate nerved; finer venation reticulate, sunken above, prominent and raised below; finely stellate hairy above, very densely so underneath; dark green above, very pale light green beneath; c. 1.5-8 x 0.7-7.5 cm. **Petioles** with the same indumentum as on the branches, 0.3-5 cm long. **Inflorescence** a terminal, compact raceme, and solitary from the leaf axils of upper, reduced leaves; axes with indumentum as on the branchelets. **Bracts** like reduced leaves, linear to oblong, maroon or greenish, 5-12 x 1-2 mm. **Pedicels** 0-1 mm long. **Flowers** few, regular, 5-merous. **Epicalyx** campanulate, 5-lobed, glabrous, maroon; tube c. 3 mm long; lobes lanceolate, tips acuminate, c. 3 mm long. **Calyx** slightly longer than the epicalyx, mostly glabrous, and stellate hairy only on the margins, maroon; tube c. 4 mm long, lobes alternating with the epicalyx lobes, 3 mm long. **Petals** 5, thin, convolute, base connate to the filament tube for c. 6 mm long; blades obovate, apex rounded, densely, finely stellate hairs outside in bud, glabrescent when open, glabrous inside, pinkish-purple, and

darker at the base, 30 x 16-18 mm. **Stamens** numerous, monadelphous; filament tube glabrous, pinkish, c. 13-17 mm long; anthers dorsifixed, bilocular, violet, c. 0.6-0.8 mm long; free filaments c. 0.2-1 mm long. **Stigmas** 10, alternately shorter, subequal, pink; c. 3 mm long; style glabrous, shortly exceeding the staminal column. **Ovary** superior, globose, shallowly 5-grooved, smooth and glabrous, c. 1.5 mm diameter; 5-carpeled, 5-loculed, each locule with one axile ovule. **Schizocarps** globose, with persistent calyx and epicalyx, glabrous, c. 6-7 mm diameter, mericarps cuneate, smooth or indistinctly veined, c. 4 x 2.5 mm. **Seeds** as large as their mericarp, smooth, glossy brown.

Habitat: open fire-damaged, degraded areas

Phenology: leafing: September-February; flowering: October-November; fruiting: October-February

Abundance: medium

Distribution: northern Thailand, Burma, India, Indo-China

Distinguishing features: mature leaf blades usually 3-lobed, petals purple-pink; schizocarps smooth

Voucher specimen: 341, 15 November 2001; **Plate** 14 C

References: Gagnepain (1910) 413, 416-417; Craib (1925) 154-155; Borssum Waalkes (1966) 137 (*sub Pavonia rigida* (Wall. ex Mast.) Hochr.)

Melastomataceae

3 genera, 3 species

key to genera and species

1. Flowers 3-merous.....*Sonerila*
1. Flowers 4-5-merous
 2. Flowers 4-merous; stamens similar; leaf blades < 1 cm wide, herb
*Osbeckia chinensis* L. var. *chinensis*
 2. Flowers 5-merous; stamens dimorphic; blades always > 2 cm wide, shrub.....*Melastoma*

Melastoma malabathricum L. ssp. *malabathricum*

Evergreen shrub to 2 m high, basal diameter to c. 20 mm. Stem and branches terete, epidermis brown and light green on young branches, densely covered with adpressed linear-lanceolate basifixed scales. **Leaves** simple, opposite, decussate. **Blades** subcoriaceous, lanceolate to elliptic, apex acute to acuminate, base cuneate; margins entire; venation with 3-5 basal nerves which are sunken above, prominent and raised below; finer venation distinct, scalariform; densely sericeous on both sides; dark green above, very pale light green beneath; 4-9 x 2-3.3 cm. **Petioles** pilose and with adpressed linear scales, brownish-green, c. 3-10 mm long. **Inflorescence** in terminal, compact cymes, 3-7-flowered; axes with indumentum as on the branches, light green. **Pedicels** 2-11 mm long. **Bracts** leaf-like, coriaceous, paired, elliptic, green, c. 12-16 x 6-10 mm, caducous. **Flowers** regular, 5- merous. **Hypanthial tube** symmetrically urceolate, densely adpressed scaly, green, 11-13 mm long; calyx lobes 5, elliptic, apex acuminate, base thickened, adpressed scaly, velutinous inside, green or reddish-pink, 15-17 x 7-8 mm. **Petals** 5, imbricate in bud; symmetrically obovate, apex broadly acute to rounded, margins ciliate, glabrous on both sides, pinkish-violet, 30-35 x 22-26 mm. **Stamens** 10, dimorphic, anthers bilocular, linear-lanceolate, filaments whitish, glabrous; the outer and longer stamens 5, locules lilac, 10 mm long with a glabrous whitish linear sterile zone, base bifid, c. 6-7 mm long, filaments 11-12 mm long; inner and shorter stamens 5, locules yellow, 7-8 mm long, without a sterile zone, filaments 9-10 mm long. **Stigma** minutely capitate, style glabrous, pinkish, 20-23 mm long. **Ovary** inferior, 5- loculed, each locule with numerous axile ovules.

Fruit a berry, subglobose, densely brownish scaly, 12-14 diameter, irregularly rupturing. **Seeds** numerous, cochleate, papillose, brownish to black, c. 1 mm long.

Habitat: open and shaded, disturbed places, not in fire-damaged areas

Phenology: flowering: March-October; fruiting: April-November

Abundance: common

Distribution: throughout Thailand, south Asia to Malesia, Philippines to New Guinea, New Hebrides, Australia

Distinguishing features: shrub with adpressed scales on many parts; leaf blades 3-5-nerved from the base; showy pinkish-violet petals; dimorphic anthers

Voucher specimen: 219, 23 June 2001; **Plate** 17 A

Reference: Renner, Clausen, Cellinese, & Meyer (2001) 438-439, 441-442

***Sonerila erecta* Jack**

Annual, erect ground herb, 5-20 cm high. **Stem** and branches quadrangular, reddish-brown, finely and sparsely ciliolate and with fine, scattered, hooked, capitate indumentum. **Leaves** simple, opposite, decussate, spaced. **Blades** thin, elliptic to lanceolate, apex acute, base cuneate and deccurent on the petiole, margins serrate, with 3 basal nerves which are sunken above, and prominent below; finer venation obscure; with scattered gland-tipped cilia on both sides; dark green above, very pale light green beneath; c. 4-23 x 2-8 mm. **Petiole** 1-3 mm long. **Inflorescence** in terminal, helicoid cymes, 2-3 cm long with 2-7 flowers; axes similar to the branches. **Pedicels** 2-5 mm long. **Flowers** 3-merous, regular. **Hypanthial tube** cylindric, 3-angled, with indumentum as on the pedicels, light green, 3-5 x 1.6-2 mm; calyx shallowly 3-lobed, triangular, c. 0.8 mm long. **Petals** 3, thin, broadly elliptic to suborbicular, base shortly clawed, glabrous, purple inside, pink outside, c. 2-2.2 x 2 mm, evanescent. **Stamens** 3, similar, alternipetalous; anthers bilocular, basifixed, base bluntly sagittate, yellow, c. 1 mm long; filaments glabrous, c. 1.5-1.6 mm long. **Stigma** capitate, shallowly 2-lobed, purple; style glabrous, purple, c. 2.7-3 mm long. **Ovary** inferior, 3-loculed, each locule with numerous axile ovules. **Capsules** cylindrical, trigonous with persistent calyx lobes, brownish, c. 5 x 2 mm. **Seeds** numerous, obovoid, smooth, brownish, c. 0.3 mm long.

Habitat: open fire-damaged, degraded areas

Phenology: leafing: September-December; flowering: October-November; fruiting:
November-December.

Abundance: common

Distribution: throughout Thailand, India, southern China, Burma, Malay Peninsula,
Malay Archipelago

Distinguishing features: annual herb to 20 cm high, with gland-tipped cilia;
3-merous flowers, pinkish-purple petals; stamens all similar

Voucher specimen: 326, 2 November 2001

Reference: Renner, Clausen, Cellinese, & Meyer (2001) 412-413, 484-486, 485 (fig.)

Myrsinaceae

1 species

Ardisia crenata Sims var. *crenata*

Evergreen, glabrous herb to c. 50 cm high. **Stem** and branches glabrous, light greenish-brown. **Leaves** simple, spirally arranged, often closely so at the top of the branches. **Blades** subcoriaceous, elliptic to obovate-lanceolate, apex acute, base cuneate and decurrent on the petiole, margins crenate with glands in the crenation sinuses; venation distinct, pinnate, secondary nerves 5-15 pairs, midnerve sunken above, prominent and raised below; glabrous with numerous minute glandular dots; dark green above, pale light green beneath; c. 2-10 x 0.7-3 cm. **Petiole** 2-7 mm long. **Inflorescence** terminal on lateral leafy branches, umbellate; peduncle light green, c. 6-9 mm long; pedicels c. 5-8 mm long. **Flowers** few to several, regular, 5-merous. **Calyx** deeply 5-lobed, lobes imbricate in bud, broadly ovate, tips acute to obtuse, very pale light green, c. 2-2.5 x 1.7 mm. **Corolla** deeply 5-lobed, lobes imbricate in bud, ovate to ovate-lanceolate, tips acute, light pink to pinkish-purple, c. 5-6 x 3 mm. **Stamens** 5, oppositipetalous; anther sessile, bilocular, lanceolate, apically dehiscing, cream, c. 4 mm long, margins coherent forming a cone with glandular dots. **Stigma** filiform; style light green, c. 5 mm long. **Ovary** superior, globose, glabrous, c. 1 mm diameter; unilocular with 10 ovules on a free central placenta. **Berries** depressed globose, glossy bright red at ripening, c. 6-8 mm diameter, edible.

Habitat: open degraded areas near wet places

Phenology: flowering: April-June; fruiting: May-December

Abundance: common

Distribution: throughout Thailand, India, Burma, southern China, Vietnam, Japan, Philippines, Malay Peninsula

Distinguishing features: evergreen herb; leaves spirally arranged close to the stem and branches tips; blades with numerous minute glandular dots, margins crenate; inflorescence terminal umbellate; corolla lobes spreading; margins of the anthers coherent forming a cone; berries depressed globose, bright red when ripe

Voucher specimen: 189, 6 June 2001; Plate 14 D

Reference: Larsen & Hu (1996) 135-136

Ochnaceae

1 species

Ochna integerrima (Lour.) Merr.

Deciduous, glabrous, treelet to 50 cm high, becoming a tree to 6 m high in less disturbed areas, basal diameter 4-7 mm, frequently coppicing when cut or grazed. **Rootstock** woody. **Stem** light green-brown. **Leaves** simple, spirally arranged. **Blades** subcoriaceous, elliptic, lanceolate to oblanceolate, apex acute to acuminate, base cuneate and decurrent on the petiole, margins finely and sharply serrulate; venation pinnate, midnerve prominent on both sides, secondary nerves 10-15 pairs; finer venation reticulate; immature blades glossy red-brown on both sides, maturing dark green above, light green beneath; 4-13 x 2-4 cm. **Petioles** 2-5 mm long. **Inflorescence** terminal and axillary cymose. **Peduncle** 3-5 mm long. **Pedicels** reddish, 20-30 cm long. **Flowers** several, regular, 5-merous. **Sepals** 5-(-6), spreading and reflexed, apex obtuse, yellowish-green or reddish-brown, 14-17 x 6 mm. **Petals** 5-(-6), thin, broadly elliptic or obovate, apex obtuse, yellow, 23-25 x 15-17 mm, claws c. 3 mm long, evanescent. **Stamens** numerous, equal, free; anthers basifixed, bilocular, locules linear, orange-brown, c. 4-4.5 mm long; filaments yellow, c. 7-8 mm long. **Stigma** of 8 peltate lobes, light green; style solitary, 17-19 mm long. **Ovary** superior, deeply 6-8-lobed, each lobe ellipsoid and with one basal ovule. **Fruiting receptacle** convex, light yellowish, later reddish, c. 13 mm diameter; persistent sepals and filaments dark red. **Drupe** 1-6, obliquely ovoid, green, then reddish, ripening glossy black, c. 10-13 x 7-7.5 mm.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: March-October; flowering: February-March; fruiting: April-August

Abundance: common

Distribution: throughout Thailand, northeast Pakistan, Burma, Indo-China, Hainan, Andaman and Nicobar Islands, Malay Peninsula

Distinguishing features: deciduous, coppicing treelet; immature leaf blades often glossy red-brown; sepals red, petals yellow; fruiting receptacle reddish bearing several blackish drupes, persistent reddish filaments; usually flowering when leafless

Voucher specimens: 131, 13 March 2001; Maxwell 94-565, 29 April 1994 (a leafing and fruiting specimen from Doi Kuhn Dahn National Park, 825 m); **Plate** 17 C

Reference: Kanis (1970) 24-26

Orobanchaceae

1 genus, 2 species

Aeginetia

key to species

1. Flowers solitary, pedicels 10-30 cm long.....*A. indica* Roxb.
1. Flowers few to several in corymb, pedicels < 5 cm long.....*A. pedunculata*

Aeginetia pedunculata Wall.

Perennial deciduous, glabrous, parasitic, leafless, ground herb to c. 15 cm high. **Roots** yellowish-brown. **Inflorescence** corymbose; axes terete, brownish, few to several-flowered. **Bracts** ovate, thickened, incurved and carinate, margins finely frimbriate in the upper half, c. 8-13 x 4-6 mm. **Pedicels** 1.5-4.5 cm long. **Flowers** irregular, 5-merous. **Calyx** spathiform, thickened, ventrally split, light brown outside, cream inside, 3-5.5 x 3-4 cm. **Corolla** bilabiate; tube light yellow-cream outside, bright yellow inside, throat very dark violet, 3-4 cm long; lobes suborbicular, subequal, margins undulate, slightly reflexed, violet-purple; upper lip 2-lobed, 1.5 x 1.4-1.5 cm; lower lip 3-lobed, 1.35-1.4 x 1.5 mm. **Stamens** 4, didynamous, inserted on and included in the corolla tube; anthers unilocular, connate, dorsifixed, cream, 4-4.5 mm long; two anterior anther locules on a short stipitate connective, their filament light yellow, 10-12 mm long; the connective of two posterior anthers spurred which are connate to the anterior ones, oblong, c. 5-6 mm long, their filaments c. 10 mm long. **Stigma** peltate, suborbicular, white, c. 6-6.5 x 5-6 mm, included in the corolla; style cream, c. 3 cm long. **Ovary** superior, ovoid, c. 5-7 mm long; unilocular with 4 parietal placentas, each with numerous ovules. **Capsules** not seen.

Habitat: open, fire, damaged, grassy areas

Phenology: flowering: October; fruiting: October-December

Abundance: rare

Distribution: throughout Thailand, India, Indo-China, Java, Sumatra

Distinguishing features: leafless parasitic herb, < 15 cm high, usually found growing together with grasses; roots yellowish-brown; inflorescence corymbose; corolla bilabiate, purple-violet

Voucher specimen: 311, 17 October 2001; **Plate** 17 E

References: Pellegrin (1927) 461-464; Pellegrin (1930) 465 (fig.); Parnell (2001) 72-79

Oxalidaceae

1 species

Biophytum umbraculum Welw.

Annual, erect ground herb c. 8 cm high. **Stem** simple, terete, finely sericeous, reddish-green. **Leaves** densely spirally arranged at the top of the stem, 1.5-2.5 cm long; paripinnate. Leaflets opposite, 2-5 pairs, sessile, gradually increasing in size distally, slowly sensitive; rachis finely sericeous, 3-20 mm long with a subulate tip c. 1.5-2 mm long. **Leaflet blades** thin, asymmetrically elliptic, apex acute to obtuse, base truncate (lower ones) or obliquely obtuse (distal ones); margins remotely ciliolate; venation prominent, pinnate, the midnerve mostly curved, eccentric; secondary nerves 5-7 pinnate; finest venation reticulate; glabrous on both sides; dark green above, dull light green beneath; 2-7 x 1.5-4 mm. **Bracts** lanceolate, acuminate, glabrous, whitish-green, c. 0.4 x 1.2 mm. **Pedicels** glabrescent, whitish-green, 1-2 mm long. **Flowers** terminal, solitary or in few-flowered groups; regular, 5-merous. **Sepals** 5, ovate-lanceolate, tips acuminate; glabrous inside, pilose outside; whitish-green, c. 4 x 1 mm. **Corolla** funnelform, glabrous; tube yellow, 3-3.5 mm long; lobes 5, imbricate, obovate, reddish-yellow or orangish, 2.5 x 2 mm. **Stamens** 10, 5 longer ones alternating with 5 shorter ones; anthers dorsifixed, bilocular, yellow, c. 0.2 mm diameter; the longer filaments with minute, glandular hairs near the tip, light green, 2.1-2.2 mm long; the shorter filaments glabrous, 1.5 mm long. **Stigmas** 2-lobed; styles 5, pilose, c. 1.5 mm long. **Ovary** superior, ellipsoid, longitudinally 5-lobed, glabrous; 5-loculed, each locule with 2 rows of several axile ovules. **Capsules** ellipsoid, shallowly 5-lobed, enveloped by the persistent sepals, glabrous, c. 3.5-4 x 2.8 mm. **Seeds** ellipsoid, unequally trigonous, tuberculate, c. 0.8 x 0.5 mm.

Habitat: open, and partly shaded, degraded areas

Phenology: leafing: August-November; flowering and fruiting: August-November

Abundance: common

Distribution: N, NE Thailand, southeast Asia to New Guinea, tropical Africa, Madagascar, introduced in Australia,

Distinguishing features: small herb with paripinnate, sensitive leaves grouped on the top of the stem, asymmetric leaflets; corolla yellow-orange.

Voucher specimen: 258, 11 August 2001;

Reference: Veldkamp (1970) 16, 18-19 (*sub Biophytum petersianum* Klot.)

Polygalaceae

1 genus, 3 species

Polygala

key to species

1. Inflorescence terminal; leaf blades linear to linear-lanceolate; inner sepals purple-pink
.....*P. longifolia* Poir.
1. Inflorescence axillary; leaf blades lanceolate, elliptic or ovate; inner sepals yellowish or violet
 2. Leaf blades ovate; bracts caducous, inner sepals yellowish; seed with a strophiole; plant mostly glabrous.....*P. umbonata*
 2. Leaf blades elliptic; bracts persistent; inner sepals violet; seeds without a strophiole; plant puberulous*P. persicariifolia* L.

Polygala umbonata Craib

Annual, mostly glabrous herb to c. 35 cm high. **Roots** very aromatic. **Stem** and branches terete, light green to dull light maroon. **Leaves** simple, alternate or subopposite. **Blades** thin, ovate, apex acute, base cuneate and decurrent on the petiole, margins entire, very minutely setulose; venation distinct, pinnate; main veins sunken above, prominent and raised below; finer venation reticulate; with scattered, minute setulae, dark green above, glabrous and very pale light green beneath; 1.5-7 x 1-4 cm. **Petioles** light green or dull maroon, 5-20 cm long. **Inflorescence** in axillary racemes, 1.5-6 cm long; axes light green to dull light maroon. **Flowers** several, irregular. **Bracts** caducous. **Pedicels** distally swollen, c. 1 mm long. **Sepals** 5, thin; outer sepals 3, ovate, light green, c. 1.3 x 1 mm; inner sepals 2, much larger, appearing as wings, slightly incurved and carinate, base with claws c. 0.5 mm long, glabrous, yellowish-orange; 3-3.2 x 2-2.2 mm. **Petals** 3, unequal, basally and ventrally connate, yellowish and turning reddish-pink; upper petals 2, equal, obliquely ovate-oblong, c. 4 x 1.3-1.5 mm; lower petal carinate, upper half incurved and united embracing the stamens, c. 4.5 x 2.5 mm, extended with 2 crest appendages. **Stamens** 8, equal, inserted medially on the lower petal; anthers basifixed, bilocular, opening by an apical pore, cream, c. 0.2 mm long; filaments whitish-light green, c. 1 mm long. **Stigma** irregularly 2-lobed; style gradually swollen distally, reflexed, whitish, c. 3-3.4 mm long. **Disc** of 2 suborbicular lateral lobes, c. 0.4 mm long. **Ovary** superior,

laterally compressed, obovate or suborbicular, *c.* 1.2-1.4 x 0.8-1 mm; bilocular, each locule with one apical ovule. **Capsules** compressed, obovate or orbicular, apex emarginate, *c.* 3-3.5 x 3 mm, usually with narrow marginal wings *c.* 0.3-0.5 mm wide. **Seeds** 2, ovoid to ellipsoid, papillose and with white puberulous hairs, brownish-black, *c.* 1.1 x 0.8 mm; arillate at base, with an apical globose strophiole which is hollow inside, glossy black with a sunken scar, scattered white puberulous, *c.* 0.8 mm diameter.

Habitat: partly shaded areas in bamboo thickets near the seasonal stream, rarely in fire-damaged areas

Phenology: leafing, flowering, and fruiting: August-October

Abundance: medium

Distribution: N, NE, SW Thailand, Burma, Indo-China

Distinguishing features: leaf blades ovate; inflorescence an axillary raceme; 2 inner sepals appearing as wings, yellow-orange, lower petal carinate; capsule compressed, obovate, tip emarginate

Voucher specimen: 260, 10 August 2001

Reference: Pendry (2001) 498-501, 518-519 (fig.)

Polygonaceae

1 genus, 2 species

key to species

1. Leaf blades elliptic-oblong, < 1.5 cm wide; ochrea without auricles; inflorescence narrowly spicate; plant < 40 cm high *P. persicaria* L.
1. Leaf blades ovate to elliptic, > 3 cm wide; ochrea with auricles; inflorescence spreading cymose; plant up to 2 m high..... *P. chinensis*

Polygonum chinensis L.

Evergreen herb up to 2 m high, basal diameter *c.* 8-10 mm. **Stem** branched, densely adpressed golden strigose; brownish. **Leaves** simple, alternate, spaced. **Blades** thin, ovate to elliptic, apex acuminate, base cuneate, obtuse to truncate, sometimes slightly oblique, margins entire; venation distinct, pinnate, secondary nerves 7-12 pairs, prominent below; midnerve raised on both sides and more prominent below; finer venation reticulate; with long golden strigose indumentum on both sides and densely so beneath; dark green above, pale light green beneath; *c.* 5-14 x 2-7 cm. **Petiole** with indumentum as on the stem and blades, *c.* 3-8 mm long. **Ochrea** membranous, cylindric or split (spathiform), margins few-several-toothed, tips acuminate with several vertical nerves, sparsely strigose outside, glabrous inside; pale light green, turning light brown, *c.* 1-2.5 cm long; usually with an auricle at the base of petiole, indumentum as on the blades, *c.* 5-10 x 7-20 mm. **Inflorescence** in terminal compound cymes, *c.* 13 cm long; axes with sparser indumentum than on the stem. **Bracts** ovate, tips acute, pale light green, *c.* 2-13 x 2.5-5 mm; bracteoles ovate, carinate, keels strigose, very pale light green, *c.* 1-1.5 x 0.8-1 mm. **Flowers** many, regular, sessile. **Perianth** 6-lobed, ovate, apex acute to obtuse, puberulous outside, glabrous inside; base greenish-white, otherwise white-cream to pinkish, *c.* 3-4 x 2.5 mm. **Stamens** 8; anthers dorsifixed, bilocular, ellipsoid, dull purple, turning grayish, *c.* 0.3 mm long; filaments whitish-pink, glabrous, *c.* 1.7-2 mm long. **Stigmas** 3, capitate; style (including the stigmas) *c.* 0.8-0.9 mm long. **Ovary** superior, 3-angled, glabrous, *c.* 0.7-1 mm long; unilocular with one basal ovule. **Achenes** broadly ovoid, trigonous, smooth, dark brown to blackish, usually enclosed in the dry perianth, *c.* 3-3.5 x 3 mm.

