

ความหลากหลายของเทอร์โคไฟต์บริเวณภูทับเบิก อุทยานแห่งชาติภูหินร่องกล้า จังหวัดเพชรบูรณ์



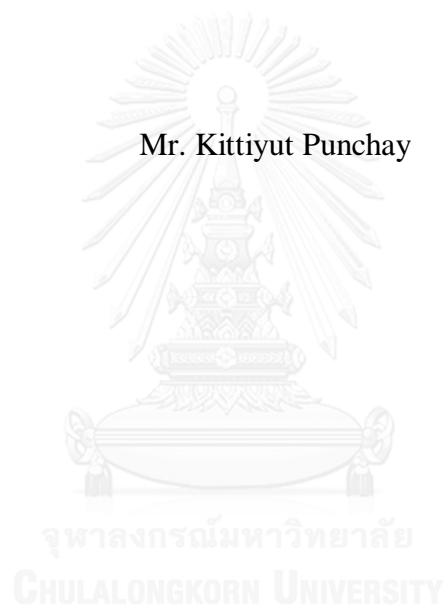
บทคัดย่อและแฟ้มข้อมูลฉบับเต็มของวิทยานิพนธ์ตั้งแต่ปีการศึกษา 2554 ที่ให้บริการในคลังปัญญาจุฬาฯ (CUIR)  
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DIVERSITY OF PTERIDOPHYTES IN PHU THAB BOEK AREA, PHU HIN  
RONG KLA NATIONAL PARK, PHETCHABUN PROVINCE

Mr. Kittiyut Puchay



A Thesis Submitted in Partial Fulfillment of the Requirements  
for the Degree of Master of Science Program in Botany

Department of Botany

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กิตติยูทธ ปั่นฉาย : ความหลากหลายของเทอริโดไฟต์บริเวณภูทับเบิก อุทยานแห่งชาติภู  
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Ching และ *Plagiogyria euphlebica* (Kunze) Mett. เป็นครั้งแรกในประเทศไทย เทอริโด  
ไฟต์ 2 ชนิด คือ *Cyclosorus siamensis* (Tagawa & K. Iwats.) Panigrahi และ *Arthromeris*  
*phuluangensis* Tagawa & K. Iwats. มีสถานภาพเป็นพืชถิ่นเดียว ในการศึกษาในครั้งนี้ได้  
จัดทำคำบรรยายลักษณะของพรรณไม้แต่ละชนิด รูปวิธานจำแนก สกุลและชนิด พร้อมข้อมูลทาง  
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ภาควิชา พฤกษศาสตร์

ลายมือชื่อนิสิต .....

สาขาวิชา พฤกษศาสตร์

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KITTIYUT PUNCHAY: DIVERSITY OF PTERIDOPHYTES IN PHU THAB BOEK AREA, PHU HIN RONG KLA NATIONAL PARK, PHETCHABUN PROVINCE. ADVISOR: PROF. THAWEESAKDI BOONKERD, Ph.D., 205 pp.

The diversity of pteridophyte was explored in the lower montane rainforest in Phu Thab Boek area, Phu Hin Rong Kla National Park, Phetchabun Province from March 2013 to June 2014. A total of 108 species belonging to 53 genera and 20 families of pteridophytes were recorded from 10 transects (ca 10 kilometers) at altitude ranging from 1,600 – 1,800 AMSL. Among these, 2 families, 4 genera and 4 species are lycophytes, the remaining majority being ferns. Three families of ferns, namely Aspleniaceae, Dryopteridaceae and Polypodiaceae, were the most common families with 11, 13 and 25 species, respectively. According to habitat, there are 57 species of terrestrial plants, followed by 33 species of epiphyte, 6 species of lithophytes and 12 species occur in more than one habitat, although it is worth noting that some of these species were uncommon or rare. In addition, *Pteris mcclurei* Ching (Pteridaceae) and *Plagiogyria euphlebia* (Kunze) Mett. (Plagiogyriaceae) are a new records for Thailand, 2 species namely *Cyclosorus siamensis* (Tagawa & K.Iwats.) Panigrahi and *Arthromeris phuluangensis* Tagawa & K.Iwats. are endemic species, respectively. Key to genera and species were constructed. Full description, ecological data, distribution, vernacular name and photographs of each species were prepared. The voucher specimens are deposited at Professor Kasin Suvatabhandhu Herbarium, Department of Botany, Faculty of Science, Chulalongkorn University and the Forest Herbarium, Department of National Park, Wildlife and Plant Conservation.

Department: Botany

Student's Signature .....

Field of Study: Botany

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# CHAPTER I

## INTRODUCTION

Thailand is located at the center of the Indochina peninsula in Southeast Asia. It is bordered to the north by Myanmar and Laos, to the east by Laos and Cambodia, to the south by the Gulf of Thailand and Malaysia and to the west by the Andaman Sea and the southern of Myanmar. Thailand has total area of 513,115 square kilometers from 5° 27' to 20° 28' north and 97° 21' to 105° 38' east (Royal Instituted, 2002). Most of Thailand climate is tropical wet and dry or savanna climate. According to the southwest monsoon from the South China Sea, the tropical cyclone and the northeast monsoon from China are influence climate of Thailand that divided into three seasons, summer, rainy season and winter. The average temperatures are 18-34 ° C and annual average rainfalls are 1,500 mm (Tourism Authority of Thailand, 2000c)

Thailand is located between two biogeographical region, Indochina biogeographical region and Sunda-typical of Malaysia, Sumatra, Borneo and Java biogeographical region that makes Thailand is the center of three floristic elements such as Indo-Burmese elements, Indo-Chinese element and Malesian elements. The Plant community is Thai monsoon forests, Indochina forest and Malayan forest, overall called the Tropical Dry or Deciduous Forest (Santisuk, 1989). According to Smitinand (1989) Thailand can be divided into seven floristic regions i.e. the Northern (N), North-eastern (NE), Eastern (E), Central (C), South-eastern (SE), South-western (SW), and Peninsular (PEN). van Welzen et al. (2011) divided area into four floristic regions, Peninsular Province (extending in the South-eastern), Northern Province (with extensions into the South-western and South-eastern), Eastern Province and the Central Lowlands.

Phu Hin Rong Kla National Park is the 48th national park in Thailand, covers an area of approximately 307 square kilometers and parts of Phitsanulok, Loei and Phetchabun province. It was a stronghold of communist party that detrimental to the nation stability in 1968-1972. After the situation ended, the government has controlled the area and established the national park. In general, Phu Hin Rong Kla National Park is the mountainous area with many peaks, the highest peak is Phu Mahn

Khao peak located in Phu Thab Boek area. Phu Thab Boek area in Phu Hin Rong Kla National Park covers an approximated area of 30 square kilometers and ranged in elevation from 1,600-1,800 meters above mean sea level. For the plant exploration and collection in the area are most flowering plants and a few pteridophytes in specific area. But the collections of pteridophytes in Thailand show that 118 species are from Phitsanulok, 218 species from Loei and 46 species from Phetchabun. It seems that these provinces are rich in pteridophytes diversity (Tagawa and Iwatsuki, 1979, 1985, 1988, 1989). Moreover, Phu Thab Boek area is located in North Eastern floristic region and there are few data about diversity of pteridophytes in area that higher than 1,500 m above mean sea level.

It is necessary to explore pteridophytes diversity in Phu Thab Boek area, Phu Hin Rong Kla National Park because the risk of deforestation from road construction may lead to the risk of pteridophyte extinction. Moreover the biodiversity knowledge will be increased and the data from this study can be useful in biodiversity conservation in protected area in the future.

#### **Aim of this thesis**

To explore the diversity of pteridophytes in Phu Thab Boek area, Phu Hin Rong Kla National Park, Phetchabun province.

## CHAPTER II

### LITERATURE REVIEW

The taxonomic study of plant in Thailand has been studied for two hundred years ago and it has been mainly focused on flowering plant or economic crops, while pteridophytes have little information. The following are example of previous botanical works.

In 1901, Johannes Schmidt, a Danish botanist, collected plant specimens from Koh Chang, South-eastern Thailand. 67 species and 35 genera of pteridophytes were found (Schmidt, 1901). In 1922, Eryl Smith, English physician, collected pteridophytes in peninsular Thailand. She collected 1,984 specimens and reported collection of pteridophytes in National History Bulletin of Siam Society. These specimens were kept in Kew Herbarium (K), Natural History (BM), Singapore Herbarium (SING) and Forest Herbarium (BKF). During 1934-1935 Gunnar Seidenfaden reported a small collection of pteridophytes in two different parts of Thailand, Surat circle in Peninsular and Trat circle near Chantaburi, 47 species and 30 genera were recorded. Most of specimens were kept in Natural History Museum of Denmark (C) and Kew Herbarium (K). (Seidenfaden, 1958)

In 1954, Richard Eric Holttum, Kew botanist, reported 108 genera and 468 species of pteridophytes in "The Ferns of Malaya" (Holttum, 1969). During 1957-1960, Thailand has been coordinated with Denmark in project "Studies in Flora of Thailand". Moreover, during 1965-1966 the Center for Southeast Asians studies sent a botanical party to Thailand and the first Thai-Japanese Botanical Expedition was begun in cooperation with Royal Forest Department in Bangkok. Motozi Tagawa and Kunio Iwatsuki, Japanese botanists, studied pteridophyte for Flora of Thailand. In their enumeration, 116 genera and 446 species are listed (Tagawa and Iwatsuki, 1967). In 1979-1989, M. Tagawa and K. Iwatsuki were published 121 genera and 630 species of Pteridophytes in Flora of Thailand Vol. III, part 1-4 (Tagawa and Iwatsuki, 1979, 1985, 1987, 1989)

In 1986, Sutheera Arkarakraisri studied pteridophytes in family Dennstedtiaceae in Thailand, 5 genera 16 species were reported and pteridophyte

namely *Pteridium aquillinum* sub. *aquillinum* var. *wightianum* was collected from Phu Hin Kla, Phetchabun province (Sutheera Akarakraisri, 1986). Then Kitichate Sridith observed non flowering plant on rock platform at Phu Hin Rong Kla National Park during 1987-1988, he found 27 species which included 12 species of bryophytes, 14 species of pteridophytes and 1 species of pine (Kitichate Sridith, 1987).

In 1993, Seree Promkeaw collected pteridophytes family Polypodiaceae in Phu Kradung National Park, 13 genera and 14 species were reported (Seree Phromkaew, 1993), During 1994-1997, Piyakaset Suksathan studied taxonomy and ecology of epiphytic and lithophytic pteridophytes at Doi Chiang Dao, Chiang Mai Province. 35 genera, 84 species of pteridophytes were listed and *Cheilanthes argentea* (S.G. Gmel.) Kunze was a new record for Thailand (Piyakaset Suksathan, 1998).

In 1995, Putthachart Sangarun reported result from fern survey study of Kao Loung, Ramkhamhaeng National Park, Sukhothai Province. There were 10 families, 32 genera and 61 species of ferns reported. Most of them were Polypodiaceae and epiphytic ferns found on tree trunks, moist rocks and grown in dense shady forest with high humidity (Putthachart Sangarun, 1995).

During 1996-1999, Thaweesakdi Boonkerd and Piyapong Rachata explored diversity of fern and fern allies at Khunkorn Waterfall Forest Park, Chiang Rai Province, 64 genera and 154 species were reported. Two species were new records namely *Dicranopteris linearis* (Burm. f.) Underw. var. *montana* Holttum and *Selaginella ciliaris* (Retz.) Spring (Boonkerd and Ratchata, 2002).

In 2000, Thaweesakdi Boonkerd and Rossarin Pollawatn reported the checklist of pteridophyte in Thailand and booklet was purposed a new classification system for the pteridophytes in Thailand. They listed 35 families, 139 genera, 671 species, 4 subspecies and 28 varieties. Moreover, 27 species were reported as new records in Thailand (Boonkerd and Pollawatn, 2000).

During 2001-2002, Wilawan Rattanathirakul studied taxonomy of fern and fern allies at Phu Hin Rong Kla National Park, Phitsanulok province. 55 genera, 112 species and 2 varieties of fern and fern allies were reported and *Acrorumohra diffracta* (Baker) H. Itô was new record for Thailand (Wilawan Rattanathirakul, 2002). In 2003, Siridarat Jujia explored diversity of fern and fern allies at Thung



Salaeng Laung National Park, Phitsanulok province and Phetchabun province. 22 families, 40 genera and 72 species were reported (Siridarut Jujia, 2003).

In 2006, Kitima Makgomol reported a total of 21 families, 34 genera, 66 species of pteridophytes in Phu Phan National Park, Sakon Nakhon province (Makgomol, 2006). In 2008, Boonkerd and Khwaiphan studied diversity of pteridophyte in Khao Khiao area in Khao Yai National Park and 25 families, 59 genera, 113 species were reported (Khwaiphan and Boonkerd, 2008). A total of 10 families, 18 genera and 29 species of pteridophytes in three waterfalls in Nam Nao National Park were reported by Makgomol (2009).

In 2011, Wasinee Kwaiphan and others studies diversity of fern and fern allies at Phu Pha Man, Khon Kaen Province and Loei Province, 38 species were recognized belonging to 23 genera and 13 families. Among these, 2 families, 2 genera, 3 species are fern allies, while 11 families, 21 genera and 35 species are ferns (Khwaiphan et al., 2011). Sumon Masuthon (n.d.) reported diversity of fern in mountain ecosystem, Phu Luang Wildlife Sanctuary, Loei Province. A total 24 families, 51 genera and 115 species of ferns were recorded (Masuthon, n.d.).

From the above mentioned information, the botanical surveys of pteridophytes in Thailand have been continuing studied and Phu Thab Boek area in Phu Hin Rong Kla National Park has lacked pteridophytes diversity information. Therefore Phu Thab Boek area is a suitable site for the purpose of diversity exploration and to increase of pteridophytes data in Thailand.

## CHAPTER III

### STUDY SITE

#### 3.1 Location and History

Phu Hin Rong Kla National Park is located in boundaries of three provinces by Nakhon Thai District in Phitsanulok province, Lom Sak District in Phetchabun province and Dan Sai District in Loei province. The area of Phu Hin Rong Kla National Park is approximately 307 square kilometers or 191,875 rai. (Fig 3.1A)

During 1968-1972, Phu Hin Rong Kla was a major stronghold of communist party who threatened public security of Thailand. In 1982, the government of Thailand has taken possession of forcefully Phu Hin Rong Kla but not successful. Later, the army commander changed battle plan to combat the communist terrorists. This new battle plan had led to the successful without even the flesh. In 1983 Royal Forest Department began developing this area by open the road through Phu Hin Rong Kla and sent a letter to the government of Thailand for consider to established Phu Hin Rong Kla to national park because terrain, forest, many featured of the geographical stone and historic battle between Thai soldiers and the communist terrorists (Pakeerun, 2000).

The topography of Phu Hin Rong Kla is consisting of complicated mountains. The mountain peaks are Phu Paeng Ma, Phu Kee Thao, Phu Mahn Khoa, Phu Lom Lo and Phu Hin Rong Kla. The highest elevation is around 1800 meters above mean sea level at Phu Man Khoa. The mountains are high in descending order from the east to the west and these mountains are fountainhead of many streams such as Huay Nam Kamaun, Huay Om Singh and Huay Luang Yai (Soil and forest resources part National Resource Conservation Office, 1997).

Phu Hin Rong Kla is a beautiful natural source and plentiful forest, especially waterfall namely Man Daeng waterfall, Rom Klao-Pradon waterfall and geological characteristics of Lan Hin Taek and Lan Hin Poom which may be caused by deflection or movement of the earth surface. The area is also covered with mosses, lichens, ferns and orchids in different species. Moreover, the historical of fighting site

between governments of Thailand against communist terrorists. From these reasons have made Phu Hin Rong Kla be 48<sup>th</sup> National Park in Thailand since 26 July 1984.

### **3.2 Geological data**

The geological condition of Phu Hin Rong Kla National Park is steep in the south east and west. The rock in Phu Hin Rong Kla is metamorphic rock and sedimentary rock of Korat group which contain Phu Phan formation (Kpp), Phra Wihan formation (Jpw), Sao Khua formation (Jsk) and Khok Kruat formation (Kkk). (Fig 3.1B) In the past, Geologist presumed that rock caused by the accumulation of silt, call braided stream, for Cretaceous period (120-100 million years ago) until Tertiary period (55 million years ago). The soil caused by decomposition of rock which include sandstone, shale, lime stone, quartzite and phyllite. Most of soil type in Phu Hin Rong Kla National Park is slope complex; the others are Hang Chat series and Satuk series. (Soil and forest resources part National Resource Conservation Office, 1997)

### **3.3 Climate**

The climate in Phu Hin Rong Kla National Park was forecasted by nearest Meteorological station is Lom Sak station. There were three data were collected, temperature, rainfall and relative humidity (Thai Meteorological Department, 2014) (Fig 3.2)

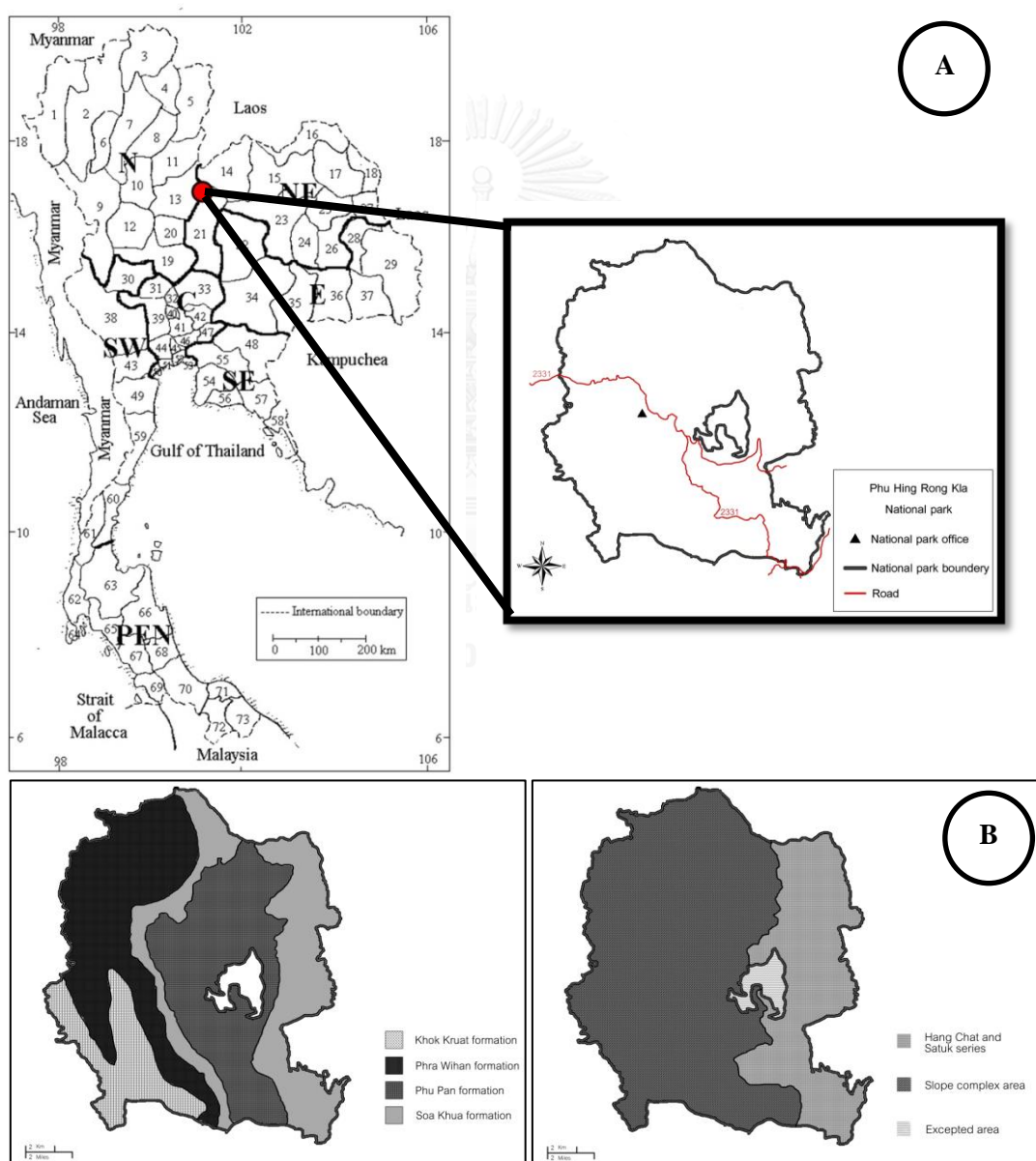
### **3.4 Vegetation**

Most of the area from foothill up to 1,200 meters above mean sea level is trespass by hill tribe for their cultivation and forest turn to the abandon area or grassland. The forest, that higher than 1,200 meters above mean sea level, is still well-preserved area in the south of national park. The vegetation of Phu Hin Rong Kla National Park includes deciduous dipterocarp forest, mixed deciduous forest, dry evergreen forest, lower montane rainforest and lower montane scrub (Soil and forest resources part National Resource Conservation Office, 1997).

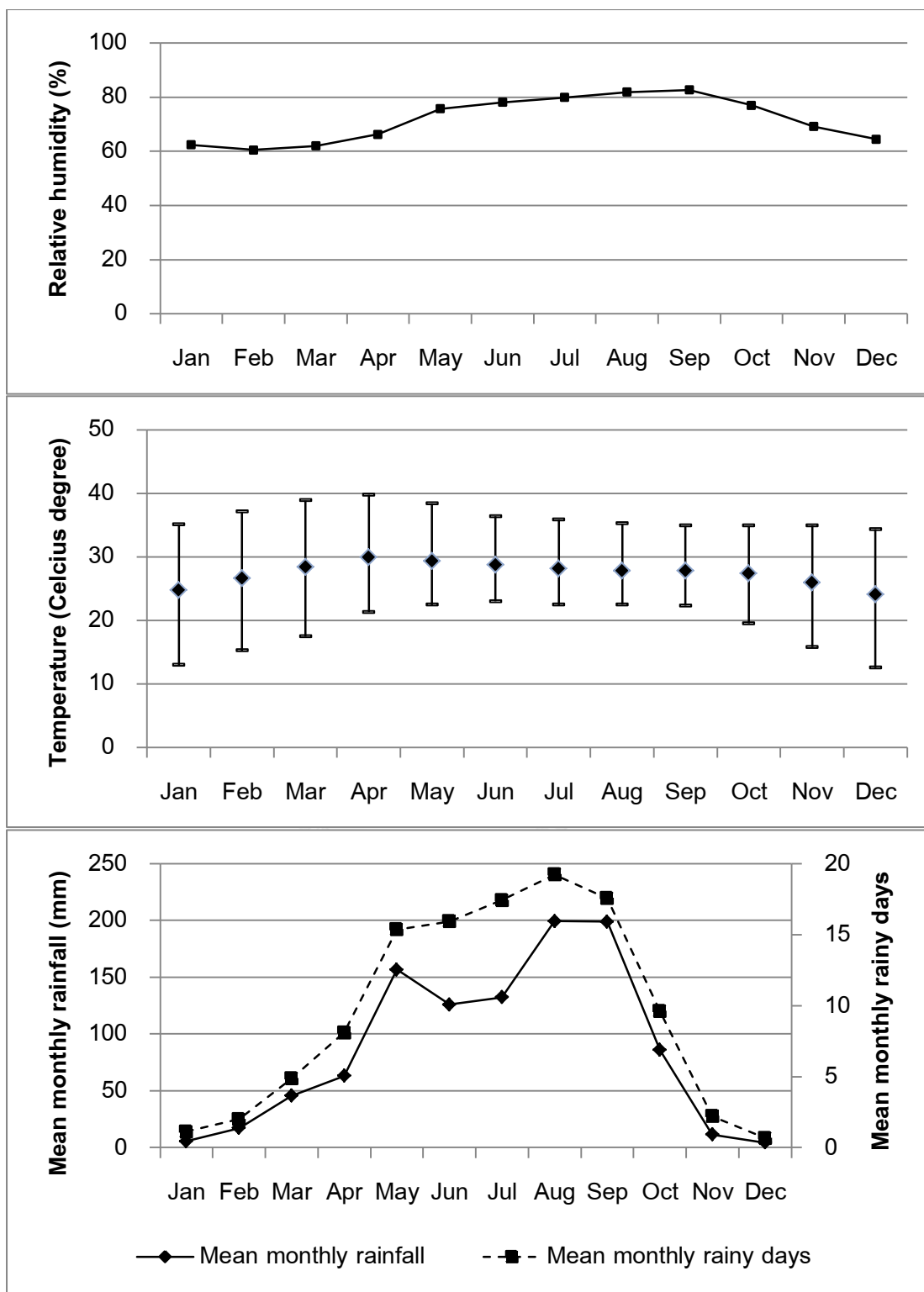
1. Dry dipterocarp forest can be found on mountain slopes at elevation of 600 meters. Only small tree and frutescent plant are found because trees were cut off. Characteristic trees include: *Dipterocarpus tuberculatus* Roxb., *D. obtusifolius* Teijsm. ex Miq., *Shorea obtusa* Wall. ex Blume, *S. siamensis* Miq., *Pterocarpus macrocarpus* Kurz, *Albizia odoratissima* (L. f.) Benth., *Phyllanthus emblica* L., *Fernandoa adenophylla* (Wall. ex G. Don) Steenis etc.
2. Mixed deciduous forest can be found in groups alternate with dry dipterocarp forest that appears in narrow strip at dry evergreen forest boundary and the soil fertility is richer than dry dipterocarp forest. Characteristic trees include: *Pterocarpus macrocarpus* Kurz, *Xylia xylocarpa* var. *kerrii* (Craib & Hutch.) I.C. Nielsen, *Millettia brandisiana* Kurz, *M. leucantha* Kurz var. *buteoides* (Gagnep.) P.K. Loc, *Bauhinia malabarica* Roxb., *Careya sphaerica* Roxb., *Lagerstroemia macrocarpa* Wall., *Gardenia coronaria* Buch.-Ham. *Cratoxylum formosum* (Jacq.) Dyer etc.
3. Dry evergreen forest was appeared in large area at 300-800 meters but at present it was completely cleared. The trees that still remain in deforestation area are *Lagerstroemia calyculata* Kurz, *Irvingia malayana* Oliv. ex A.W. Benn., *Anogeissus acuminata* (Roxb. ex DC.) Guill. & Perr. var. *lanceolata* C.B. Clarke, *Mangifera caloneura* Kurz, *Anisoptera costata* Korth., *Stereospermum fimbriatum* (Wall. ex G. Don) A. DC., *Alstonia scholaris* (L.) R.Br., *Xerospermum noronhianum* (Blume) Blume etc.
4. Lower montane rainforest can be found in the south of Phu Hin Rong Kla National Park at 1,200 meters above mean sea level. The crown covers dense and continuous. Characteristic trees include: *Calophyllum polyanthum* Wall. ex Choisy, *Knema globularia* (Lam.) Warb., *Cinnamomum iners* Reinw. ex Blume, *C. tamala* (Hamilton) Nees & Eberm. *Acer calcaratum* Gagnep. and members of Fagaceae such as *Castanopsis acuminatissima* (Blume) A. DC., *C. brevispinula* Hickel & A. Camus, *C. echidnocarpa* A. DC., *C. crassifolia* Hickel & A. Camus, *Lithocarpus polystachyus* (A. DC.) Rehder, *Quercus aliena* Blume, *Q. kingiana* Craib. In forest fire disturbance area, *Pinus kesiya*

Royle ex Gordon and *P. merkusii* Jungh. & de Vriese are usually found with Fagaceae members.

- Lower montane scrub can be found in rocky open space. It consists of small tree or shrub in rock crevice, epiphytic plant and parasitic plant. Characteristic trees include: *Rhododendron lyi* H. Lév., *Rhamnus crenata* Siebold & Zucc., *Melastoma malabathricum* L. subsp. *normale* (D. Don) F.K. Mey., *Hedychium ellipticum* Buch.-Ham. ex Sm. *Fagraea ceilanica* Thunb. etc.



**Fig. 3.1** A: Phu Hin Rong Kla National Park location, B: soil formations and soil series in Phu Hin Rong Kla National Park



**Fig. 3.2:** Climatic data consist of relative humidity, temperature, mean monthly rainfall and mean monthly rainy days.

## **CHAPTER IV**

### **MATERIALS & METHODS**

#### **4.1 Materials**

##### **4.1.1 Specimen collecting equipments**

- Plant presses, 30 x 45 cm
- Sheets of newspapers
- Corrugated paperboards
- Hand pruner
- Plastic bags
- Zipper bags
- Field note
- Digital camera
- The global positioning system (GPS) equipment, Garmin model: GPSmap 60CSx
- Collector number card

##### **4.1.2 Herbarium specimen preparing equipments**

- Deep freezer (-30° C)
- Hot air oven (35° -55° C)
- Mounting papers, 30 x 42 cm
- Species covers, 30 x 42 cm
- Genus covers, 30 x 42 cm
- Mounting glue (latex mixed with synthetic glue in ration 1:1 by volume)
- Herbarium label 10.5 x 13.5 cm
- Needle and thread
- Sand bags

##### **4.1.3 Identification equipments**

- Dissecting microscope
- Dissecting needles
- Razor blades
- Petri dishes

- Light microscope
- Microscopic slides and cover glasses
- Relate taxonomic literature of pteridophyte
- Voucher specimens in herbaria: Forest Herbarium (BKF) and Professor Kasin Suvatabhanhu Herbarium (BCU)

## **4.2 Methods**

### **4.2.1 Literature review**

Taxonomic literatures were searched from CU-reference database at Office of Academic Resources, Professor Kasin Suvatabhanhu Herbarium at Department of botany, Chulalongkorn University (BCU). The data of Phu Hin Rong Kla National Park such as location, area, boundary, topography, vegetation were studied from Library of forest and Plant Conservation Research Office, Department of National Parks, Wildlife and Plant Conservation. Moreover, climate information was supported by Thai Meteorological Department, Bangkok.

### **4.2.2 Exploration and collection**

The exploration of pteridophytes was conducted from March 2013 to May 2014 at Phu Thab Boek area, Phu Hin Rong Kla National Park. Pteridophytes were collected along 10 km of road number 2331 (Nakhonchai-Ban Rong Kla-Ban Thab Boek) as the main line, extending about 5 m on south side of the road. Furthermore, 8 transect lines were cut at least 50 m from the main line. Three duplicates of specimens were collect and photographs were taken.

### **4.2.3 Laboratory study**

Laboratory study was preceded at Plant of Thailand Research Unit, Department of Botany, Chulalongkorn University. Dry specimens were prepared as described in Boonkerd et al. (1987) and deposited in BCU and BKF. The internal and external morphological characters of each specimen were examined. Pteridophyte specimens were identified by using taxonomic keys and description from taxonomic literatures, such as Flora, monograph, revision research papers etc. botanical names of each specimen were verified by comparison to the specimens at BCU and BKF. The abbreviations of scientific author names follow Brummit and Powel (1992). Classification system of Pteridophytes in this thesis follow Lindsay, Middleton, Boonkerd, and Suddee (2009). Dichotomous key to genera species variety and



infraspecific taxon were for determining each taxon in the studied area. Description of each species was prepared from specimens that collected from Phu Hin Rong Kla National Park. The ecological data geographical distribution, vernacular name and uses of each species were prepared additionally.



## CHAPTER V

### RESULT

Two hundreds and ninety specimens were collected during March 2013 to June 2014. A total of 21 families, 53 genera and 108 species were determined. Among these 2 families, 4 genera and 4 species are lycophytes the remaining majority 19 families, 49 genera and 104 species (Table 5.1) are monilophytes. Descriptions and keys to taxa are represented as below.

**Table 5.1 List of Lycophytes and monilophytes at Phu Thab Boek area, Phu Hin Rong Kla National Park.**

Habitat T= terrestrial, E= epiphytic, L= Lithophytic

Abundance: R= rarely found, UC= uncommon, C= common, A= abundant

\* = New record species, \*\* = Endemic species

Taxon	Habitat	Abundance
<b>LYCOPHYTES</b>		
<b>LYCOPODIACEAE</b>		
<i>Huperzia hamiltonii</i> (Spreng. ex Grev. & Hook.) Trevis.	E	C
<i>Lycopodiella cernua</i> (L.) Pic.Serm.	T	A
<i>Lycopodium clavatum</i> L.	T	A
<b>SELAGINELLACEAE</b>		
<i>Selaginella siamensis</i> Hieron.	T	C
<b>MONILOPHYTES</b>		
<b>ASPLENIACEAE</b>		
<i>Asplenium contiguum</i> Kaulf.	E, L	UC
<i>Asplenium ensiforme</i> Wall. ex Hook. & Grev.	E, L	A
<i>Asplenium normale</i> D. Don	T, L	C
<i>Asplenium perakense</i> C.G. Matthew & Christ	T	R
<i>Asplenium phyllitidis</i> D. Don. subsp. <i>phyllitidis</i>	E	C
<i>Asplenium scortechinii</i> Bedd.	E	A
<i>Asplenium yoshinagae</i> Makino	E	A

Taxon	Habitat	Abundance
<i>Asplenium</i> sp.	L	UC
<i>Hymenasplenium cheilosorum</i> (Kunze ex Mett.) Tagawa	T, L	C
<i>Hymenasplenium excisum</i> (C. Presl) S. Linds.	E	C
<i>Hymenasplenium obscurum</i> (Blume) Tagawa	E	C
BLECHNACEAE		
<i>Blechnum orientale</i> L.	T	C
CYATHEACEAE		
<i>Cyathea spinulosa</i> Wall. ex Hook.	T	C
DAVALLIACEAE		
<i>Humata repens</i> (L. f.) Diels	E, L	C
DENNSTAEDTIACEAE		
<i>Histiopteris incisa</i> (Thunb.) J. Sm.	T	C
<i>Hypolepis punctata</i> (Thunb.) Mett. ex Kuhn	T	C
<i>Microlepia herbacea</i> Ching & C. Chr. ex Tardieu & C. Chr	T	UC
<i>Microlepia puberula</i> Alderw.	T	C
<i>Microlepia speluncae</i> (L.) T. Moore	T	C
<i>Microlepia strigosa</i> (Thunb.) C. Presl	T	A
<i>Pteridium aquilinum</i> (L.) Kuhn subsp. <i>wightianum</i> (J. Agardh) W.C. Shieh	T	A
DRYOPTERIDACEAE		
<i>Arachniodes chinensis</i> (Rosenst.) Ching	T	R
<i>Arachniodes speciosa</i> (D. Don) Ching	T	UC
<i>Arachniodes spectabilis</i> (Ching) Ching	T	A
<i>Bolbitis sinensis</i> (Baker) K. Iwats. var. <i>sinensis</i>	T, L	C
<i>Dryopteris hasseltii</i> (Blume) C. Chr.	T	R
<i>Dryopteris sparsa</i> (D. Don) Kuntze	T	C
<i>Dryopteris polita</i> Rosenst.	T	UC
<i>Elaphoglossum malayense</i> Holttum	E	C
<i>Elaphoglossum subellipticum</i> Rosenst.	E, L	UC
<i>Leucostegia immersa</i> C. Presl	T	C

Taxon	Habitat	Abundance
<i>Peranema aspidioides</i> (Blume) Mett.	T	C
<i>Polystichum attenuatum</i> Tagawa & K. Iwats.	T	UC
<i>Polystichum biaristatum</i> (Blume) T. Moore	T	C
EQUISETACEAE		
<i>Equisetum ramosissimum</i> Desf. subsp. <i>debile</i> (Roxb. ex Vaucher) Hauke	T	A
GLEICHENIACEAE		
<i>Dicranopteris splendida</i> (Hand.-Mazz.) Tagawa	T	C
<i>Dicranopteris linearis</i> (Burm.f.) Underw. var. <i>linearis</i>	T	A
<i>Dicranopteris linearis</i> (Burm.f.) Underw. var. <i>tetraphylla</i> (Rosenst.) Nakai	T	UC
<i>Diplopterygium norrisii</i> (Mett.) Nakai	T	UC
HYMENOPHYLLACEAE		
<i>Crepidomanes bipunctatum</i> (Poir.) Copel.	E	A
<i>Crepidomanes latealatum</i> (Bosch) Copel.	E	UC
<i>Crepidomanes minutum</i> (Blume) K. Iwats.	E	R
<i>Hymenophyllum badium</i> Hook. & Grev.	E	A
<i>Hymenophyllum barbatum</i> (Bosch) Baker	E	C
<i>Hymenophyllum exsertum</i> Wall. ex Hook.	E	UC
<i>Hymenophyllum polyanthos</i> (Sw.) Sw.	E	A
<i>Vandenboshia birmanica</i> (Bedd.) Ching	L	UC
LINDSAEACEAE		
<i>Sphenomeris chinensis</i> (L.) Maxon var. <i>chinensis</i>	T	C
LOMARIOPSISIDACEAE		
<i>Nephrolepis cordifolia</i> (L.) C. Presl	E, L	A
OLEANDRACEAE		
<i>Oleandra musifolia</i> (Blume) C. Presl	L	A
OPHIOGLOSSACEAE		
<i>Ophioglossum petiolatum</i> Hook.	T	UC

Taxon	Habitat	Abundance
<b>PLAGIOGYRIACEAE</b>		
<i>Plagiogyria adnata</i> (Blume) Bedd.	T	R
<i>Plagiogyria euphlebia</i> (Kunze) Mett.*	T	R
<b>POLYPODIACEAE</b>		
<i>Arthromeris lehmannii</i> (Mett.) Ching	E	UC
<i>Arthromeris phuluangensis</i> Tagawa & K. Iwats.**	E	R
<i>Belvisia henryi</i> (Hieron. ex C. Chr.) Tagawa	E	C
<i>Goniophlebium amoenum</i> (Wall. ex Mett.) Bedd.	E, L	A
<i>Goniophlebium manmeiense</i> (Christ) Rödl-Linder	E	C
<i>Goniophlebium mengtzeense</i> (Christ) Rödl-Linder	E	C
<i>Goniophlebium subauriculatum</i> (Blume) C. Presl	E	C
<i>Gymnogrammitis dareiformis</i> (Hook.) Ching ex Tardieu & C. Chr.	E	C
<i>Lemmaphyllum carnosum</i> (J.Sm. ex Hook.) C. Presl	E, L	A
<i>Lepisorus contortus</i> (Christ) Ching	E	UC
<i>Lepisorus nudus</i> (Hook.) Ching	E	UC
<i>Lepisorus scolopendrium</i> (Ching) Mehra & Bir	E	A
<i>Lepisorus subconfluens</i> Ching	E	UC
<i>Leptochilus decurrens</i> Blume	L	C
<i>Leptochilus ellipticus</i> (Thunb.) Noot.	T	A
<i>Leptochilus hemionitideus</i> (C. Presl) Noot.	L	C
<i>Leptochilus pedunculatus</i> (Hook. & Grev.) Fraser-Jenk.	E	UC
<i>Loxogramme chinensis</i> Ching	E	C
<i>Microsorium insigne</i> (Blume) Copel.	L	UC
<i>Microsorium superficiale</i> (Blume) Ching	E	C
<i>Neocheiropteris normalis</i> (D. Don) Tagawa	E	A
<i>Pyrrhosia lingua</i> (Thunb.) Farw. var. <i>heteractis</i> (Mett. ex Kuhn) Hovenkamp	E, L	C
<i>Pyrrhosia porosa</i> (C. Presl) Hovenkamp var. <i>tonkinensis</i> (Giesenh.) Hovenkamp	E	C

Taxon	Habitat	Abundance
<i>Selliguea oxyloba</i> (Wall. ex Kunze) Fraser-Jenk.	E, L	UC
<i>Selliguea rhynchophylla</i> (Hook.) Fraser-Jenk.	E	UC
PTERIDACEAE		
subfam. Pteridoideae		
<i>Pityrogramma calomelanos</i> (L.) Link	T	C
<i>Pteris bella</i> Tagawa	T	A
<i>Pteris biaurita</i> L.	T	C
<i>Pteris mcclurei</i> Ching*	T	R
<i>Pteris tokioi</i> Masam.	T	UC
<i>Pteris vittata</i> L.	T	C
<i>Pteris wallichiana</i> J. Agardh	T	C
subfam. Vittarioideae		
<i>Antrophyum parvulum</i> Blume	E	UC
<i>Haplopteris angustifolia</i> (Blume) E.H. Crane	E	UC
THELYPTERIDACEAE		
<i>Cyclosorus canus</i> (Baker) S. Linds.	T	UC
<i>Cyclosorus lakhimpurens</i> (Rosenst.) Copel.	T	UC
<i>Cyclosorus papilio</i> (C. Hope) Ching	T	UC
<i>Cyclosorus siamensis</i> (Tagawa & K. Iwats.) Panigrahi**	T	C
<i>Cyclosorus tylodes</i> (Kunze) Panigrahi	T	A
<i>Macrothelypteris torresiana</i> (Gaudich.) Ching	T	A
<i>Thelypteris confluens</i> (Thunb.) C.V. Morton	T	UC
<i>Thelypteris flaccida</i> (Blume) Ching	T	C
WOODSIACEAE		
<i>Athyrium mackinnonii</i> (C. Hope) C. Chr.	T	UC
<i>Athyrium</i> sp.	T	R
<i>Cornopteris opaca</i> (D. Don) Tagawa	T	UC
<i>Diplazium conterminum</i> Christ	T	UC
<i>Diplazium dilatatum</i> Blume	T	A
<i>Diplazium griffithii</i> T. Moore	T	UC

<b>Taxon</b>	<b>Habitat</b>	<b>Abundance</b>
<i>Diplazium lobatum</i> (Tagawa) Tagawa	T	UC
<i>Diplazium polypodioides</i> Blume	T	C
<i>Diplazium procumbens</i> Holttum	T	R
<i>Diplazium</i> sp.	T	R



## LYCOPODIACEAE

P. Beauv. ex Mirb., Hist. Nat. Vég. 4: 293. 1802; Tagawa & K. Iwats., Fl. Thailand 3(1): 7. 1979.

Terrestrial, or epiphytic, small to large. Main stems creeping, pendulous, climbing, or short and erect. Leaves simple, spirally arranged, ascending or spreading, subulate, linear, lanceolate, ovate, or scalelike. Strobili terminal on branchlets or main stem, abruptly becoming much smaller than or similar to sterile branches, solitary, erect or pendulous, sessile or stalked. Sporophylls monomorphic or dimorphic, papery, margin toothed, membranous. Sporangia in axils of sporophylls, yellow, reniform. Spores trilete

### Key to the genera

- 1a. Horizontal stems present, sporophylls different from vegetative trophophylls, solitary or aggregated into erect or pendulous strobili
- 2a. Strobili solitary or aggregated, stipitate.....**3. Lycopodium**
- 2b. Strobili solitary, sessile.....**2. Lycopodiella**
- 1b. Horizontal stems absent, sporophylls similar to vegetative trophophylls.....  
.....**1. Huperzia**

### 1. HUPERZIA

Bernhardi, J. Bot. (Schrader) 1800(2): 126. 1801. — *Lycopodium* L., Sp. Pl. 2: 1100. 1753, pro parte; Tagawa & K. Iwats., Fl. Thailand 3(1): 7. 1979, pro parte.