Habitat: open or partly shaded areas near the seasonal stream

Phenology: flowering: October-December; fruiting: October-January

Abundance: midium

Distribution: Thailand, India, Indo-China, China, Java, Sumatra, Philippines, Japan

Distinguishing features: evergreen with golden strigose indumentum; blades ovate or elliptic; ochrea with a pair of auricles; inflorescence in terminal compound cymes; perianth whitish; achenes trigonous

Voucher specimen: 350, 15 November 2001; **Figure** 41

Reference: Courchet (1910) 37-38

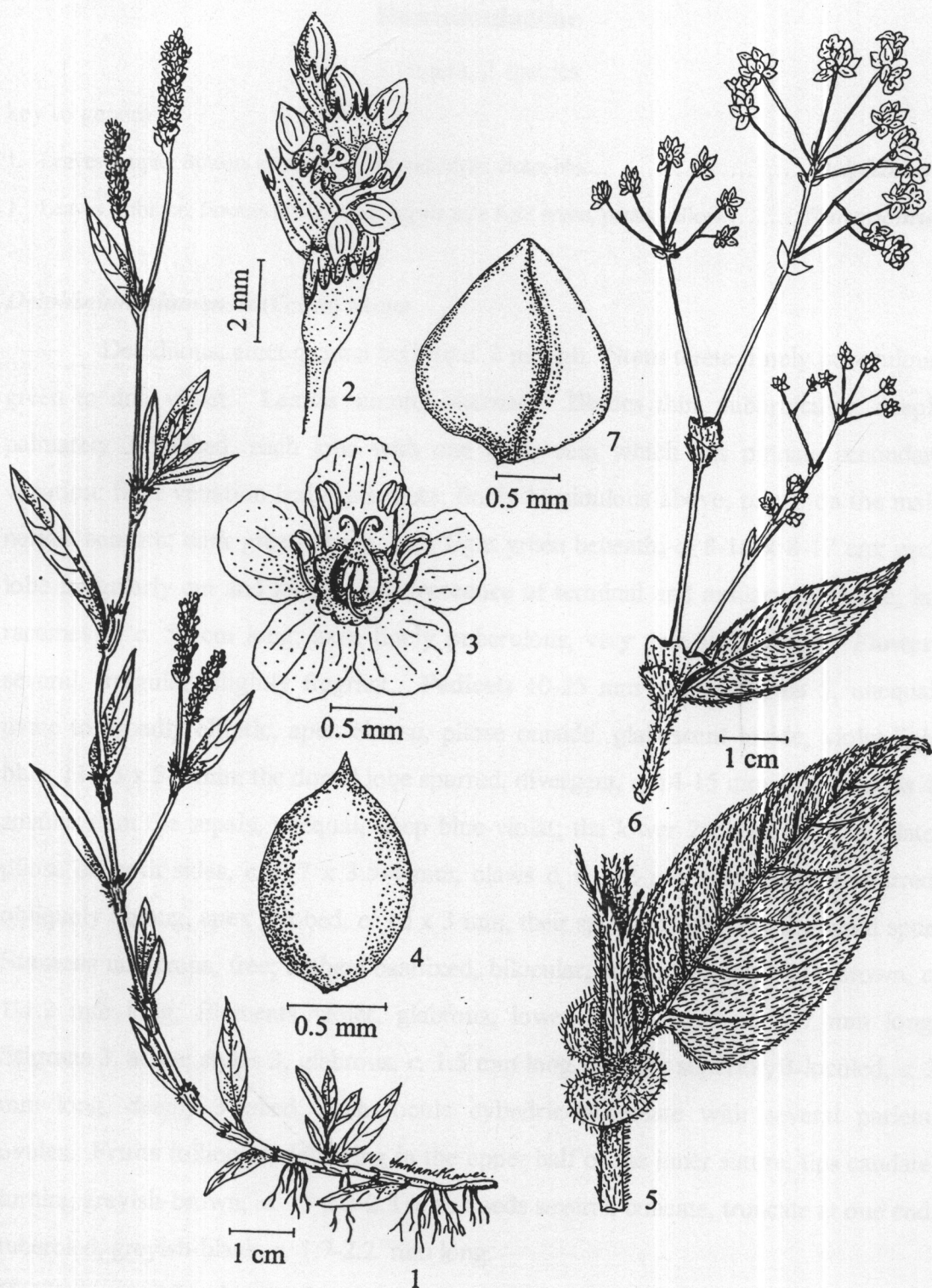


Figure 41 *Polygonum pesicaria* L. (#206): 1 = habit, 2 = inflorescence, 3 = flower, 4 = seed; *P. chinensis* L. (#350): 5 = stem, ochrea with auricles, leaves, 6 = inflorescence, 7 = seed

Ranunculaceae

2 genera, 2 species

key to genera

1. Leaves simple; flowers spurred; sepals and petals violet-blue.....*Delphinium*
1. Leaves trifoliate; flowers not spurred; sepals pale light green, petals yellow.....*Ranunculus*

Delphinium siamensis (Craib) Munz

Deciduous, erect ground herb to c. 2 m high. **Stem** terete, finely puberulous, green to dull violet. **Leaves** simple, alternate. **Blades** thin, suborbicular, deeply palmately 3-5-lobed, each lobe with one main vein which has pinnate secondary venation; finer venation laxly reticulate; finely hispidulous above, pilose on the main nerves beneath; dark green above, pale light green beneath; c. 8-16 x 8-17 cm; each lobe irregularly cut and lobed. **Inflorescence** of terminal and axillary, elongate, lax racemes to c. 50 cm long; axes finely puberulous, very pale light green. **Flowers** several, irregular, slightly fragrant. **Pedicels** 10-25 mm long. **Sepals** 5, unequal; ovate to broadly elliptic, apex obtuse, pilose outside, glabrescent inside, violet-light blue, 11-13 x 5-7 mm; the dorsal lobe spurred, divergent, c. 14-15 mm long. **Petals** 4, smaller than the sepals, unequal, deep blue-violet; the lower 2 obliquely spatulate, pilose on both sides, c. 6-7 x 3.5-4 mm, claws c. 6 x 2 mm; the upper 2 spurred, obliquely oblong, apex 2-lobed, c. 10 x 3 mm, their spurs enclosed by the sepal spur. **Stamens** numerous, free; anthers basifixed, bilocular, cream, turning black-brown, c. 1-1.2 mm long; filaments violet, glabrous, lower half winged, c. 5-7 mm long. **Stigmas** 3, acute; styles 3, glabrous, c. 1.5 mm long. **Ovary** superior, 3-loculed, c. 2 mm long, deeply 3-lobed, each locule cylindric-lanceolate with several parietal ovules. **Fruits** follicular, dehiscing in the upper half of the inner suture, tips caudate, turning greyish-brown, c. 15 x 2-2.3 mm. **Seeds** several, cuneate, truncate at one end, tubercled, greyish-black, c. 1.7-2.2 mm long.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: June-January; flowering: August-December; fruiting:

September-January

Abundance: rare

Distribution: endemic to northern Thailand

Distinguishing features: deeply lobed, palmatifid leaf blades; inflorescence of terminal and axillary elongate, racemes; sepal spurred, sepals and petals bluish; stamens numerous; follicles deeply 3-lobed

Voucher specimens: 270, 30 August 2001 (flowers); 281, 28 September 2001 (fruits);

Plate 18 C

Reference: Tamura (1997) 63-64

***Ranunculus siamensis* Tam.**

Annual or perennial evergreen, slightly succulent herb, 30-70 cm high. **Stem** terete, finely and sparsely pilose, lower part dull maroon, upper young part light green. **Leaves** spiral, widely spaced, 1-2x trifoliate. **Leaflet blades** thin, suborbicular; rosette leaves trifoliate, each leaflet lobed to near the base; cauline leaves trifoliate, each leaflet deeply lobed and irregularly serrate; apex acute, base acute, margins irregularly serrate; venation fine with 3-5 basal nerves, each main nerve with pinnate venation; finer venation laxly reticulate with scattered pilose on both sides; green or dull dark green above, dull light green beneath; 15-35 x 10-35 mm. **Leaf axes** with indumentum as on the stem; rosette petioles up to c. 10 cm long; cauline petioles 1-6.5 cm long; petiolules 2-15 mm long. **Inflorescence** axillary, cymose, 5-12 cm long; axes pilose, light green. **Bracts** like reduced leaves, 2-4 lobed, each lobe oblanceolate, glabrous, green, c. 4-6 x 2-3 mm. **Flowers** few, regular, 5-merous. **Sepals** 5, pale light green, elliptic, shallowly carinate; apex mucronate, glabrous inside, tips puberulous, base pilose outside, pale light green, c. 4 x 3 mm. **Petals** 5, thin, elliptic to obovate, apex obtuse to rounded, spreading; glabrous on both sides, yellow, c. 9-11 x 5-6 mm; each petal with an orbicular basal appendage, c. 1-1.2 mm diameter, caducous. **Stamens** numerous, free; anthers basifixed, bilocular, yellow, c. 1 mm long; filaments glabrous, yellow, c. 2-2.6 mm long. **Pistils** several, free on a receptacle; stigmas acute; styles gradually tapering to the tip, light yellow, c. 2 mm long; ovaries superior of separate carpels, each obliquely compressed, ovoid, glabrous, c. 1 mm long, with one basal ovule. **Achenes** several on each receptacle appearing as a globose cephalium, c. 1 cm diameter; compressed orbicular with a terminal beak; style remnant c. 1 mm long; glabrous, green when immature, c. 3-3.5 x 3 mm.

Habitat: partly shaded or open wet places

Phenology: flowering: March-September; fruiting: April-September

Abundance: medium

Distribution: northern Thailand, Himalayas, Nepal, eastern India, Burma, northern Vietnam

Distinguishing features: 1-2 x trifoliate leaves; petals yellow; several free pistils in a globose receptacle; only found in marshes and moist gullies

Voucher specimens: Maxwell 00-284, 1 July 2000; 147, 11 April 2001 (topotypes);

Plate 18 B

Reference: Tamura (1997) 63, 76-78 (fig. 77)

Note: type from Baw Luang

Rubiaceae

7 genera, 8 species

key to genera and species

1. Leaves in whorls.....*Rubia siamensis*
1. Leaves opposite
 2. Fruit a drupe
 3. Scandent shrub; some marginal flowers having a calyx with one an enlarged white lobe; corolla yellow.....*Mussaendra parva* Wall. ex D. Don
 3. Erect shrub, calyx without an enlarged lobe; corolla white..... *Pavetta fruticosa*
 2. Fruit a capsule
 4. Inflorescence of terminal cymes
 5. Leaf blades lanceolate, glabrous; cymes compact
.....*Knoxia brachycarpa* R. Br. ex Hk. f.
 5. Leaf blades ovate, hispid; cymes helicoid*Ophiorhiza hispidula*
 4. Inflorescence of axillary glomerules
 6. Ovules numerous in each locule; blades > 5 cm long
.....*Hedyotis uncinella* Hk. & Arn. var. *cephalophora*
 6. Ovule one in each locule; blades mostly < 5 cm long
 7. Leaf blades linear to linear-lanceolate.....*Borreria brachystemma*
 7. Leaf blades elliptic to lanceolate.....*Borreria laevis* (Lamk.) Griseb.

Borreria brachystemma (R. Br. ex Benth.) Valet.

Annual, erect, ground herb to c. 30 cm high. **Stem** quadrangular, glabrous, reddish-brown. **Leaves** simple, opposite, decussate, sessile. **Blades** subcoriaceous, linear-lanceolate; apex acute, base attenuate, base of flowering leaf blades deccurrent; margins entire; venation pinnate, obscure; midnerve distinct, sunken above, raised below; scabrous above and dark green, glabrous and pale light green below, c. 15-53 x 1-2.5 mm. **Stipules** interpetiolar, top with 3-5 lobes, base pilose, c. 2-6 mm long. **Inflorescence** axillary, glomerulate, many-flowered; upper flowering leaves close, appearing in a whorl of 4. **Bracts** several, filiform, scarcely finely cystoliths. **Pedicels** 0-0.2 mm long. **Flowers** 4-merous, regular. **Calyx** urceolate, densely pilose, very pale light green, c. 1 mm long; lobes 2, subulate, c. 1 mm long. **Corolla** funnelform, glabrous, tube c. 1.2-1.5 mm long; 2-4-lobed, lobes ovate, tips acute and

ciliolate, *c.* 0.9-1.1 x 0.6-0.8 mm. **Stamens** 3-4, free, alternipetalous; anthers dorsifixed, bilocular, locules oblong, *c.* 0.25 mm long, white-cream; filaments white, *c.* 1 mm long. **Stigmas** capitate, white; styles glabrous, white, *c.* 2 mm long. **Disc** cupular, shallowly 4-lobed, glabrous. **Ovary** inferior, compressed obovoid, *c.* 1 mm long; bilocular, each locule with one axile ovule. **Capsules** obovoid with persistent calyx lobes, brownish, upper half pilose, lower half glabrous, *c.* 1.2-1.5 mm long. **Seeds** oblong, ellipsoid, obtuse at both ends, channeled at one side, smooth, glossy dark brown, *c.* 1-1.2 x 0.5 mm.

Habitat: open, fire-damage, degraded areas

Phenology: leafing: September-November; flowering: September-October; fruiting: October-February

Abundance: abundant

Distribution: throughout Thailand, Africa to Philippines

Distinguishing features: erect herb, stem unbranched; leaves opposite, decussate, inflorescence leaves close and appearing in a whorl of 4; stipules pectinate, leaf blades linear; flowers numerous, in axillary glomerules; corolla 2-4-lobed, white; capsules obovoid with persistent calyx

Voucher specimen: 310, 16 October 2001

References: Craib (1934) 231; Backer & Bakhuizen van den Brink (1965) 354 (*sub Borreria stricta* (L.f.) K. Sch.)

Ophiorhiza hispidula* Wall. ex G. Don var. *hispidula

Annual, erect or sprawling, ground herb to *c.* 20 cm tall. **Stem** quadrangular, hispid, lower old parts glabrescent, light green. **Leaves** simple, opposite, decussate. **Blades** thin, ovate; apex acute, base obtuse to cuneate, sometimes slightly oblique; margins entire; venation distinct, pinnate, midnerve raised on both sides; secondary nerves 8-12 pairs; finer venation reticulate; sparsely finely hispid on the main nerves on both sides; dark green above, pale light green beneath, *c.* 15-50 x 10-35 mm. **Petioles** with indumentum as on the stem, *c.* 3-8 mm long. **Stipules** interpetiolar, broadly rectangular, aristate, light green, *c.* 2-3 x 1.5-2.5 mm, cystoliths dense. **Inflorescence** in terminal and axillary, compound helicoid cymes; axes terete, densely finely hispid, light green. **Bracts** linear-lanceolate, caducous, puberulous, light green,

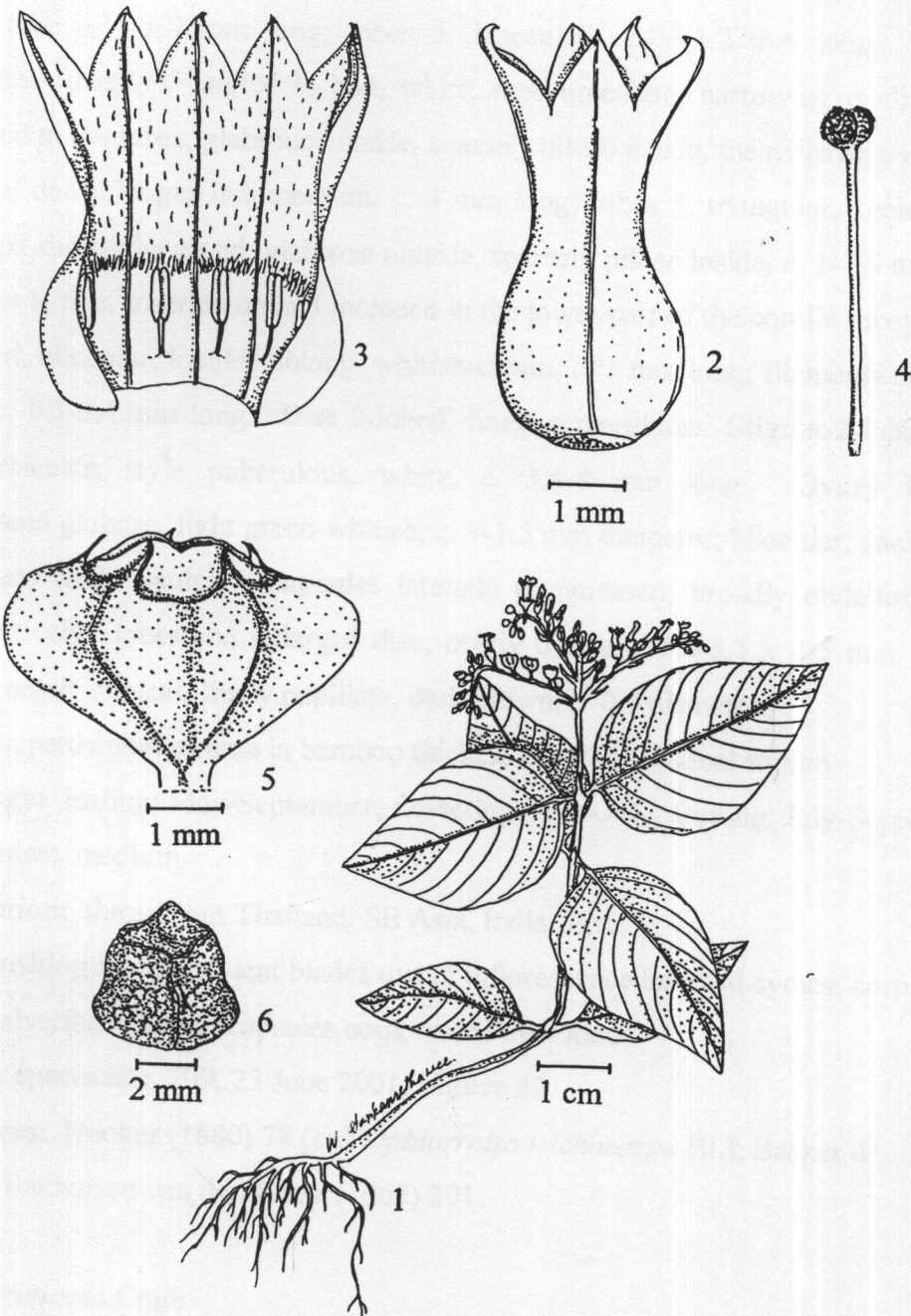


Figure 42 *Ophiorrhiza hispidula* Wall. ex G. Don var. *hispidula* (#209): 1 = habit, 2 = corolla, 3 = opened corolla, 4 = stigmas and style, 5 = capsule, 6 = seed

2 mm long. **Pedicels** finely hispid, 0-0.6 mm long. **Flowers** numerous, regular, 5-merous. **Calyx** urceolate, distinctly 5-ribbed, finely hispid as on the pedicels, whitish-green; tube c. 1-1.5 mm long; lobes 5, lanceolate, c. 1-1.2 mm long. **Corolla** salverform, deeply 5-angled in bud, white; tube urceolate, narrowing medially and expanded to the lobes, glabrous outside, sparsely pilose inside, the narrowest part with a ring of dense longer indumentum, c. 4 mm long; lobes 5, triangular, keeled, apex acute and shortly incurved; glabrous outside, sparsely pilose inside, c. 1-1.5 mm long. **Stamens** 5, free, inserted on and included in the lower part of the corolla tube; anthers basifixed, bilocular, locules oblong, whitish-cream, c. 1 mm long; filaments glabrous, white, c. 0.3-0.4 mm long. **Disc** 2-lobed, finely puberulous. **Stigma** 2-lobed, each lobe orbicular; style puberulous, white, c. 3.5-4 mm long. **Ovary** inferior, compressed globose, light green-whitish, c. 1-1.5 mm diameter; bilocular, each locule with many axile ovules. **Capsules** laterally compressed, broadly obdeltoid, with persistent calyx lobes and enlarged disc, nearly truncate, 2.5-3.5 x 4-5 mm. **Seeds** several, nearly cubical, finely papillate, dark brown, c. 0.4 diameter.

Habitat: partly shaded area in bamboo thickets near the seasonal stream

Phenology: leafing: May-September; flowering: June-July; fruiting: July-September

Abundance: medium

Distribution: throughout Thailand, SE Asia, India, Java

Distinguishing features: leaf blades ovate; inflorescence helicoid cymes; corolla salverform, white; capsules compressed obdeltoid

Voucher specimen: 209, 23 June 2001; **Figure** 42

References: Hooker (1880) 78 (*sub Ophiorrhiza trichocarpa* Bl.); Backer & Bakhuizen van den Brink (1965) 291

Pavetta fruticosa Craib

Deciduous shrub to 70 cm high, basal diameter 8-10 mm. **Branchlets** sparsely puberulous, light green. **Leaves** simple, opposite, decussate. **Blades** suncoriaceuos, obovate to obovate-lanceolate; apex acute, obtuse to rounded, sometimes shallowly retuse, base cuneate; margins entire; venation distinct, pinnate, midnerve sunken above, raised below; secondary nerves 7-12 pairs; finer venation reticulate; sparsely puberulous to glabrescent above, pilose beneath; dull dark green

above, pale light green underneath; *c.* 4-16 x 1.5-7.5 cm. **Petioles** puberulous, *c.* 3-20 mm long. **Stipules** interpetiolar sheathing, persistent; broadly ovate, apex acuminate to caudate, densely pilose, green, *c.* 3-8 x 3-10 mm. **Inflorescence** in terminal and axillary, compound cymes, 5-10 cm diameter; axes puberulous, light green. **Bracts** stipule-like, puberulous outside, densely pilose at the base inside, otherwise glabrescence. **Pedicels** glabrous, 3-5 mm long. **Flowers** numerous, regular, 4-merous. **Calyx** urceolate, light green; tube glabrous, *c.* 2-2.5 mm long; lobes 4, triangular, tips acuminate, puberulous outside, glabrous inside, *c.* 0.7 mm long. **Corolla** salverform; tube glabrous outside, pilose inside, cream-pale light green, 7-11 mm long; lobes 4, spreading, elliptic to obovate-lanceolate, apex acute, glabrous on both sides, 5-7 x 2.5 mm. **Stamens** 4, alternipetalous, inserted on the corolla throat and long exserted; anthers dorsifixed, bilocular, locules linear, base sagittate, grey, *c.* 4 mm long; filaments pilose at the base, *c.* 0.8 mm long. **Disc** cupular, glabrous, *c.* 1 mm diameter. **Stigma** clavate, minutely puberulous, pale light green; style much exerted from the corolla tube, glabrous, whitish, *c.* 20-25 mm long. **Ovary** inferior, subglobose, *c.* 2-2.5 mm diameter; 2 (-3)-loculed, each locule with one basal ovule. **Drupe**s globose with persistent calyx lobes, immature bright light green to dark green, ripening black, 4-6 mm diameter.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: March-November; flowering: April-May; fruiting: May-September

Abundance: medium

Distribution: northern Thailand

Distinguishing features: sheathing interpetiolar stipules; inflorescence of dense compound cymes; corolla salverform, white; stamens and style long exserted; drupes globose, ripening black

Voucher specimens: 196, 6 June 2001; Maxwell & Sankamethawee 00-245, 5 May 2000; Plate 18 E

References: Bremekamp (1934) 115; Craib (1932) 431, Craib (1934) 167

***Rubia siamensis* Craib**

Deciduous, decumbent or scrambling, ground herb *c.* 80 cm long. **Stem** sharply quadrangular, sparsely scabrous, light green. **Leaves** simple, in whorls of 4, sessile, usually unequal in the same whorl. **Blades** subcoriaceous, broadly ovate to elliptic; apex acute to broadly acute, base cuneate; margins entire; venation distinct with 3-7 main nerves from the base, sunken above and raised below; finer venation obscurely reticulate; densely and finely muricate above, smooth and glabrescent beneath, sparsely scabrous on the main nerves on both sides; dark green above, very pale light green beneath; *c.* 10-35 x 5-23 mm. **Inflorescence** terminal and axillary, thyrsoïd; axes sharply quadrangular, green or light green. **Bracts** ovate-lanceolate, acute, sparsely scabrous, light green, *c.* 2-2.5 x 1 mm. **Pedicels** 0.3-2 mm long. **Flowers** several, regular, 5-merous. **Calyx** urceolate, truncate, light green, *c.* 0.3 mm long; **Corolla** campanulate, sparsely pilose outside, glabrous inside; light green with minute reddish dots outside, light yellowish-green inside; tube 1 mm long; lobes 5, ovate acute, *c.* 1.1-1.3 mm long. **Stamens** 5, free, alternipetalous, inserted on and included in the corolla tube; anthers dorsifixed, bilocular, cream, *c.* 0.35-0.4 mm long; filaments glabrous, white, *c.* 0.4 mm long. **Disc** cupular, glabrous, whitish-green, *c.* 0.25 mm diameter. **Stigmas** 2, capitate; style 1, light green-whitish, *c.* 0.2 mm long. **Ovary** inferior, deeply 2-lobed, each lobe globose, whitish-green; *c.* 0.5 mm diameter; each locule with one basal ovule. **Drupe**s globose, glabrous, immature whitish-green, ripening black, *c.* 3-4 mm diameter.

Habitat: open, fire-damaged areas

Phenology: leafing: May-November; flowering: June-August; fruiting: July-October

Abundance: medium

Distribution: N and NE Thailand

Distinguishing features: scrambling, scabrous herb with sessile leaves in whorl of 4; leaf blades obovate to elliptic; inflorescence thyrsoïd

Voucher specimen: 213, 23 July 2001; **Figure** 43

Reference: Craib (1934) 232

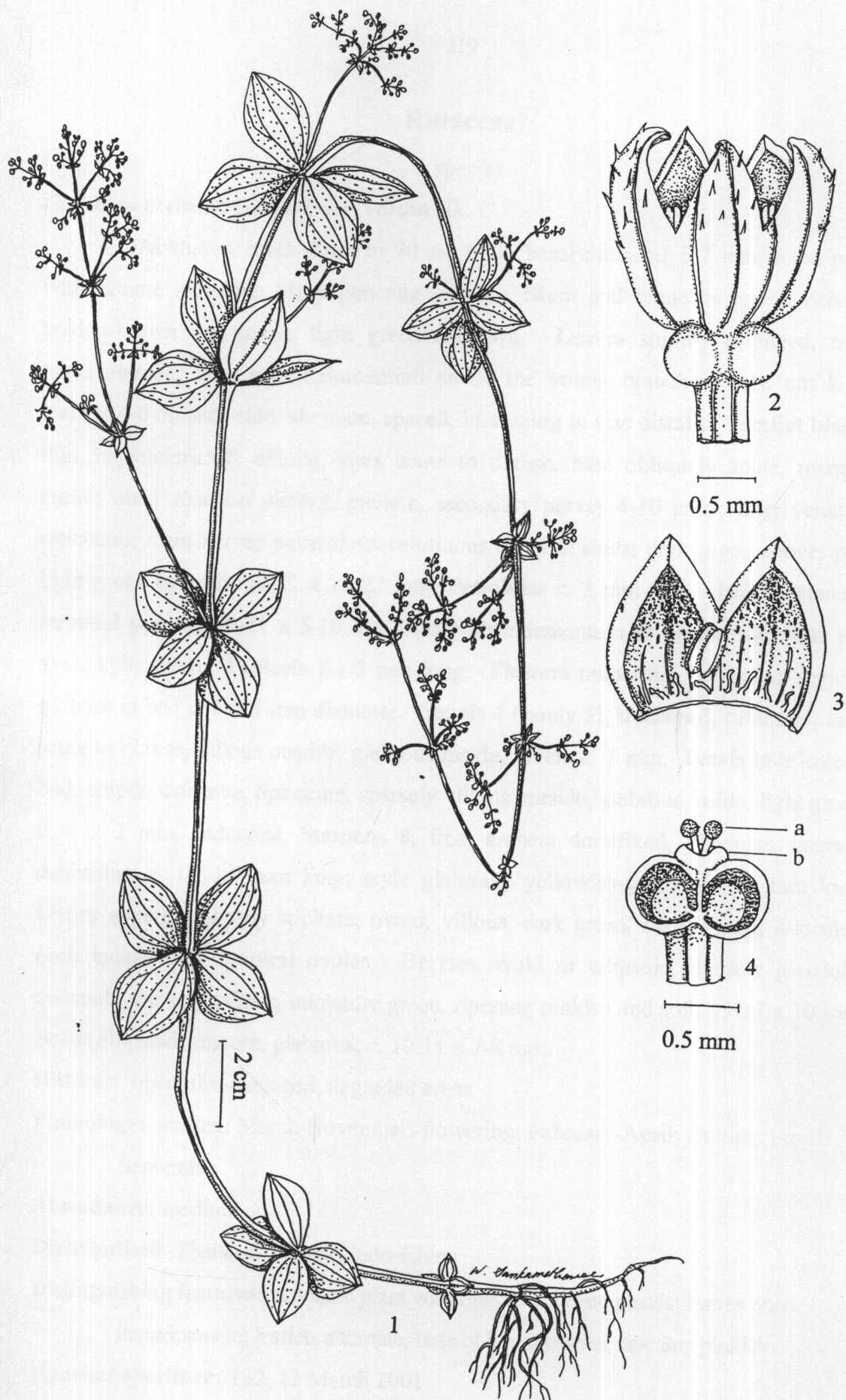


Figure 43 *Rubia siamensis* Craib (#213): 1 = habit, 2 = flower, 3 = part of an opened calyx and a stamen, 4 = pistil with opened ovary: a = stigma, b = disc

Rutaceae

1 species

Clausena excavata Burm. f. var. *villosa* Hk. f.

Deciduous, erect shrub to 70 cm high, basal diameter 5-7 mm, most parts with minute aromatic, black punctate glands. **Stem** and branches terete, densely golden-brown velutinous, light greenish-brown. **Leaves** spirally arranged, once imparipinnate; axes with indumentum as on the young branches, 8-18 cm long; leaflets 4-6 on each side, alternate, spaced, increasing in size distally. **Leaflet blades** thin, asymmetrically oblong, apex acute to obtuse, base obliquely acute, margins entire; main venation distinct, pinnate, secondary nerves 4-10 pairs; finer venation reticulate; main nerves puberulous-velutinous on both sides; dark green above, pale light green beneath; 20-72 x 10-22 mm. **Petiolules** c. 2 mm long. **Inflorescence** a terminal panicle, 10-21 x 5-10 cm; axes with indumentum as on the stem and leaf axes, light green. **Pedicels** 1-1.5 mm long. **Flowers** numerous, 4-merous, regular, globose in bud c. 3-3.5 mm diameter. **Sepals** 4 (rarely 5), thickened, orbicular, apex acute to obtuse, villous outside, glabrous inside, green; c. 1 mm. **Petals** imbricate in bud, elliptic, concave, tips acute, sparsely villous outside, glabrous inside, light green, c. 4 x 2 mm, caducous. **Stamens** 8, free; anthers dorsifixed, bilocular, laterally dehiscent, c. 1.7-1.9 mm long; style glabrous, yellowish-green, c. 1.5 mm long. **Ovary** superior, shortly stipitate, ovoid, villous, dark green, 1.3 x 1 mm; 4-loculed, each locule with 2 apical ovules. **Berries** ovoid or ellipsoid, densely glandular punctate, sparsely villous, immature green, ripening pinkish and soft; 15-17 x 10 mm. **Seeds** ellipsoid, smooth, glabrous, c. 10-11 x 7-8 mm.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: March-November; flowering: February-April; fruiting: April-September

Abundance: medium

Distribution: Thailand, Burma, Indo-China

Distinguishing features: aromatic plant with minute punctate glands; leaves once imparipinnate; leaflets alternate, base oblique; berries, ripening pinkish

Voucher specimen: 132, 13 March 2001

References: Molino (1994) 117; Craib (1926) 232; Guillaumin (1911) 660-662

Scrophulariaceae

9 genera, 11 species

key to genera and species

1. Plants aromatic, glandular-punctate
 2. Inflorescence of terminal racemes *Limnophila chinensis* (Osborn) Merr.
 2. Inflorescence of axillary cymes
 - *Limnophila villifera* Miq. ssp. *gracilipes* (Craib ex Hoss.) Kama.
1. Plants not aromatic, not glandular-punctate
 3. Flowers solitary, axillary
 4. Corolla purplish or violet; leaf blades ovate
 5. Leaves sessile..... *Lindernia pusilla* (Willd.) Bold.
 5. Leaves petiolate..... *Torenia*
 4. Corolla yellowish; leaf blades pinnatisect or lanceolate
 6. Plant sticky, glandular-pilose; leaf blades pinnatisect..... *Phtheirospermum*
 6. Plant not sticky glandular or pilose; leaf blades not pinnatisect..... *Alectra*
 3. Flowers in terminal racemes or spikes
 7. Calyx campanulate
 8. Leaf blades always < 2 mm wide; corolla funnelform..... *Sopubia*
 8. Leaf blades usually > 5 mm wide; corolla salverform..... *Buchnera*
 7. Calyx spathiform
 9. Corolla funnelform, pinkish-white; plant scabrous; leaves opposite..... *Centranthera*
 9. Corolla bilabiate, purple-pink; plant glabrous; leaves alternate..... *Pedicularis*

Alectra avensis (Benth.) Merr.

Annual, erect, ground herb, c. 10-80 cm high. **Roots** orangish-yellow. **Stem** quadrangular, sparsely puberulous; maroon to light green. **Leaves** simple, opposite, decussate. **Blades** thin, lanceolate to ovate-lanceolate; apex acute, base cuneate and decurrent on the petiole, margins sharply serrate or the upper blades deeply and irregularly lobed; with 3 main nerves from the base; finer venation obscure; very finely and sparsely scabrous above, sparsely so on the main nerves below; dull dark green above, pale light green above; c. 10-24 x 2.5-17 mm. **Petioles** 1-3 mm long. **Bracts** filiform, finely and sparsely ciliolate, light green, c. 5-8 mm long. **Flowers** axillary, solitary, partly irregular, sessile, 5-merous. **Calyx** campanulate, regularly 5-

lobed, strigose outside, glabrous inside; light green; tube 4 mm long; lobes triangular, acuminate, 3 mm long. **Corolla** irregularly 5-lobed; pale light yellow; tube 5-6 mm long; upper lip 2-lobed, slightly shorter than the lower lip, lobes suborbicular, apex rounded, c. 2.6 mm diameter; lower lip 3-lobed, 3-3.2 mm diameter. **Stamens** 4, didynamous, inserted on the lower half of and included in the corolla tube; anthers dorsifixed, subglobose, bilocular, shortly apiculate, pale yellow; anterior pair larger c. 1 mm diameter, the posterior pair shorter c. 0.8 mm diameter; filaments curved, very pale light green-whitish, anterior pair longer velutinous, c. 5 mm long, posterior pair shorter glabrous, c. 2.5 mm long. **Stigma** clavate or cylindric, 4.5-5 mm long; style glabrous, 4 mm long. **Ovary** superior, globose, glabrous, c. 1.7-1.8 mm diameter; bilocular with numerous axile ovules. **Capsules** globose, smooth, glabrous, green, turning black, loculicidal. **Seeds** numerous, flat, fusiform, c. 1 mm long, wings thin from both ends, finely reticulate, seed supra medial, ellipsoid, black, c. 0.25 mm long.

Habitat: open, fire-damaged, degraded areas

Phenology: flowering and fruiting: October-December.

Abundance: medium

Distribution: N, NE, SW Thailand, Himalayas, Assam, Burma, southern China, Indo-China, Philippines, Malaysia

Distinguishing features: erect herb, blades with 3 basal nerves and sharply serrate margins; flowers axillary, solitary, sessile, corolla irregular, yellowish; capsules globose; seeds flat, fusiform c. 1 mm long, wings on both ends, finely reticulate, supra medial ellipsoid

Voucher specimen: 330, 3 November 2001

Reference: Yamazaki (1990) 139-141, 222-223, plate IX

Buchnera cruciata Buch.- Ham. *ex* D. Don

Annual, erect, ground herb to c. 80 cm high. **Stem** simple or branched, quadrangular and becoming terete; finely puberulous, pale maroon. **Leaves** simple, sessile, basal rosette leaves spreading, flat on the ground; cauline leaves opposite, decussate, well-spaced; internodes c. 4-12 cm long. **Rosette blades** thin, elliptic, obovate, apex obtuse, 15-35 x 7-20 mm. **Cauline blades** thin, oblanceolate to linear-lanceolate; apex acute, obtuse to rounded, base attenuate, margins entire or irregularly

and remotely shallowly serrulate; finely scabrellous on both sides; dark green above, light green beneath; *c.* 4.5-7 x 2-20 mm. **Inflorescence** terminal, compactly spicate (sometimes almost capitate), 4-angled, *c.* 10-80 x 7-10 mm. **Peduncle** with indumentum as on the stem, light green-brownish, 10-15 mm long. **Bracts** crustaceous, ovate, acuminate to caudate, scabrellous on both sides, dark green, *c.* 5-6 x 3-3.5 mm, persistent. **Bracteoles** linear, acuminate, margins incurved, *c.* 3.5-4 mm long. **Flowers** several, sessile, 4-ranked, irregular, 5-merous. **Calyx** cylindric, irregularly 5-lobed, dark green; tube scabrellous outside, glabrous inside, *c.* 4-4.5 mm long; lobes linear-lanceolate, acuminate, scabrellous, 2 mm long, the posterior segment slightly shorter than the other 4. **Corolla** salverform; tube cylindric, glabrous at the base, otherwise puberulous, whitish-purple, 7-9 mm long; lobes 5, imbricate in bud, spreading at maturity, obovate or elliptic, apex rounded, finely puberulous, pale violet outside, deep blue to violet inside, *c.* 3 x 2 mm. **Stamens** 4, didynamous, inserted on and included in the lower half of the corolla tube; anthers dorsifixed, ellipsoid, apiculate, *c.* 0.8-0.9 mm long; filaments glabrous, posterior pair longer, 1.3 mm long, anterior pair shorter, *c.* 0.3 mm long. **Stigma** irregularly 2-lobed, shorter lobe lanceolate, *c.* 0.5 mm long, longer lobe clavate, *c.* 1 mm long; style glabrous, *c.* 1.2 mm long. **Ovary** superior, ellipsoid, glabrous, *c.* 1.3 mm long; bilocular with numerous axile ovules. **Infrutescence** elongating. **Capsules** enveloped by the persistent enlarged calyx; smooth, glabrous, black, *c.* 5-5.5 x 2.5 mm, loculicidal. **Seeds** numerous, obliquely rectangular or cuneate, ribbed, *c.* 0.4 mm long.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: August-December; flowering: September-December;
fruiting: September-February

Abundance: common

Distribution: N, NE, E, SE, SW Thailand, Nepal, Khasia mountains (Assam),
Burma, southern China, Indo-China

Distinguishing features: erect, scabrous herb with basal rosette leaves flat on the ground; cauline leaves spaced, sessile; inflorescence compactly spicate, flowers in 4 ranks; corolla salverform, deep blue-violet

Voucher specimen: 308, 17 October 2001; **Plate** 19 A

Reference: Yamazaki (1990) 139-141, 216 (fig.) 230-231

Note: specimens drying blackish

Centranthera cochinchinensis* (Lour.) Merr. ssp. *cochinchinensis

Annual, erect, ground herb to c. 80 cm high. **Roots** orangish-yellow. **Stem** quadrangular, scabrous; pale light green-brownish, internodes 4-8 cm long. **Leaves** simple, opposite, decussate, sessile. **Blades** subcoriaceous, linear to linear-lanceolate; apex acute, base cuneate, margins entire or finely and remotely serrate; midnerve prominent, sunken above, raised below; other venation obscure; scabrous on both sides; light green-brownish above, pale light green beneath; c. 7-30 x 2.5-5 mm. **Inflorescence** terminal, racemose, to 25 cm long, and merging with solitary, axillary flowers; axes quadrangular, scabrous, pale light green-brownish. **Pedicels** 2-3 mm long. **Bracts** like very reduced leaves, 4-8 x 2-4 mm. **Flowers** several, irregular 5-merous. **Calyx** spathiform, 4-ribbed dorsally, apex acute, sparsely scabrellous outside, glabrescent inside, reddish-brown, 13-16 x 13-14 mm. **Corolla** funnelform; tube finely glandular puberulous on both sides, light brown-reddish and with orangish-yellow dorsally, 23-25 mm long; lobes 5, subequal, orbicular, whitish-pink: upper lip 2-lobed, 3 mm diameter; lower lip 3-lobed, slightly smaller than the upper one. **Stamens** 4, didynamous, inserted on the lower part of and included in the corolla tube; anthers dorsifixed, unequally bilocular, cream; upper locule larger, reniform, basally apiculate, c. 2 mm long; lower locule reduced, base aristate, fertile part c. 0.8 mm long; connective densely velutinous; filaments flattened, pilose in the upper part on one margin with flattened, linear scales on the opposite margin, very pale light green-yellowish; anterior pair longer 16 mm long, posterior pair shorter 7-8 mm long. **Stigma** elliptic, flat, 3 x 1.5 mm; style included in the corolla, glabrous, pale light green-yellow, c. 20-22 mm long. **Ovary** superior, ovoid, glabrous, 2 mm long; bilocular with numerous axile ovules. **Capsules** ellipsoid, smooth, glabrous, black, 7-8 x 4 mm, loculicidal. **Seeds** numerous, fusiform, ribbed, dark brown, 0.7-0.9 mm long.

Habitat: open marshes

Phenology: leafing: September-November; flowering: October-November; fruiting: October-December

Abundance: rare

Distribution: throughout Thailand, southern China, Indo-China

Distinguishing features: scabrous herb; quadrangular stem; loose spicate inflorescence; spathiform, reddish-brown calyx; pinkish-white funnellform corolla; only found in marshes

Voucher specimen: 327, 3 November 2001

Reference: Yamazaki (1990) 139-141, 226-228

***Pedicularis nigra* Van. ex Bon.**

Deciduous, decumbent or erect, ground herb, vegetative parts glabrous, c. 70 cm high. **Roots** swollen, fleshy. **Stem** and branches subterete, glabrous, older basal part dull maroon, upper younger part very pale light green to greenish-cream. **Leaves** simple, alternate, sessile, glabrous. **Blades** subcoriaceous, oblanceolate or lanceolate; apex acute to obtuse, base attenuate, margins shallowly and broadly serrate; venation pinnate, midnerve sunken above, raised below, secondary nerves obscure 7-12 pairs; finer venation finely reticulate; dark green above, dull light green beneath; 25-80 x 4-13 mm. **Inflorescence** in terminal and axillary racemes, 5-13 cm long; axes glabrous, reddish-pink to pale light green. **Pedicels** 1-2 mm long. **Bracts** ovate, elliptic or lanceolate, margins finely crenulate, scabellous on the midnerve above, light green, embracing the flowers, c. 12-18 x 5-8 mm. **Flowers** several, irregular, 5-merous. **Calyx** spathiform, slit posterior; apex shallowly 2-lobed, glabrous on both sides, light green, c. 10-12 x 7-10 mm. **Corolla** bilabiate, pinkish-purple; tube puberulous outside, velutinous inside; c. 1.5-1.8 cm long; upper lip entire, galeate, mostly glabrous, puberulous on the keel outside, c. 17 x 10 mm; lower lip 18-22 mm long, 3-lobed, the midlobe orbicular with a whitish band from the throat, c. 6-7 mm diameter, the lateral lobes obliquely ovate, glabrous, c. 10 x 8 mm. **Stamens** 4, equal, inserted at the base of the corolla tube and embraced by the upper corolla lip; anthers dorsifixed, bilocular, cream; c. 3.5 mm long; filaments whitish-pink, pilose, c. 3.5 cm long. **Stigma** capitate, green; style glabrous, whitish-pink, c. 4 cm long. **Ovary** superior, obliquely ovoid, tip compressed, acute, base swollen; glabrous, c. 4 x 2 mm; bilocular, each locule with numerous axile ovules. **Capsules** obliquely ovoid, calyx persistent, slightly compressed in the upper half; glabrous; ripening black, dehiscing

loculicidal dorsally, c. 15-18 x 6-7 mm. **Seeds** numerous, irregularly ellipsoid, tuberculate, dark brown-black, c. 1.2-1.5 x 1-1.3 mm.

Habitat: partly shaded, fire-damaged, degraded areas

Phenology: leafing: September-February; flowering: December-January; fruiting: December-February

Abundance: medium

Distribution: N and NE Thailand, Burma, Laos, Vietnam

Distinguishing features: plant perennial, mostly glabrous; spiral, sessile leaves; pinkish-purple, bilabiate corolla with the upper lip galeate; spathiform calyx

Voucher specimen: 373, 24 December 2001; **Plate** 19 C

Reference: Yamazaki (1990) 139-141, 235-237, plate XI

***Phtheirospermum parishii* Hk. f.**

Annual, erect, ground herb to c. 18 cm high. **Stem** simple or branched, terete with sticky, simple, glandular and multicellular indumentum; dull violet to pale light green. **Leaves** simple, opposite, decussate, sessile. **Blades** thin, broadly ovate to orbicular in outline, pinnatisect, mainly 3-lobed, each lobe irregularly sinuate, bases narrowing and appearing as a petiolule, c. 2-3 mm long; one-nerved with fine scattered glandular indumentum above, densely so beneath; dark green above, pale light green beneath, sometimes dull violet on both sides, especially the lower side of older ones; 6-14 x 5-16 mm. **Flowers** solitary, axillary, irregular, 5-merous. **Pedicels** with indumentum as on the stem, c. 2 mm long. **Calyx** tube campanulate, densely glandular pilose outside, scarcer inside, light green, c. 2-2.5 mm long; posterior lobe 1, entire, ovate, c. 1 mm long; anterior lobes 4, larger and equal, oblong, apices acute, c. 3 mm long. **Corolla** bilabiate, yellow, sparsely glandular pilose outside, glabrous inside; tube 4.5-5 mm long; upper lip 1-lobed, shallowly bifid, c. 2 x 3 mm; lower lip spreading, 3-lobed, each lobe obovate or suborbicular, apex truncate, the midlobe slightly larger than the lateral ones, c. 3.5 x 2-2.5 mm. **Stamens** 4, didynamous, inserted at the base of and included in the corolla tube; anthers basifixed, subequally bilocular, ellipsoid, sparsely pilose along the sutures, c. 0.5 mm long, shortly apiculate; filaments pilose, white; longer pair 4 mm long, shorter pair with less indumentum, c. 2 mm long. **Stigma** 2-lobed, elliptic, flattened, tips acute, slightly

reflexed; style glabrous or scarcely puberulous at the base, 3.5 mm long. **Ovary** superior, obliquely ovoid, densely pilose in the upper half, *c.* 1 mm long; bilocular with numerous axile ovules. **Capsules** obliquely ovoid, pilose, 2.7-3 x 2-2.3 mm, calyx persistent. **Seeds** numerous, ellipsoid, dark brown, tuberculate, *c.* 0.2 mm long.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing, flowering and fruiting: November-December

Abundance: medium

Distribution: northern Thailand, Burma

Distinguishing features: glandular-sticky, pilose herb < 20 cm tall; blades deeply pinnatisect; corolla yellow, bilabiate with upper lip 1-lobed and spreading 4-lobed lower lip

Voucher specimen: 358, 14 November 2001

Reference: Yamazaki (1990) 139-141, 233-235 (fig.)

Sopubia trifida Buch.-Ham. *ex* D. Don

Annual, erect, branched ground herb to *c.* 1 m high. **Stem** and branches quadrangular and becoming terete, young branches quadrangular; finely puberulous and with scattered glands, pale light green to light brown. **Leaves** simple, opposite, decussate, sessile. **Blades** chartaceous, filiform or linear; apex acute, base decurrent, margins entire; venation obscure, midnerve sunken above; scabrellous above, glabrous beneath; dark green above, pale light green beneath, sometimes dull maroon on both sides, especially the lower, older blades; 3-30 x 0.5-1 mm. **Inflorescence** terminal, racemose, lax, *c.* 20 cm long; axes puberulous, pale light green to light brown. **Pedicels** *c.* 5-10 mm long. **Bracts** as reduced leaves, linear, *c.* 2.5-3 x 0.4 mm; bracteoles subulate, *c.* 1.5 mm long. **Flowers** numerous, irregular, 5-merous, *c.* 2-2.5 mm diameter. **Calyx** campanulate, 5-lobed, dark green; tube bluntly 10-ribbed, scabrellous outside, glabrous inside, *c.* 3 mm long; lobes acute, scabrous outside, velutinous inside, *c.* 1 mm long. **Corolla** globose in bud, deeply and almost regularly 5-lobed, pale light yellow; tube glabrous on both sides, *c.* 3 mm long; lobes orbicular, finely puberulous outside, inside glabrous and with dull reddish spots, *c.* 5 mm diameter. **Stamens** 4, didynamous, inserted on the middle of and included in the corolla tube; anthers basifixed, bilocular with one fertile and one sterile locule; the

fertile locule puberulous on the dehiscent side, yellow, *c.* 1.7 mm long; sterile locule clavate, glabrous, dark maroon, *c.* 1.2 mm long; filaments glabrous, maroon: longer pair curved, *c.* 3 mm long; shorter pair *c.* 2 mm long. **Stigma** flattened oblong, bilabiate, yellowish-cream; style glabrous, yellowish-cream, *c.* 4-4.5 mm long. **Ovary** superior, globose, glabrous, *c.* 1.5 mm diameter, bilocular, each locule with numerous axile ovules. **Capsules** globose, glabrous, black, *c.* 4-4.5 mm diameter, loculicidal, calyx persistent. **Seeds** numerous, irregularly ellipsoid, tuberculate, dark brown-black, *c.* 0.7 mm long.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: September-December; flowering: September-December; fruiting: September-February

Abundance: common

Distribution: N, NE, E Thailand, Pakistan, India, Sri Lanka, Nepal, Sikkim, southern China, Indo-China, Philippines, Malaysia

Distinguishing features: leaf blades linear or filiform, scabrous, up to *c.* 1 mm wide; inflorescence terminal, racemose; corolla nearly regular, yellowish; corolla buds and capsules globose

Voucher specimen: 335, 3 November 2001

Reference: Yamazaki (1990) 139-141, 223-224, plate XIV

Torenia

key to species

1. Corolla < 1 cm long; calyx not winged *Torenia benthamiana*
1. Corolla > 2 cm long; calyx winged..... *Torenia violacea* (Aza. ex Blanco) Pennell

Torenia benthamiana Hance

Annual ground herb, 6-18 cm high. **Stem** simple or branched, quadrangular, sparsely pilose, glabrescent; maroon to reddish-brown. **Leaves** simple, opposite, decussate. **Blades** thin, ovate, ovate-lanceolate or elliptic; apex acute, base acute, rounded to truncate and decurrent on the petiole, margins serrate; venation pinnate, midnerve distinct, secondary nerves 4-6 pairs; finer venation reticulate; sparsely pilose on both sides; dark green above, pale light green beneath; *c.* 10-30 x 4-16 mm.