Stem erect or ascending, dichotomously branched. Leaves linear or lanceolate, often papery, margin entire or serrate. Strobili homomorphic with sterile branches or branchlets; sporophylls homomorphic or slightly smaller than trophophyll; sporangia in axils of sporophylls of upper portion of stem or branchlets, reniform, homosporous.

*Huperzia hamiltonii* (Spreng. ex Grev. & Hook.) Trevis. Atti Soc. Ital. Sci. Nat. 17: 248 1874; Boonkerd & Pollawatn, Pterid. Thailand: 48. 2000. — *Lycopodium*



*hamiltonii* Spreng. ex Grev. & Hook., Bot. Misc. 2: 366. 1831.; Tagawa & K. Iwats., Fl. Thailand 3(1): 9. 1979. **Fig. 5.2: G-F.**

Stems dichotomous branching, pendulous, 7.5-15 cm long, 0.9-1.5 in diameter near base. Leaves ascending, subadnate, rarely subpatent, sometimes twisted, lanceolate, apex acute to acuminate, broadest near middle or lower part, sessile to very short stalk, 6.4-9.5 mm long, 1.4-2.2 mm wide, entire; vein less distinct; texture softly chartaceous to thicker, green to yellowish green. Strobili slightly thinner than sterile part, not columniform, terminal on branches, 1.5-5.7 cm long, 0.4-1.1 in diameter; sporophylls usually smaller than tropophylls, up to 6 mm long, 0.8-1.2 mm wide, Sporangia yellowish, reniform, vertically bisected ca. 1 mm long and wide.

Thailand. — NORTHERN: Chiang Rai (Doi Chiang Dao, Khun Mae Lan, Khun Kong San, Doi Suthep, Doi Inthanon), Mae Hong Son (Doi Khun Hui Pong), Phitsanulok (Phu Miang) Phetchabun (Phu Thab Boek); NORTH-EASTERN: Loei (Phu Luang); CENTRAL: Nakhon Nayok (Khao Yai); South-eastern Chantaburi (Khao Soi Doa); SOUTH-WESTERN: Kanchanaburi (Sisawat); PENINSULAR: Nakhon Si Thammarat (Khao Luang).

Distribution. — Himalaya (type) to S. China and Japan also in Indochina and Taiwan.

Ecology. — On mossy tree trunks or mossy rocks at 1,600 m alt.

Specimens examined. — *K. Puchay 002, 132* (BCU); *T. Smitinand 2481, K. Puchay 273* (BKF).

## 2. LYCOPODIELLA

Holub, Preslia. 36: 20, 22. 1964. — *Lycopodium* L., Sp. Pl. 2: 1100. 1753; Tagawa & K. Iwats., Fl. Thailand 3(1): 7. 1979, pro parte.

Stem creeping and erect, dichotomously branched. Leaves spirally arranged, dimorphic or monomorphic, lanceolate, linear, or scalelike, papery, midrib indistinct, sessile, margin entire, apex acuminate. Strobili solitary, sessile, pendulous;

sporophylls sub-peltate, margin membranous and irregularly toothed, apex acute, acuminate, or obtuse; sporangia yellow, reniform to subglobose.

*Lycopodiella cernua* (L.) Pic. Serm., *Webbia* 23: 166. 1968; Boonkerd & Pollawatn, *Pterid. Thailand*: 49, 105. 2000. — *Lycopodium cernuum* L., *Sp. Pl.* 2: 1103. 1753; Tagawa & K. Iwats., *Fl. Thailand* 3(1): 7. 1979. **Fig. 5.3: A-B.**

Stems two types, creeping and erect, creeping stem grow indefinitely, erect stem about 70 cm tall, bearing many lateral branches with dense leaves, 2-4 mm in diam. lateral branches smaller usually 10 cm or more long. Leaves linear, yellowish green, point at apex, 3-5 mm long, about 0.5 mm wide, entire, patent and recurved in upper portion, thick. Strobili solitary, pendulous, 4-7 mm long, 2-3 mm in diam.; sporophylls ovate, long acuminate at apex, margin with minute projection.

Thailand NORTHERN: Chaing Rai (Doi Tung, Kui Thap Yang, Nae Lao, Doi Phacho), Chiang Mai (Doi Chaing Dao, Wang Tao, Doi Suthep, Mae Rim), Lampang (Mae Tam), Phitsanulok (Phu Hin Rong Kla, Thung Salaeng Luang), Tak (Doi Musoe); NORTH-EASTERN; Loei (Phu Kradung); CENTRAL; Nakhon Nayok (Khao Yai); SOUTH-WESTERN: Kanchanaburi (Wang Ka); PENINSULAR: Chumphon (Bang Son), Surat Thani (Ban Don), Satun (Tarutao), Nakhon Si Thammarat (Thung Song, Ron Phibun), Trang (Khoa Chong, Thale Song Hong, Sam Roi Yoi), Songkhla (Saba Yoi), Narathiwat (Bacho, Nikhom Waeng), Yala (Gunong Ina, Ban To, Pagang Besar).

Distribution. — Tropics and subtropics throughout the world (type from India).

Ecology. — Terrestrial on mountain slopes along road, usually found on dry ground and opening places.

Specimens examined. — *K. PUNCHAY* 260, *T. Boonkerd* 470, 1280 (BCU); *C. Phengkklai et al.* 15674, *J.F. Maxwell* 86-854 (BKF).

### 3. LYCOPODIUM

L., Sp. Pl. 2: 1100. 1753; Tagawa & K. Iwats., Fl. Thailand 3(1): 7. 1979.

Main stems creeping, erect, or scandent, sparsely or densely leafy. Lateral branches ascending or erect, dichotomously branched. Leaves on lateral branches and branchlets, spirally arranged, papery to leathery, midrib indistinct, margin entire or toothed, apex acuminate. Strobili solitary or aggregated, stipitate; sporophylls subpeltate, margin membranous and irregularly toothed, apex caudate; sporangia reniform.

*Lycopodium clavatum* L., Sp. Pl. 2: 1101. 1753; Tagawa & K. Iwats., Fl. Thailand 3(1): 7. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 49, 16. 2000.

Main stems creeping, green to yellowish green, irregular branching, 1-2 mm in diam., bearing sparse narrow leaves; Aerial stem ascending to erect, ca. 25 cm long, dichotomous branching. Leaves patent, spirally arranged, texture coriaceous, curved, linear to linear-lanceolate, apex acuminate with long caducous membranous setae, sessile, 6 mm long, 0.3-0.6 mm wide; vein hardly visible; green to yellowish green. Strobili 2 or 3 together on the erect stalk; stalk 7-9 cm long, bearing adpressed linear leaves sparsely, producing each strobili on short stalk, strobili cylindrical, 3.0-4.6 cm long, 3-4 mm in diameter; sporophyll broadly ovate, 3-5 mm long, 1.6-1.9 mm wide, margin membranous and transparent, dentate, apex acute to acuminate with short tip.

Thailand NORTHERN: Chiang Mai (Doi Inthanon), Lampang (Mae Tam), Phetchabun (Phu Thap Boek) NORTH-EASTERN; Loei (Phu Kradung); PENINSULAR: Chumphon (Bang Son), Surat Thani (Ban Don), Satun (Tarutao), Nakhon Si Thammarat (Khao Laung).

Distribution. — Cosmopolitan (Type from “Europae”).

Ecology. — Terrestrial, usually found on wet ground and opening places.

Specimens examined. — *K. Punchay 090, 166* (BCU); *K. Iwatsuki, H. Koyama, M. Hutoh, A. Chintayungkun T8390* (BKF).

### SELAGINELLACEAE

Willk., Anleit. Stud. Bot. 2: 163. 1854; Tagawa & K. Iwats., Fl. Thailand 3(1): 14. 1979.

Stem elongate, creeping, dichotomously or pinnately branched, bearing leaves and rhizophores. Leaves monomorphic, microphyllous, spirally arranged or dimorphic arranged in four rows, ventral two patent or ascending, the dorsal two smaller, adpressed to stem. Sporophyll uniform or dimorphic and form cylindrical spike, arranged in four rows, dorsal and ventral rows unequal.

### SELAGINELLA

P. Beauv., Mag. Encycl. 9(5): 478. 1804; Tagawa & K. Iwats., Fl. Thailand 3(1): 14. 1979.

Stems elongate, creeping, dichotomously or pinnately branched, bearing leaves and rhizophores. Leaves monomorphic, microphyllous, spirally arranged or dimorphic arranged in four rows, ventral two patent or ascending, the dorsal two smaller, adpressed to stem. Sporophyll uniform or dimorphic and form cylindrical spike, various shape ranging from ovate to ovate-lanceolate, margin denticulate, ciliolate, or entire, arranged in four rows, dorsal and ventral rows unequal; sporangium single per sporophyll; spores tetrahedral, trilete, heterosporous.

*Selaginella siamensis* Hieron., Bot. Tidsskr. 24: 113. 1901; Tagawa & K. Iwats., Fl. Thailand 3(1): 18. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 56. 2000. **Fig. 5.3: C.**

Stems long, growing indefinitely, climbing up bushes or procumbent, irregularly rooted, 0.7-1.5 mm in diameter, bearing sparsely monomorphic leaves, glabrous, rhizophores long, 0.3-0.5 mm in diameter; lateral branch tripinnate, ovate to oblong-subtriangular in outline, ultimate branch about 3 mm wide. Stem leaves brown, ovate, apex long aristate, 2.7-3.2 mm long, 1.6-1.9 mm wide; ventral leaves ascending, ovate-oblong, acute to mucronate with long aristate at apex, cordate at

base, 1.5-1.8 mm long, 1.0-1.2 mm wide; edges ciliate with white setae about 0.1 mm at base up to middle of leaves, papyraceous, green or sometimes reddish; dorsal leaves, nearly the same as or smaller than the ventral leaves in size, asymmetrically oblong to suborbicular with long pale tails at apex, 1.3-1.7 mm long, 0.9-1.0 mm wide, ciliate at margin. Strobili 2-5 mm long, 1.6-2.9 mm in diameter with sporophyll; sporophyll uniform, ovate-subtriangular with long tail, 1.3-1.6 mm long, 0.6-0.9 mm wide; sporangia vertically bisected 0.5-0.6 mm long and wide.

Thailand NORTHERN: Chiang Rai (Doi Pacho), Chiang Mai (Khun Khong), Lampang, Phitsanulok (Thung Saleang Luang, Phu Miang), Tak (Ban Musoe); NORTH-EASTERN: Loei (Phu Luang, Phu Kradung); CENTRAL: Nakhon Nayok (Khao Yai); EASTERN: Nakhon Ratchasima (Khao Yai); SOUTH-EASTERN: Trat (Koh Chang-type); SOUTH-WESTERN: Kanchanaburi (Thung Kang Yang Hill); PENINSULAR: Satun (Rawai).

Distribution. — Indochina and Malaysia.

Ecology. — Terrestrial, usually found on dry ground with rocks in light shade between rock plain and forest at 1,500 m alt.

Specimens examined. — *K. Punchay* 214 (BCU); *M. Tagawa*, *K. Iwatsuki*, & *N. Fukuoka* T636, *CH. Charoenphol*, *K. Larsen* & *E. Warncke*, 4234, 4289 (BKF).

#### ASPLENIACEAE

Newman, *Hist. Brit. Ferns* 6. 1840; C.E. Devol & C.M. Kuo, *Fl. Taiwan*. ed. 2: 476. 1980; Tagawa & K. Iwats., *Fl. Thailand* 3(2): 216. 1988.

Plants small to medium-sized, terrestrial, epilithic or epiphytic. Rhizomes creeping, ascending or erect; scale clathrate, Fronds simple, pinnate or more compounds, variable in shapes and sizes venation free or anastomosing, bearing scales or hairs. Stipes with 2 vascular bundles at base and x-shaped in upper part in cross section. Sori linear, elongate, indusiate, indusium along one side of sorus; spore monolete.

### Key to the genera

- 1a. Rhizome erect, short erect or ascending, not slender, fronds simple to decompose  
 .....**1. Asplenium**
- 1b. Rhizome long creeping, slender, frond one pinnate.....**2. Hymenasplenium**

### 1. ASPLENIUM

L., Sp. Pl. 2: 1078. 1753.; Tagawa & K. Iwats., Fl. Thailand 3(2): 216. 1988.

Rhizomes short erect, with clathrate scales. Fronds herbaceous to leathery; stipe dull, green to castaneous or black and then often shiny, simple to pinnately compound; rachis margin of; margin entire to coarsely serrated, each tooth usually with one veinlet, obtuse, mucronate to acute; veins free, rarely anastomosing, not reaching margin. Sori elongate along veins, superficial, linear to oblong; indusia thinly membranous to papery.

### Key to the species

- 1a. Frond simple
- 2a. Vein all free
- 3a. Midrib distinctly raised on both surface, angle between vein and midrib less than 30° .....**2. A. ensiforme**
- 3b. Midrib raised below, angle between vein and midrib more than 30°, frond up to 2 cm wide.....**6. A. scortechinii**
- 2b. Vein anastomosing.....**5. A. phyllitidis**
- 1b. Frond pinnate or more compound
- 4a. Frond pinnate
- 5a. Costae indistinct, not grooved above.....**3. A. normale**
- 5b. Costae grooved above
- 6a. Rhizome creeping, sori parallel and closed to costae.....**1. A. contiguum**
- 6b. Rhizome ascending to erect, sori not as above
- 7a. Pinnae up to 5 cm long, short stalked, scale entire.....**7. A. yoshinagae**
- 7b. Pinnae more than 5 cm long, stalked, scale with hair pointed at apex  
 .....**4. A. perakense**

4b. Frons bipinnate to tripinnatifid, rachis sparsely scaly, pinnae gammiferous.....**8. A. sp.**

- 1. *Asplenium contiguum*** Kaulf., Enum. Filic. 172. 1824; S. Lindsay, D.J. Middleton & Suddee, Thai Forest Bull., Bot. 41: 61–63. 2013. **Fig. 5.3: D-F.**

Rhizomes long creeping, 3-5 mm in diam. close with scale; scale linear-lanceolate, entire, up to 5 mm long by 0.5-0.9 mm Stipes 12-18 cm long, 1 mm in diam., cover with filliform brown scale, not polish, grooved on adaxial side. Laminae simply pinnate, ovate or oblong lanceolate in outline, broadest near middle, base slightly reduced, papery, 21-33 cm long, 8-10 cm wide; pinnae 15-20 pairs, 4.7-5 cm long, 1-1.2 cm wide, lanceolate, falcate, shortly stalked, reducing in size upward, lower base narrowly cuneate, upper broadly cuneate or round, narrow into long acuminate apex, margin irregularly deeply lobe; vein scaly beneath, distinct on lower surface and indistinct above, fork reaching to margin. Sori 6-7 mm long, forming parallel row near costa.

Thailand. — NORTHERN: Phitsanulok (Phu Hin Rong Kla); NORTH-EASTERN: Loei (Phu Luang, Phu Ruea)

Distribution. — Laos, Vietna 15m, China (Hainan), Philippines, Vanuatu, Hawaii.

Ecology. — On mossy rocks in shaded area in lower montane rainforest at 1,600 m alt.

Specimens examined. — *K. PUNCHAY 159, 220 (BCU); K. PUNCHAY 044, 166 (BKF).*

- 2. *Asplenium ensiforme*** Wall. ex Hook. & Grev., Icon. Filic.: t. 71. 1829; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 85. 1967; Tagawa & K. Iwats., Fl. Thailand 3(3): 266. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 110, 140. 2000. **Fig. 5.3: G; Fig. 5.4: A.**

Rhizomes short, suberect, up to 4 mm in diam., bearing fronds in a tuft, scaly at apex; scales gradually narrowing from base towards apex, dark reddish brown, concolorous, about 6 by 1 mm at base, somewhat stiff, entire, clathrate with long cells and short tooth at margin. Stipes dark, 2-4 cm long, narrowly winged nearly to the base. Laminae simple, entire or rarely irregularly waved at margin, broadest in upper quarter, narrowing towards caudately acuminate apex, gradually narrowing and attenuate at base, 15-35 by 1-2 cm, subcoriaceous, glabrous; midrib distinctly raised on both surfaces, grooved on upper surface; lateral veins ascending, forming angles of about 20-30° to midrib, forked near base, visible on lower surface, hardly so above. Sori oblique, elongate along acroscopic branches of veins, 0.9-3 cm long; indusia opaque, thick in lower part but with thin and translucent irregular and hairy margin.

Thailand. — NORTHERN: Chiang Mai (Doi Chang, Doi Khun Huai Pong, Doi Chiang Dao, Doi Suthep, Doi Inthanon, Doi Pha Hom Pok), Phitsanulok (Phu Hin Rong Kla); NORTHEASTERN: Loei (Phu Luang).

Distribution. — Ceylon, India (type), SW. China and Indochina, north to southern age of Japan.

Ecology. — On mossy rocks and mossy tree trunk in lower montane rainforest at 1,700 m alt.

Specimens examined. — *K. PUNCHAY* 005, 062, 079 (BCU); *M. TAGAWA*, *K. IWATSUKI*, & *N. FUKUOKA* T2886, *K. PUNCHAY* 027, 079, 198 (BKF); *P. H. HOANG* & *L. AVERYANOV* CBL2099 (P).

3. *Asplenium normale* D. Don, Prodr. Fl. Nepal.: 7. 1825; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 8. 1967; Tagawa & K. Iwats., Fl. Thailand 3(3): 280. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 111, 112, 143. 2000. **Fig. 5.3: B-D.**

Rhizomes short, erect, scaly, 4-6 mm in diam.; scales lanceolate, entire, gradually narrowing from base towards hair-pointed apex, up to 2 by 0.5 mm, bicolored, the central portion black, with longitudinal cells, the edges brown to dark brown. Stipes very deep castaneous to nearly black, polished, 11-18 cm long, distinct



ridges on adaxial surface, groove beneath. Laminae lanceolate to narrower, pinnate, slightly narrowing at base, gradually narrowing upwards, caudately acuminate at apex, 25-30 cm by 2.5-2.8 cm; rachis wingless throughout, proliferous; lateral pinnae up to 57 pairs, sessile, patent or slightly reflexed, oblong, rounded at apex, lobed to 1/5 way on both margins, narrowly cuneate at basiscopic base, auricled and truncate at acroscopic base, about 15 by 6 mm; veinlets simple or forked, not running to the very top of lobes. Sori up to 4 mm long; indusia thin.

Thailand. — NORTHERN: Chiang Mai (Doi Khun Huai Pong), Mae Hong Son (Khun Mae Lan); NORTH-EASTERN: Phetchabun (Phu Miang), Loei (Phu Luang, Phu Kradung); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chantaburi (Khao Soi Dao); PENINSULAR: Krabi (Khao Phanom Bencha), Nakhon Si Thammarat (Khao Luang), Songkla (Khao Khieo).

Distribution. — Old world tropic throughout, north to Himalaya (type) and Japan.

Ecology. — Terrestrial under moist shaded area or mossy rock in lower montane rainforest at 1,700 m alt.