Petioles with indumentum as on the blades, 0-6 mm long. **Flowers** solitary, axillary, often appearing as a terminal cyme, irregular, 5-merous. **Pedicels** sparsely pilose, maroon to reddish-brown, *c.* 3-6 mm long, later elongating to *c.* 13 mm in fruit. **Calyx** campanulate, bilabiate, densely pilose outside, glabrous inside, light green with 5 brownish ridges; tube 5 mm long; upper lip 3-lobed, lobes linear, *c.* 2-3 mm long; lower lip 2-lobed, lobes subulate, *c.* 1.5 mm long. **Corolla** glabrous; tube whitish-purple, 5-6 mm long; upper lip entire, suborbicular, shallowly emarginate, purple, *c.* 3 mm diameter; lower lip 3-lobed, each lobe suborbicular, purple, with a rounded, yellowish, patch below the midlobe. **Stamens** 4, didynamous, posterior pair inserted on the middle part of and included in the corolla tube; anthers basifixed, bilocular, divergent, *c.* 0.8 mm long, apiculate, connective broad, lower locule spurred, appearing winged on one side; filaments glabrous, *c.* 1 mm long; anterior pair smaller than the posterior pair, inserted on the corolla throat, connective swollen; their filaments glabrous and each with an erect spur medially, *c.* 2 mm long. **Stigma** equally 2-lobed, flattened, tips acute, *c.* 0.4 mm long; style glabrous, whitish, 4 mm long. **Disc** cupular, glabrous. **Ovary** superior, ellipsoid, tip slightly curved and finely puberulous, otherwise glabrous, *c.* 2 mm long; bilocular with numerous axile ovules. **Capsules** ellipsoid, enclosed in the persistent calyx, loculicidal, *c.* 8 x 3 mm. **Seeds** numerous, irregularly several-angled, tuberculate, brownish, *c.* 0.2 mm long.

Habitat: open, degraded, non fire-damaged areas

Phenology: leafing: October-November; flowering: October; fruiting: October
November

Abundance: medium

Distribution: northern Thailand, Indo-China

Distinguishing features: herb < 20 cm tall, stem quadrangular, leaf blade margins serrate; solitary axillary flowers < 1 cm long, bilabiate purplish corolla

Voucher specimen: 307, 17 October 2001; **Figure** 44

References: Yamazaki (1990) 139-141; Yamazaki (1985) 136-137, 139, 141 (fig.)

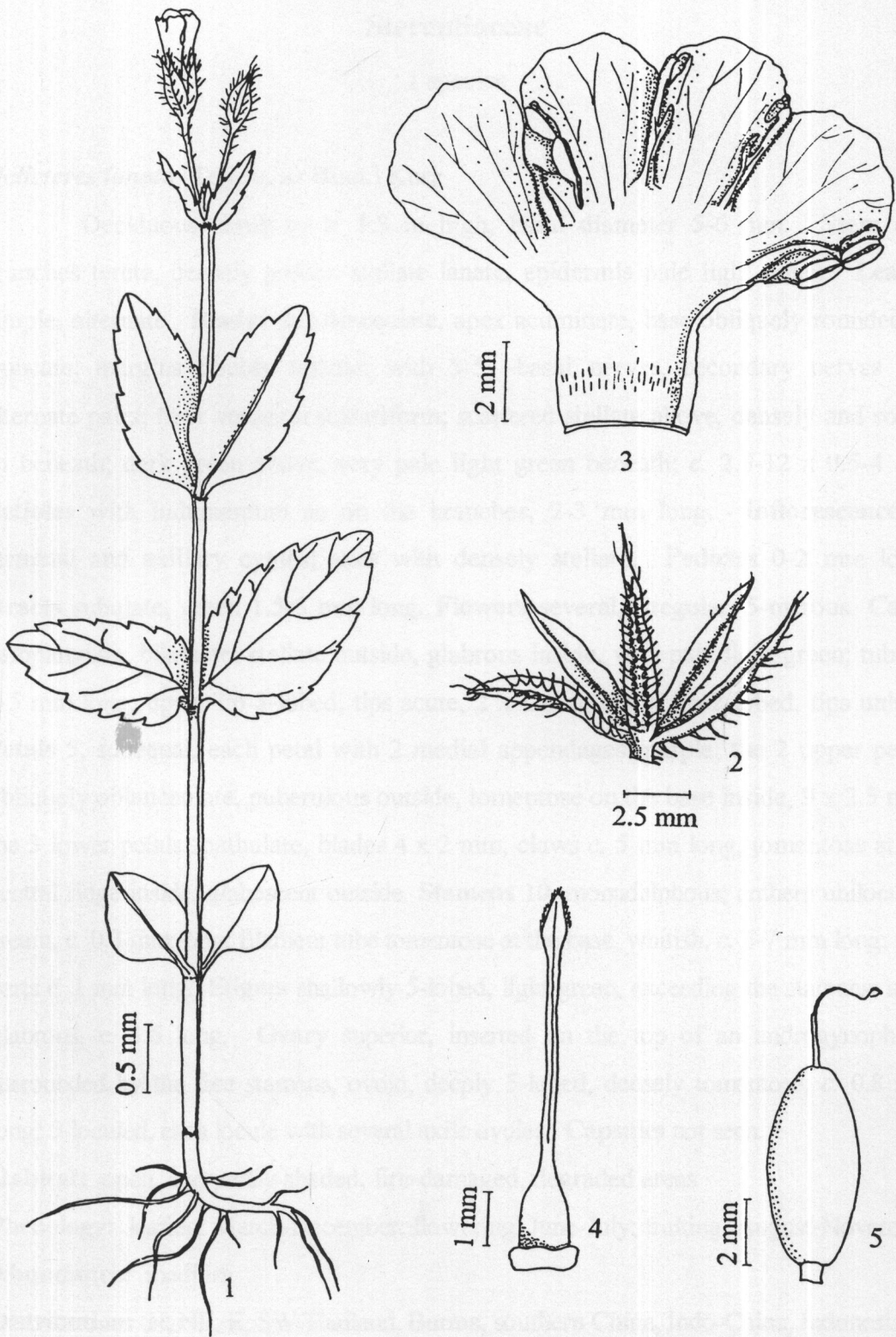


Figure 44 *Torenia benthamiana* Hance (#307): 1 = habit, 2 = calyx, 3 = opened corolla, 4 = pistil, 5 = capsule

Sterculiaceae

1 species

Helicteres lanata (Teijsm. ex Binn.) Kurz

Deciduous shrub to c. 1.3 m high, basal diameter 5-6 mm. **Stem** and branches terete, densely golden stellate lanate, epidermis pale light green. **Leaves** simple, alternate. **Blades** thin lanceolate, apex acuminate, base obliquely rounded to truncate, margins doubly serrate; with 3-5 –basal nerves, secondary nerves 3-5 alternate pairs; finer venation scalariform; scattered stellate above, densely and softly so beneath; dark green above, very pale light green beneath; c. 2.5-12 x 0.5-4 cm. **Petioles** with indumentum as on the branches, 2-3 mm long. **Inflorescence** in terminal and axillary cymes; axes with densely stellate. **Pedicels** 0-2 mm long. **Bracts** subulate, green 1.5-3 mm long. **Flowers** several, irregular, 5-merous. **Calyx** campanulate, bilabiate; stellate outside, glabrous inside, very pale light green; tube c. 4-5 mm long; upper lip 3-lobed, tips acute, 2 x 1 mm; lower lip 2-lobed, tips united. **Petals** 5, subequal, each petal with 2 medial appendages, purple; the 2 upper petals obliquely oblanceolate, puberulous outside, tomentose on the base inside, 9 x 2.5 mm; the 3 lower petals spatulate, blades 4 x 2 mm, claws c. 5 mm long, tomentose at the central ridge inside, glabrescent outside. **Stamens** 10, monadelphous; anthers unilocular, cream, c. 0.3 mm long; filament tube tomentose at the base, whitish, c. 6-7 mm long; free parts c. 1 mm long. **Stigma** shallowly 5-lobed, light green, exceeding the stamens; style glabrous, c. 1.5 long. **Ovary** superior, inserted on the top of an androgynophore, surrounded by the free stamens, ovoid, deeply 5-lobed, densely tomentose, c. 0.8 mm long; 5-loculed, each locule with several axile ovules. **Capsules** not seen.

Habitat: open, and partly shaded, fire-damaged, degraded areas

Phenology: leafing: March-December; flowering: June-July; fruiting: August-November

Abundance: medium

Distribution: N, NE, E, SW Thailand, Burma, southern China, Indo-China, Indonesia

Distinguishing features: leaf blades lanceolate, base oblique; plant with stellate indumentum; flowers irregular; petals purple; stamen monadelphous

Voucher specimen: 222, 13 July 2001; **Figure** 45

Reference: Phengkklai (2001) 562, 568, 570 (fig.)-571

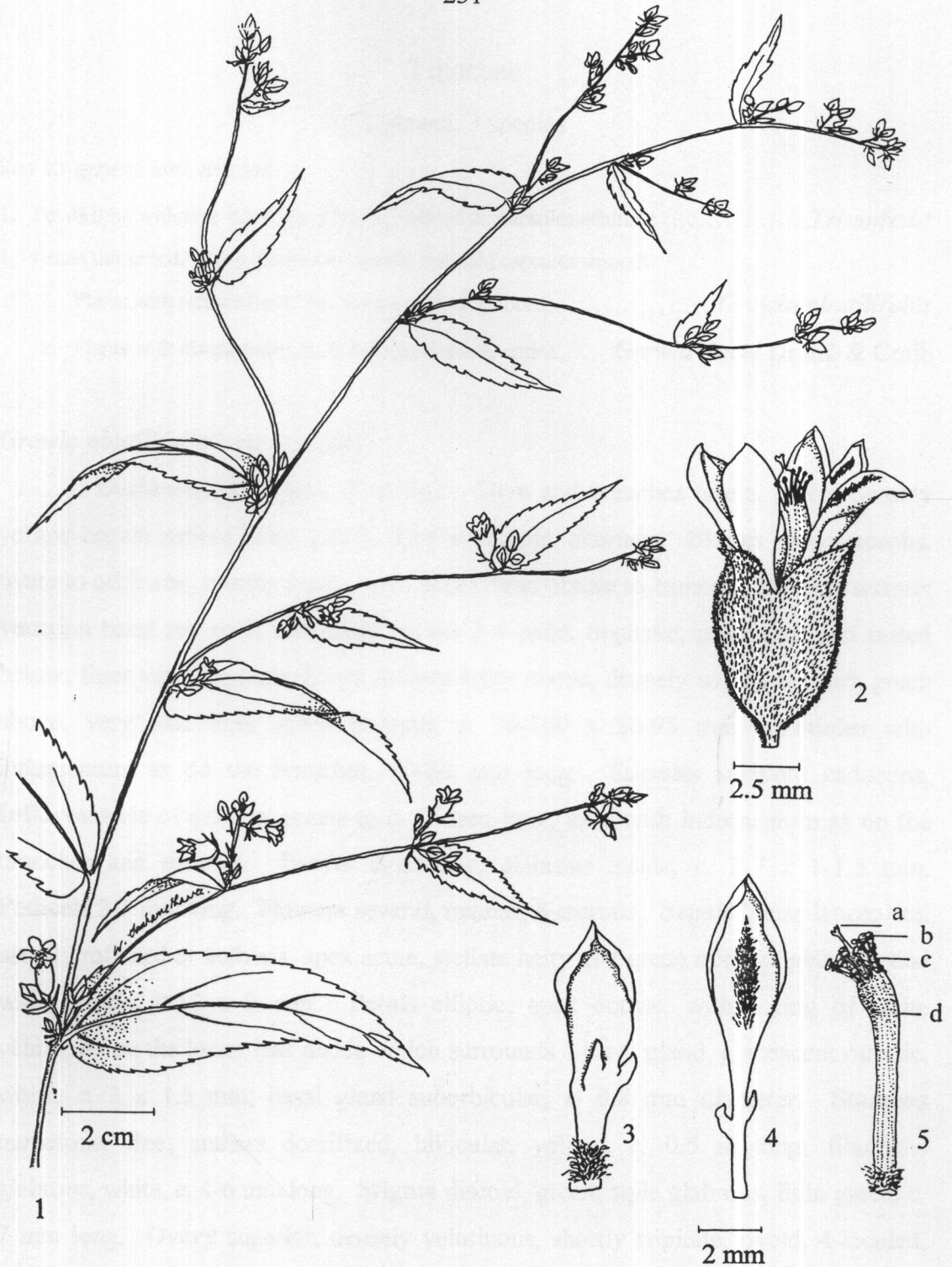


Figure 45 *Helicteres lanata* (Teijsm. & Binn.) Kurz (#222): 1 = upper part of plant, 2 = flower, 3 = upper petal, 4 = lower petal, 5 = androgynophore: a = stigma, b = anther, c = filament, d = filament tube

Tiliaceae

2 genera, 3 species

key to genera and species

1. Petals thin, without a basal gland inside, yellowish; capsules echinate.....*Triumfetta*
1. Petals thickened, with a basal gland inside, whitish; capsules smooth
 2. Plants with stellate hairs; leaf blades orbicular, lobed.....*Grewia abutilifolia*
 2. Plants with simple hairs; leaf blades lanceolate, entire..... *Grewia lacei* Drum. & Craib

***Grewia abutilifolia* Vent. ex Juss.**

Deciduous shrub to c. 1 m high. **Stem** and branches terete, green, densely yellow-brown stellate hairy, green. **Leaves** simple, alternate. **Blades** subcoriaceous, ovate to orbicular, usually lobed, apex acute, base obtuse to truncate, margins serrate; venation basal nerves 3, secondary nerves 3-4 pairs, opposite, prominent and raised below; finer venation scalariform; stellate hairy above, densely so below; dark green above, very pale light green beneath; c. 30-100 x 20-95 mm. **Petioles** with indumentum as on the branches, 10-20 mm long. **Stipules** subulate caducous. **Inflorescence** of axillary cymes to c. 15 mm long; axes with indumentum as on the branches and petioles. **Bracts** lanceolate, glabrous inside, c. 3-7 x 1-1.5 mm. **Pedicels** 2-3 mm long. **Flowers** several, regular, 5-merous. **Sepals** linear-lanceolate, usually reflexed at anthesis, apex acute, stellate hairy and green outside, glabrous and white inside, 9-10 x 2 mm. **Petals** elliptic, apex obtuse, with a ring of white velutinum on the lower half inside which surrounds a basal gland, glabrescent outside, white, c. 3 x 1.5 mm; basal gland suborbicular, c. 0.8 mm diameter. **Stamens** numerous, free; anthers dorsifixed, bilocular, yellow, c. 0.5 mm long; filaments glabrous, white, c. 4-6 mm long. **Stigma** discoid, green; style glabrous, light green, c. 7 mm long. **Ovary** superior, densely velutinous, shortly stipitate, ovoid, 4-loculed, each locule with 2 axile ovules. **Fruits** not seen.

Habitat: open fire-damaged, degraded areas

Phenology: leafing: April-December; flowering: April-August; fruiting: April-October

Abundance: medium

Distribution: throughout Thailand, India, Burma, China, Indo-China, Malay Peninsula

Distinguishing features: plants covered with yellow-brown stellate hairs; leaf blades

orbicular, lobed; sepals larger than the petals which have a basal gland inside

Voucher specimen: 161, 3 May 2001

Reference: Phengklai (1993) 14, 16, 19-21 (fig.)

Note: A related species is *G. lacei* Drumm. & Craib which has lanceolate, entire leaf blades and very dense brownish lanate indumentum on the blades underneath.

***Triumfetta pilosa* Roth**

Deciduous shrub, 0.5-1.2 m high, basal diameter 5-6 mm. **Stem** and branches terete, densely stellate. **Leaves** simple, alternate. **Blades** thin, ovate to lanceolate, apex acute, base acute to rounded, margins doubly serrate; with 3 basal nerves, secondary nerves 2-3 alternate pairs, prominent and raised below; finer venation obscurely reticulate; scattered stellate above, very densely so beneath; dark green above, very pale light green beneath; c. 17-70 x 9-40 mm. **Petioles** 2-16 mm long. **Inflorescence** in terminal and axillary cymes, c. 8-14 mm long; axes reddish-brown. **Pedicels** 1-3 mm long. **Bracts** subulate, 3-4 mm long. **Flowers** several, regular, 5-merous. **Sepals** linear, tips with short cusps; stellate hairy outside, glabrous inside, yellowish-brown, c. 6-7 x 1 mm. **Petals** thin, oblanceolate, apex rounded, mostly glabrous, stellate at base, bright yellow-orange, c. 5 x 1.2-1.3 mm. **Stamens** 10, free; anthers dosifixed, bilocular, yellow, c. 0.5-0.6 mm long; filaments glabrous, light yellow, c. 4-6 mm long. **Disc** pilose. **Stigma** capitate; style glabrous, light yellow, c. 4-5 mm long. **Ovary** superior, globose, densely setulose, c. 1 mm diameter; 4-locular, each locule with 2 axile ovules. **Capsules** immature, globose, echinate; green, c. 1 mm diameter (including the echinae).

Habitat: open fire-damaged, degraded areas

Phenology: leafing: July-January; flowering: September-October; fruiting: September-January

Abundance: medium

Distribution: throughout Thailand, India, Nepal, China, Indo-China, Malay Peninsula, Indonesia, Philippines

Distinguishing feature: most parts with stellate indumentum; echinate, globose capsules

Voucher specimen: 280, 28 September 2001

Reference: Phengklai (1993) 44, 46-47 (fig.)

Umbelliferae

2 genera, 2 species

key to genera

- 1. Leaves once pinnate.....*Heracleum barmanicum*
- 1. Leaves simple.....*Pimpinella cambodgiana*

Heracleum barmanicum Kurz

Deciduous, erect, unbranched, ground herb to 1.3 m high, basal diameter 8-12 mm. **Rootstock** hard outside, fleshy inside. **Stem** terete, upper young part tomentose, light green; lower old part puberulous, brownish-green; grooved when dry, puberulous on older parts, brownish-green, **Leaves** spirally arranged, once pinnate, irregular; rachis 4-12 cm long, channeled above, puberulous. **Leaflet blades** thin; distal leaflet deeply 3-5-lobed, apex acute, margins irregularly serrate; lateral leaflet blades opposite, 1-2-paired, oblong with entire margins or irregularly 3-5-lobed; venation pinnate, 2-6 pairs; finer venation reticulate, midnerve sunken above, prominent and raised beneath; scabrellous and dark green above, puberulous and very pale light green below; 3.5-12.5 x 0.8-12.5 cm. **Petioles** sheathing at the base, puberulous, light green c. 4-17 cm long, upper leaves reduced and with more developed sheaths. **Inflorescence** a terminal, compound umbel, 6-9 cm diameter. **Peduncle** densely puberulous, light green, c. 6 cm long; primary umbel axes several, c. 1.5-3.5 cm long; pedicels 1-4 mm long. **Bracts** lanceolate, apex caudate, margins undulate, c. 8-11 x 1.5-2 mm; bracteoles filiform, 2-4 mm long. **Flowers** numerous, regular, 5-merous, slightly fragrant. **Sepals** absent. **Petals** 5, reflexed, apex mucronate, glabrous, whitish, c. 1.8-2 x 1-1.2 mm. **Stamens** 5; anthers dorsifixed, introrse, bilocular, reddish in bud, maturing cream, c. 0.7-0.8 mm long; filaments glabrous, white, 2.5 mm long. **Stigma** 2, punctate; styles 2; fused and enlarged at base (stylopodc), glabrous, whitish-green, c. 0.8 mm diameter. **Ovary** inferior, puberulous, c. 1 mm diameter; 2-carpeled, 2-loculed, each locule with one apical ovule. **Schizocarp** immature, greenish, with 2 compressed, winged mericarps, seeds aromatic.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: June-November; flowering: September-October; fruiting:

October-February

Abundance: medium

Distribution: N and SW Thailand, Assam, Burma, SW China

Distinguishing features: erect simple stem; large once pinnate leaves with basal sheaths; inflorescence a compound umbel; sepals absent; petal reflexed, white

Voucher specimen: 318, 16 October 2001

Reference: Hedge & Lamond (1992) 442-443, 461(fig.), 469-470

Note: dry seeds edible, used as a spice by local Lawa people

***Pimpinella cambogiadna* H. Boiss.**

Deciduous, erect, branched ground herb to c. 90 cm high. **Stem** terete, shallowly grooved when dry, finely and sparsely puberulous and glabrescent; basal part dull maroon, upper part light green. **Leaves** simple, spirally arranged, mostly in a basal rosette. **Rosette blades** thin, flat on the ground, ovate, apex obtuse, base deeply cordate, basal lobes c. 5-37 x 5-25 mm, margins serrulate; main nerves 5 from the base, midnerve sunken above, prominent and raised below, secondary nerves 2-4 pairs, each pinnately nerve; finer venation reticulate; glabrous on both sides; dark green above, very dull light green or sometimes dull light violet underneath; 25-75 x 20-60 mm. **Petioles** light green or dull light violet-maroon, 25-65 mm long. **Cauline leaf blades** thin, variously shaped, linear or oblanceolate with divergent basal lobes, margins serrulate to pinnatisect, 12-60 x 2-10 mm, basal lobes 10-30 x 1.5-3 mm, petiole sheathing c. 10-20 mm long. **Inflorescence** of terminal and axillary compound umbels c. 4-9 diameter; axes finely puberulous, light green. **Peduncle** c. 2.5-10 cm long; secondary axes several, slender, c. 10-30 mm long; pedicels c. 3-6 mm long. **Bracts** linear, glabrous, margins ciliolate, 5 x 1 mm. **Flowers** numerous, regular, 5-merous, c. 2 mm diameter. **Sepals** absent. **Petals** 5, obcordate, medially keeled, puberulous outside, papillose inside, white, c. 0.8-0.7 mm. **Stamens** 5, alternipetalous; anthers basifixed, orbicular, bilocular, cream c. 0.3 mm long; filaments glabrous, white, c. 1-1.2 mm long. **Style** fused or enlarge at base (stylopodic), elongating in fruit. **Ovary** inferior, 2-carpeled, 2-loculed, each locule with one apical ovule. **Schizocarps** immature, with 2 mericarps and a persistent stylopodium, irregularly ovoid, 4-5-ribbed, tuberculate, 1.5 x 1 mm. **Seeds** cuneate, 4-5-ribbed, c. 1.5 x 1 mm.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: May-November; flowering: June-October; fruiting: July-December

Abundance: abundant

Distribution: N, NE, SW Thailand, Cambodia

Distinguishing features: leaves simple, basal rosette, flat on the ground, base deeply cordate, margins serrulate, 5 nerves from base; cauline leaf blades linear or lanceolate with divergent basal lobes; inflorescence of compound umbels, sepals absent; shizocarps ovoid, 4-5-ribbed

Voucher specimen: 199, 22 June 2001; **Plate** 19 D

Reference: Hedge & Lamond (1922) 442-443, 452-454, 459 (fig.)