Specimens examined. — *K. Punchay 029, 195, D. J. Middleton, P. Karaket, S. Lindsay, T. Phutthai & S. Suddee 5086 (BKF); Rakotondrainibe F. 2503 (P).*

4. *Asplenium phyllitidis* D. Don, Prodr. Fl. Nepal.: 7. 1825; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 84. 1967; Tagawa & K. Iwats., Fl. Thailand 3(3): 268, f. 21.3,4,5. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 112, 144. 2000.

**Fig. 5.4: E-F.**

subsp. *phyllitidis*

Rhizomes short, erect or ascending, stout, bearing a rosette of fronds, usually with a mass of roots on which are growing various epiphytes, scaly; scales dark brown, membranous, pale with glandular hair at margin, 6 mm long, 3 mm broad, clathrate. Stipes stramineous to dark, 2-5 cm long, scaly at base. Lamina simple, 42-60 cm long, 4-5.5 cm, broadest at middle, gradually narrowing towards both apex and base, coriaceous, grass-green when living, paler below; midrib distinct and raised on

upper surface, flat below, veins once or rarely twice forked, the first forking near midrib and then running parallel, uniting at apex to form submarginal veins about 0.5 mm inside leaf margin. Sori elongate along veins, usually reaching more than half-way to margin, often occupying 3/4 of the length of veins; indusia about 0.5 mm broad, with a space of 0.5 mm or wider between.

Thailand. — NORTHERN: Tak (Huai Krasa), Lampang.

Distribution. — Himalaya (type).

Ecology. — On mossy tree trunk in lower montane rainforest at 1,600 m alt.

Specimens examined. — *K. Punchay 250, M. Tagawa, K. Iwatsuki, & N. Fukuoka T6812, E. Hennipman 3594* (BKF).

5. *Asplenium scortechinii* Bedd., J. Bot. 1887: 322; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 85. 1967; Tagawa & K. Iwats., Fl. Thailand 3(3): 271. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 177. 2000. **Fig. 5.5: A-B.**

Rhizomes short, suberect, 3.5 mm in diam., bearing a few to several fronds in a tuft, scaly near apex; scales oblong-lanceolate, gradually narrowing towards acute apex, about 2 by 0.6 mm, dark brown centrally, paler at edges, sometimes bearing irregular projections at margin, clathrate. Stipes not distinct from lamina, winged, stramineous or brownish. Laminae simple, linear, 24-32 by 1.4-1.8 cm, broadest at middle, narrowing towards caudately long-acuminate apex, attenuate towards base, with shallow serration at margin at least in upper part or subentire; chartaceous, minutely scaly on midrib; midrib distinct on both surface, raised below, flat above, rather thick; lateral veins forming angles of 70-80° to midrib, simple or forked. Sori elongate along simple veins or acroscopic branches of forked ones, from near midrib to about 2/3 way towards edge of frond, up to 6 mm long; indusia entire, up to 1.3 mm broad, firm.

Thailand. — NORTHEASTERN: Loei (Phu Luang, Phu Kradung); SOUTH-EASTERN: Chantaburi (Kao Soi Dao); PENINSULAR: NaKhon Si Thammarat (Kao Luang), Trang (Khao Chong, Khao Sung).

Distribution. — Indochina and Malaysia (type).

Ecology. — On mossy tree trunk in lower montane rainforest at 1,600 m alt.

Specimens examined. — *K. Punchay* 032, 036 (BCU); *M. Tagawa*, *K. Iwatsuki*, & *N. Fukuoka* T6834, *T. Smitinand* 3210 *K. Punchay* 025, 201 (BKF).

6. *Asplenium perakense* C.G. Matthew & Christ, J. Soc. Bot. 39: 214. 1909; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 88. 1967; Tagawa & K. Iwats., Fl. Thailand 3(3): 286. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 144. 2000.

Rhizomes short, suberect, bearing a tuft of fronds, densely scaly; scales gradually narrowing from base towards hair-pointed apex, entire, or with a few long projections near base, up to 10 by 1 mm at base, brown. Stipes polished black to dark brownish-purple, scaly throughout, 10-25 cm long. Laminae narrowly oblong, acute at apex, a little reduced downwards, up to 40 by 16 cm; rachis like the upper part of stipe, scaly with narrow scales; pinnae 15-20 pairs, stalked, middle ones the largest, ascending, narrowly subtriangular, caudately acuminate at apex, auricled at acroscopic and cuneate at basiscopic bases, lobed nearly to costa, up to 8 by 2.5 cm; lobes oblong or quadrangular, oblique, dentate at apex, usually 5-7 mm wide; softly chartaceous to chartaceous, veins visible. Sori long, crescent shaped, 1-4 for each lobe; indusia herbaceous.

Thailand. — PENINSULAR: Nakhon Si Thammarat (Khao Luang).

Distribution. —Malaysia (type).

Ecology. — Terrestrial below tree trunk in lower montane rainforest at 1,700 m alt.

Specimens examined. — *K. Punchay* 100 (BCU); *K. Iwatsuki*, *H. Koyama*, *M. Hutoh*, *A. Chintayungkun* T8396, *R. Pooma* 1150 (BKF).

7. *Asplenium yoshinagae* Makino, Phan. Pterid. Jap. Icon. 1: pl. 64. 1900; K. Iwats., Acta Phytotax. Geobot. 26: 172. 1975; Tagawa & K. Iwats., Fl. Thailand 3(3): 285, f. 23.1. 1985; Boonkerd & Pollawatn, Pterid. Thailand:

179. 2000. — *Asplenium indicum* Sledge, Bull. Brit. Mus. (Nat. Hist.) Bot. 3: 264. 1965. **Fig. 5.5: C-D.**

Rhizomes short, erect, scaly; scales dark brown to nearly black, narrow, subulate, entire, up to 5 by 0.5 mm Stipes usually up to 15 cm long, dark green to brownish, not polished, sparsely scaly. Laminae narrowly lanceolate, commonly about 20 by 5 cm, sometimes up to 40 by 8 cm, acute to acuminate at apex, pinnate; rachis like the upper part of stipe, rarely bulbils at bases of first acroscopic pinnules and on rachis near frond apex; pinnae 12-25 pairs, stalked, dimidiate, rhomboid, acute at apex, broadly cuneate and auricled at acroscopic base, narrowly cuneate and entire at basiscopic base, margin irregularly lobed with dentate margin, 2-4 by 0.7-1.5 cm, chartaceous, deep green, brownish in dried specimens. Sori elongate, near the costa; indusia entire.

Thailand. — NORTHERN: Chiang Rai (Doi Pacho), Chiang Mai (Doi Chiang Dao, Doi Suthep, Doi Inthanon, Doi Pha Hom Pok), Lamphun (Doi Khun Tan), Tak (Ban Musoe); NORTHEASTERN: Phetchabun (Phu Miang), Loei (Phu Luang, Wang Sapung), Khon Kaen (Phu Wiang); CENTRAL: Saraburi (Hin Lap); PENINSULAR: Surat Thani.(Ban Don).

Distribution. — Ceylon, N. & S. India, Myanmar, S. China, Indochina, Taiwan, Philippines, north of Japan (type).

Ecology. — On mossy tree trunk in lower montane rainforest at 1,600-1,700 m alt.

Specimens examined. — *K. Punchay 006, 028* (BCU); *K. Iwatsuki, N. Fukuoka, A. Chintayungkun T9583, J.F. Maxwell 98-701 K. Punchay 119* (BKF).

#### 8. *Asplenium* sp. **Fig. 5.5: F-H.**

Rhizomes short, erect, scaly; scales dark brown to nearly black, narrow, lanceolate, entire, small, 3-5 by 0.5 mm Stipes usually 5-6 cm or more long, dark green to brown, not polished, sparsely scaly. Laminae narrowly lanceolate, 18-20 by 3-5 cm, acute to acuminate at apex, bipinnate; rachis like the upper part of stipe; pinnae about 20 pairs, gemmiferous, stalked, acute at apex, broadly cuneate and

auricled at acroscopic base, margin irregularly, 2-3 cm long, about 1.2 cm, herbaceous, deep green, brownish in dried specimens; pinnules 0.8-1 cm long, 0.6 cm wide. Sori elongate, near the costules; indusia entire.

Thailand. — NORTHEASTERN: Phetchabun (Phu Thab Boek).

Distribution. — N/A

Ecology. — On mossy rocks in lower montane rainforest at 1,650 m alt.

Specimens examined. — *K. PUNCHAY 146* (BCU).

Note. — *Asplenium* sp. is a lithophyte on mossy rocks in shaded area in lower montane rainforest. It is similar to *Asplenium gueinzianum* Mett. ex Kuhn by pinnae gemmiferous but shape of pinnae are different.

## 2. HYMENASPLENIUM

Hataya, Bot. Mag. (Tokyo) 41(492): 712.

Epilithic, epiphytic, or terrestrial. Rhizomes dorsiventral widely creeping, with clathrate scales. Stipe usually shiny and castaneous to dark purplish or black. Lamina 1-pinnate, herbaceous; pinnae asymmetrical at base, basispic margin entire, acroscopic margin crenate, undulate, or serrate, veins free. Sori elongate along vein, indusiate

### Key to the species

- 1a. Stipe dark purple to black and polished  
 2a. Upper margin of pinnae deeply-cut.....**1. *H. cheilosorum***  
 2b. Upper margin of pinnae crenate to serrate.....**2. *H. excisum***  
 1b. Stipe grayish-green to dark not glossy or polished; sori many per pinnae.....  
 .....**3. *H. obscurum***

- 1. *Hymenasplenium cheilosorum*** (Kunze ex Mett.) Tagawa, Acta Phytotax. Geobot. 7: 84. 1938. — *Asplenium cheilosorum* Kunze ex Mett., Abh. Senckenberg. Naturf. Ges.: 177. 1859; Tardieu & C. Chr., Fl. Indo-Chine 7(2): 223 1940; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 84. 1967; Tagawa &

K. Iwats., Fl. Thailand 3(3): 279, 1985; Boonkerd & Pollawatn, Pterid. Thailand: 139. 2000. **Fig. 5.6: A-C.**

Rhizomes long creeping, 2.5-4 mm diam., bearing two rows of alternate fronds closely on dorsal surface, scaly near apex; scales gradually narrowing from base towards long, hairy apex, 1.9-2.7 by 0.3 mm, clathrate, sometimes the cell-walls very thick. Stipes 15-27 cm long, dark purple, polished but dirty on the lower portion, more or less warty on upper portion. Lamina pinnate, narrowly lanceolate in outline, subtruncate at base, attenuately acuminate at apex, 29-35 by 4.5-5 cm; pinnae up to 50 pairs, subquadrangular, dimidiate, the lower half very narrow, thus the midrib close to entire lower margin, rounded at apex, truncate at acroscopic base, lobed to 1/5 way on upper margin, lobes rounded or forked at apex, about 1 mm broad, usually a lobe placed on each apical portion of lower margin, up to 30 by 7-9 mm, a few lower pairs slightly reduced or reflexed, shortly stalked, thin, pale green; veins distinct, all free. Sori confined to lobes, one or rarely two on each lobe, about 2 mm long; indusia thin, opening outwardly.

Thailand. — NORTHERN: Chiang Rai (Doi Pacho), Chiang Mai (Doi Suthep, Doi Intanon, Doi Hua Mot), Mae Hong Son (Mae La Noi); NORTH-EASTERN: Phetchabun (Phu Miang, Phu Hin Rong Kla), Loei (Phu Kradung); SOUTH-EASTERN: Chanthaburi (Kao Soi Dao); PENINSULAR: Nakhon Si Thammarat (Khao Luang).

Distribution. — Sri Lanka, S India, E Himalaya, S China, Burma, Indochina, Peninsular Malaysia, Borneo, Philippines, Taiwan and north to southern edge of Japan.

Ecology. — On moist muddy rocks or terrestrial on wet slopes along streams in lower montane rainforest at 1,600 m alt.

Specimens examined. — *K. Punchay 251* (BKF).

2. *Hymenasplenium excisum* (C. Presl) S. Linds., Thai Forest Bull., Bot. 37: 69. 2009. — *Asplenium excisum* C. Presl, Epimel. Bot.: 74. 1851; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 84. 1967; Tagawa & K. Iwats., Fl. Thailand

3(3): 278. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 140. 2000. **Fig. 5.6: D-E.**

Rhizomes long creeping, 3-4 mm diam., bearing many roots on ventral and two rows of fronds on dorsal surfaces, scaly; scales gradually narrowing from base towards hair-pointed apex, up to 4 by 0.5 mm, dark brown, clathrate. Stipes close or up to 1 cm apart, castaneous to purplish, polished, groove above, scaly near the base 36 cm long. Frond pinnate, lanceolate, broadest near base, almost parallel gradually becoming smaller upwards and suddenly reduced as long acuminate at apex, 30-47 cm long, about 12 cm wide; rachis terete throughout; pinnae 25-27 pairs, roundly quadrangular, posterior half of lower portion dimidiate, truncate and slightly auricled at acroscopic base, rounded at apex, lobed to 1/5 way at upper and anterior half of lower margin, lobes rounded, oblique, moderately acute to acuminate at apex, 6-7 cm long, 1.4 cm wide, the largest ones shortly stalked, slightly smaller, upward little falcate, thin, herbaceous, light green; veins visible. Sori 5-6 mm long; indusia herbaceous, pale, entire, opening towards anterior side.

Thailand. — NORTHERN: Chiang Mai ( Doi Suthep, Doi Chiang Dao), Lampang, Tak (Mae Sot, Ban Musoe), Phitsanulok (Thung Saleang Luang, Phu Hin Rong Kla); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); PENINSULAR: Yala (Bannang Sata)

Distribution. — Tropical Africa, Sri Lanka, S India, Himalaya, throughout Malesia to Polynesia and Hawaii, north to Vietnam, S China, Taiwan and the Ryukus.

Ecology. — On wet ground or on wet muddy rocks usually along streams in dense forests at 1,500 m alt.

Specimens examined. — *K. Puchay 081, M. Tagawa, K. Iwatsuki & N. Fukuoka T4836, J.F. Maxwell 93-111* (BKF).

3. *Hymenasplenium obscurum* (Blume) Tagawa, Acta Phytotax. Geobot. 7: 83. 1938. — *Asplenium obscurum* Blume, Enum. Pl. Javae.: 181. 1828; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 85. 1967; Tagawa & K. Iwats., Fl. Thailand

3(3): 279. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 143. 2000. **Fig. 5.6: F-G.**

Similar to *Hymenasplenium excisum* (C. Presl) S. Linds. but differing in: rhizomes not so long, often green and fleshy; stipe and rachis green or brownish, never polished; lateral pinnae patent, little falcate, less widely spaced; sori short, usually up to 3 mm long, allantodioid or in more or less sausage-form; indusial sometimes undulate.

Thailand. — NORTHERN: Chiang Rai (Doi Tung, Doi Pacho, Khun Korn), Chiang Mai (Doi Intanon, Doi Chiang Dao), Lamphun (Doi Khun Tan), Tak (Um Phang).

Distribution. — Madagascar, Sri Lanka, S India and E Himalaya, Burma, Indochina, S China, Taiwan, and throughout Malesia.

Ecology. — On wet sandy ground or on moist muddy rocks in lower montane rainforest at 1,600 m alt.

Specimens examined. — *M. Tagawa, 2077 (P), Th. Santisuk et al. 135, K. Panchay 177 (BKF).*

## BLECHNACEAE

Newman, Hist. Brit. Ferns, ed. 2 8. 1844. Tagawa & K. Iwats., Fl. Thailand 3(3): 297. 1985.

Terrestrial, sometimes tree ferns (like small trees). Rhizomes mostly erect scales brown, entire. Fronds monomorphic or dimorphic; lamina pinnate, pinnatifid, or bipinnatifid, rarely simple, thickly papery to leathery, glabrous or usually with small scales; veins free or anastomosing. Sori elongate on either side of midrib, indusiate

## BLECHNUM

L., Sp. Pl. 2: 1077. 1753; Tagawa & K. Iwats., Fl. Thailand 3(3): 297. 1985.



Rhizomes stout, erect, bearing frond in tuft; scale narrow entire. Laminae pinnate with apical pinna, glabrous, costal grooved; vein free, usually once or few time forked. Sori linear parallel and close to costa, sometimes forming costal areole; indusial attached on side away from costae and opening inward.

*Blechnum orientale* L., Sp. Pl. 1077. 1753; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 88. 1967; Tagawa & K. Iwats., Fl. Thailand 3(3): 298. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 146, 180. 2000. **Fig. 5.7: A-B.**

Rhizomes thick, ascending or suberect, densely covered with scales; scales linear, gradually narrowing towards apex, 2 cm or more long, up to 2 mm broad, tailed at apex, dark brown with pale cartilaginous edges which sometimes becoming uneven. Stipes stout, stramineous, or sometimes purplish when young, 90 cm long, densely scaly at base, bearing small auricles (reduced pinnae) throughout. Laminae up to 2 m long, to about 70 cm wide. Lateral pinnae many in number, close, 4-4.5 cm apart from each other in basal part, ascending, linear, gradually narrowing towards long-tailed apex, round or subtruncate at sessile base, or decurrent at posterior base and adnate in the upper ones, entire, 35-41 by 1.7-1.8 cm; veins simple or forked usually near costa, distinct on both surfaces, very close, up to 0.5 mm apart; coriaceous, green, glabrous throughout. Sori narrow, long-continuous along costa; indusia narrow, usually broken before maturity.

Thailand. — NORTHERN: Chiang Mai (Kong Kat, Doi Suthep, Mae Rim), Chiang Rai (Doi Tung), Tak (Ban Musoe, Raheng); NORTH-EASTERN: Loei (Phu Ruea, Phu Luang, Phu Kradung), Udon Thani (Phon Phisai), Nong Khai; EASTERN: Chaiyaphum (Khao Kong) SOUTH-EASTERN: Chanthaburi (Leam Sing, Phriu Waterfall, Makham, Khao Sabap), Trat (Koh Kut, Koh Chang); PENINSULAR: Chumphon (Lang Suan, Ban Pak Chan), Ranong (Nok Nang), Surat Thani (Ban Don), Phangnga, Nakhon Si Thammarat (Khao Luang, Thap Chang), Trang (Khao Chong), Satun, Yala (Betong, Bunnang Sata), Narathiwat (Waeng, Sungai Padi).

Distribution. — Tropics of Asia, Australia and the Pacific, India to Polynesia, north to southern edge of Japan (Yakushima).

Ecology. — On dry open slopes under light shade in lower montane rainforest at 1,600 m alt.

Specimens examined. — *K. Punchay 089*, *C. Niyomdham 3241*, *C. Phengkklai et al. 14201* (BKF).

### CYATHEACEAE

Kaulf., Wesen Farrenkr. 119. 1827; Tagawa & K. Iwats., Fl. Thailand 3(1): 101. 1979.

Rhizomes erect, massive, forming trunk in most species, when old covered with fibrous roots. Bearing scale more or less densely, Stipe scaly near base and when young. Frond larged, simply pinnate to tripinnatifid, more or less scaly on rachis and costae, vein simple or forked. Sori on the vein, sporangia attached on small raise receptacles often mixed with hair, with or without indusium. Sporangia with completely oblique annulus.

### CYATHEA

Sm. Mém. Acad. Roy. Sci. (Turin) 5: 416. 1793; Tagawa & K. Iwats., Fl. Thailand 3(1): 101. 1979

Terrestrial tree fern. Stem erect, tall to 10 m or more, scaly at apex and base of stipe, bearing rosette of fronds. Frond usually larged bearing scales and hairs, pinnately compound, vein usually free. Sori round, dorsal on veinlet and distinct receptacles; without or with cup shape indusia or enclosed sori when young; annulus oblique.

*Cyathea spinulosa* Wall. ex Hook., Sp. Fil. 1: 25, t. 12C. 1844; Tagawa & K. Iwats., Fl. Thailand 3(1): 102. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 114. 2000.  
**Fig. 5.7: C-D.**

Trunks to 4.5 m tall. Stipes dark purplish, distinctly short spiny near base; scales shining dark brown, stiff, their bases later develop into spines, about 60 cm

long. Laminae about 2.6 m long, 1.2 m wide, broadest above middle; c.23 pairs of pinnae, a few basal pinnae reduced, larger pinnae about 60 cm long, 15 cm wide; pinna-rachis bearing scales; pinnules broadly cuneate at subsessile base, acuminate at apex, about 8 cm long, 1.4 cm wide; ultimate segments toothed distally; costae underneath with brown scale but not hairy; costules and lower surface of lamina minutely pubescent. Sori near costules, indusia attached at base with apical portion of sori naked.

Thailand. — NORTHERN: Chiang Mai (Doi Intanon), Mae Hong Son.

Distribution. — E. Himalaya, S. India, Burma, SW. China, Taiwan, and S. Japan.

Ecology. — In deep shade usually in moist places in the lower montane rainforest at about 1,600 m alt.

Specimens examined. — *K. Punchay 072* (BCU); *M. Tagawa, 2077* (P); *Th. Santisuk et al. 135* (BKF); *G. Murata, K. Iwatsuki, C. Phengkklai & C. Charamphol T15560, K. Punchay 098* (BKF).

#### DAVALLIACEAE

M.R. Schomb. ex A.B. Frank, *Reis. Br.-Guiana* 3: 883. 1848.

Epiphytic or epilithic with rhizomes long creeping, densely scaly, Stipes articulated to rhizomes. Laminae simple, pinnate or more compound, vein free. Sori abaxial, submarginal terminal on veinlet, round to oblong or elliptic; indusia tubular scale-like or linear continuous, opening toward margin.

#### HUMATA

Cav., *Descr. Pl.* 272-273. 1802; Tagawa & K. Iwats., *Fl. Thailand* 3(2): 164. 1985.

Rhizomes long creeping, densely scaly with peltate scale, bearing fronds remotely. Stipes articulated with rhizome, grooved above. Lamina simple to tripinnatifid, coriaceous, glabrous. Sori round, terminal on veinlet, marginal; indusial attached by base or rarely by the side.

*Humata repens* (L.f) Diels, Nat. Pflanzenfam. 1(4): 209. 1899; C. Chr., Bot. Tidsskr. 32: 345. 1916; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 77. 1967; Tagawa & K. Iwats., Fl. Thailand 3(2): 166. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 172, 236. 2000. — *Adiantum repens* L. f. Suppl. 446. 1781. **Fig. 5.7: E-G.**

Rhizomes long creeping, 1.7-2 mm diam., glabrous, densely scaly throughout; scales linear-lanceolate, long-acuminate at apex, 1.7-2.6 mm by 0.6 mm, brown with paler margin. Stipes stramineous, terete, 4-7 cm long, sparsely scaly. Laminae oblong-subdeltoid or roundly pentagonal, 4.5-7 cm long, 2.5-4 cm wide, pinnatifid to tripinnatifid in basal pinnae; basal pinna the largest, asymmetrically subtriangular to oblong-subdeltoid; upper pinnae linear-subtriangular, gradually becoming smaller upwards, shallowly lobed or entire, sessile or adnate; pinnules oblong, oblique, round at apex, lobed or subentire, coriaceous, glabrous. Sori marginal, small, 1-5 sori on each pinnule; indusia nearly semi-circular, entire and free except for the base to 1 mm broad.

Thailand. — NORTHERN: Mae Hong Son (Doi Pha Dam), Chiang Mai (Doi Suthep, Doi Intanon, Doi Chiang Dao), Chiang Rai (Doi Tung), Lamphun (Doi Khun Tan), Lampang, Phitsanulok (Phu Miang); NORTH-EASTERN: Loei (Phu Luang, Phu Kradung); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi (Khao Sabap), Trat (Ko Chang, Khao Kuap); SOUTH-WESTERN: Kanchanaburi, Phetchaburi, Prachuap Khiri Khan (Khao Luang); PENINSULAR: Ranong, Surat Thani (Khao Nom Sao), Phangnga (Takua Pa, Khao Phra Mi), Nakhon Si Thammarat (Khao Luang, Khiriwong), Trang (Khao Chong), Yala.(Gunong Ina, Khao Kala Khiri).

Distribution. — Widely distributed in the tropics of the Old World: Madagascar and Seychelles, Mascarene Islands, Himalayas to S Japan, SE Asia generally, throughout Malesia to Polynesia and Australia.

Ecology. — On dry slope and rocks along road at 1,600 m alt.

Specimens examined. — *K. PUNCHAY 264, J.F. Maxwell 95-626, 96-1091, R. Pooma, C. Chamchumroon & K. Phattarahirunkanok 1961 (BKF).*

## DENNSTAEDTIACEAE

Pic.Serm., Webbia 24: 704. 1970. 1970; Tagawa & K. Iwats., Fl. Thailand 3(1): 111. 1979.

Terrestrial, rhizomes usually long creeping covered with multicellular hairs, scales absent. Laminae medium-sized to large, 1-4-pinnately compound, monomorphic; stipes not articulate to rhizome, usually hairy, thinly herbaceous to leathery, hairy or glabrous. Sori marginal or intramarginal, linear or orbicular, terminal on a veinlet or on a vascular commissure joining apices of veins; indusia linear or bowl-shaped or formed from thin reflexed lamina margin.

### Key to the genera

- 1a. Sori round, solitary at apex of veinlet, indusiate or naked  
 2a. Sori submarginal or dorsal; indusial thin cup-shaped, attached by base and sides .....**3. Microlepia**  
 2b. Sori naked, rarely protected when young by reflex marginal flap ...**2. Hypolepis**  
 1b. Sori elongate along margin of lobes, protected by reflexed edge of lobes  
 3a. Veins free.....**4. Pteridium**  
 3b. Veins reticulate.....**1. Histiopteris**

### 1. HISTIOPTERIS

(J. Agardh) J. Sm., Hist. Fil. 294. 1875; Tagawa & K. Iwats., Fl. Thailand 3(1): 126. 1979.

Rhizomes long creeping, covered with thick hairs; stipe long, usually dark purplish, polished; rachis grooved. Lamina bipinnate to tripinnate with opposite pinnae and pinnules; vein anastomosing, areole with free included veinlets; herbaceous, usually glaucous beneath. Sori submarginal, linear, cover by reflex margin.

*Histiopteris incisa* (Thunb.) J.Sm., Hist. Fil.: 295. 1875; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 79. 1967; Tagawa & K. Iwats., Fl. Thailand 3(1): 127. 1979; Boonkerd

& Pollawatn, Pterid. Thailand: 38, 86. 2000. — *Pteris incisa* Thunb., Prodr. Pl. Cap. 171. 1800. **Fig. 5.8: A-B.**

Rhizomes long creeping, covered with dark hairs. Stipes long, about 67 cm long, up to 1 cm in diam. at base, or dark purplish, polished; laminae bipinnate to quadripinnatifid, 1.2 m, pinnae and pinnules opposite; rachis, costae and costules grooved on upper surface, a pair of reduced stipule-like pinnules usually present at base of each pinnae; pinnae 66-75 cm long, about 36-40 cm wide, about 20 pairs; pinnules 22-27 cm long, 7.5-10 cm wide; veins copiously anastomosing, rather distinct below. Sori continuous at edge of lobes, linear, submarginal, covered by the reflexed edge of lobes.

Thailand. — NORTH-EASTERN: Phetchabun (Phu Miang), Loei (Phu Luang, Phu Kradung); CENTRAL: Nakhon Nayok (Khao Yai); PENINSULAR: Ranong (Khao Kanta), Krabi (Panom Bencha), Nakhon Si Thammarat (Khao Luang).

Distribution. — Pantropic.

Ecology. — On rather dry slopes usually at opening area at 1,600 m alt.

Specimens examined. — *K. Punchay 182, E. Smith 1423, M. Tagawa, K. Iwatsuki, & N. Fukuoka T786* (BKF).

## 2. HYPOLEPIS

Bernh., Schrad. Neues Journ. 1(2). 34. 1806; Tagawa & K. Iwats., Fl. Thailand 3: 124. 1979.

Rhizomes long creeping, hairy. Stipe usually covered with hair. Lamina pinnately compound, herbaceous or papyraceous, hairy or glabrous; vein always free. Sori round, terminal on veinlet, usually near the margin of lobes, lacking indusial or protected by thin reflexed margin of lobes.

*Hypolepis punctata* (Thunb.) Mett. ex Kuhn, Fil. Afr.: 120. 1868; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 73. 1967; Tagawa & K. Iwats., Fl. Thailand 3(1): 124.

1979; Boonkerd & Pollawatn, Pterid. Thailand: 39, 86. 2000. — *Polypodium punctatum* Thunb., Fl. Jap.: 337. 1784. **Fig. 5.8: C-D.**

Rhizomes long creeping, blackish, densely hairy at apex, glabrous on the older part. Stipes stramineous with dark brown base with hairs, 80 cm long. Laminae oblong, acute at apex, widest at base, tripinnate-quadrripinnatifid, 135 cm long, about 100 cm wide; rachis like the upper part of stipes, stramineous, grooved on upper surface, hairy, the bases remaining as minute prickles; lower lateral pinnae subopposite, oblong-subtriangular, acute at apex, about 50 cm long, 30 cm wide, upper pinnae gradually reduced; larger pinnules oblong-subtriangular, acuminate at apex, stalked and subtruncate at base, about 16 cm long, 8 cm wide; costules grooved, hairy throughout; secondary pinnules oblong, round at apex, truncate and sessile at base, 3.5 cm long, 1 cm wide, lobed towards costules; ultimate lobes round, oblique, dentate at margin, veins pinnate, hairy but indistinct on both surfaces, papyraceous, green above. Sori terminal on veinlets, exindusiate, near the margin of lobes, reflexing of small flap in sinus of lamina margin.

Thailand. — NORTHERN: Chiang Mai (Doi Chiang Dao, Mae Lui); NORTH-EASTERN: Phetchabun (Phu Miang), Loei (Phu Luang, Phu Kradung).

Distribution. — Tropics of the Old World generally, northwards to Japan and Korea and southwards to New Zealand.

Ecology. — On marshy ground or on wet sandy slopes in open areas or in light shade in lower montane rainforest at 1,600 m alt.; usually invading recent clearings.

Specimens examined. — *K. Punchay 139, D. J. Middleton, P. Triboun, V. Chamchumroon, S. Seangrit & R. Simma 4404* (BKF)

### 3. MICROLEPIA

C. Presl, Tent. Pterid. 124. 1836; Tagawa & K. Iwats., Fl. Thailand 3(1): 112. 1979.

Terrestrial. Rhizomes creeping, covered with multicellular grayish stiff hairs, without scales. Stipes base without articulation, hairy, vertically grooved above.

Lamina 1-4-pinnately compound, oblong to ovate-oblong; pinnules or lobes slightly oblique, acroscopic pinnule at base larger than basiscopic, usually parallel to rachis or pinna rachis, mostly triangular, usually with hairs on rachis and pinna rachis; veins free, pinnately branched, veinlets not reaching margin. Sori orbicular, intramarginal, terminal on one veinlet; indusium hemitelioid, attached at base and sides, opening toward margin.

### Key to the species

- 1a. Frond bipinnate to tripinnatifid
- 2a. Lamina 40-70 cm long, pinnules up to 3 cm long
- 3a. Lamina texture herbaceous; vein not so distinct on lower surface of lobes.....**1. *M. herbacea***
- 3b. Lamina texture subcoriaceous; vein on lower surface of lobes raised and paler than lamina.....**4. *M. strigosa***
- 2b. Lamina 80-130 cm long, pinnules more than 5 cm long.....**2. *M. puberula***
- 1b. Frond tripinnate or more compound.....**3. *M. speluncae***

- 1. *Microlepia herbacea*** Ching & C. Chr. ex Tardieu & C. Chr., Not. Syst. 6: 6. 1937; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 72. 1967; Tagawa & K. Iwats., Fl. Thailand 3(1): 115. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 87. 2000. **Fig. 5.8: E-F.**

Rhizomes long creeping, densely covered with stiff blackish brown hairs, about 3-5 mm diam. Stipes stramineous, densely hairy at base, glabrescent or minutely pubescent above, 22-35 cm long; lamina oblong-lanceolate, gradually narrowing towards attenuately acuminate apex, round or cuneate at base, bipinnate, about 35-60 cm long, 30 cm wide; rachis stramineous, distinctly grooved on the upper surface, densely hirsute throughout; lateral pinnae usually more than 10 in pairs, upper ones gradually reduced in size not forming a distinct apical pinna, larger ones distinctly stalked, straight or subfalcate, ascending, pinnate, lanceolate, gradually narrowing towards caudately acuminate apex, broadly cuneate at base, 10-20 cm long, 3-5 cm wide; costa grooved, densely pubescent; pinnules oblong or roundly



quadrangular, round or moderately acute at apex, cuneate at sessile base, lobed to 1/3 way to costules, the larger ones 2 cm long, 1.2 cm wide; ultimate lobes quadrangular round or obtuse at apex, with a few distinct teeth at margin, sinus very narrow; herbaceous, mid- to light green, glabrous except the underside of veins, or minutely or rather densely hirsute on the lamina underneath. Sori terminal on basal acroscopic veinlets, at bottom of sinus between lobes, small; indusia cup-shaped, hairy.

Thailand. — NORTH: Chiang Rai (Doi Tung), Chiang Mai (Doi Inthanon); NORTH-EASTERN: Phetchabun (Phu Miang), Loei (Phu Luang, Phu Kradung); CENTRAL: Nakhon Nayok (Khao Yai).

Distribution. — S China and Taiwan, Vietnam (type).

Ecology. — On rather dry slopes with humus in lower montane rainforest at 1,600 m alt.

Specimens examined. — *K. Punchay 041* (BCU); *E. Hennipman 3931*, *M. Tagawa*, *K. Iwatsuki*, & *N. Fukuoka T591*, *K. Punchay 043* (BKF).

2. *Microlepia puberula* Alderw., Bull. Jard. Bot. Buitenzorg, Ser. 2, 11: 17. 1913; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 73. 1967; Tagawa & K. Iwats., Fl. Thailand 3(1): 120. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 88. 2000. **Fig. 5.8: G-H.**

Rhizomes creeping, thick, densely hairy at apex, glabrescent in the older part. Stipes stramineous, 30-40 cm long, almost glabrous throughout; lamina oblong-subtriangular or oblong with moderately acute apex, bipinnate-tripinnatisect, 110-130 cm long, 80-90 cm wide; rachis stramineous or brown, grooved on the upper surface, rather densely pubescent on the upper portion; lateral pinnae less than 10 in pairs, the lower ones more than 30 cm apart, upper ones gradually reduced in size, the basal largest ones oblong-subtriangular, gradually narrowing towards caudately acuminate apex, distinctly stalked at base, 35-47 cm long, 11-20 cm wide; costae like the upper parts of rachis, hairy on adaxial side than abaxial side; larger pinnules oblong-subtriangular, long caudate at apex, unequally cuneate at base, basal acroscopic lobes large, basisopic ones smaller than the next anterior ones, pinnatisect, stalked at base

and sessile in upper part, 5-13 cm long, 1.7-3.0 cm wide; costules densely hairy on both surfaces; ultimate lobes oblong, oblique, or spatulate in larger ones, entire or obscurely undulate at margin, round at apex; veins rather distinct and hairy below, less so above, green, papyraceous to chartaceous, hairy on the under surface of laminar parts. Sori at or a little within the margin of lobes; indusia shallowly cup-shaped, hairy.

Thailand. — NORTHERN: Chiang Mai (Doi Suthep); SOUTH-WESTERN: Kanchanaburi (Song Tho), Phetchaburi; PENINSULAR: Yala (Betong).

Distribution. — W. Malesia.

Ecology. — On rather dry slopes in lower montane rainforest at 1,600 m alt.

Specimens examined. — *K. Punchay 145, J.F. Maxwell 04-738, 98-939* (BKF).

3. *Microlepia speluncae* (L.) T. Moore, Index Fil.: 93. 1857; E. Smith, J. Siam Soc. Nat. Hist. Suppl. 8: 3. 1929; Tagawa & K. Iwats., Fl. Thailand 3(1): 118. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 88. 2000. — *Microlepia speluncae* var. *pubescens* (Hook.) Sledge, Kew Bull. 11: 525. 1956; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 72. 1967. — *Polypodium speluncae* L., Sp. Pl. 1093. 1753. **Fig. 5.9: A-B.**

Rhizomes long creeping, almost naked in the older part, deep brown, more than 7 mm diam. Stipes stramineous or brownish, pubescent or glabrescent, 64 cm long. lamina large, tripinnate to quadripinnatifid, up to 70 cm long, 50 cm wide; rachis stramineous to brownish, grooved on upper surface, more or less hairy; larger pinnae oblong-subtriangular, broadly cuneate at base, broadest at lower second or third pinna, gradually narrowing towards caudately acuminate apex, with more than 20 pinnules, about 60 cm long, 20 cm wide; costa grooved on upper surface, more or less hairy, upper pinnae gradually reduced in size; larger pinnules oblong-subtriangular or oblong-lanceolate, gradually narrowing towards apex, unequally cuneate at base, up to 15 cm long, 3 cm wide, distinctly stalked, apical secondary pinnules (segments) a little protruding; segments lobed to pinnatisect, oblong to

subquadrangular, round to acute at apex, unequally cuneate at sessile base, 1.5-2 cm long, 6-8 mm wide; ultimate lobes round or spatulate, round to acute at apex, entire or undulate at margin of larger ones; softly papyraceous to papyraceous, deep green above, green below, variously hairy on axes or on laminar surfaces; veins pinnate, veinlets once or twice forked, indistinct on both surfaces, variously hairy. Sori a little within the margin of lobes, small; indusia cup-shaped, hairy.

Thailand. — NORTHERN: Chiang Mai (Doi Chiang Dao, Doi Suthep, Mae Suai, Wang Tao), Chiang Rai (Doi Tung, Mae Nam Kok, Doi Phacho), Mae Hong Son (Mae Sariang), Lampang, Tak (Huai Krasa, Ban Musoe, Lan Sang); NORTH-EASTERN: Phetchabun (Phu Miang), Loei (Phu Luang); SOUTH-EASTERN: Chonburi (Si Racha), Chanthaburi (Khao Soi Dao); PENINSULAR: Chumphon (Lam Lieng, Khao Thalu), Surat Thani (Ko Tao), Phuket (Khao Thong Lang), Nakhon Si Thammarat (Khao Luang), Trang (Khao Chong), Satun, Yala (Betong, Bunnag Sata), Narathiwat (Waeng, Bacho Falls)

Distribution. — Pantropical according to the current delimitation of the species.

Ecology. — On dry slopes in open areas at lower montane rainforest.

Specimens examined. — *K. Punchay 246* (BCU); *Ch. Charoenphol, Kai Larsen & E. Warncke 3479, C. Phengklae et al. 12604* (BKF).

- 4. *Microlepia strigosa*** (Thunb.) C. Presl, Epimel. Bot.: 95. 185; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 72. 1967; Tagawa & K. Iwats., Fl. Thailand 3: 116. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 89. 2000. — *Trichomanes strigosum* Thunb., Fl. Jap.: 339. 1784. **Fig. 5.9: C-E.**

Rhizomes long creeping, about 5 mm diam., densely covered with yellow brown setose hairs about 2 mm long. Stipes stramineous or brownish, densely pubescent especially in the grooves on upper surface or glabrescent in older ones, 30-50 cm long; lamina bipinnate, or tripinnatifid in larger fronds, 40-70 cm long, 25-35 cm wide, ovate-oblong to oblong-lanceolate, acuminate at apex; rachis like the upper part of stipes, distinctly grooved on upper side, the groove not joined to that of pinna-

rachis, densely pubescent below; lateral pinnae sometimes more than 20 in pairs, a few lower ones a little reduced or not, the upper ones gradually reduced in size, the largest ones straight, ascending, distinctly stalked, linear-subtriangular, gradually narrowing towards long-caudate acuminate apex, cuneate at base, 17-28 cm long, 3-4 cm wide; the largest pinnules oblong to oblong-subdeltoid; oblique, moderately acute at apex, subtruncate anteriorly and very narrowly cuneate posteriorly at base, deeply lobed to pinnatisect, up to 2.3 cm long, 1 cm wide, sessile or petiolulate; ultimate lobes round to spatuliform, obscurely undulate at margin; veins pinnate, veinlets forked, distinct on undersurface of lobes, paler, hairy, softly chartaceous; deep green above, glabrous except on veins. Sori between the crenae of lobes, submarginal; indusia rather broadly cup-shaped, small, less than 1 mm broad, hairy.

Thailand. — NORTHERN: Chiang Mai (Doi Khun Huai Pong, Doi Suthep, Doi Inthanon, Doi Hua Mot), Lampang; EASTERN: Nakhon Ratchasima (Bu Phram); PENINSULAR: Chumphon (Khao Tong), Yala (Khao Kalakhiri).

Distribution. — Himalaya to Ceylon and Polynesia, northward to Japan (type).

Ecology. — On dry slopes in half-shade area in lower montane rainforest at 1,600-1,750 m alt.