Urticaceae

2 genera, 2 species

key to genera and species

1. Leaf blades elliptic, margins serrate, petioles > 2 cm long; inflorescence open, of helicoid cymes
.....*Pilia trinervia* Wight
1. Leaf blades lanceolate, margins entire, petioles < 5 mm long; flowers in dense clusters
.....*Pouzolzia pentandra*

Pouzolzia pentandra (Roxb.) Benn.

Deciduous, ascending, monoecious, ground herb to 90 cm high. **Roots** digitiform, tuberous, brown outside, white and fleshy inside, up to 30 cm long. **Stem** terete, glabrous or with scattered hispid, scabrous indumentum; reddish-brown. **Leaves** simple, opposite, decussate and decreasing in size toward the top of the stem. **Blades** thin, lanceolate, ovate-lanceolate, apex acuminate, base truncate or shallowly cordate, margins minutely cuspidate; 3-nerved from the base, nerves sunken above, prominent and raised below; finer venation reticulate, with scattered hispid indumentum on both sides and densely so beneath; green above, very pale light green beneath, c. 3-7 x 1.5-2 cm. **Petiole** 0-2 mm long. **Flowers** unisexual, regular, 5-merous. **Male flowers** several, in dense axillary clusters. **Pedicels** light green-whitish, glabrous, c. 0.5-3 mm long. **Bracts** like reduced leaves, alternate on upper part of the branches; subulate to ovate, thin, margins ciliolate, c. 0.8-1 mm long. **Flower buds** suborbicular or obconical, flat-topped or depressed, c. 2 mm diameter. **Tepals** 5; upper 1/3 strongly incurved and covering the stamens, apex acuminate, reddish-brown, sparsely hooked hispid, c. 0.5 mm long; lower 2/3 pale light green with scarcer indumentum outside, glabrous inside, c. 1 mm long. **Stamens** 5; opposite the tepals; anthers basifixed, introse, bilocular, cream, c. 0.7-0.8 mm long; filaments 1-1.3 mm long. **Female flowers** several in reduced leaf axils, sessile. **Perianth** urceolate with 10-15 vertical ridges, scattered hispid, c. 1-1.3 mm long; **Stigma/style** 1, filiform, whitish, c. 4-5 mm long, caducous. **Ovary** superior, ovoid, unilocular with one basal ovule, c. 1 mm long. **Achenes** as large as, and completely enclosed by the perianth, brownish.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: April-December; flowering: May-August; fruiting: July-November

Abundance: common

Distribution: northern Thailand, Indo-China

Distinguishing features: ascending, deciduous, braching herb with long digitiform tubers up to 30 cm long; leaves opposite, decussate, subsessile, blades lanceolate with 3 main nerves from the base, scabrous; bracts like reduced leaves alternate near the tip of the stem; flowers minute, unisexual in dense axillary clusters; female flowers in upper bracts axils, with a single filiform, white style

Voucher specimens: 183, 5 June 2001; Maxwell 00-272, 30 June 2000; **Plate** 19 E

Reference: Gagnepain (1929) 847, 852-853

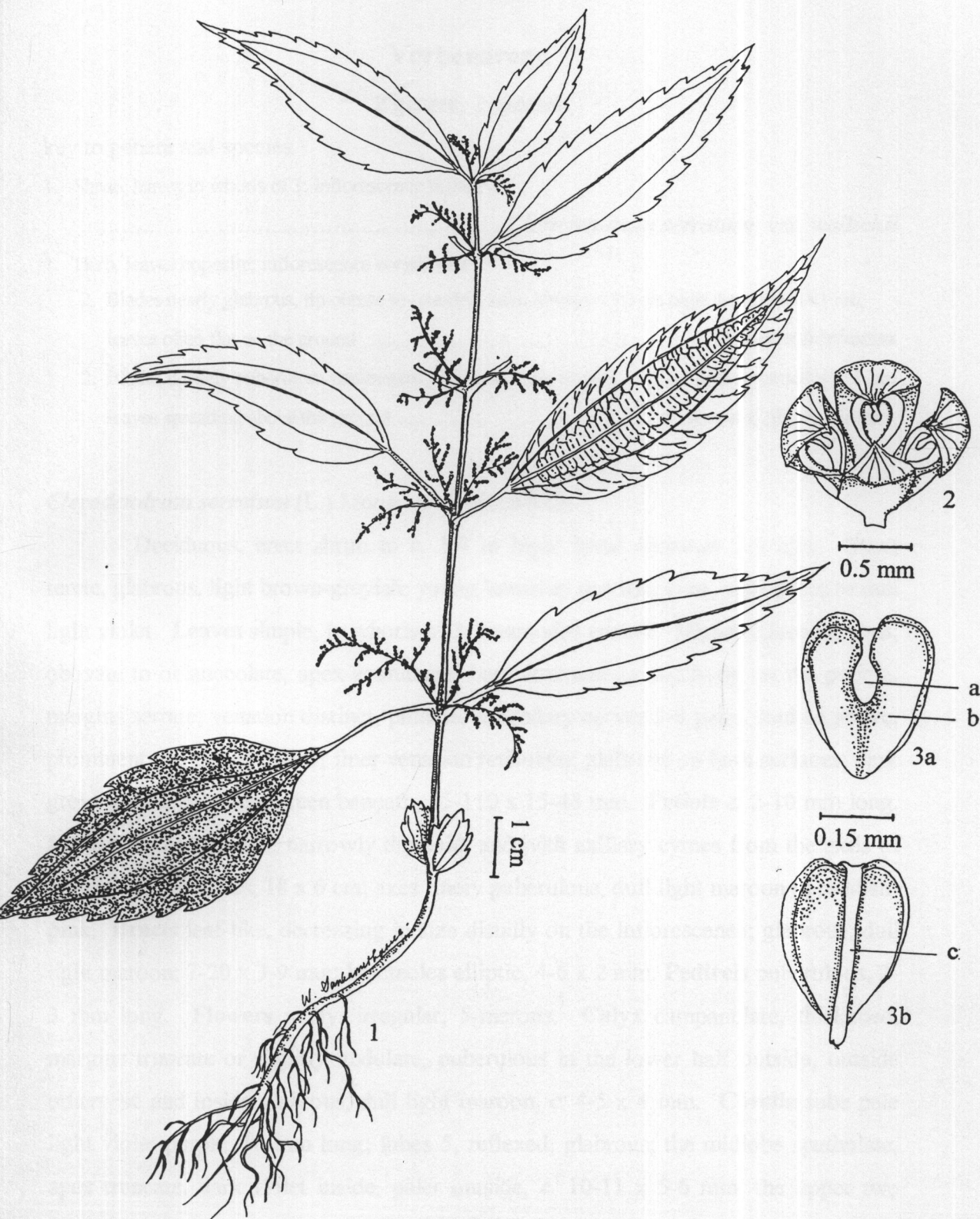


Figure 46 *Pilea trinervia* Wight (#268): 1 = habit, 2 = male flower (opened bud), 3a = anther in bud (anterior): a = connective, b = locule, 3b = anther in bud (posterior): c = filament

Verbenaceae

2 genera, 2 species

key to genera and species

1. Shrub, leaves in whorls of 3; inflorescence thyrsoïd

.....*Clerodendrum serratum* var. *wallichii*

1. Herb, leaves opposite; inflorescence corymbose

2. Blades nearly glabrous, tip obtuse to rounded; stem always < 10 cm high, internodes < 1 cm;

leaves often flat on the ground*Premna herbacea*

2. Blades densely puberulous underneath, tip acute, stem usually > 30 cm high, internodes > 5 cm;

leaves spreading above the ground.....*P. nana* Coll. & Hemsl.

Clerodendrum serratum (L.) Moon var. *wallichii* Cl.

Deciduous, erect shrub to c. 1.4 m high, basal diameter 7-9 mm. **Stem** terete, glabrous, light brown-greyish; young branches quadrangular, light green to dull light violet. **Leaves** simple, in whorls of 3, internodes spaced. **Blades** subcoriaceous, obovate to oblanceolate, apex acuminate, base attenuate to decurrent on the petiole, margins serrate; venation distinct, pinnate, secondary nerves 5-8 pairs, sunken above, prominent and raised below; finer venation reticulate; glabrous on both surfaces; dark green above, pale light green beneath; 35-110 x 15-48 mm. **Petiole** c. 2-10 mm long. **Inflorescence** terminal, narrowly thyrsoïd, and with axillary cymes from the axils of reduced upper leaves, 18 x 6 cm; axes finely puberulous, dull light maroon to reddish-pink. **Bracts** leaf-like, decreasing in size distally on the inflorescence; glabrous, dull light maroon; 7-20 x 3-9 mm; bracteoles elliptic, 4-6 x 2 mm. **Pedicels** puberulous, 2-3 mm long. **Flowers** many, irregular, 5-merous. **Calyx** campanulate, thickened, margins truncate or slightly undulate, puberulous in the lower half outside, outside otherwise and inside glabrous, dull light maroon, c. 4-5 x 4 mm. **Corolla** tube pale light violet-purple, 10 mm long; lobes 5, reflexed, glabrous; the midlobe spatulate, apex truncate, dark violet inside, paler outside, c. 10-11 x 5-6 mm; the upper two lateral pairs oblong, apex rounded, pale light violet-purple, lower pair 7 x 4 mm, upper pair 10 x 4 mm. **Stamens** 4, didynamous, inserted on the anterior side of the corolla tube, exerted; anthers dorsifixed, bilocular, dark brown-black, c. 2.2 x 2 mm; filaments curved, base velutinous, violet-pinkish, longer pair c. 25-27 mm long,

shorter pair 22-24 mm long. **Stigma** irregularly 2-lobed, longer lobe 2-2.2 mm long, the shorter lobe c. 0.8 mm long. **Ovary** superior, obliquely ovoid, glabrous, 2.5 x 2 mm; 4-loculed, each locule with 1 basal ovule. **Fruits** not seen.

Habitat: partly shaded, fire-damaged, degraded areas

Phenology: leafing: May-December; flowering: July-August; fruiting: July-October

Abundance: rare

Distribution: throughout Thailand, Indo-China, peninsular Malaysia

Distinguishing features: shrub; leaves whorls of 3, blade margins serrate; inflorescence thyrsoid; corolla lobes reflexed, spreading, 5-lobed, violet-purple; stamens long exserted

Voucher specimen: 235, 13 July 2001

Reference: Fletcher (1938) 424-425, 429

***Premna herbacea* Roxb.**

Deciduous ground herb. **Rootstock** irregular, woody. **Stem** 1-5 cm high, puberulous, light green-brownish. **Leaves** simple, opposite, decussate, usually flat on the ground. **Blades** subcoriaceous, obovate, elliptic to lanceolate, apex acute to rounded, base attenuate and decurrent on the petiole, margins, irregularly crenate or shallowly serrate; venation distinct, pinnate, sunken above, raised below, secondary nerves 3-5 ascending pairs; finer venation reticulate; with scattered, fine pilose indumentum above, slightly more so underneath; dark green to greenish-maroon above, light green to brown-maroon and often with purplish hue underneath; 5-20 x 1.5-8 cm. **Petiole** densely puberulous, 4-8 mm long. **Inflorescence** terminal, corymbose, 15-25 x 20-25 mm; axes densely puberulous, dull light green-brown. **Pedicels** c. 1.5-3 mm long. **Bracts** lanceolate, c. 2.5 x 0.5 mm. **Flowers** numerous, irregular, 5-merous. **Calyx** campanulate, 5-lobed, puberulous outside, dull light green, c. 4 mm long; tube glabrous inside, 2 mm long; lobes subequal, ovate, apex obtuse to rounded, c. 1.2 x 1 mm. **Corolla** puberulous outside, tube densely velutinous inside; whitish-green, c. 3 mm long; 5-lobed; upper (posterior) lip shallowly 2-lobed or emarginate, whitish-green total size c. 2 x 1.8 mm; lower anterior lip 3-lobed, cream, each lobe suborbicular, c. 1.5 x 2.5-3 mm. **Stamens** 4, didynamous, inserted on and included in the corolla tube; anthers dorsifixed, orbicular, bilocular, c. 0.5 mm

diameter; filaments glabrous, whitish, anterior pair longer, 1 mm long, posterior pair shorter, 0.5 mm long. **Stigma** equally 2-lobed; style glabrous, *c.* 0.7 mm long. **Ovary** superior, globose, glabrous, *c.* 1.2 mm diameter; 4-loculed, each locule with one axile ovule. **Drupe**s globose, immature light green, ripening red-brown; *c.* 3.5-4.5 diameter.

Habitat: open, fire-damaged, degraded areas

Phenology: leafing: March-October; flowering: March-May; fruiting: May-August

Abundance: common

Distribution: N, NE, SE Thailand, India, Hainan, Indo-China

Distinguishing features: irregular woody rootstock, stem 1-3 cm high; leaves opposite, mostly flat on the ground, blades usually with purplish or brown-maroon hues underneath; inflorescence compactly corymbose

Voucher specimen: 171, 4 May 2001; **Plate** 19 F

References: Fletcher (1938) 415-417, 421; Dop (1935) 805-807, 815-816

Violaceae

1 species

Viola betonicaefolia J. E. Sm.

Perennial, deciduous, glabrous ground herb, *c.* 8-20 cm high. **Stem** brownish-violet to greenish. **Tap root** light brown, *c.* 5-10 cm long, straight. **Leaves** simple, , spreading, usually in a close spiral at the top of the stem. **Blades** ovate to ovate-lanceolate, apex obtuse, base truncate and decurrent on the petiole, margins shallowly crenate; venation pinnate, midnerve sunken above, prominent and raised below, secondary nerves 3-6 pairs; finer venation reticulate; glabrous on both sides; dark green above, dull violet-green beneath, *c.* 1.5-2.5 x 3-7 cm. **Petioles** light green, 3-6 cm long. **Flowers** solitary, from away the leaves, irregular, 5-merous. **Pedicels** slender, quadrangular, glabrous, very pale light green, 10-18 cm long, top reflexed (flowers nodding). **Bracts** 2, in about the middle or nearly so of the pedicels, usually in pairs, subulate, glabrous, light green, 5-7 mm long. **Sepals** 5, subequal, ovate-lanceolate, apex acute to acuminate, each sepal with a basal appendage, which are varied in shapes *viz.* shallow lobed, truncate or acute; densely covered with tiny red dots at the base and scattered along the main nerves, pale light green; *c.* 5-8 mm long including the appendage. **Petals** 5, subequal, obovate-oblong, apex obtuse to broadly acute, membranous, pinkish with bluish specking on the veins inside, *c.* 3.5-4 x 10 mm; the upper two petals glabrous, usually reflexed at anthesis, the lateral ones densely hirsute near the base, the lower (anterior) one often shortly spurred, saccate. **Stamens** 5, free, sessile; anthers bilocular, with a broadly ovate appendage at the tip; two anterior anthers spurred, pale yellow-orange, *c.* 1.5 mm long (including appendage). **Stigma** terminal, shallowly 3-lobed, unequal; style oblanceolate, widening towards the stigma. **Ovary** superior, ovate, usually enclosed by the stamens, tip acute, glabrous, *c.* 2 mm long; unilocular with numerous parietal ovules in 3 rows. **Capsules** ovoid-oblong, trigonous, tip acute, style and stigma persistent; glabrous, 5-6 x 10-13 mm, loculicidal, splitting into 3 valves. **Seeds** many, obovoid, smooth, light brown-greyish, *c.* 1.5-2 mm long.

Habitat: open places, often near the edges of marshes

Phenology: leafing: February-November; flowering: March-June; fruiting: March-July

Abundance: rare

Distribution: N and NE Thailand, Himalays, Sri Lanka, Indo-China, China, Japan, Philippines, Sumatra, eastern Java, Lesser Sunda Islands, Celebes, New Guinea, Australia

Distinguishing features: deciduous herb < 20 cm high; leaves closely spiraled on the top of the stem, blades ovate-lanceolate, base decurrent on the petiole; pedicels usually longer than 10 cm; flowers solitary, irregular, nodding; sepals with a basal appendage; petals pinkish, spur saccate; capsules loculicidally 3-valved

Voucher specimen: 138, 14 March 2001

References: Jacobs & Moore (1971) 202-203; Craib (1925) 87; Hooker (1872) 183
(*sub Viola partinii* DC.)

Pteridophytes

10 families, 12 genera, 19 species

key to families, and species

1. Leaves (sphenophylls) microphyllous, whorled at the nodes; stem distinct, straight
**Equisetaceae** (*Equisetum debile* Roxb. ex Vauch.)
1. Leaves micro- or macrophyllous (fronds), not whorled at the nodes; stem, when present, not straight
 2. Microphyllous; sporangia in terminal strobili, cylindrical
 3. Leaves monomorphic, linear-falcate, spirally arranged
**Lycopodiaceae** (*Lycopodium cernuum* L.)
 3. Leaves dimorphic, alternate, distichous on the ventral and dorsal sides of the stem and branches.....**Selaginellaceae**
 2. Macrophyllous; sporangia not strobili, but in sori on fronds
 4. Sori naked (lacking indusia)
 5. Sori dense superficial throughout the ventral surface, frond laminae ventrally covered with white waxy powder.....**Parkeriaceae** (*Pityrogramma calomelanos* (L.) Link)
 5. Sori isolated; frond laminae without white waxy powder
 6. Fronds pinnate; pinnae entire, glabrous.....**Polypodiaceae**
 (*Arthromeris tatsienensis* (Franch. & Bureau ex Christ) Ching)
 6. Fronds bipinnate-tripinnatifid, pinnae lobed, setose.....**Dennstaedtiaceae**
 (*Hypolepis punctata* (Thunb.) Mett. ex Kuhn)
 4. Sori indusiate or protected by reflexed marginal flaps of the frond
 7. Sori isolated, not in line
 8. Fronds bipinnate, dimorphic.....**Dryopteridaceae**
 (*Dryopteris cochleata* (D. Don) C. Chr.)
 8. Fronds once pinnate, monomorphic
 9. Longest pinnae < 3 cm long, margins crenate; sori arranged in one row near the margin
**Oleandraceae** (*Nephrolepis delicatula* (Dcne.) Pichi-Ser.)
 9. Longest pinnae > 10 cm long; lobed or serrate; sori not as above..**Thelypteridaceae**
 7. Sori in a marginal line
 10. Sori protected by a true indusia, pinnae sessile.....**Pteridaceae**
 10. Sori protected by the reflexed margin of the lamina, pinnae stalked
**Parkeriaceae**

Parkeriaceae

3 genera, 3 species

key to species

1. Fronds once pinnate, monomorphic; pinnae crescent-shaped *Adiantum philippense* L.
1. Fronds bipinnate-tripinnatifid or tripinnate, dimorphic
 2. Fronds covered with white waxy powder underneath..... *Pityrogramma calomelanos*
 2. Fronds without white waxy powder; sori covered with bright yellow waxy powder
 *Onychium siliculosum* (Desv.) C. Chr.

Pityrogramma calomelanos (L.) Link

Deciduous, ground or epilithic herb. **Rhizome** erect, brown to dark brown, c. 2-3 cm long. **Scales** linear to linear-lanceolate, dark brown, c. 2-3 mm long. **Stipe** subterete, scaly at the base, otherwise glabrous; glossy dark brown-blackish, 20-35 cm long. **Fronds** dimorphic; lanceolate in outline, bipinnate-tripinnatifid, c. 12-21 x 4-13 cm. **Sterile fronds** slightly larger than the fertile fronds; margins of pinnules irregularly serrate, base decurrent and united with the excurrent pinnules; venation free, pinnate, each veinlet 2-branched; dark green above, with white waxy powder below; the lower largest pinnules c. 1.3-1.4 x 4 mm. **Fertile fronds** with entire pinnules, margins revolute, the lower pinnules largest c. 7-8 x 1.5-2 mm. **Sori** dense superficial and acrostichoid, without indusia. **Sporangia** compressed globose, glabrous, brownish; annulus with a single row of cells.

Habitat: open areas in sandy soil or on rocks near the seasonal stream

Phenology: fronds: June-March; sori: February

Abundance: rare

Distribution: throughout Thailand, pantropical, introduced in the Old World

Distinguishing features: fronds slightly dimorphic; lower surface with white waxy powder; sporangia dense superficial throughout the ventral surface, without indusia

Voucher specimen: 415, 7 February 2002

Reference: Tagawa & Iwatsuki (1985) 193-194

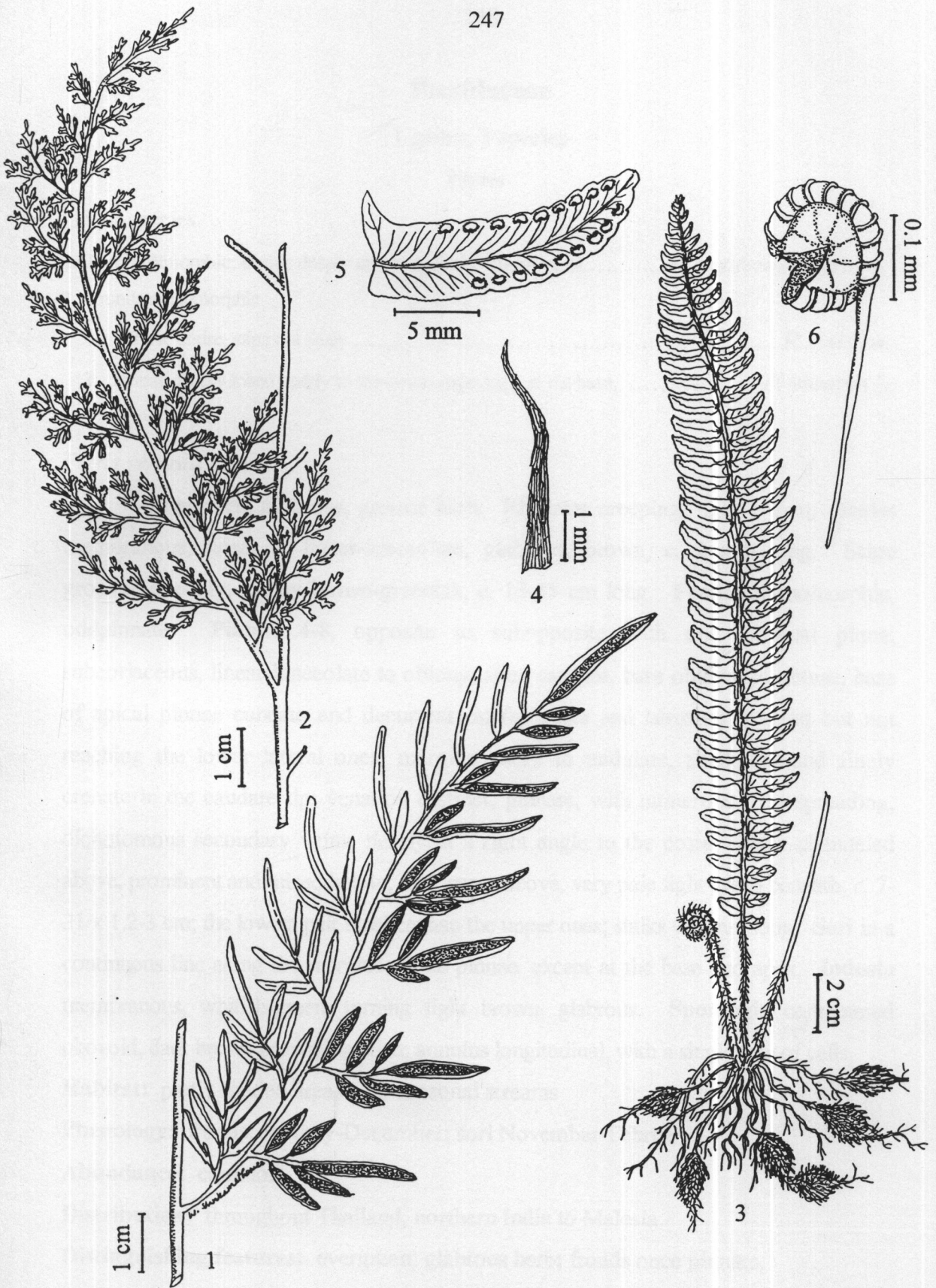


Figure 47 *Onychium siliculosum* (Desv.) C. Chr. (Parkeriaceae) (#411):
 1 = one pinna of fertile frond, 2 = one pinna of sterile frond;
Nephrolepis delicatula (Dcne.) Pichi-Ser. (Oleandraceae) (#351): 3 = habit,
 4 = rhizome scale, 5 = lower surface of pinna with sori, 6 = mature sporangium

Pteridaceae

1 genus, 3 species

Pteris

key to species

1. Fronds dimorphic; fronds deeply and irregularly, linear-lobed.....*P. ensiformis* Burm. f.
1. Fronds monomorphic
 2. Pinnae entire, stipe not scaly*P. venusta*
 2. Pinnae deeply lobed nearly to the costa, stipe scaly at the base.....*P. biaurita* L.

Pteris venusta Kunze

Evergreen, glabrous, ground herb. **Rhizome** creeping, light brown. **Scales** membranous, linear to linear-lanceolate, glabrous, brown, c. 2 mm long. **Stipe** grooved dorsally, glossy brown-greenish, c. 15-45 cm long. **Fronds** monomorphic, oddpinnate. **Pinnae** 4-8, opposite to subopposite with one terminal pinna; subcoriaceous, linear-lanceolate to oblong, apex caudate, base oblique to obtuse, base of apical pinnae cuneate and decurrent on the costa and narrowly winged but not reaching the lower lateral ones; margins entire to undulate, shallowly and finely crenate in the caudate tip; venation distinct, pinnate, with numerous, free spreading, dichotomous secondary veins, nearly at a right angle to the costa; costae channeled above, prominent and raised below; dark green above, very pale light green beneath; c. 7-31 x 1.2-3 cm; the lowest pair smaller than the upper ones; stalks 0-3 mm long. **Sori** in a continuous line along the margins of the pinnae, except at the base and apex. **Indusia** membranous, whitish-green, turning light brown, glabrous. **Sporangia** compressed obovoid, dark brown brown-blackish; annulus longitudinal, with a single row of cells.

Habitat: partly shaded areas near seasonal streams

Phenology: fronds: January-December; sori November-February

Abundance: common

Distribution: throughout Thailand, northern India to Malesia

Distinguishing features: evergreen, glabrous herb; fronds once pinnate,

pinnae entire; base of the apical pinnae decurrent and winged on the costa, but not reaching the lower lateral ones; sori continuous along most of the margins of the pinnae; indusia membranous

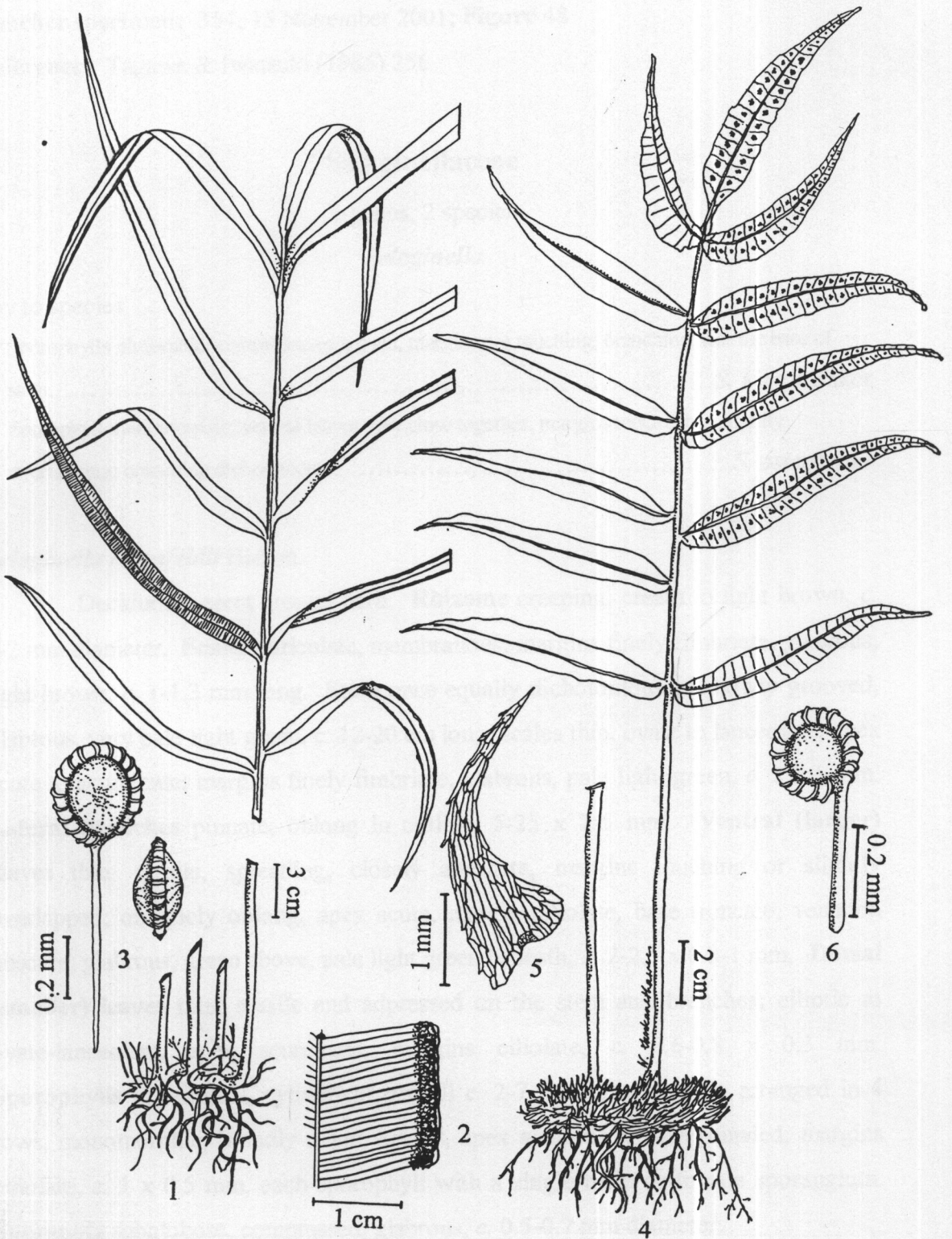


Figure 48 *Pteris venusta* Kunze (Pteridaceae) (#354): 1 = habit, 2 = lower surface of pinnae with sori, 3 = sporangium; *Arthromeris tatsienensis* (Franch. & Bureau ex Christ) Ching (Polypodiaceae) (#234): 4 = habit, 5 = scale, 6 = sporangium

Voucher specimen: 354, 15 November 2001; **Figure** 48

Reference: Tagawa & Iwatsuki (1985) 256

Selaginellaceae

1 genus, 2 species

Selaginella

key to species

1. Sporophylls dimorphic; ventral leaves spaced, margins not touching; branching near the base of stem.....*S. kurzii* Baker
1. Sporophyll monomorphic; ventral leaves very close together, margins touching or slightly overlapping; branching dichotomous.....*S. ostenfeldii*

Selaginella ostenfeldii Hieron.

Deciduous, erect ground herb. **Rhizome** creeping, cream to light brown, c. 1-2 mm diameter. **Scales** auriculate, membranous, margins finely fimbriate, glabrous, light brown, c. 1-1.3 mm long. **Stem** once equally dichotomous, shallowly grooved, glabrous, very pale light green, c. 12-20 cm long; scales thin, ovate to lanceolate, apex acute to acuminate; margins finely fimbriate, glabrous, pale light green, c. 2 x 1 mm. **Lateral branches** pinnate, oblong in outline, 5-25 x 2-5 mm. **Ventral (larger) leaves** thin, sessile, spreading, closely alternate, margins touching or slightly overlapped; obliquely oblong, apex acute, margin ciliolate, base truncate; venation obscure, glabrous, green above, pale light green beneath, c. 2-2.5 x 0.8-1 mm. **Dorsal (smaller) leaves** thin, sessile and adpressed on the stem and branches; elliptic to ovate-lanceolate, apex acuminate, margins ciliolate, c. 0.6-0.8 x 0.3 mm. **Sporophylls** in terminal, cylindrical strobili c. 2-7 mm long; spirally arranged in 4 rows; monomorphic, broadly ovate, keeled, apex acuminate, base rounded, margins ciliolate, c. 1 x 0.5 mm, each sporophyll with a single male or female sporangium. **Sporangia** subglobose, compressed, glabrous, c. 0.5-0.7 mm diameter.

Habitat: partly shaded in bamboo thickets along and near the seasonal stream

Phenology: leafing: June-November; strobili: August-November

Abundance: medium

Distribution: throughout Thailand, Burma, Indo-China

Distinguishing features: deciduous, ground herb; rhizome creeping; stem erect, once equally dichotomous, scales finely fimbriate; branches pinnate; margin of leaves touching or slightly overlapping; sporophylls monomorphic in 4 rows

Voucher specimen: 313, 16 October 2001

Reference: Tagawa & Iwatsuki (1979) 16

Thelypteridaceae

1 genus, 5 species

Thelypteris

key to species

1. Lower pinnae reduced to auricles
 2. 2-3 veins united below each sinus; pinnae hirsute on both sides; rhizome erect
..... *T. dentata* (Forssk.) St. John
 2. 5-6 veins united below each sinus; pinnae hirsute below; rhizome creeping..... *T. valida*
1. Lower pinnae not reduced to auricles
 3. Pinnae nearly entire, veins all united, laminae > 3 cm wide..... *T. nudata* (Roxb.) Morton
 3. Pinnae deeply lobed, at least ½ towards the costa, 1 pair of veins united
 4. Stipe and indusia glabrous; rhizome erect..... *T. xyloides* (Kunze) Ching
 4. Stipe dorsally hirsute, indusia setose; rhizome creeping..... *T. parasitica* (L.) Fosb.

Thelypteris valida (Christ) Tag. & K. Iwats.

Evergreen, ground herb. **Rhizome** creeping, to c. 1 m long, 4-5 mm diameter, brownish. **Scales** membranous, lanceolate to linear-lanceolate, tips acuminate, glabrous, dark brown, c. 2.5-3.5 x 1 mm. **Roots hairs** dense, dark brown. **Stipes** erect and spreading, scaly and glossy brownish-maroon at the base, hirsute and light green in the upper parts, up to c. 180 cm long. **Fronde**s once pinnate, oblong-lanceolate in outline. **Pinnae** alternate, up to c. 86 including the terminal segment; lower 6-7th ones longest and gradually becoming reduced to auricles proximally; linear-lanceolate, apex caudate, base truncate; margins lobed to c. 1/3 toward the costa; tips of lobes acute; venation distinct, pinnate, secondary veins up to c. 50 pairs in the longest pinna, prominent on both sides; veins pinnate, 5-6 pairs united below sinus; costa and secondary veins hirsute on both sides; costa sunken above, raised

below; pinnae glabrous and dark green above, hirsute and pale light green below; c. 3-20 x 0.6-2 cm; terminal pinna larger than the others. **Sori** 4-6 pairs per pinna lobe in 2 rows, rounded, brownish c. 0.4-0.5 mm diameter. **Indusia** round, usually smaller than sorus when mature, sparsely setose. **Sporangia** compressed orbicular or biconvex, sparsely setulose, brown; annulus longitudinal with a single row of cells.

Habitat: partly shaded, wet places; not in fire-damaged areas

Phenology: fronds: January-December; sori: February

Abundance: medium

Distribution: northern Thailand, Vietnam

Distinguishing features: rhizome creeping, up to 1 m long, stipe scaly at the base, otherwise hirsute; fronds with c. 86 pinnae and the terminal one; lower pinnae auricular; pinna with 5-6 pairs of veins united below the sinus; indusia setose

Voucher specimen: 419, 20 February 2001

Reference: Tagawa & Iwatsuki (1988) 393-396, 420

CHAPTER 5

DISCUSSION

There are 262 species of vascular ground flora in the study area. There were 195 species of perennial herbs and 67 annuals in three basic habitats:

1. **Open, fire-damaged, degraded areas (Plate 1B-C)** This habitat covers more than 90 % of the study site. This area is dominated by deciduous Gramineae (grasses) and the canopy is open due to fires and forest destruction. The ground flora here is very diverse with both perennial deciduous and annual herbs. There are 130 perennial deciduous species (49.8 % of total and 66.7 % of deciduous herbs). The dominant deciduous Gramineae include: *Arundinella setosa* var. *setosa*, *Alloteropsis semialata* var. *semialata*, *Capillipedium parviflorum*, *Heteropogon contortus*, *Pseudopogonatherum contortum*, and *Themeda triandra*. Common annual Gramineae are *Arthraxon hispidus* var. *hispidus*, *Sacciolepis indica*, and *Setaria parviflora*. A naturalized grass, *Urochloa ruziziensis* is found in open, but not fire-damaged areas. Most Gramineae flower during the cool-dry season, especially in November. Some common deciduous Cyperaceae (sedges) are *Frimbistylis thomsonii*, *F. yunnanensis*, *Carex continua*, and *C. cruciata*. The perennial evergreen palm, *Phoenix loureiri* var. *loureiri* is very common and restricted to fire-prone places. Most other monocots are deciduous. Some abundant species are: *Curcuma zedoaria*, *Kaempferia rotunda*, *Globba reflexa*, *Zingiber* sp. (all Zingiberaceae), *Murdannia scapiflora*, *M. gigantea*, and *Aneilema sinicum* (all Commelinaceae).

A common and typical woody deciduous dicots is *Ochna integerrima* (Ochnaceae). Some common deciduous herbs include: *Crotalaria sessilifolia*, *Desmodium oblongum*, *Dunbaria bella* (all Leguminosae, Papilionoideae); *Inula nervosa*, *Piloselliodes hirsuta*, *Vernonia squarrosa* var. *orientalis* (all Compositae); *Perilepta siamensis* (Acanthaceae), *Premna herbacea* (Verbenaceae), *Scutellaria glandulosa*, *Orthosiphon rubicundus*, *Leucas decemdentata* (both Labiatae), and *Pouzolzia pentandra* (Urticaceae).

There were 42 species of annual herbs (63.6 % of total) found in this habitat. Most are common in open places. *Blumeopsis flava* and *Blumea fistulosa* (both

Compositae) are abundant. *Crotalaria* (Leguminosae, Papilionoideae), the most common genus in this area, has 10 species. The most common species are: *C. alata*, *C. ferruginea*, and *C. montana* var. *montana*. Some other common species are: *Isodon lophanthoides* var. *lophanthoides* (Labiatae), *Rungia parviflora*, *Justicia procumbens* (both Acanthaceae), *Buchnera cruciata*, *Sopubia trifida* (both Scrophulariaceae), *Biophytum umbraculum* (Oxalidaceae), *Drymaria diandra* (Caryophyllaceae), *Sonerilia erecta* (Melastomataceae), and *Borreria brachystema* (Rubiaceae).

The DOF in the study area is quite similar to similar forested places on nearby mountains. Some widespread species include: *Pimpinella cambodgiana* (Umbelliferae), *Blumeopsis flava*, *Inula cappa forma cappa*, *I. wissmanniana forma wissmanniana* (all Compositae); *Rubia siamensis* (Rubiaceae), and *Drosera peltata* (Droseraceae) are dominant in EGF and EG/Pine in the uplands of Doi Chiang Dao (Maxwell, 1998), Doi Sutep-Pui (Maxwell and Elliott, 2001), and Jae Sawn (Maxwell *et al.* 1997). *Apostasia wallichii* (Orchidaceae) and *Arisaema prazeri* (Araceae) are quite rare and restricted to DOF at Mae Sanam. They are only found in BB/DF and MXF in Doi Suthep-Pui (Maxwell and Elliott, 2001). *Globba reflexa*, *Kaempferia rotunda* (both Zingiberaceae) are very common and also grow in BB/DF at Jae Sawn National Park, while *Murdannia gigantea* (Commelinaceae) is only found in MXF there. *Delphinium siamensis* (Ranunculaceae) is rare in Doi Sutep-Pui (1450 m) (Maxwell, 2001) and in the uplands of Doi Chiang Dao Wildlife Sanctuary (c. 1,800 m) (Maxwell, 1998). The deciduous insectivorous *Drosera peltata* (Droseraceae) is abundant in poor nitrogen deficient soil in the study area as well as in EG/Pine forest in the uplands in other places *e.g.* Doi Sutep-Pui (Maxwell, 2001), Doi Luang (Maxwell, 2000), and Doi Chiang Dao (Maxwell, 1998).

Two parasitic deciduous Orobanchaceae are less abundant, *viz.* *Aeginetia pedunculata* is rare and mostly found in very open places near the top of the hill in grass clumps and is usually covered by matted leaves. *A. indica* is also found in this habitat, but is easily seen on bare ground, and is more common near the stream in habitat 3.

All Orchidaceae (orchids) found are deciduous. Although this family is diverse, most species are medium or rare, *e.g.* *Pecteilis susannae*, *Cymbidium ensifolium*, *Eulophia spectabilis*, *E. macrobulbon*, and *Habenaria dentata*. Commercial collecting

has caused this lack of individuals. Some species are more commonly seen in the rainy season, e.g. *Arundina graminifolia*, *Anthogonium gracile*, *Habenaria chlorina*, and *Liparis paradoxa*. From my observations, I found more than 10 orchid and mushroom sellers along the highway within 5 kilometers from Ban Mae Sanam Mai to Ban Bo Luang. The most common orchids they sell throughout the year are epiphytic including many species of *Dendrobium* and *Vanda*. Ground orchids are sold in the rainy season when they are flowering, e.g. *Pecteilis susannae* (L.) Raf., *Brachycorythis henryi*, *Habenaria dentata*, and *H. chlorina*. This is one of the main reasons for their depletion as well as forest fires, grazing, and land clearing.

Some species are variable by having different pigmentation, e.g. the various flower colors of *Eulophia spectabilis* (Orchiaceae) with whitish and maroonish-violet variants, even in the same population and less than 1 meter from each other.

The type material of *Inula wissmanniana forma disciformia* (Compositae) was collected from this area, but my voucher specimen is *forma wissmanniana*, which grows both in habitats 1 and 3. It may be that *forma disciformia* may not be a distinct taxon.

2. Open bog/marshy areas (Plate 1D) are found in seasonally moist gullies. There are three perennial marshes scattered in the study site and cover an area of c. 200 m². There are 5 small moist gullies which are in partly shaded areas. Cyperaceae (sedges) are common in marshes, e.g. *Fimbristylis miliacea*, *C. pilosus* Vahl, *Fuierena ciliaris*, and *Scirpus mucronatus*. Many annual species are and restricted to this area, e.g. *Eriocaulon gracile*, *E. oryzetorum* (Eriocaulaceae), *Xyris capensis* (Xyridaceae), *Burmanna coelestis* (Burmanniaceae), *Drosera burmannii* (Droseraceae), *Hypericum japonicum* (Guttiferae), *Utricularia scandens*, *U. minutissima*, and *U. hirta* (Lentibulariaceae). Common weeds are *Spilanthes iabadicensis*, *Crassocephalum crepidioides*, and *Artemisia japonica* var. *japonica* (all Compositae). Common evergreen species restricted to this habitat are *Pogostemon pentagonus* (Labiatae), *Rotala rotundifolia* (Lythraceae), *Impatiens chinensis* (Balsaminaceae), and *Limnophila villifera* ssp. *gracilipes* (Scrophulariaceae). Some common deciduous species often occur in seasonally drier soil, e.g. *Viola betonaetifolia* (Violaceae), *Pogostemon auricularius* (Labiatae), *Osbeckia chinensis* var. *chinensis* (Melastomataceae), and *Centranthera cochinchinensis*

(Scrophulariaceae). An ecotone of this habitat and habitat 1 has some common species which include: *Aeschenomene americana*, *Desmodium microphyllum* (both Leguminosae, Papilionoideae), *Urena lobata* ssp. *lobata* var. *lobata* (Malvaceae), *Melastoma malabathricum* ssp. *malabathricum* (Melastomataceae), and *Justicia procumbens* (Acanthaceae).

Ranunculus siamensis (Ranunculaceae/topotype) is common in moist, partly shaded gullies as well as in the open marshes. Many pteridophytes are usually found along moist gullies, e.g. *Equisetum debile* (Equisetaceae), *Thelypteris dentata*, *T. xyloides*, *T. valida* (all Thelypteridaceae), and *Onychium siliculosum* (Parkeriaceae). *Phiaus tankervilleae* (Orchidaceae) is rare and mostly found in open places in this habitat. It has been extirpated by locals because of its economic ornamental value.

3. Shaded areas along the seasonal stream (Plate 1E-F) forms the northern boundary of the study area. There are bamboo thickets scattered along the stream banks. The vegetation consists of many species which are also found in the other two habitats. There are many common evergreen species which are only found in this area, viz. *Hygrophila intermedia*, *Sericocalyx parviflora*, and *Strobilanthes anfractuosus* (all Acanthaceae). Common annual species are *Canscora diffusa* (Gentianaceae), *Blumea mollis*, *Cyathocline purpurea* (both Compositae)- the last species being usually found in the dry stream bed during January-February. Some common species along steep banks are: *Selaginella ostefeldii*, *S. kurzii* (Selaginellaceae), *Zingiber parishii*, *Globba* sp. (both Zingiberaceae), and *Pilea trinervia* (Urticaceae). Deciduous herbs are often found away from the stream in bamboo thickets and sometimes in burnt places, e.g.: *Gomphostemma strobilinum* var. *acualis* (Labiatae), *Peliosanthes tetra* ssp. *humilis* (Liliaceae), *Desmodium laxiflorum* ssp. *laxiflorum*, *D. pulchellum* (Leguminosae, Papilionoideae), *Aeginetia indica* (Orobanchaceae), *Curcuma ecomata*, and *Zingiber* sp. (both Zingiberaceae). Some common annuals found in moist shaded areas include: *Blumea napifolia* (Compositae) and *Drymaria diandra* (Caryophyllaceae). Some rare deciduous species include *Paris polyphylla* (Liliaceae), *Geodorum recurvum*, and *Zeuxine affinis* (both Orchidaceae). There are three deciduous species restricted to this habitat which are down to a few individuals, viz. *Brachycorythis henryi*, *Peristylus prainii*, and

Tainia viridifusca (all Orchidaceae) (Table 5). Ground pteridophytes (ferns) appear here as well as along the gullies with *Thelypteris parasitica*, *T. dentata* (Thelypteridaceae), *Pteris venusta*, *P. ensiformis* (Pteridaceae), and *Dryopteris cochleata* (Dryopteridaceae).

Figure 6 shows that the flowering peak for the ground flora in this area is in October with 94 species (36 % of total) and lowest in March with 28 species. The flowering curves for annuals are different between the rainy and cool-dry seasons. The peak for annuals is in November with 41 species (62 % of all annual herbs). Annual herbs germinate and develop during the rainy season, then flower and fruit before the hot-dry season and fires come.

Most of the annuals are in Leguminosae, Papilionoideae e.g. *Crotalaria ferruginea*, *C. alata*, and Compositae e.g. *Anaphalis adnata*, *Blumeopsis flava*, and *Blumea fistulosa*. Scrophulariaceae here are mostly annual and flower after the rainy season include: *Phtheirospermum parishii*, *Alectra avensis*, and *Buchnera cruciata*. The flowering curve is lowest during the beginning of the rainy season (April-May) with only 5 species. Some common herbs which flower and fruit all year round include: *Spilanthes iabadicensis*, *Crassocephalum crepidioides* (both Compositae), *Hypericum japonicum* (Guttiferae), and *Polygonum persicaria* (Polygonaceae).

The flowering curve of perennial herbs is rather stable during the rainy season (June-October) with approximately 25.6 % of all perennial herbs. Many deciduous species flower after fires and before or at the beginning of the rainy season, e.g. *Ochna integerrima* (Ochnaceae), *Murdannia scapiflora* (Commelinaceae), *Disporum calcaratum* (Liliaceae), *Curcuma zedoaria*, *Kaempferia rotunda* (both Zingiberaceae), and *Scutellaria glandulosa* (Labiatae). Some deciduous species flower in the hot-dry season, e.g. *Eulophia macrobulbon*, *Pachystoma pubescens*, (both Orchidaceae), and *Gentiana timida* (Gentianaceae).