Specimens examined. — *K. PUNCHAY 47, 48 (BCU); G. MURATA, K. IWATSUKI, C. PHENGLAI & C. CHARAMPHOL T16064, M. TAGAWA, K. IWATSUKI & N. FUKUOKA T3013, D.J. MIDDLETON, S. SUDDEE & C. HEMRAT 1568, K. PUNCHAY 228 (BKF).*

### PTERIDIUM

Gled. ex Scop., Fl. Carniol. 169.1760. Tagawa & K. Iwats., Fl. Thailand 3(1): 125. 1979

Terrestrial. Rhizomes creeping, deep in earth, hairy. Lamina large, tripinnate to quadripinnatifid, leathery to papery; axes grooved adaxially, glabrous or pubescent; pinnae subopposite or alternate, stalked, basal pinnae pair larger than other pinnae, triangular; veins free except soral commissure. Sori submarginal, linear, indusia formed two parts; outer layer consisting of thin reflexed margin of lamina, inner layer thinner, persistent.

*Pteridium aquilinum* (L.) Kuhn, Bot. Ost-Afrika 3(3): 11. 1879.; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 78. 1967; Tagawa & K. Iwats., Fl. Thailand 3(1): 125. 1979. — *Pteridium aquilinum* (L.) Kuhn in Deck., Reis. Ost-Afr. 3(3): 11. 1879; Holttum, Rev. Fl. Malaya ed. 1, 2: 389, f. 225. 1955. — *Pteris aquilina* L., Sp. Pl.: 1075. 1753. **Fig. 5.9: F-H.**

subsp. *wightianum* (J. Agardh) W.C. Shieh., Quart. J. Chin. Forest. 6(4): 98. 1973. — *Pteris recurvata* var. *wightiana* J. Agardh, Recens. Spec. Pter. 50–51. 1836.

Rhizomes long creeping covered with fine pale brown hairs. Stipes long, 84 cm long, thick about 1 cm in diam., dark brown to black, stramineous upwards, densely covered with pale brown hairs; lamina tripinnate to quadripinnatifid at base, the apex growing for a considerable period, about 80 cm, both in length and width; rachis, costae and costules grooved above, the grooves decurrent to those in the next higher order; basal pair of pinnae larger, about 70 cm long, 35 cm wide, or rather narrower; pinnules about 18 cm long, 3 cm wide; ultimate leaflets small and narrow, subcoriaceous, usually covered with pale brown hairs, veins free, forked, raised beneath, hairy. Sori linear, submarginal, the apices of veins joined by vascular commissure, thus forming long continuous receptacles; indusia formed in two parts, one consisting of the thin reflexed edge of the leaflets, the other thin, almost transparent membrane attached just below the receptacles.

Thailand. — NORTHERN: Chiang Rai (Doi Tung, Doi Phacho), Chiang Mai (Doi Chiang Dao, Doi Suthep, Pang Ton, Doi Pha Hom Pok, Chom Thong, Huai San), Lamphun (Doi Khun Tan), Phitsanulok (Thung Saleang Luang); NORTH EASTERN: Phetchabun (Phu Miang), Loei (Phu Kradung).

Distribution. — Himalaya to Malaysia and Taiwan.

Ecology. — Terrestrial in open areas in lower montane rainforest at 1,600 m alt.

Specimens examined. — *K. Punchay 101, E. Hennipman 3235, J.F. Maxwell 93-356, 98-339, M. Tagawa & I. Yamada T62* (BKF).

## DRYOPTERIDACEAE

Herter, Revista Sudamer. Bot. 9: 15. 1949; Tagawa & K. Iwats., Fl. Thailand 3(3): 327. 1988;

Terrestrial, lithophytic or epiphytic. Rhizomes erect, ascending, creeping, scaly. Stipe with several vascular bundles. Lamina 1-5-pinnate, or simple, monomorphic or dimorphic; rachises grooved adaxially, with or without proliferous bulbil, vein free, or anastomosing. Sori terminal or dorsal on veins, indusiate or exindusiate; if indusiate then indusia orbicular or reniform.

### Key to the genera

- 1a. Frond dimorphic; sporangia acrostichoid
  - 2a. Frond pinnate or rarely bipinnate, vein reticulate.....**2. Bolbitis**
  - 2b. Frond simple, vein free.....**4. Elaphoglossum**
- 1b. Frond monomorphic
  - 3a. Rhizome creeping; stipe articulated at base, glabrous.....**5. Leucostegia**
  - 3b. Rhizome not as above, stipe not articulated at base
    - 4a. Indusia globose. Bearing articulated hairs on upper surface of vein and on axes of frond.....**6. Peranema**
    - 4b. Indusia round or reniform. No articulated hairs on axes of frond
      - 5a. Indusia round, peltate. Scale bicolored.....**7. Polystichum**
      - 5b. Indusia round-reniform, attached at base. Scale usually concolorous
        - 6a. Pinnules anadromic.....**1. Arachniodes**
        - 6b. Pinnules catadromic.....**3. Dryopteris**

### 1. ARACHNIODES

Blume, Enum. Pl. Javae 2: 241-242. 1828; Tagawa & K. Iwats., Fl. Thailand 3(3): 339. 1988. — *Byrsopteris* C.V. Morton, Amer. Fern J. 50(1): 149. 1960.

Terrestrial. Rhizomes short creeping, ± ascending, densely scaly; scales entire, concolorous. Stipe equal in length to lamina or longer, densely scaly at base, grooved

above. Lamina, pinnatifid or more compound, herbaceous, papery to leathery, glabrous, more or less shining, anadromic in sequence of frond; venation also anadromous, veins free, pinnate or forked. Sori orbicular, terminal or dorsal on veinlets; indusia orbicular-reniform, attached at a deep sinus, or exindusiate.

### Key to the species

- 1a. Frond tripinnatifid or more compound, sori dorsal or terminal on veinlets  
 2a. Sori terminal or rarely dorsal on veinlet, indusia rather small.....**2. *A. speciosa***  
 2b. Sori dorsal on veinlet, indusia large entirely cover sori when young, lobe aristate to mucronate; lamina more or less shining.....**3. *A. spectabilis***  
 1b. Frond bipinnate above basal pinna, sori terminal on veinlets.....**1. *A. chinensis***

- 1. *Arachniodes chinensis*** (Rosenst.) Ching, Acta Bot. Sin. 10: 257. 1962; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 93. 1967; Tagawa & K. Iwats., Fl. Thailand 3(3): 344. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 199. 2000. — *Rumohra chinensis* (Rosenst.) Ching, Sinensia 5: 46, pl. 3. 1934; Tardieu & C. Chr., Fl. Indo-Chine 7(2): 322. 1941. — *Polystichum amabile* var. *chinense* Rosenst. Repert. Spec. Nov. Regni Veg. 13(355–358): 130. 1914. **Fig. 5.10: A-B.**

Rhizomes short creeping or ascending, about 6 mm diam.; scales dense, dark brown, about 10 mm long, 1 mm wide or narrower, margin entire. Stipes stramineous, 20-30 cm long, grooved, densely scaly throughout; scales on upper portion narrow, dark brown, entire. Laminae ovate-subdeltoid with suddenly shortened acuminate to caudate apex, 32-46 cm long, 36-39 cm wide, bipinnate above basal pinna; rachis densely covered with fibrillose blackish scales, grooved on upper surface, papyraceous; basal pinnae largest, 16-19 cm long, 4-7 cm wide, with large basiscopic and acroscopic pinnules, stalked up to 7 mm long; middle pinnae narrowly subtriangular, slightly falcate, widest at near base, base broadly cuneate and gradually narrowing towards apex; pinnules lobed to pinnatisect in larger ones, shortly stalked or sessile, narrowly rhomboid, acute at apex, more or less auricled at anterior base, unequal cuneate at base, about 25 mm long, 0.7 mm wide, ; ultimate lobes with sharp

awns at acuminate apex, entire, glabrous, deep green; midrib of pinnule raised on lower surface, veins pinnate. Sori terminal on veinlets, round; indusia round-reniform, naked.

Thailand. — NORTHERN: Chiang Rai; NORTH-EASTERN: Loei (Phu Kradung); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao).

Distribution. — S & SW China, Indochina (type) and Malaysia.

Ecology. — On moist mountain slopes in lower montane rainforest at 1,600 m alt.

Specimens examined. — *K. Panchay 158* (BKF); *Schmidt VN127* (P).

2. *Arachniodes speciosa* (D. Don) Ching, Acta Bot. Sin. 10:259. 1962; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 93. 1967; Tagawa & K. Iwats., Fl. Thailand 3(3): 343. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 200. 2000. — *Rumohra speciosa* (D. Don) Ching, Sinensia 5: 53, pl. 7. 1934; — *Aspidium speciosum* D. Don, Prodr. Fl. Nepal.: 51. 1825. — *Arachniodes conifolia* (T. Moore) Ching, Acta Bot. Sin. 10: 257. 1962; Boonkerd et al., Thai For. Bull. (Bot.) 32: 8. 2004; Boonkerd & Pollwatn, Nat. Hist. J. Chulalongkorn Univ. 6: 22. 2006. **Fig. 5.10: C-D.**

Rhizomes short, erect or ascending; scales linear, brown, up to 2 cm or more long, 1.5 mm broad at base, entire, more or less crisped in linear apical portion. Stipes stramineous, densely scaly at base, more sparsely upwards, 37-60 cm long, grooved; scales on upper part smaller and narrower, dark. Laminae oblong-subdeltoid, about 50 cm long, 40-50 cm wide, tripinnate, chartaceous, deep green; rachis scaly, grooved; the lowest pinnae largest, gradually reduced in size toward apex; middle pinnae falcate, oblong-subtriangular, gradually narrowing towards acuminate apex, distinctly stalked 20-25 cm long, up to 10 cm wide, widest at base; densely fibrillose scale at rachis-pinnae junction ; pinnules oblong-subdeltoid, acuminate at apex, unequally cuneate at base, stalked to sessile upward, 5-10 cm long, about 3 cm wide; segments oblong-lanceolate to subquadrangular, oblique or slightly falcate, acute at apex,



crenate at margin, about 2-2.5 by 0.7-1.5 cm Sori terminal on veinlets, close to midrib, round; indusia round reniform glabrous.

Thailand. — NORTHERN: Chiang Mai (Doi Suthep), Phitsanulok (Thung Salaeng Luang, Salaeng Haeng).

Distribution. — Himalaya (type), SW China and Vietnam.

Ecology. — On moist mountain slopes in lower montane rainforest at 1,600 m alt.

Specimens examined. — *K. Punchay 242, J.F. Maxwell 95-326, M. Tagawa, K. Iwatsuki, & N. Fukuoka T2026* (BKF).

3. *Arachniodes spectabilis* (Ching) Ching, Acta Bot. Sin. 10: 259. 1962; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 93. 1967; Tagawa & K. Iwats., Fl. Thailand 3(3): 343. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 200. 2000. — *Rumohra spectabilis* Ching, Sinensia 5: 58, pl. 11. 1934. **Fig. 5.10: C-D.**

Rhizomes short, erect; scales brown, dense, linear, about 12 mm long, 1 mm wide, entire. Stipes stramineous, about 40 cm long, scaly on basal part, glabrescent upwards, dark-brown. Laminae oblong-subtriangular, gradually narrowing towards acuminate apex, tripinnate, 40-50 cm long by about 35 cm; rachis glabrous, grooved on upper surface; lateral pinnae more than 10 pairs, the lowest the largest, with large basal acroscopic pinnules; middle pinnae distinctly stalked, slightly falcate, narrowly subtriangular, widest at base, gradually narrowing towards caudate-acute apex, about 20 by 6-8 cm, upper ones gradually become smaller; pinnules oblong-subdeltoid, acute at apex, unequally cuneate at stalked base, often dimidiate at posterior base; segments sessile, oblong, oblique, round to moderately acute at apex, lobed at margin, up to 1.5-2 cm by 1 cm; lobes serrate at margin, ending with moderate awns; harsh, glabrous green on upper surface. Sori dorsal on veinlets, near midrib; indusia round, entirely covered and enveloping the sori when young, breaking down irregularly.

Thailand. — NORTHERN: Mae Hong Son (Doi Khun Huai Pong), Chiang Mai (Doi Inthanon), Chiang Rai (Doi Phacho), Lampang, Phitsanulok (Phu Miang);

SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); SOUTH-WESTERN: Kanchanaburi (Khao Rai Yai).

Distribution. — E Himalayas and SW China (Yunnan, type).

Ecology. — On rather dry or humus riched mountain slopes in lower montane rainforest at 1,600-1,700 m alt.

Specimens examined. — *K. Punchay* 204, 258 (BCU); *E. Hennipman* 3413, 3418, *T. Shimizu*, *K. Iwatsuki*, *N. Fukuoka*, *M. Hutoh* & *D. Chaiglom* T11600, *K. Punchay* 061 (BKF).

## 2. BOLBITIS

Schott, Gen. Fil. , pl. 14. 1834; Tagawa & K. Iwats., Fl. Thailand 3(3): 310. 1988

Terrestrial. Rhizomes creeping, dorsiventral, covered with ovate to linear-lanceolate, brown or blackish scales. Fronds dimorphic, simple, pinnate, or rarely bipinnate, apex of sterile frond usually with a bulbil, margin entire or crenate to deeply lobed, with or without teeth or spines, veins free or anastomosing, with or without included free veinlets; fertile fronds similar in shape to sterile ones, usually longer stipe and narrower lamina. Sporangia acrostichoid, without indusia.

*Bolbitis sinensis* (Baker) K. Iwats., Acta Phytotax. Geobot. 18: 49. 1959; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 90. 1967; Tagawa & K. Iwats., Fl. Thailand 3(3): 318. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 184. 2000. — *Acrostichum sinense* Baker, Bull. Misc. Inform. Kew 1906: 14. 1906. **Fig. 5.11: A-C.**

var. *sinensis*

Rhizomes short creeping; scales greyish-brown, hardly clathrate, narrowly subtriangular to lanceolate with acuminate apex, pale at margin, entire, up to 4 by 0.8 mm Sterile fronds: stipe stramineous, with scale and brown at base, 40-47 cm long; lamina narrowly subtriangular, 48-96 cm long, 20-40 cm wide, the apex attenuately long-tailed, often proliferous at apex; rachis sparsely scaly, winged in upper part; lateral pinnae about 20 pairs, basal pinnae the longest, 12-22 cm long, 4-6 cm wide,

stalked, with or without an enlarged and lobed basal basicopic pinnule, middle pinnae patent or slightly oblique, oblong-lanceolate, shortly stalked, upper ones ascending, oblong, moderately acuminate to round at apex, less lobed, adnate at base to form indistinct apical pinna; lobes oblique, rounded at apex, 4-7 mm broad, close to each other; main veins raised on abaxial side, sparsely scaly, veinlets simple or forked, all free, reaching at margin; papyraceous, deep green, dark green when dried. Fertile fronds: stipe 50-65 cm long; lamina narrower than sterile frond, narrowly oblong, 20-30 cm long, 7-8 cm; lower lateral pinnae oblong, 3.5-5 cm long, 0.7-1 cm wide, gradually narrowing from base to apex, subtruncate or broadly cuneate at distinctly stalked base, rounded to moderately acute at apex, subentire or very slightly waved at margin, terminal pinna gradually reduced with acuminate apex; veins pinnate, veinlets simple, all free, the apex ending inside the distinct cartilaginous margin; sporangia dispersed on the undersurface, naked.

Thailand. — NORTHERN: Chiang Rai (Doi Tung, Doi Phacho), Chiang Mai (Doi Chiang Dao, Doi Suthep, Pang Bo, Doi Inthanon, Doi Chang), Lampang, Lamphun (Doi Khun Tan); NORTH-EASTERN: Phetchabun (Phu Miang), Loei (Phu Luang); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao).

Distribution. — N India, Burma, SW China (type) and Vietnam.

Ecology. — Usually terrestrial on moist and humus-rich slopes near river, sometimes on muddy rocks in lower montane rainforest at 1,700 m alt.

Specimens examined. — *K. Punchay 082*, *C.F. van Beuskom & C. Phengkhai 2349*, *R. Pooma 559* (BKF).

### 3. DRYOPTERIS

Adans., *Fam. Pl.* 2: 20. 1763; Tagawa & K. Iwats., *Fl. Thailand* 3(3): 345. 1988.

Rhizomes short ascending to erect, scaly; scale mostly broad, entire, not clathrate. Stipe not articulated, usually tufted in apex of rhizome, scaly at base. Lamina pinnate or more compound, catadromic in sequence of frond architecture; usually papyraceous or firm, typically glabrous, vein all free. Sori dorsal on veinlet, indusia round-reniform, attached at sinus or exindusiate.

### Key to the species

- 1a. Lamina more than 31 cm long, sori terminal on veinlet .....**1. *D. hasseltii***  
 1b. Lamina less than 31 cm long, sori dorsal on veinlet  
     2a. Sori indusiate.....**3. *D. sparsa***  
     2b. Sori exindusiate.....**2. *D. polita***

- 1. *Dryopteris hasseltii*** (Blume) C. Chr., Index Filic. 269. 1905. — *Arachniodes hasseltii* (Blume) Ching, Acta Bot. Sin. 10: 258. 1962; Tagawa & K. Iwats., Acta Phytotax. Geobot. 24: 62. 1969; Tagawa & K. Iwats., Fl. Thailand 3(3): 340. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 199. 2000. — *Acrorumohra hasseltii* (Blume) Ching, Acta Phytotax. Sin. 9: 385. 1964; Shieh et al., Fl. Taiwan ed. 2, 1: 307. 1994. Fig. — *Polypodium hasseltii* Blume, Fl. Javae Fil.: 195, t. 92. 1828. **5.11: D-E.**

Rhizomes suberect bearing wirely root, scaly; scales large, subtriangular, gradually narrowing from base towards hair-pointed apex, 7-9 mm long, 1.6-2 mm wide, brown or darker, entire. Stipes about 27-30 cm long, stramineous, brown and scaly at base, glabrescent upwards, grooved above. Laminae oblong-subdeltoid, acuminate at apex, about 43 by 33-35 cm, tripinnate; rachis stramineous, grooved above, glabrescent; all pinnae anadromous; basal pinna largest, stalked, unequally subtriangular with larger basiscopic basal pinnules, about 18 cm by 7 cm; upper pinnae ascending, narrowly oblong with long-acuminate apex; costa stramineous, grooved above, very narrowly winged; larger pinnule shortly stalked, oblong to ovate, rounded to acuminate at apex, cordate at base, or subdimidiate to narrowly cuneate at basiscopic base; secondary pinnule sessile, about 5 mm by 3 mm, oblong, rounded at apex, round or cuneate at base, lobed with two to four lobes at each side, often with a small acute lobe on the distal margin of the larger rounded lobes; ultimate lobes obliquely subdeltoid, acute at apex; herbaceous, veins distinct below, glabrous. Sori round, terminal on veinlets, medial or closer to midribs, up to 1.2 mm diam., naked.

Thailand. — NORTH-EASTERN: Loei (Phu Luang); PENINSULAR: Nakhon Si Thammarat (Khao Ram Rom).

Distribution. — Assam, N Vietnam, Hainan, Taiwan, Ryukyus, and Malesia throughout (type from Java) to New Guinea.

Ecology. — On moist and shaded area in lower montane rainforest at 1.650 m alt.

Specimens examined. — *K. Punchay* 147 (BCU); *K. Iwatsuki*, *C. Phengkklai*, *M. Wakabayashi* & *M. Kato* 86, *D.J. Middleton*, *P. Triboun*, *C. Chamchumroon*, *S. Saengrit* & *R. Simma* 4410 (BKF); *G. Koidzumi S.N*, *Schmid M.* 5426 (P).

2. *Dryopteris polita* Rosenst., Repert. Spec. Nov. Regni Veg. 13: 218. 1914; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 96. 1967; Tagawa & K. Iwats., Fl. Thailand 3(3): 353. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 204. 2000. **Fig. 5.11: F.**

Rhizomes short, ascending or suberect, scales linear-lanceolate, light brown, entire, up to 18 by 2 mm Stipes stramineous, brown and scaly at base, more sparsely scaly upwards with smaller ones, up to 20-25 cm long, grooved, slightly polished. Laminae oblong with acuminate apex, bipinnate, up to 30 cm long, about 20 cm wide; lateral pinnae 6-7 pairs slightly smaller upwards, with stalks up to 1.5 cm long, narrowly subtriangular with acuminate apex, unequally broadly cuneate at base, about 10-11 by 4-5 cm, sometimes with a slightly enlarged basal basisopic pinnule on one or more pinnae; upper pinnae rather suddenly shortened, very shortly stalked, sessile or adnate at base, oblong-subdeltoid with acute apex, shallowly lobed at margin; pinnules oblong-subdeltoid, rounded at apex, round or cuneate at base or acroscopically auricled in larger ones, up to 3 cm long, 0.7- 1.2 cm wide, serrate at margin; papyraceous, not very thick or harsh, deep green. Sori dorsal on veinlets, medial, exindusiate.

Thailand. — NORTHERN: Chiang Mai (Doi Chiang Dao), Tak (Doi Musoe); NORTH-EASTERN: Loei (Phu Luang, Phu Kradung); CENTRAL: Nakhon Nayok

(Khao Yai); SOUTH-EASTERN: Chanthaburi; PENINSULAR: Ranong (Kapoe), Nakhon Si Thammarat (Khao Luang).