CHAPTER 6

CONCLUSIONS

There are 3 main habitats in an area of 0.8 km² 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* (Labiateae) 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 Viêtname 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 m² 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



D



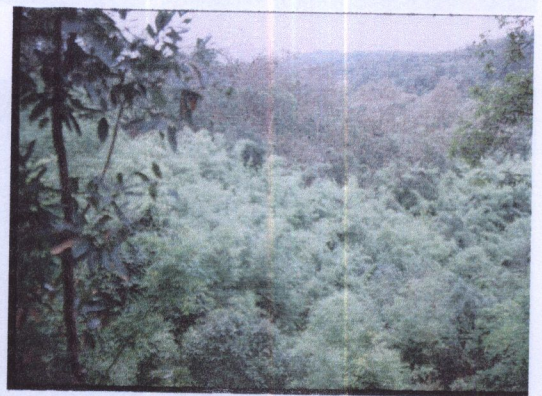
B



E



C



F

Plate 1 A = degraded area in Mae Toh National Park

B = burnt place in the study area

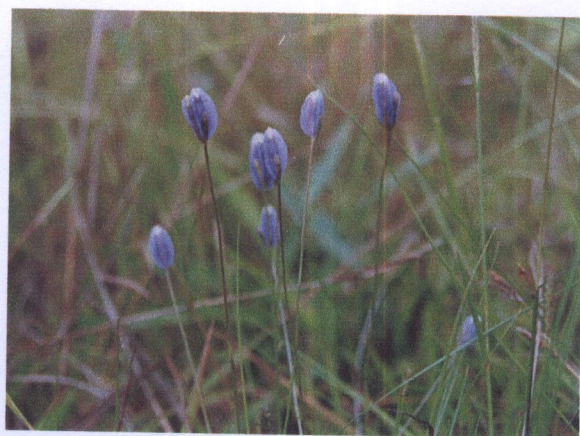
C = habitat 1 (degraded, deciduous dipterocarp-oak + pine forest)

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

F = habitat 3 (view of slopes)



A



C



D



B



E

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)



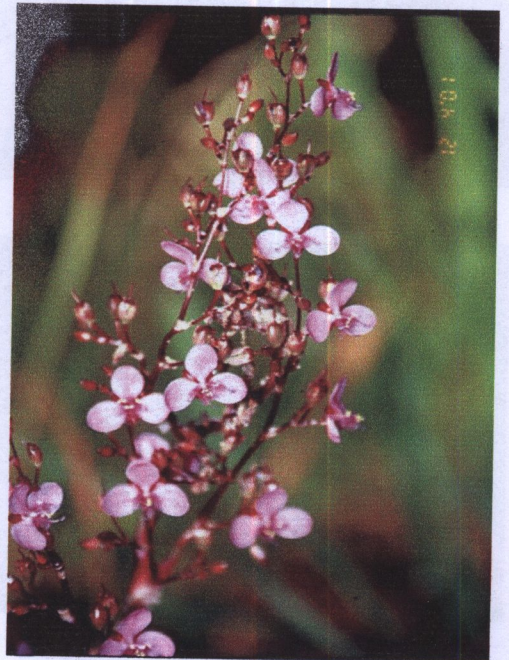
A



C

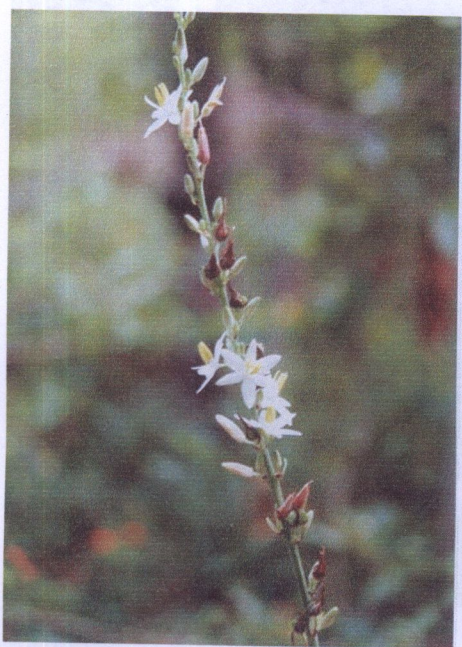


B



D

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



A



C



D



B



E

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



A



C



B



D



E

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



B



D



E

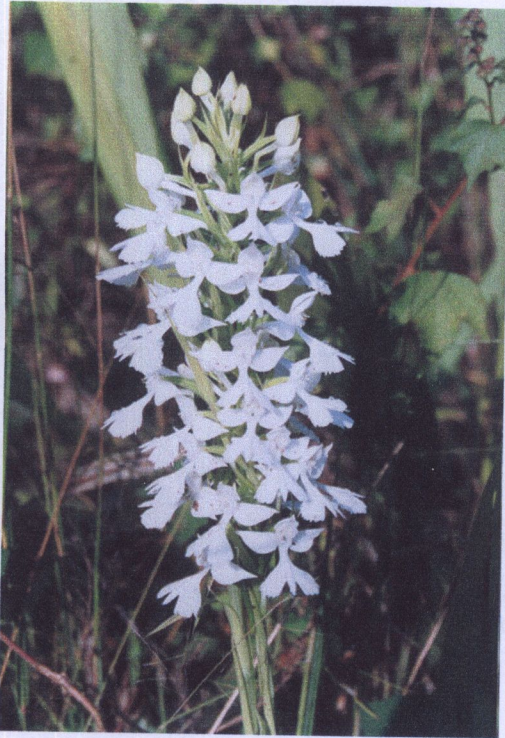
Plate 6 Orchidaceae: A = *Cymbidium ensifolium* (L.) Sw. #160
 B = *Eulophia macrobulbon* (Par. & Rchb. f.) Hk. f. #142
 C & D = *E. spectabilis* (Dennst.) Suresh #159
 E = *Brachycorythis henryi* (Schltr.) Summ. #223



A



C



B

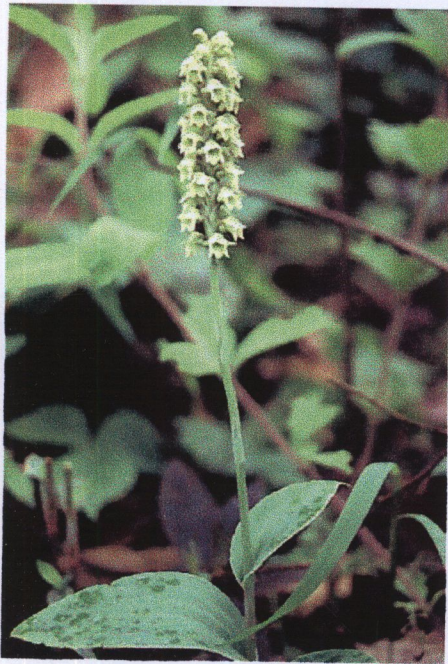


D

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



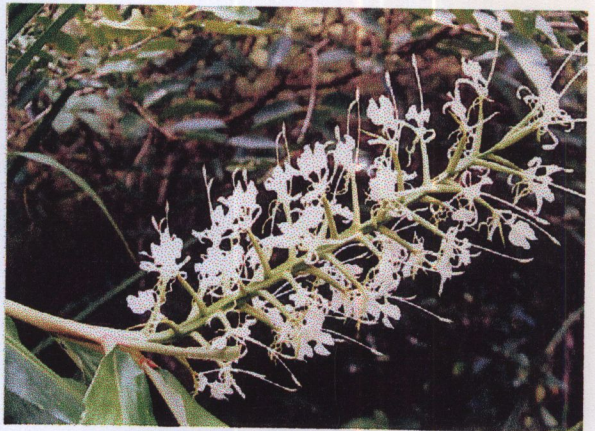
A



B



C



D



E

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



B



C



D



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



D



B



C



E

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



D



B



C



E

Plate 11 A-B Balsaminaceae: A = *Impatiens chinensis* L. #207

B = *I. craddokii* Hk. f. #221

C = *Argyreia kerrii* Craib #230 (Convolvulaceae)

D = *Gentiana timida* Kerr #173 (Gentianaceae)

E = *Lobelia nicotianaefolia* Roth ex Roem. & Schult. #400 (Campanulaceae)



A



C



B



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



A



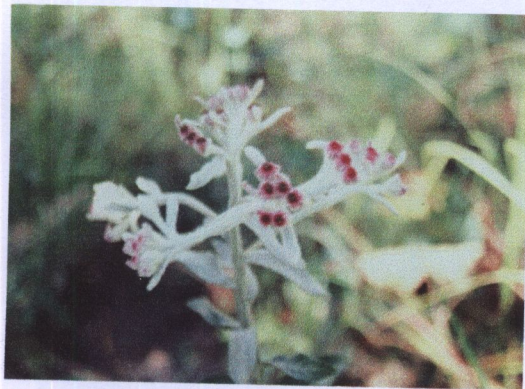
D



B



E

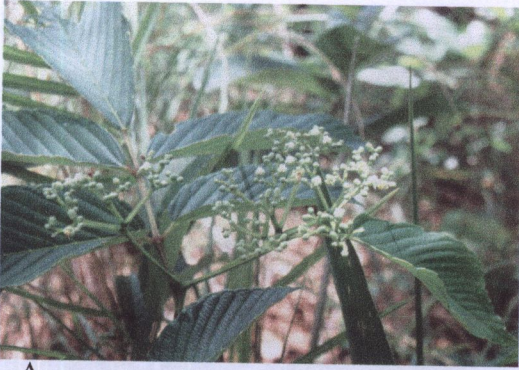


C



F

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



D



B



E



C



F

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

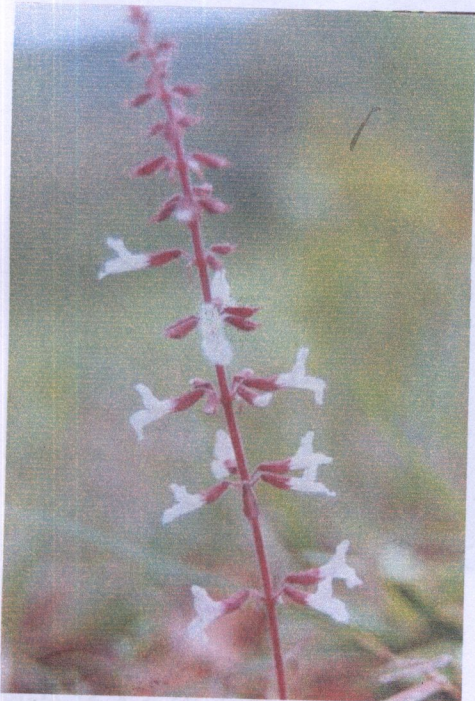
F = *Gomphostemma strobilinum* Wall. ex Benth. var. *acualis* (Kurz ex Hk. f.)
Prain #287



A



C



B



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



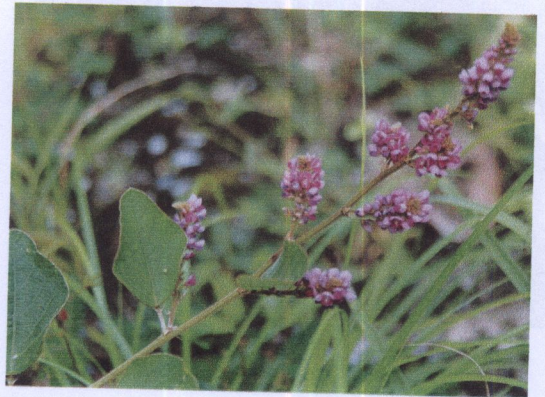
B



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



D



B



E

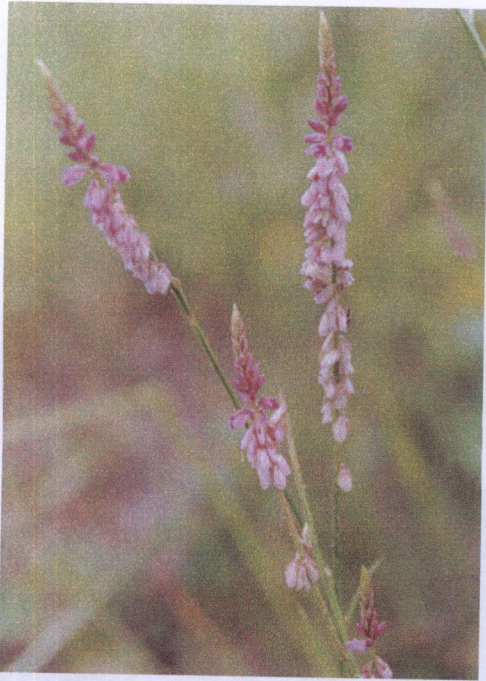


C



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 Orobanchaceae: D = *Aeginetia indica* Roxb. # 265
 E = *A. pedunculata* Wall. #311
 F = *Biophytum umbraculum* Welw. #258 (Oxalidaceae)



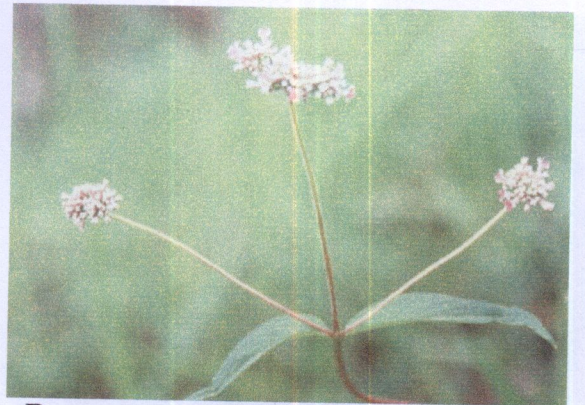
A



C



B



D



E

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



A



D



B



E



C



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)

REFERENCES CITED

- Airy Shaw H. K. 1972. The Euphorbiaceae of Siam. Kew Bulletin, 26(2), 330-334.
- Ashton P. S. 1989. Thailand: Biodiversity Center for the Tropics of Indo-Burma. Biodiversity in Thailand, 51-58.
- Backer C. A. and Bakhuizen van den Brink R. C. 1965. Rubiaceae. Flora of Java, 2, 274-354.
- Backer C. A. and Bakhuizen van den Brink R. C. 1968. Commelinaceae. Flora of Java, 3, 12-22.
- Baker J. G. 1890. Scitamineae. Flora British India, 6, 210-211.
- Beille L. 1928. Euphorbiacées. Flore Générale de L' Indo-Chine, 5, 643-655.
- Benoist R. 1935. Acanthacées. Flore Générale de L' Indo-Chine, 4, 610-774.
- Bhatti G. R. and Ingrouille M. 1997. Systematic of *Pogostemon*. (Labiatae). Bull. Nat. Hist. Mus. Lond. (Bot.), 27(2), 77-147.
- Bor N. L. 1960. Grasses of Burma, Ceylon, India, and Pakistan 1. Pergamon Press., Oxford, pp. 110-112, 357.
- Borssum Waalkes J. van. 1966. Malesian Malvaceae Revised. Blumea, 14(1), 1- 251.
- Bosman M. T. M. and de Hass A. J. P. 1983. A Revision of the genus *Tephrosia* (Leguminosae, Papilionoideae) in Malesia. Blumea, 28(2), 438.
- Braun F., Braun E. V., Hess A. and Hoch K. E. 1982. Geological Map of Northern Thailand 1:250,000, Hanover, Sheet 5.
- Bremekamp C.E.B. 1934. Monograph of the genus *Pavetta* L. Repertorium Specierum Novarum Regi Vegetabilis, 37, 115.
- Bremekamp C.E.B. 1961. Studies in the Flora of Thailand. Dansk Bot. Ark., 20(1), 65-88.
- Bremekamp C.E.B. 1965. Studies in the Flora of Thailand. Dansk Bot. Ark., 23(2), 200-224.
- Cherfils H. 1937. Commélinacées. Flore Générale de L' Indo-Chine, 6, 842-934.
- CMU Herbarium Database. 2000. Output from Chiang Mai University herbarium database.
- Costantin J. 1912. Asclépiadacées. Flore Générale de L' Indo-Chine, 4, 150-153.
- Courchet L. 1910. Polygonacées. Flore Générale de L' Indo-Chine, 5, 37-38.

- Craib W. G. 1912. Dicotyledones. Contribution to the Flora of Siam, Aberdeen University studies, 57, 137-183.
- Craib W. G. 1913. Monocotyledones. Contribution to the Flora of Siam, Aberdeen University studies, 61, 3-11.
- Craib W. G. 1925-1931. *Florae Siamensis Enumeratio* 1. Bangkok, Siam Society, pp. 87-590.
- Craib W. G. and Kerr A. F. G. 1932-1939. *Florae Siamensis Enumeratio* 2. Bangkok, Siam Society, pp. 167- 472.
- Doan T. 1936. Labiacées. *Flore Générale de L' Indo-Chine*, 4, 915-1039.
- Dop P. 1936. Verbenacées. *Flore Générale de L' Indo-Chine*, 4, 805-816.
- Dy Phon P., Ohashi H. and Vidal J. E. 1994. Légumineuses-Desmodiées. *Flore du Cambodge du Laos et du Viêt Nam*, 27, 62-120.
- Faden R. 1991. The Morphology and Taxonomy of *Aneilema* R. Brown (Commelinaceae). *Smithsonian, Contributions to Botany*, 76, 163.
- Fletcher H. R. 1938. The siamese Verbenaceae. *Bulletin of Miscellaneous Information, Royal Botanic Garden Kew*, 10, 401-444.
- Fletcher H. R. and Kerr A. F. G. 1951. *Florae Siamensis Enumeratio* 3. Bangkok, Siam Society, pp. 65-71.
- Gagnepain F. 1908. Zingibéracées. *Flore Générale de L' Indo-Chine*, 6, 67-120.
- Gagnepain F. 1910. Malvaceae. *Flore Générale de L' Indo-Chine*, 1, 413-417.
- Gagnepain F. 1916. Légumineuses. *Flore Générale de L' Indo-Chine*, 2, 294-315.
- Gagnepain F. 1921. Begoniaceae and Lythraceae. *Flore Générale de L' Indo-Chine*, 2, 970-975, 1095-1114.
- Gagnepain F. 1924. Composées. *Flore Générale de L' Indo-Chine*, 3, 449-660.
- Gagnepain F. 1929. Urticacées. *Flore Générale de L' Indo-Chine*, 5, 847-853.
- Gagnepain F. 1932. Zingiberacées. *Flore Générale de L' Indo-Chine*, 6, 118-120.
- Gagnepain F. 1934. Liliacées. *Flore Générale de L' Indo-Chine*, 6, 777-782.
- Gagnepain F. and Courchet L. 1915. Convolvulacées. *Flore Générale de L' Indo-Chine*, 4, 272-281.
- Gagnepain F. and Conrard L. 1937. Palmiers. *Flore Générale de L' Indo-Chine*, 6, 977-978.
- Geesink R., Leeuwenberg J. M., Ridsdale C. E. and Veldkamp J. F. 1981.

- Thonner's Analytical key to the Families of Flowering Plants. Center for Agricultural Publishing and Documentation, Wageningen: 231 pp.
- Guillaumin A. 1911. Rutacées. Flore Générale de L' Indo-Chine, 1, 660-662.
- Hansen B. 1987. Xyridaceae. Flora of Thailand, 5(1), 130-138.
- Hara H. 1988. A Revision of the Asiatic species of the Genus *Disporum* (Liliaceae). Univ. Mus. Univ. Tokyo Bull., 31, 163-209 and plate 27-47.
- Hedge I. C. and Lamond J. M.. 1992. Umbelliferae (Apiaceae). Flora of Thailand, 5 (4), 442-470.
- Hewson H. J. 1988. Plant Indumentum: A Handbook of Terminology. Australian Flora and Fauna, 9, 1-27.
- Hickey M. and King C. The Cambridge Illustrated Glossary of Botanical Terms. Cambridge University Press, 208 pp.
- Hooker, J. D. 1872. Violaceae. Flora of British India, 1, 183.
- Hooker, J. D. 1880. Rubiaceae. Flora of British India, 3, 78.
- Hooker, J. D. 1894. Palmae. Flora of British India, 6, 501.
- Hou D., Larsen K. and Larsen S. S. 1996. Caesalpiniaceae. Flora Malesiana, 12(2), 409-730.
- Hu S. Y. 1968. Araceae: Studies in the Flora of Thailand. Dansk Bot. Ark., 32(2), 411-457.
- Jackson B.D. 1928. A Glossary of Botanical Terms. 4th ed. London, J. B. Lippincott Co., 481 pp.
- Jacobs M. and Moore D. M.. 1971. Violaceae. Flora Malesiana, 7, 198-212.
- Jessop J. P. 1979. Liliaceae. Flora Malesiana, 9, 192-235.
- Jonker F. P. 1948. Burmanniaceae. Flora Malesiana, 4, 14-17.
- Kanis A. 1970. Ochnaceae. Flora of Thailand, 2(1), 24-30.
- Keng H. 1969. Flora Malesinae Precursors XLVIII: A Revision of Malesian Labiatae. The Gardens' Bulletin Singapore, (24), 100, 107-108.
- Keng H. 1978. Labiatae. Flora Malesiana, 8, 340-359.
- Kerr A. F. G. 1936. Florae Siamensis Enumeratio 2. Bangkok, Siam Society, 244-277.
- Kort I. and Thijssse G. 1984. A revision of the genus *Indigofera* (Leguminosae-Papilionoideae) in Southeast Asia. Blumea, 30(1), 89-151.
- Koster J. Th. 1935. The Compositae of the Malay Archipelago. Blumea, 1(3), 351-536.

- Koyama H. 1981. Taxonomic Studies in the Compositae of Thailand 1. *Acta Phytotax. Geobot.*, 32, 57-58.
- Koyama H. 1983. Taxonomic Studies in the Compositae of Thailand 2. *Acta Phytotax. Geobot.*, 34, 1-9.
- Koyama H. 1984. Taxonomic Studies in the Compositae of Thailand 4. *Acta Phytotax. Geobot.* 35: 113-125.
- Koyama H. 1985. Taxonomic Studies in the Compositae of Thailand 5. *Acta Phytotax. Geobot.*, 36, 59-68.
- Koyama H. 1986. Taxonomic Studies in the Compositae of Thailand 7. *Acta Phytotax. Geobot.*, 37, 112.
- Koyama H. 1988. Taxonomic Studies in the Compositae of Thailand 8. *Acta Phytotax. Geobot.*, 39, 151-154.
- Koyama H. 1989. Taxonomic Studies in the Compositae of Thailand 9. *Bull. Natn. Sci. Mus., Tokyo ser. B*, 15(3), 105-110.
- Koyama H. 2001. Taxonomic Studies in the Compositae of Thailand 13. *Bull. Natn. Sci. Mus., Tokyo ser. B*, 27(4), 143-144.
- Larsen K. 1966. Studies in the Flora of Thailand. *Dansk Bot. Ark.*, 23(3), 273.
- Larsen K. 1961. Studies in the Flora of Thailand. *Dansk Bot. Ark.*, 20(1), 39-47.
- Larsen K. 1987. Droseraceae. *Flora of Thailand*, 5(1), 67-69.
- Larsen K. 1992. Caryophyllaceae. *Flora of Thailand*, 5 (4), 413-243.
- Larsen K. and Chi-Ming Hu. 1996. Myrsinaceae. *Flora of Thailand*, 6(2), 135-136.
- Larsen K. and Vogel E. F. 1972. Apostasiaceae. *Flora of Thailand*, 2(2), 131-138.
- Larsen K., Larsen S. S. and Vidal J. E. 1984. Leguminosae-Caesalpinioideae. *Flora of Thailand*, 4 (1), 121-123.
- Lawrence G. H. M. 1955. *An Introduction to Plant Taxonomy*. New York, Macmillan Company, 179 pp.
- Lawrence G. H. M. 1966. *Taxonomy of Vascular Plants*. New York, Macmillan Company, 823 pp.
- Lecomte H. 1912. Eriocaulonacées. *Flore Générale de L' Indo-Chine*, 7, 1-9.
- Leeuwenberg A. J. M. and Vidal J. E. 1972. Buddlejaceae. *Flore du Cambodge du Laos et du Viêt Nam*, 13, 90-97.
- Li H. W. and I. C. Hedge. 1994. Lamiaceae (Labiatae). *Flora of China*, 17, 59.