Distribution. — Indochina, W Malaysia, Sumatra, Borneo, Taiwan (type), and northwards to southern edge of Japan.

Ecological. — On moist ground under opening area in lower montane rainforest 1,600 m alt.

Specimens examined. — *K. Punchay* 285, *K. Yoda* 465, *E. Hennipman* 3093, 3932A, *T. Smitinand* 5913A (BKF).

3. *Dryopteris sparsa* (D. Don) Kuntze, Rev. Gen. Pl. 2: 813. 1891; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 95. 1967; Tagawa & K. Iwats., Fl. Thailand 3(3): 352. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 159, 205. 2000. — *Nephrodium sparsum* D. Don, Prodr. Fl. Nepal.: 6. 1825. **Fig. 5.11: G-H.**

Rhizomes short, erect; scales membranous, light brown, dark brown at attach point oblong-ovate, about 10 mm by 4-5 mm, margin entire. Stipes brown and scaly at base, stramineous and sparsely scale above, 24-35 cm long. Laminae bipinnate, sometimes tripinnate at base, oblong-subdeltoid, acuminate at apex, widest at base, 25-31 cm long, 24-27 cm wide; basal pinnae the largest, asymmetrically subtriangular, acuminate at apex, 10-14 cm by 5 cm; middle pinnae falcate, stalked, subtriangular-lanceolate; pinnules oblong, slightly falcate, rounded or moderately acute at apex, unequally cuneate at sessile base or decurrent at base in upper ones, up 2.5-3 cm long, 1.2-1.5 cm wide, lobed 1/3 way to midrib or slightly entire; basal basiscopic pinnule of lower pinnae large, about twice as large as the next one, pinnate; lobes oblong, oblique, rounded or moderately acute at apex, serrate at margin; papyraceous to chartaceous, deep green above, pale beneath; veins pinnate, simple, reaching margin of lobes. Sori dorsal on veinlets, costular or medial; indusia large, about 1.5 mm diam., glabrous, not persistent.

Thailand. — NORTHERN: Chiang Mai (Mae Lao), Chiang Rai (Doi Chaing Dao, Doi Suthep); NORTH-EASTERN: Loei (Phu Luang, Phu Kradung); SOUTH-

EASTERN: Chanthaburi (Khao Soi Dao); PENINSULAR: Nakhon Si Thammarat (Khao Luang).

Distribution. — India (type), China, Indochina, throughout Malesia to Polynesia, Taiwan and north to S Japan.

Ecology. — On dry mountain slopes near road in lower montane rainforest at 1,600 m alt.

Specimens examined. — *K. Punchay 271, Winit 1184, E. Hennipman 3580A, 3669, D.J. Middleton, P. Karaket, S. Lindsay, T. Phutthai & S. Suddee 5082, 5156, 5169, K. Punchay 284* (BKF).

#### 4. ELAPHOGLOSSUM

Schott ex J. Sm., *J. Bot. (Hooker)* 4: 148, 1842; Tagawa & K. Iwats., *Fl. Thailand* 3(3): 303. 1988.

Epiphytic or lithophytic. Rhizomes shortly to long creeping, scales bearing short teeth at margins. Fronds close together or remote, dimorphic, scaly or glabrous; stipes joint to rhizome; sterile lamina simple, entire, leathery; fertile frond often longer; vein simple or fork. Sporangia acrostichoid, entirely covered abaxial surface of frond, exindusiate.

#### Key to the species

- 1a. Sterile frond lanceolate to oblong-lanceolate, up to 3 cm wide..... **1. *E. malayense***  
 1b. Sterile frond elliptic, more than 3 cm wide..... **2. *E. subellipticum***

- 1. *Elaphoglossum malayense*** Holttum, *Blumea* 14: 322. 1966; Tagawa & K. Iwats., *Fl. Thailand* 3(3): 308. 1988; Boonkerd & Pollawatn, *Pterid. Thailand*: 151, 186. 2000. — *Elaphoglossum callifolium* (Blume) T. Moore, *Index Fil.* 7. 1857. **Fig. 5.12: C.**

Rhizomes short, densely covered with scales; scales brown, membranous, oblong-lanceolate, about 7 mm long, 1 mm wide, entire or with irregular projections at margin. Sterile frond: stipe 2-6 cm long, stramineous with dark base, slightly

winged on upper part, scales at base dense like those on rhizome becoming more sparse upwards; lamina oblong-lanceolate to linear-lanceolate, occasionally elliptic, gradually narrowing towards both ends, about 15 cm by 2.5-3 cm, entire, narrowly margin with cartilaginous membrane; midrib raised on both surfaces, very sparsely minutely scaly or glabrescent; coriaceous, veins visible on both surfaces, green, usually brownish in dried specimens. Fertile frond: stipe 10-15 cm long; lamina elliptic, narrower than sterile frond, gradually narrowing towards both ends, 12-17 cm long, about 1-1.5 cm broad.

Thailand. — NORTH-EASTERN: Loei (Phu Kradung); EASTERN: Nakhon Ratchasima (Khao Yai); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); PENINSULAR: Surat Thani (Ko Phangan), Phangnga (Khao Phra Mi), Nakhon Si Thammarat (Khao Luang), Trang (Khao Chong).

Distribution. — Annam and Peninsular Malaysia (type).

Ecology. — On mossy tree trunks under shaded area in lower montane rainforest at 1,650 m alt.

Specimens examined. — *K. Punchay 151, M. Tagawa, K. Iwatsuki, N. Fukuoka, T4798, 4801* (BKF).

2. *Elaphoglossum subellipticum* Rosenst., Hedwigia 56: 348. 1915; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 89. 1967; Tagawa & K. Iwats., Fl. Thailand 3(3): 306. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 187. 2000. **Fig. 5.12: A-B.**

Rhizomes short 3-4 mm in diam., densely scaly throughout; scales brown or light brown, shining, linear, up to 10 by 1 mm, with irregular teeth or projections at margin. Sterile frond: narrowly elliptic; stipe 6-11 cm long, stramineous and darker at base, densely scaly at base, sparsely so on the remainder with narrow dark scales; lamina elliptic, gradually narrowing towards both ends, acute at apex, the base decurrent to very narrow wings on the upper part of stipe, about 25 by 5.5-7 cm; midrib distinctly raised on lower surface, veins forked, distinct on both surfaces, the apex ending inside the narrow cartilaginous margin; coriaceous, pure green, very



sparsely scaly on lower surface; smaller sterile frond many on a plant; stipe 3-6 cm long, winged on upper part; lamina oblong, acute at apex, round at base, 6-15 by 2.5-4 cm Fertile frond: smaller than sterile ones; stipe about 10 cm long, winged at uppermost part; lamina broadest at middle, gradually narrowing towards both ends, up to 12 by 2.5 cm

Thailand. — NORTH-EASTERN: Loei. (Phu Luang, Phu Kradung).

Distribution. — Taiwan (type) and Sumatra.

Ecology. — On mossy rocks under shaded area in lower montane rainforests at 1,600 m alt.

Specimens examined. — *K. Punchay 213*, *C.F. van Beusekom*, *C. Phengkhai*, *R. Geesink & B. Wongwan 4591* (BKF).

## 5. LEUCOSTEGIA

C. Presl, Tent. Pterid. 94. 1836; Tagawa & K. Iwats., Fl. Thailand 3(2): 168.

Rhizomes creeping, with hairs and scales; scale broad, entire, concolorous. Stipe articulated, grooved or not, glabrous, polished. Lamina compound, tripinnate or quadripinnate, glabrous herbaceous, pale green; rachis groove on upper surface. Sori indusiate, terminal on veins; indusium attached at base or both side.

*Leucostegia immersa* C. Presl, Tent. Pterid.: 95. 1836; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 76. 1967; Tagawa & K. Iwats., Fl. Thailand 3(2): 169. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 172, 173, 236. 2000. — *Davallia immersa* (C. Presl) Wall. ex Hook., Sp. Fil. 1: 156. 1846. **Fig. 5.12: D.**

Rhizomes long creeping, bearing fronds remotely, about 3 mm in diam.; scales narrowly lanceolate, up to 4 by 0.4 mm, light brown, membranous, entire at margin. Stipes stramineous, polished, brown on lower surface, glabrescent, grooved above, 23-28 cm long. Laminae oblong, acuminate at apex, quadripinnatifid, up to 50 by 23-30 cm; pinnae more than 10 pairs, the lowest the largest, with distinct petioles, lower ones asymmetrically oblong-subdeltoid, acuminate at apex, broadly cuneate at base,

about 20 cm long and 10 cm wide; pinnules oblong-lanceolate on stalks in larger ones, secondary pinnules oblong or narrower, with 1-6 segments; ultimate segments circular or terminal ones spatulate, lobed at margin; thin herbaceous, light green, glabrous. Sori terminal on veinlets, one to each segment; indusia circular, persistent, attached at base, entire, 1.3-2 mm broad, white to pale brown, glabrous.

Thailand. — NORTHERN: Chiang Rai (Doi Tung), Chiang Mai (Doi Chiang Dao, Doi Suthep, Doi Inthanon, Doi Pha Hom Pok, Pong Pa Po, Sop Aep), Lamphun (Doi Khun Tan), Tak (Doi Musoe), Phitsanulok (Phu Miang); NORTH-EASTERN: Loei (Phu Luang, Phu Kradung); SOUTH-WESTERN: Kanchanaburi (Bo Rae); PENINSULAR: Surat Thani (Ban Don).

Distribution. — S India, E Himalayas (type), SW China, Burma, Indochina, W Malesia to the Philippines, north to Taiwan.

Ecology. — Terrestrial on mountain slopes in lower montane rainforest at 1,700 m alt.

Specimens examined. — *K. Punchay 102, E. Hennipman 3153, D. J. Middleton, P. Karaket, P. Triboun, U. Kawatkul & R. Meeboonya 4472, M. Tagawa, K. Iwatsuki & N. Fukuoka T1516, C.F. van Beusekom & C. Charoenphol 1743* (BKF).

## 6. PERANEMA

D. Don, Prodr. Fl. Nepal. 12. 1825; W.C. Sheih, C.E. Devol, C.M. Kuo & J.C. Wang, Fl. Taiwan. ed. 2: 333. 1994.

Rhizomes short ascending to erect, densely scaly; scale broad, not clathrate. Stipe scaly. Lamina compound to quadripinnate, vein all free, bearing articulated hair at costa, costule and rachis. Sori globose, indusial firm, attached at base of receptacles, covering sori, tearing at maturity.

*Peranema aspidioides* (Blume) Mett., Fil. Lechl. 2. 33. 1859. — *Diacalpe aspidioides* Blume, Enum. Pl. Javae.: 241. 1828; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 92.

1967; Tagawa & K. Iwats., Fl. Thailand 3(3): 330. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 202. 2000.

Rhizomes short, ascending, covered with scales, about 2 cm in diam.; scales linear-subtriangular, up to 10 by 2 mm, entire, glabrous, brown, slightly pale at margin. Stipes stramineous to brown, deep brown on abaxial surface, grooved above, polished, 20-27 cm long, scaly throughout. Laminae oblong-subdeltoid, about as long as stipe, tripinnate to quadripinnate, widest at base, 25-31 cm long, 24-27 cm wide, subcoriaceous, ; rachis minutely scaly throughout; pinnae more than 10 pairs, basal ones the largest, up to 17 cm long, 7 cm wide, asymmetrically subtriangular, middle ones falcate, oblong-subtriangular, caudately acute at apex, broadly cuneate at base; pinnules oblong-subdeltoid, acute at apex, unequally broadly caudate at subsessile base, about 2 cm long, 0.8-1 cm wide; segments oblong to spatulate, oblique, sessile, subentire or pinnate in larger ones, rounded at apex, narrowly cuneate at base, about 7 mm by 3 mm in those of middle pinnae; pinnae papyraceous, green to deep green, sparsely hairy on veins, hairs articulated. Sori dorsal on veinlets, globose; indusia glabrous, green when young, turning dark brown to black with age, about 0.7-1 mm in diam.

Thailand. — NORTHERN: Chiang Mai (Doi Hua Mot, Doi Inthanon), Mae Hong Son (Khun Mae Lan); NORTH-EASTERN: Loei (Phu Luang, Phu Kradung); CENTRAL: Nakhon Nayok (Khao Yai) SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); PENINSULAR: Chumphon (Khao Nom Sao), Ranong (Khao Phota Luang Kaeo), Krabi (Phanom Bencha), Nakhon Si Thammarat (Khao Luang).

Distribution. — Sri Lanka, N India, S China, Indochina and throughout Malesia (type from Java).

Ecology. — On mountain slopes in lower montane rainforests at 1,600 m alt.

Specimens examined. — *K. Panchay* 270, *Kyoji Yoda* 388, *K. Iwatsuki*, *H. Koyama*, *M. Hutoh* & *A. Chintayungkun* T8388, *T. Shimizu*, *M. Hutoh* & *D. Chaiglom* 8961 *H.B.G. Garrett* 664 (BKF).

## 7. POLYSTICHUM

Roth, Tent. Fl. Germ. 3(1): 31,69. 1800; Tagawa & K. Iwats., Fl. Thailand 3(3): 333. 1988.

Rhizomes short, usually ascending or erect, bearing frond close together, scaly; scale broad, curved. Stipe densely scales. Lamina pinnate to bipinnate, usually oblong, narrow at apex, coriaceous, with mucronate apex, gemmiferous or not, vein all free, usually bearing fibroid scale. Sori dorsal on vein, round, indusial peltate or rarely exindusiate

### Key to species

- 1a. Rachis gemmiferous, frond narrowly subtriangular widest at base.....  
 .....**1. *P. attenuatum***
- 1b. Rachis not gemmiferous, frond oblong-lanceolate widest at middle.....  
 .....**2. *P. biaristatum***

- 1. *Polystichum attenuatum*** Tagawa & K. Iwats., Acta Phytotax. Geobot. 23: 113. 1968; Tagawa & K. Iwats., Fl. Thailand 3(3): 335. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 208. 2000. **Fig. 5.12: E-F; 5.13: A-B.**

Rhizomes short, scaly at apex; scales ovate or oblong with acuminate apex, rounded at base, about 7 mm long, 5 mm wide, bicolored with nearly black central portion and light brown margin, marginal portion caducous, often leaving concolorous black on older portion of rhizome. Stipes brown, sparsely scaly near base, grooved above about 28 cm long. Laminae narrowly subtriangular, commonly widest at base, bipinnate-tripinnatifid at base, 38 cm long by 25 cm; rachis scaly with brown linear scales less than 0.7 mm broad, with bulbil on rachis near apex; lateral about 25 pairs, oblong or slightly narrowing from base to apex, subopposite, broadly cuneate at base, acuminate at apex, falcate, auricled at acroscopic base, dimidiate at basiscopic base, upper ones pinnatifid, a few lowest pinnae very shortly stalked, patent, slightly falcate, lanceolate, up to 13.5 cm long, up to 4 cm wide; basal acroscopic pinnules larger than the next; costae with linear scale, narrowly winged; pinnules of lower

pinnae oblong or more usually narrowing from base to acute apex, auricled at acroscopic and dimidiate at basiscopic bases, apex of lobes ending in awns; veins minutely scaly beneath, not raised on both surfaces; subcoriaceous, glabrous on laminar surface, green. Sori terminal on vein, close to midrib of pinnule or medial; indusia small, glabrous, caducous.

Thailand. - NORTHERN: Chiang Mai (Doi Chiang Dao, Doi Suthep, Doi Inthanon); NORTH-EASTERN: Loei (Phu Luang, type, Phu Kradung); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao).

Distribution. — N India, S China, Thailand.

Ecology. — Terrestrial on humus-rich mountain slopes in lower montane rainforests at 1,700 m alt.

Specimens examined. — *K. Panchay 124* (BCU), *R. Geesink, P. Hiepko & C. Phengklay 8130, G. Murata, K. Iwatsuki & C. Phengklay T15107, T. Shimizu, H. Toyokuni, H. Koyama, T. Yahara & D. Phanichaphol T23766* (BKF).

2. *Polystichum biaristatum* (Blume) T. Moore, Index Filic.: 86. 1858; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 94. 1967; Tagawa & K. Iwats., Fl. Thailand 3(3): 337. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 161, 208. 2000. — *Aspidium biaristatum* Blume, Enum. Pl. Javae 164. 1828. **Fig. 5.13: C-D.**

Rhizomes short, suberect; scales narrowly subtriangular, attenuate at apex, entire at margin, 16-22 mm long, about 3-6 mm wide, bicolored, central portion shining black and tough, the margin brown to dark brown with ferruginous margin. Stipes 37-47 cm long; scales at base of two kinds, one like those on rhizome, the other narrower, linear, up to 1 cm long, brown, toothed at margin, those on upper part linear, black with brown broader base. Laminae oblong-lanceolate, widest at middle, slightly narrowing towards base, acuminate at apex, 38-60 cm long, 37-40 cm; rachis densely scaly throughout with linear black scales with brown broader base; pinnae about 18 pairs, lower pinnae patent or slightly ascending, very shortly stalked, oblong with gradually acuminate at apex, broadly cuneate or subtruncate at base, about 20 cm long, 3.5-4 cm wide; basal acroscopic pinnules larger; pinnules rather close, oblong or

gradually narrowing towards apex, falcate, acute and ending in sharp awns at apex, sessile, 2-2.5 cm long, 0.8-1 cm wide, slightly lobed at margin; veinlets a little raised on lower surface, minutely scaly; coriaceous, dark green. Sori arranged in one row at submarginal or medial part of pinnules; indusia pale brown, about 1 mm diam.

Thailand. — NORTHERN: Chiang Rai (Mae Talop, Doi Phacho), Chiang Mai (Doi Suthep, Doi Inthanon), Tak (Khun Kong San); NORTH-EASTERN: Loei (Phu Paek); SOUTH-EASTERN: Prachin Buri (Khao Yai), Chanthaburi (Khao Soi Dao); PENINSULAR: Ranong (Khao Dan).

Distribution. — Sri Lanka, N India, S China, Taiwan and Java (type).

Ecology. — On humus-riched ground in lower montane rainforest at 1,700 m alt.

Specimens examined. — *K. PUNCHAY 115* (BCU); *C. Phengklay et al. 7022*, *J.F. Maxwell 00-1*, *M. Tagawa T3846*, *K. Iwatsuki & N. Fukuoka T3433*, *D. J. Middleton*, *C. Hemrat*, *S. Lindsay*, *S. Suddee & S. Suwanachat 3942* (BKF); *C.C. Hosseus 346*, *G. Gardner 48* (P).

### EQUISETACEAE

Michx. ex DC., *Essai Propr. Méd. Pl.* 49. 1804; Tagawa & K. Iwats., *Fl. Thailand* 3(1): 34. 1979.

Rhizomes creeping, erect or ascending, blackish brown, branched, with nodes. Aerial stems annual or perennial, erect, green but lower nodes often blackish brown, hollow, unbranched or with whorled branches; internodes with longitudinal ridges and grooves. Leaves scalelike, whorled; lower form a sheath around base of internode. Strobili conelike, terminal on stem or branches with several sporangia, homosporous with elators.

### EQUISETUM

*L.*, *Sp. Pl.* 2: 1061, 1753; Tagawa & K. Iwats., *Fl. Thailand* 3(1): 34. 1979.

Plant usually monomorphic or rarely dimorphic, growing in marsh, stem with nodes and internodes, with longitudinal ridges and grooves, nodes bearing roots, leaves in whorls, leaves scalelike. Cones consisting only sporangiophores, terminal on stem with 5-10 sporangia, homosporous with elators.

*Equisetum ramosissimum* Desf., Fl. Atlant. 2: 398. 1799. — *Hippochaete ramosissima* (Desf.) Börner, Fl. Deut. Volk, 282. 1912.

subsp. *debile* (Roxb. ex Vaucher) Hauke. Amer. Fern J. 52: 33. 1962. — *Equisetum debile* Roxb. ex Vaucher, Mém. Soc. Phys. Genève 1: 387. 1822; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 32. 1967; Tagawa & K. Iwats., Fl. Thailand 3(1): 34. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 21, 61. 2000; **Fig. 5.13: F.**

Stem more than 1 m. tall, about 4 mm in diameter, dark toward base, with 7-20 grooves; main stem often branch 0-4 branching; internode 3-10 cm long. Frond monomorphic; sheath 3.8 mm long, with the teeth up to 5 mm long, green or brown above portion; teeth pale green to brown, caducous, Strobili solitary terminal on stem or their branches, clavate, about 1 cm long, 4 mm in diameter; sporangiophores hard, hexagonal, 1.1-1.3 mm in diameter, 5-7 sporangia per sporangiophores.