- Mauric A. 1999. A Bibliography of Taxonomic Revisions for Vascular Plants in Thailand. Bangkok, The Forest Herbarium.
- Maxwell J.F. 1975a. Collecting Plant Specimens -The Right Way. Tigerpaper (FAO), 2(2), 24-25.
- Maxwell J.F. 1975b. Building and Maintaining a Herbarium. Tigerpaper (FAO), 2(4), 26-27.
- Maxwell J. F. 1985. Taxonomic Revision of *Utricularia* L. (Lentibulariaceae) in Thailand. Songklanakarin J. Sci. Technol., 7(4), 410-412, 417-418.
- 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. 1996. Vegetation of the Mae Soi conservation area, Chom Tong District, Chiang Mai Province, Thailand. Tigerpaper. (FAO), 23(1), 22-27.
- 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. 2000. Vegetation of Doi Luang National Park, Northern Thailand. Tigerpaper (FAO), 27(1), 14-23.
- Maxwell J. F. and Elliott S. 2001. Vegetation and Vascular Flora of Doi Sutep-Pui National Park, Northern Thailand. Thai Study in Biodiversity, 5, 1-250.
- Maxwell J. F., Elliott S, Palee P. and Anusarnsunthorn V. 1995. The Vegetation of Doi Kuhn Tan National Park, Lamphun-Lampang Provinces, Thailand. Nat. Hist. Bull. Siam Soc., 43(2), 71-79.
- Maxwell J. F., Elliott S, Palee P. and Anusarnsunthorn V. 1997. The Vegetation of Jae Sawn National Park, Lampang Province, Thailand. Nat. Hist. Bull. Siam Soc., 45(1), 71-79.
- Moeliono B. and Tuyn P. 1960. Campanulaceae. Flora Malesiana, 6, 129-130.
- Monilo J.-F. 1994. Révision du genre *Clausena* Burm. f. (Rutaceae). Bull. Mus. natl. Hist. nat., 4(6), 117.
- Murata G. 1971. Contribution to the Flora of Southeast Asia: A list of Labiatae known from Thailand. The Southeast Asian Studies, 8(4), 497-516.
- Neal D. G. 1967. Statistical Description of the Forests of Thailand. Bangkok, Military Research & Development Center, pp. 6.

- Niyomdham C. 1978. A Revision of the Genus *Crotalaria* L. (Papilionaceae) in Thailand. Thai For. Bull. (Bot.), 11, 113-127.
- Niyomdham C. 1994. Key to the genera of Thai Papilionaceous plants. Thai For. Bull. (Bot.), 22, 76.
- Ogawa H., Yoda K. and Kira T. 1961. A Preliminary survey on the Vegetation of Thailand. Kyoto, Nature and Life in SE. Asia, pp. 66-67.
- Opie P. and Parnell J. 2002. Loganiaceae (Buddlejaceae) in Flora of Thailand, 7(4), 655-657.
- Palee P. and Maxell J. F. 2000. Vascular Flora of Doi Muang Awn, Chiang Mai Province, Northern Thailand. Nat. Hist. Bull. Siam Soc., 48, 95-116.
- Parnell J. 2001. A revision of Orobanchaceae in Thailand. Thai For. Bull. (Bot.), 29, 72-80.
- Pellegrin F. 1927-30. Orobanchacées. Flore Generale de L' Indo-Chine, 4, 461-466.
- Pendry C. A. 2001. Polygalaceae. Flora of Thailand, 7(3), 498-519.
- Phengklai C. 1993. Tiliaceae. Flora of Thailand, 6(1), 14-47.
- Phengklai C. 2001. Sterculiaceae. Flora of Thailand, 7(3), 562-571.
- Phengklai C., Sukhon W., Khao-Iam S. and Pooma R. 1988. The vegetation in bog area. Thai For. Bull. (Bot.), 17, 1-105.
- Phuakam A. 1994. A Survey of Herbaceous Ground Flora on the Eastern Side of Doi Suthep, Altitude 670-750 metres. M. S. Thesis, Chiang Mai University, Chiang Mai.
- Phuphathanaphong L. 1987. Aristolochiaceae. Flora of Thailand, 5(1), 1-19.
- Radanachaless T. and Maxwell J. F. 1994. Weeds of Soybean Fields in Thailand. Multiple Cropping Center, Chiang Mai University, 408 pp.
- Rajanapaiwong S. 2000. State of the Thai Environment 1997-98. Bangkok. Green World Foundation, Amarin Printing and Publishing Co. Ltd., pp. 70.
- Randeria A. J. 1960. The Composite Genus *Blume*, A Taxonomic Revision. Blumea, 10(1), 176-317.
- Renner S. S., Clausen G., Cellinese N. and Meyer K. 2001. Melastomataceae. Flora of Thailand, 7(3), 412-486.
- Ridsdale C.E. 1974. A Revision of The Family Leeaceae. Blumea, 22, 57-100.
- Ridsdale C.E. 1972. Leeaceae. Flora Malesiana, 7(4), 755-782.
- Robson N. K. B. 1974. Hypericaceae. Flora Malesiana, 8(1), 14-16, 27-29.

- Royen P. van. 1954. Xyridaceae. Flora Malesiana, 4, 365-376.
- Rundel P.W. and Boonpragob K. 1995. Dry Forest Ecosystems of Thailand. In Bullock S. H., Mooney H. A. and Medina E.(Eds.), Seasonally dry Tropical Forests, New York, Cambridge University Press, pp. 93-123.
- Santisuk T. 1997. Geographical and Ecological Distributions of the two Tropical Pines. Thai For. Bull. (Bot.), 25, 102-123.
- Schuiteman A. and de Vogel E. F. 2000. Orchid Genera of Thailand, Laos, Cambodia and Vietnam. Leiden, National Herbarium Nederland Universiteit, pp. 27,31, 87.
- Seidenfaden G. 1976. Orchid Genera in Thailand 4. Dansk Bot. Ark., 31(1), 9-11, 27-29, 38-41, 48-50.
- Seidenfaden G. 1977. Orchid Genera in Thailand 5. Dansk Bot. Ark., 31(3), 9-12, 22-23, 65-69, 105-106.
- Seidenfaden G. 1983. Orchid Genera in Thailand 11. Opera Botanica, 72, 28-46, 65-74.
- Seidenfaden G. 1986. Orchid Genera in Thailand 13. Opera Botanica, 89, 27-31, 67-68.
- Seidenfaden G. 1992. The Orchids of Indochina. Opera Botanica, 114, 330.
- Shimizu T. 1970. Contribution to the Flora of Southeast Asia: *Impatiens* of Thailand and Malaya. The Southeast Asian Studies, 8(2), 187-192.
- Simpson D. and Koyama T. 1998. Cyperaceae. Flora of Thailand, 6(4), 296-455 and Plate XXVIII.
- Sirirugsa P. 1992. Taxonomy of the genus *Kaempferia* (Zingiberaceae) in Thailand. Thai For. Bull. (Bot.), 19, 1-15.
- Smitinand T. 1966. The vegetation of Doi Chiang Dao, A Limestone Massive in Chiangmai, North Thailand. Nat. Hist. Bull. Siam Soc., 21 (1-2), 93-128.
- Smitinand T. 1969. The Distribution of the Dipterocarpaceae in Thailand. Nat. Hist. Bull. Siam Soc., 23 (1), 72.
- Stott, P. 1984. The savanna forests of mainland southeast Asia: An ecological survey. Progress in Physical Geography, 8(3), 315-335.
- Tagawa M. and Iwatsuki K. 1979. Selaginellaceae. Flora of Thailand, 3(1), 16.
- Tagawa M. and Iwatsuki K. 1985. Parkeriaceae and Pteridaceae. Flora of Thailand, 3(2), 183-216, 256.
- Tagawa M. and Iwatsuki K. 1988. Thelypteridaceae. Flora of Thailand, 3(3), 393-420.

- Tamura M. 1997. Synoptic Flora of the Ranunculaceae in Thailand. Thai For. Bull. (Bot.), 25, 63-64, 76-78.
- Theilade I. 1999. A synopsis of the genus *Zingiber* (Zingiberaceae) in Thailand. Nord. J. Bot., 19(4), 389-410.
- Thuan N. V. 1979. Légumineuses-Papilionidées (Phaséolées). Flore du Cambodge du Laos et du Viêtname, 17, 43-44, 48, 115-151.
- Thuan N. V., Dy Phon P. and Niyomdham C. 1987. Légumineuses-Papilionidées. Flore du Cambodge du Laos et du Viêtname, 23, 65-174.
- Ubolcholaket A. 1987. Gentianaceae. Flora of Thailand, 5(1), 70-91.
- van Steenis C. G. G. J. 1982. Addenda, Corrigenda et Emendanda. Flora Malesiana, 9, 567.
- Veldkamp J.F. 1970. Oxalidaceae. Flora of Thailand, 2(1), 16-23.
- Welzen P.C. 1981. A Taxonomic Revision of the genus *Arthraxon* Beauv. (Gramineae). Blumea, 27, 255-300.
- Welzen P. C. 1998. Analytical key to the genera of Thai Euphorbiaceae. Thai For. Bull. (Bot.), 26, 1-11.
- Yamazaki T. 1985. Scrophulariaceae. Flore du Cambodge du Laos et du Viêtname, 21, 136-141.
- Yamazaki T. 1990. Scrophulariaceae. Flora of Thailand, 5(2), 139-237 and Plates IX, XI, XIV.

APPENDICES

Appendix A Glossary

The terms as defined here are applicable to the species included in this research

- acaulescent** stemless
- achene** a dry, one-seeded, indehiscent fruit
- acrostichoid** fronds with dense sporangia, not in sori, covering the ventral surface
- acuminate** gradually narrowing to a point
- acute** abruptly pointed
- adnate** united with a different part (see connate)
- androphore** a column/stalk of stamens; united filaments in a solid stalk
- annulus** a ring of cells on a sporangium
- anterior** front side (see posterior)
- anther** the portion of a stamen which contains the pollen
- anthesis** expansion, *i.e.* opening of a flower
- apex** tip
- appendage** a projecting part
- aristate** tapering to a very narrow tip or much elongated apex (see caudate)
- attenuate** drawn out and gradually narrowing (see acuminate)
- auricle** ear-like lobe/appendage
- awn** a bristle-like appendage in Gramineae spikelets
- axil** the area between a main axis and its branch
- axile** placentation of ovules along the central axis of the ovary
- axis** (plural axes) a central line or main stem
- axillary** in or from an axil
- basifixed** basally attached
- beak** a slender extension from the tip of some achenes in Compositae
- berry** an indehiscent fruit with the seeds immersed in a fleshy/juicy mesocarp
- bifid** divided into two parts or lobes
- bilabiate** two lips of calyx or corolla; in an irregular flower as in Labiatae, Scrophulariaceae, Lentiburaliaceae, and Acanthaceae
- bilocular** having two compartments
- bisexual** having both functional sexes in one flower (see unisexual)

- blade** the expanded part of leaf or petal
- bract** scale or reduced leaf, usually subtending a flower or inflorescence
- bracteoles** a secondary bract, subtending each flower and accompanying bracts
- bulb** a modified underground stem with imbricating scale-like leaves
- bullate** surface with blister-like swellings
- caducous** falling off early
- callus** thickened or raised area
- calyx** the outer perianth whorl, composed of united sepals (see corolla)
- campanulate** bell-shaped
- canaliculate** channeled or grooved
- capitate** globose cluster; dense "head"-like group of flowers
- capsule** a dry, dehiscent fruit, opening at maturity by one or more valves
- carinate** keeled, sharply folded ("V"-shaped)
- carpel** a section of a compound pistil
- cataphyll** reduced leaves
- caudate** with a slender tail-like tip (see aristate)
- cauline** borne on the stem
- chaff** scales or bristles between the flowers in the capitula of some Compositae
- chartaceous** papery or tissue-like texture
- cilia** fine filiform hairs/appendages
- ciliate** with cilia
- ciliolate** minute cilia
- claw** the stalk-like base of a petal or sepals
- cochleate** coiled, like a snail shell
- column** fused stamens, stigmas, and styles into a single structure in Orchidaceae
- connate** united with a similar part (see adnate)
- connective** the portion of a stamen which joins the anther locules
- cordate** heart-shaped
- coriaceous** leathery, thick texture
- corolla** the inner perianth whorl, composed of united petals (see calyx)
- corona** a whorl of floral parts between the corolla and stamens
- corymb** a flat-topped inflorescence, which different pedicel lengths

- corymbose** corymb form
- costa** the main axis of a frond
- crenate** shallow, rounded marginal undulations
- crenulate** shallow, wavy (margin)
- crest** expanded part at the top of an organ
- cucullate** hood-shaped (galeate)
- culm** the jointed stems of Gramineae and Cyperaceae
- cuneate** wedge-shaped
- cupular** cup-shaped
- cuspidate** with a minute point (mucro) at the tip
- cyme** a determinate inflorescence, with the central flowers opening first
- cystoliths** intercellular thickenings, usually of calcium carbonate/oxalate
- decurrent** extending down, as when the base of a blade is prolonged down the petiole
- decussate** in opposite pairs, each pair at right angles to the other pair (see distichous)
- dehiscent** splitting open
- dentate** with sharp, incisions along the margin
- denticulate** minutely or finely toothed
- depressed** flattened from above, pressed down
- diadelphous** with two groups of stamens (5+5, 9+1)
- dichotomous** forked or branching in pairs
- didynamous** 4 stamens in 2 pairs of different lengths
- digitate** like finger, with the members arising from one point/level
- dimorphic** 2 different forms (bimorphic)
- dioecious** unisexual plants (see monoecious)
- disc** an organ outside and usually surrounding of the ovary, inside of the stamens or corona
- discoid** disc-like
- distichous** 2-ranked or rows, the leaves from opposite sides of the stem in the same plane (see decussate)
- disc flower** inner, regular flower in the capitula of Compositae (see ray flower)
- dorsal** upper side, outer surface (see ventral)
- dorsifixed** with the anthers attached to the back (dorsal) of the filament

- drupe** a fleshy fruit with the seed(s) enclosed in a hard endocarp (pyrene)
- eccentric** the axis not centrally, slightly asymmetric (see oblique)
- echinate** prickly
- elliptic** widest at or about the middle (see table 5)
- emarginate** with a shallow notch at the apex
- ensiform** sword-shaped
- entire** margin smooth, *e.g.* not toothed or lobed
- epicalyx** a whorl of a calyx-like organ outside and on the calyx in Malvaceae
- epichile** the distal portion of the lip in Orchidaceae (see hypochile)
- erect** upright
- erose** having irregularly cut or toothed margins
- evanescent** short-lived
- exserted** projecting above the surrounding parts (see included)
- galeate** hooded (cucullate)
- geniculate** abruptly bent or knee-like, jointed
- glabescent** becoming glabrous
- glabrous** without indumentum
- glandular** with secreting organs or glands
- globose** spherical
- glume** lowest scale-like organ(s) in spikelets in Gramineae and Cyperaceae
- grain** a dry, 1-seeded, indehiscent fruit in Graminae
- gynophore** stalk of a pistil
- hastate** having arrow head lobes, “^”- shaped (see sagittate)
- helicoid cyme** a determinate inflorescence which the lateral flowers from the same side
- hirsute** with rough/coarse, erect hairs
- hirtellous** softly or minutely hirsute
- hypanthium** a cup-shaped or tubular enlarged receptacle (resembling a calyx tube)
- imbricate** margins overlapping (see valvate, convolute)
- imparipinnate** pinnate with a terminal leaflet or pinna
- incised** irregularly slashed, deeply and sharply cut
- included** not protruding (see exserted)
- incurved** curved inwards (see recurved)

- indumentum** hairs or scales
- indusium** protective organ covering sporangia
- inferior** ovary embedded in the receptacle below the other floral parts (see superior)
- inflated** enlarged, expanded, blown up
- inflorescence** group of flowers
- infructescence** group of fruits
- inserted** point of origin
- internode** the part of stem/inflorescence/infructescence between the nodes
- interpetiolar** between petiole pairs
- lacerate** irregularly and deeply cleft/cut
- lanate** very densely covered with long, soft, woolly hairs
- lanceolate** lance-shaped (see table 5)
- lemma** part of a spikelet between the glumes and palea in Graminae
- ligule** the thin projection from the inside top of the leaf sheath especially in Gramineae and Cyperaceae; the limb of ray flowers in Compositae (see disc flower)
- limb** the broader or expanded part of an organ
- lip** one of the two divisions of a bilabiate calyx or corolla; the labellum in orchidaceae and Zingiberaceae
- lobe** any incomplete division or segment of an organ
- loculicidal** splitting (dehiscing) along the locule wall (see septicidal)
- membranous** thin and slightly transparent/translucent
- mericarp** an indehiscent, 1-seeded portion of a schizocarp
- microphyllous** very small (microscopic) leaf
- monadelphous** all filaments united in one group (see diadelphous)
- monoecious** bisexual plant (see dioecious)
- mucronate** with a short and straight cusp/point
- multicellular** many-celled
- muricate** roughed with minute, short and hard projections
- nodosity** knob or small bump
- nut** an indehiscent, 1-seeded, hard dry fruit
- nutlet** a small nut in Labiatae
- oblanceolate** inversely lanceolate, broadest above the middle (see table 5)

- oblique** unequal-sided, asymmetric (see eccentric)
- oblong** longer than broad, with the sides mostly parallel (see table of shapes)
- obovate** reversely ovate, broadest above the middle (see table of shapes)
- obovoid** 3-dimensionally, obovate in outline
- obtuse** blunt, rounded
- ochrea** a tubular sheathing stipule from the nodes as in Polygonaceae
- odd pinnate** imparipinnate (see paripinnate)
- operculum** a lid/top
- orbicular** circular
- ovary** ovule containing part of a flower
- ovate** egg-like in outline, broadest below the middle (see table of shapes)
- ovoid** 3-dimensionally ovate in outline
- palea** the upper scale-like part of spikelets in Graminae (see lemma)
- palmatifid** hand-shaped, leaf blade lobed about half way or more to the base
- palmatisect** hand-shaped, with the lobes of the leaf extending almost to the base
- panicle** a spreading, indeterminate inflorescence, the branches being racemose
- papillate** with minute, pimple-like surface swellings
- pappus** whorl/tufts of hairs, bristles, scales on the top of ovaries and achenes in most
Compositae
- parietal** placentation of ovules from the inner ovary wall (see axile)
- paripinnate** compound leaf having an equal number of leaflets/pinnae and without a
terminal segment (see odd pinnate/imparipinnate)
- pectinate** pinnatifid with narrow segments like the teeth of a comb
- pedicel** stalk of a flower/fruit
- peduncle** main stalk of an inflorescence or infructescence
- peltate** insertion from inside the margin
- pendulous** hanging down
- perianth** united, undistinguishable calyx and corolla (see tepals)
- petiolar** relating to the petiole
- petiole** leaf stalk
- petiolule** leaflet stalk
- pilose** with long, ascending, soft hairs

pinnate a compound leaf/frond which the leaflets/pinnae on either side of the primary axis

pinnatifid pinnately divided (see palmatifid)

pinnatisect pinnately parted (see palmatisect)

pistil stigma, style and ovary

plicate folded into plaits, usually lengthwise

plumose with fine dense/spreading hairs on a central stalk, as the stigmas of Gramineae

pod a usually dehiscent dry fruit of one locule with one parietal (marginal) placenta in Leguminosae, dehiscing along one margin

pollinium(ia) a pollen mass

posterior back side (see anterior)

pseudobulb the thickened or bulbiform succulent stems of some Orchidaceae

pubescent with hairs (see glabrous)

pulvinus enlarged portion of the petiole or petiolule

punctate with minute dots

raceme an unbranched indeterminate inflorescence with pedicelled flowers

racemose an inflorescence having flowers in racemes

rachilla axis of a raceme, or spikelet

rachis main axis of a leaf/frond or inflorescence/infructescence

ray flower outer, irregular flower in the capitula of some Compositae (see disc flower)

receptacle an enlarged or elongated tip of the flower axis, bearing the flower parts

recurved curved downward or backward (see incurved)

reflexed abruptly recurved

reniform kidney-shaped

reticulate net-like, joined veins (see scalariform)

retuse shallowly notched (see emarginate)

revolute rolled backward

rhizome underground stem, with nodes, buds, or scales

rigid stiff

rosette a cluster of leaves at the base of the stem

rugose wrinkled

saccate bag-like

sagittate long, arrow head-shaped lobes, pointing downward, deeply “^” shaped
(see hastate)

salverform a slender corolla tube with an abruptly expanded and flat limb

scabrous surface roughened like sand paper

scabrellous finely scabrous

scalariform ladder-like, or having ladder-like veins (see reticulate)

scape a stalk of an inflorescence in Araceae

schizocarp a dry, dehiscent fruit that splits into 2 or more mericarps

scorpioid cyme a determinate inflorescence with lateral pedicelled flowers,
appearing racemose

sepal an outer, free segment of a flower

seriate in a series or row

sericeous adpressed silky hairs

serrate saw-toothed margin

serrulate minutely serrate

setose erect, rigid, stiff hairs

setulose finely setose

sheath a tubular covering (*i.e.* leaf sheath, ochrea)

sinus the space between two lobes

sorus (plural sori) a cluster of sporangia in ferns

spadix a spike-like inflorescence surrounded by a spathe in Araceae and Palmae

spathe a large bract enveloping the spadix in Araceae

spicate spike-like, sessile flowers/fruits

spike an unbranched inflorescence with sessile flowers/fruits

spikelet an inflorescence unit in Gramineae and Cyperaceae consisting of one or
more florets with glumes; a branch of a spike

spinescent with a spine or hard sharp point

sporangium a spore case

sporophyll a sporangium-bearing leaf/frond

spur tubular or sac-like appendage

stamen male sex organ, usually consisting of anther, connective and filament

staminode a sterile stamen

- standard** the upper or posterior petal of a papilionaceous flower
- stellate** star-like, radiating from one point indumentum
- stigma** the apex of the style
- stipe** stalk of fronds (petiole)
- stipitate** having a stipe
- stipule** an appendage associated with the base of the petiole or node
- stipulate** having stipules
- strigose** erect, stiff hairs or bristles
- strobili** cone-like structure containing the reproductive organs (sporophylls) in pteridophytes and gymnosperms
- strobiliform** cone-like
- strophiole** topknot or appendage on seeds of Polygonaceae
- stylopodium** fused style bases in some Umbelliferae
- stylid** sterile style in Gramineae
- synandria** androecium of coherent anthers
- sub-** a prefix, signifying somewhat, slightly, less than, or below
- subulate** awl-shaped, narrowly tapering from base to apex
- superficial** shallowly covering or depressed
- tepal** a free flower segment not clearly a sepal or petal
- terete** circular in cross section
- thyse** panicle of cymes
- thryoid** resembling a thyse
- tomentose** densely covered with woolly indumentum
- translator** structure which connect pairs of pollinia in Asclepiadaceae
- truncate** abruptly cut off at the base or apex
- tuberculate** with minute, rough knobby projections
- ultrajugal** the part of the leaf rachis from the upper most pair of lateral leaflets to the terminal leaflet as in Leguminosae
- umbel** an indeterminate, flat-topped inflorescence whose axes arise from a common point and are same length
- umbellate** with umbels , umbel-like
- undulate** wavy

unilocular a single chamber

unisexual one sex; male (staminate) or female (pistilate) only (see bisexual)

urceolate urn-shaped

utricle a small bladder in Lentibulariaceae; dry, 1-seeded fruit in some Cyperaceae

vaginate sheathing

valvate margins touching, as in buds (see imbricate)

vascular conductive tissue, strands

velutinous with velvety indumentum

venation nerves, arrangement of veins/nerves

ventral bottom side, inner face (see dorsal)

verticillate arranged in whorls

villous with long, soft, erect hairs

vexillary opposite the standard (posterior) petal in Leguminosae, Papilionoideae

wing thin lateral expansion of an organ; the lateral petals of a papilionaceous flower

Appendix B

Table 5 Table of shapes (Radanachaleess and Maxwell, 1994)

SHAPES			
length/width	widest at the		
	base	middle	apex
~ 1	-	orbicular	-
1-2	ovate	elliptic	obovate
2-3	ovate-oblong	oblong	obovate-oblong
3-5	ovate-lanceolate	lanceolate	obovate-lanceolate
5-10	-	linear-lanceolate	-
10 +	-	linear-subulate	-

CURRICULUM VITAE

NAME	Wangworn Sankamethawee
DATE OF BIRTH	5 November 1974
NATIONALITY	Thai
MARITAL STATUS	Single

EDUCATION

GRADUATE SCHOOL	2000-2003 Department of Biology, Faculty of Science, Chiang Mai University
BACHELOR	1993-1996 Environmental Ecology Department, Faculty of Science, Khon Kaen University, Thailand
DEGREE	Bachelor's degree of Science (Environmental Ecology)
SECONDARY SCHOOL	1990-1992 Wapeepathum School, Mahasarakham

EMPLOYMENT AND RESEARCH

1. December 1999 - May 2001: Huai Kaew Arboretum (Chiang Mai)
2. April 1998 - October 1999: research assistant in Eastern Botanic Garden (Khao Hin Sorn, Chachoengsao) and RFD Centennial Botanic Garden (Sra Kaew)
3. May 1997 - March 1998: doing a research project in Khon Kaen University in topic "Study on floristic biodiversity in riparian ecosystem in Northeastern Thailand" on behalf of "Seasonally flooded riparian forests in Northeastern Thailand: Distribution, classification, dynamics and biodiversity" funded by German Tropical Ecological Support Programme.