Thailand. — NORTHERN: Chiang Mai (Doi Chiang Dao, Doi Saket, Doi Inthanon, Doi Mae Klang, Mae Rim, Bo Luang), Lampang (Muang Ngao); NORTH-EASTERN: Loei, Phetchabun (Lomsak, Nam Nao); EASTERN: Chaiyaphum; SOUTH-EASTERN: Chanthaburi (Kao Soi Dao), Trat; SOUTH-WESTERN: Kanchanaburi (Song Tho, Kha Thalai).

Distribution. — India (type) to S China, Indochina and Taiwan, through Malesia to Polynesia.

Ecology. — Terrestrial on wet ground or along road in open areas or in light shade at 1,630 m alt.

Specimens examined. — *K. Puchay 165, 266* (BCU); *Th. Wongprasert 997-92, T. Smitinand 2760, C.F. van Beusekom, C. Phengkklai, R. Geesink & B. Wongwan 4071* (BKF).

## GLEICHENIACEAE

C. Presl, Reliq. Haenk. 1: 70. 1825; Tagawa & K. Iwats., Fl. Thailand 3(1): 50. 1979.

Terrestrial. Rhizomes long creeping, with scales or hairs. Laminae usually long, sometimes climbing; stipe not articulate, apex forked with apical bud and covered with hairs or scales or leaflet with stellate hairs and/or ciliate scales when young; pinnules pinnatisect; veins free, forked; lamina papery or subleathery. Sori on both sides of lobe costules, without indusiate, sporangia few.

### Key to the genera

- 1a. Vein simple or once forked; scale present, hair stellate.....**2. Diplopterygium**  
 1b. Vein forked more than once; scale lacking, hair branching.....**1. Dicranopteris**

### 1. DICRANOPTERIS

Bernh., Neues J. Bot. 1(2): 38. 1805; Tagawa & K. Iwats., Fl. Thailand 3(1): 53. 1979.

Rhizomes creeping; frond pinnate, or pseudodichotomous; vein fork at least twice; hairs on young parts of plant multicellular, variously branched, scale lacking, sporangia 8-15 or more in a sorus.

### Key to the species

- 1a. Costule more than 1 cm apart.....**2. D. splendida**  
 1b. Costule less than 1 cm apart.....**1. D. linearis**

- 1. *Dicranopteris linearis*** (Burm.f.) Underw., Bull. Torrey Bot. Club 34: 249. 1907; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 36. 1967; Tagawa & K. Iwats., Fl. Thailand 3(1): 55. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 32, 33, 78. 2000. — *Polypodium lineare* Burm. f., Fl. Indica: 235, t. 67, f. 2. 1768.



### Key to the varieties

- 1a. Two branches at each forked equal, .....1. *D. linearis* var. *linearis*  
 1b. Two branches at each forked in many case unequal  
     2a. Accessory branches not always present at ultimate fork.....  
     .....1. *D. linearis* var. *linearis*  
     2b. Accessory branches always present at ultimate fork.....  
     .....1. *D. linearis* var. *tetraphylla*

#### var. *linearis* Fig. 5.13: G.

Rhizomes widely creeping, slender hairy. Stipes erect, about 4 mm in diam., stramineous or brown, glabrescent. Lamina primary rachis-branches twice or forked, two branches each fork nearly equal; ultimate branches 15 cm long, 4-5 cm wide, ovate to lanceolate, no accessory branches at ultimate branches; accessory branches attached at fork, 3-6 cm long, 2-3 cm wide; ultimate segment linear, entire, round at apex, up to 3 mm broad; costules less than 1 cm apart; texture hard leathery, lower surface slightly glaucous or not distinct, glabrescent, vein moderately prominent on lower surface and hairy. Sori exindusiate, single row at each side of costule; sporangia 5-8.

Thailand. — NORTHERN: Chiang Rai (Mae Ton, Doi Chang, Doi Tung Doi Phacho), Chiang Mai (Doi Chiang Dao, Doi Suthep, Doi Hua Mot), Lamphun (Doi Khun Tan), Lampang (Thoen); NORTH-EASTERN: Loei (Phu Luang, Phu Kradung); SOUTH-EASTERN: Prachinburi (Khao Yai), Chanthaburi (Makham, Khao Sabap), Trat (Ko Chang); SOUTH-WESTERN: Prachuap Khiri Khan ; PENINSULAR: Chumphon (Ban Thung Maha), Ranong (Muang Laen), Surat Thani (Ban Don), Nakhon Si Thammarat (Khao Luang, Thung Song), Phuket (Ko Mak), Trang (Khao Chong), Yala (Bannang Sata, Padang Besar).

Distribution. — Tropical and subtropical regions in the Old World (type from Ceylon), north to Central Japan.

Ecology. — In clearings usually at edge of forest in open area at 1,600 m alt.

Specimens examined. — *K. Punchay 087* (BCU), *D.J. Middleton*, *R. Namdang*, *R. Pooma*, *S. Suddee*, *S. Suwanachat* & *K. Williams 2594*, *K. Iwatsuki*, *H.*

*Koyama, N. Fukuoka & A. Nalampoon T9400, M. Tagawa, K. Iwatsuki & N. Fukuoka T635 (BKF).*

var. *tetraphylla* (Rosenst.) Nakai, Bull. Natl. Sci. Mus., Tokyo 29: 67. 1950; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 36. 1967; Tagawa & K. Iwats., Fl. Thailand 3(1): 56. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 79. 2000. — *Gleichenia linearis* (Burm.f.) C.B. Clarke var. *tetraphylla* Rosenst., Repert. Spec. Nov. Regni Veg. 13: 213. 1914. **Fig. 5.14: A-C.**

Similar to *Dicranopteris linearis* var. *linearis* but differ in accessory branches always present at ultimate branches; ultimate branches 17-26 cm long, 6-7 cm wide; costules less than 1 cm apart; accessory branches, 7-13 cm long, 3-4 cm wide; texture subcoriaceous.

Thailand. — NORTH-EASTERN: Loei (Phu Kradung).

Distribution. — South China (Guangdong, Hainan), Indochina and Sumatra (type).

Ecology. — On dry slope in slightly shaded area at 1,600 m alt.

Specimens examined. — *K. Punchay 184 (BCU); Ch. Chareonphol, Kai Larsen, & E. Warncke 4716, T. Shimizu, N. Fukuoka & A. Nalampoon T8144, K. Punchay 208 (BKF).*

2. *Dicranopteris splendida* (Hand.-Mazz.) Tagawa, Acta Phytotax. Geobot. 8: 164. 1939; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 35. 1967; Tagawa & K. Iwats., Fl. Thailand 3(1): 54. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 80. 2000. — *Gleichenia splendida* Hand.-Mazz., Akad. Wiss. Abh. Math.-Naturwiss. Kl. 61: 81. 1924. **Fig. 5.14: D.**

Rhizomes dichotomously branched, near the apex protected by peltate scales, long creeping, about 4 mm in diameter, densely hairy with shining brown stiff hairs. Fronds of mature plants usually with indefinite growth in length, bearing primary branches in pairs. Stipes about 50 cm long, stramineous or brown, glabrescent. Pinnæ twice forked; ultimate lobes bearing no accessory branches, narrowly oblong, about

50 cm long, 14-18 cm wide; ultimate segments linear, round to moderately acute at apex, entire and usually flat at margin, to 10 cm long, 1 cm broad; costules 1-1.3 cm apart; veins pinnate, distinct on both surfaces, texture rigid, green, glabrous, lower surface glaucous. Sori more than one row at each side of costules.

Thailand. — NORTHERN: Chiang Mai, Lampang; PENINSULAR: Krabi (Khao Panom Bencha), Nakhon Si Thammarat (Khao Luang),

Distribution. — Khasia, Upper Burma, S and SW China, and Indochina. Khao Luang is the southern limit of the distribution of this species ; not recorded from Malesia.

Ecology. — On moist slopes in half-shaded places at 1,600 m alt.

Specimens examined. — *K. Punchay 183, J.F. Maxwell 02-330, 87-1620, Y. Ponpim 3, E. Hennipman 3984* (BKF).

## 2. DIPLOPTERYGIUM

(Diels) Nakai, Bull. Natl. Sci. Mus. 29: 47-49, 1950. — *Gleichenia* sect. *Diplopterygium* Diels, Nat. Pflanzenfam. 1(4): 353, f. 188A. 1900. — *Gleichenia* subgen. *Diplopterygium* (Diels) Holttum, Reinwardtia 4: 261. 1957.

Terrestrial. Rhizomes long creeping, slender, much branched, covered with scales; scales brown, lanceolate, margin entire or ciliate. Fronds erect, capable of indefinite growth, climbing and repeated forking, primary branch in pairs, the apex of the main rachis forming a dormant bud, while each pair of primary branches develop, primary branches often branching 4-5 times, with a dormant apex between each branch, primary apices covered with fringed scales, or protected by a pair of stipule-like leaflets; stipe and rachis with lanceolate scales and stellate hairs; apical bud with dense brown scales and stellate hairs, ultimate segments pinnate-pinnatifid; veins forked, 1-2 times. Sori exindusiate, at base of lobes near the margin, sporangia large with completely annulus.

*Diplopterygium norrisii* (Mett.) Nakai, Bull. Natl. Sci. Mus. 29: 54. 1950. — *Gleichenia norrisii* Mett., Linnaea 36: 165. 1869; Tagawa & K. Iwats., Fl. Thailand

3(1): 51. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 33, 81. 2000. **Fig. 5.14: E-H.**

Terrestrial. Rhizomes widely creeping, bearing fronds remotely, scaly throughout; scales bright brown, lanceolate, long-acuminate at apex, toothed at margin, to 5 mm long, 0.7 mm broad. Fronds of mature plants usually with indefinite growth in length, bearing primary branches in pairs. Stipes thick, to more than 1 m long, stramineous to pale green, scaly at base with the scales like those on rhizome, sparsely scaly upwards with scales like those on the main axes; rachis scales oblong-lanceolate, up to 5 mm long, 0.5 mm broad, concolorously dark brown, hairy; pinnae a few in opposite pairs, bipinnatifid, oblong-lanceolate, acuminate at apex, 145 cm long, 30-32cm wide; leaflets 13-17 cm long, 2.5-3 cm wide, stalked 2-3 mm, about 4 cm apart, all reflexed, basal leaflets not stipuliform, or with broad blunt lobes; scales on resting buds 2-3 mm long, 0.4 mm broad, narrow, reddish brown, with short oblique concolourous setae at margin; lobes narrowly oblong, patent, round to moderately acute at apex, larger ones about 1.5 mm long, 5 mm broad, separated by sinus up to 2 mm in width; veinlets free, once or twice forked, distinct on both surfaces, dark brownish stellate hairs often present on lower surface of veins and laminae. Sori exindusiate, dorsal on acroscopic branch of veinlets, round, 2-5 sporangia.

Thailand. — NORTHEASTERN: Loei (Phu Kradung); CENTRAL: Nakhon Nayok (Khao Yai); PENINSULAR: Nakhon Si Thammarat (Khao Luang, Khao Nan).

Distribution. — Peninsular Malaysia (type), Sumatra and N Borneo.

Ecology. — On moist slopes in lower montane rainforest at 1,600 m alt.

Specimens examined. — *K. Puchay 064* (BCU), *E. Hennipman 3996*, *K. Larsen & S.S. Larsen 33480*, *G. Murata*, *N. Fukuoka & C. Phengkklai T16262*, *K. Puchay 190* (BKF); *E. Hennipman 3692*, *J. & M. S. Clemens 29430*, *K. Larsen & S. S. Larsen 33480* (P)

## HYMENOPHYLLACEAE

Mart., Consp. Regn. Veg. 3. 1835; Tagawa & K. Iwats., Fl. Thailand 3(1): 68. 1979;  
Tagawa & K. Iwats., Fl. Thailand 3(4): 610. 1989.

Epiphytic or lithophytic. Rhizomes erect, bearing a tuft of fronds; or rhizome long creeping, slender, frond distant. Laminae typically one cell thick, having no stomata, diversified in shape, curled when dry. Sori terminal on veins, solitary, at apex of ultimate segments; involucre cup-shaped to deeply cleft nearly to base; receptacles included or extruded; annulus oblique, not interrupted; spores trilete.

### Key to the genera

- 1a. Rhizome subglabrous or with sparse light-colored hairs; involucre usually bivalvate.....**2. Hymenophyllum**
- 1b. Rhizome covered with reddish to dark-colored hairs; involucre usually not bivalvate
- 2a. Stipes and rachises with minute clavate hairs, root present....**1. Crepidomanes**
- 2b Stipes and rachises without minute clavate hairs, root absent..**3. Vandenboshia**

### 1. CREPIDOMANES

C. Presl, Epim. Bot. 258. 1851; Tagawa & K. Iwats., Fl. Thailand 3(1): 87. 1979.

Rhizomes long creeping, densely brownish hair, rachis winged throughout or wingless near base. Lamina pinnately decompose or flabellate, entire, false veinlets present or lacking. Sori axillary or apical on short acroscopic segments; involucre obconic to campanulate or funnel-shaped, rounded to acuminate at apex, with bilabiate mouth; lips circular or triangular; receptacles extrude.

### Key to the species

- 1a. False veinlets present
- 2a. Submarginal false veinlet distinct, continuous or interrupted, oblique striae absent or few.....**1. C. bipunctatum**
- 2b. Submarginal false veinlet absent, oblique striae many or few.....**2. C. latelatum**

1b. False veinlets wanting.....**3. *C. minutum***

- 1. *Crepidomanes bipunctatum*** (Poir.) Copel., Philipp. J. Sci. 67: 59. 1938; 1965; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 41. 1967; Tagawa & K. Iwats., Fl. Thailand 3(1): 90. 1979; Tagawa & K. Iwats., Fl. Thailand 3: 613. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 68. 2000. — *Trichomanes bipunctatum* Poir. in Lam., Encycl. (Lamarck) 8: 69. 1808. **Fig. 5.15: A-B.**

Rhizomes creeping (0.3)-0.6-(10) mm diam., cover with dark brown hairs. Stipe (0.2)-0.8-(15) mm long, winged, wing almost to the base and bearing short brown hairs. Lamina ovate to oblong or sometimes lanceolate, apex acute or round, tripinnatifid, usually (3.7)-5.0-(6.8) cm long, 1.9-4.0 cm wide; pinnae ovate, lanceolate or oblong, 5-9 pairs, alternate, the larger one 1-2.2 cm long, 0.4-1.4 cm wide, short stalk or sessile in upper parts; pinnules 3-4 pairs, entire and flat at margin sometimes slightly crisped; false veinlets marginal and internal, continuous or interrupted, the other striae few to many.; involucre tubular, 1.2-2.2 mm long, 0.4-1.4 mm wide, winged, the mouth bilabiate, the lips round to acute, receptacles exerted. Lamina dark green when dry.

Thailand. — NORTH-EASTERN: Loei (Phu Kradung); EASTERN: Nakhon Ratchasima (Pak Thong Chai, Kathok, Ban Thakum); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi (Taruang, Khao Sabap, Makham, Phriu waterfall), Trat (Ko Chang, Ko Tao, Dan Chumphon); SOUTH-WESTERN: Kanchanaburi (Khlung Wa); Phetchaburi, Prachuap Khiri Khan; PENINSULAR: Chumphon (Tha Ngo, Tha San, Lang Suan), Ranong (La-un, Khao Phota Chongdong), Surat Thani (Khlung Nam Wing, Ban Kop Kaep, Ko Tao, Ban Don), Krabi (Khao Phanom Bencha), Nakhon Si Thammarat (Khao Luang, Ao Luk), Phuket (Ko Talibong, Thalang), Phatthalung (Khlung Hin Khao), Trang (Khao Chong), Satun (Khuan, Kalong, Nam Tok Boripat, Thung Nui), Yala (Khao Kalakhiri, Bannang Sta, Muang Wing), Narathiwat (Sungai Padi).

Distribution. — Old World tropics (type! from Madagascar).

Ecology. — On mossy tree trunks in low montane rain forest at 1,600-1,700 m alt.

Specimens examined. — *K. Punchay 021, 030* (BCU); *E. COSSON 18, J. Florence 4580, J.L. de Soover P175* (P); *K. Punchay 033, 034* (BKF),

2. *Crepidomanes latealatum* (Bosch) Copel., Philipp. J. Sci. 67: 60. 1938; Tagawa & K. Iwats., SouthE. Asian Stud. 5:42. 1967; Tagawa & K. Iwats., Fl. Thailand 3(1): 89. 1979; Tagawa & K. Iwats., Fl. Thailand 3: 613. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 70. 2000. — *Trichomanes latealatum* (Bosch) Christ, Verh. Naturf. Ges. Basel 11: 424. 1896. — *Didymoglossum latealatum* Bosch, Ned. Kruidk. Arch. 5(3): 138. 1863; **Fig. 5.15: C-D.**

Rhizomes creeping 0.3-0.5 mm diam., densely covered with dark brown short hairs. Stipe 0.2-0.4-(0.8) mm long, hardly winged, wing usually ciliate, remote 1.5-2.5 cm apart, dark brown or green-brown, Rachis and costae winged, slightly zigzag, glabrous. Lamina bipinnate to tripinnatifid, ovate to oblong or triangular, base cuneate to subcordate, apex acuminate to obtuse, 3-5.7 cm long, 1.3-3.0 cm wide; pinnae 5-10 pairs, alternate, 0.7-1.6 cm long, 0.4-1.0 cm wide, short stalk or sessile in upper parts, margin entire sometimes crisped. Veins dichotomous; false veinlets marginal, continuous or interrupted. Sori on upper parts of frond, apical on short acroscopic segments; involucre tubular, elliptic, 1.4-1.6 mm long, 0.9-1.2 mm wide, acute or obtuse at apex, dilated at mouth, receptacles exerted, brown, 2-3 mm

Thailand. — NORTHERN: Mae Hong Son (Doi Khun Huay Pong), Chiang Mai (Doi Chiang Dao, Doi Suthep, Doi Inthanon), Chiang Rai (Doi Tung, Doi Phacho), Tak (Ban Musoe), Phitsanulok (Thung Saleang Luang); NORTHEASTERN: Loei (Phu Luang); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); SOUTH-WESTERN: Kanchanaburi (Song Tho), Prachuap Khiri Khan (Khao Luang); PENINSULAR: Nakhon Si Thammarat (Khao Luang), Trang (Khao Chong).

Distribution. — N India (type), S China and in SE Asia.

Ecology. — On mossy tree trunks in lower montane rainforest at 1,600 m alt.

Specimens examined. — *K. Punchay* 137 (BCU); *J.F. Maxwell* 87-1151, 95-1147, 96-1264, *Winit* 1182, *T. Shimizu & M. Hutoh* T10196, *K. Punchay* 141 (BKF).

3. *Crepidomanes minutum* (Blume) K. Iwats., J. Fac. Sci. Univ. Tokyo, Sect. 3, Bot. 13: 524. 1985; Tagawa & K. Iwats., Fl. Thailand 3(4): 613. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 71. 2000. — *Trichomanes minutum* Blume, Enum. Pl. Javae 2: 223. 1828. — *Gonocormus minutus* (Blume) Bosch, Hymenophyll. Javan.: 7, t. 3. 1861; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 40. 1967.

Rhizomes creeping, dark brown or black, creeping, 0.2-0.3 mm in diam., densely covered with brown or dark brown short hairs. Stipes dark brown to dark green, 2-6 mm, densely hairy at base, subglabrous upward. Lamina flabellate or ovate, 6-7 mm long, 7 mm wide, base cuneate; irregularly branching dichotomously or with short main axis, margin entire, apex obtuse. Veins dichotomous; false veinlets absent. Sori terminal on lobes; involucre tubular, 1.1-1.6 mm long, 0.8-1.2 mm wide, winged, dilated or truncate at mouth.

Thailand. — NORTH-EASTERN: Loei (Phu Luang, Phu Kradung); EASTERN: Nakhon Ratchasima (Khao Lotung); SOUTH-EASTERN: Prachiburi (Khao Yai), Trat (Ko Kut); SOUTH-WESTERN: Prachuap Khiri Khan (Khao Luang); PENINSULAR: Ranong (Khao Phota Chongdong), Surat Thani (Ko Tao), Krabi (Ko Pu) Nakhon Si Thammarat (Khao Luang), Phuket (Khao Phra), Trang (Khao Chong, Khao Sung), Satun (Khuan, Kalong, Nam Tok Boripat, Thung Nui), Yala (Khao Kalakhiri, Betong), Narathiwat (Bacho Falls).

Distribution. — Old World tropics, east to Polynesia and north to Japan.

Ecology. — On mossy tree trunks in low montane rain forest at 1,700 m alt.

Specimens examined. — *K. Punchay* 163 (BCU); *M. Tagawa, K. Iwatsuki & N. Fukuoka* T1310, T1833, T2015, T6813 (BKF); *G. Rouhan* 594, *K. R. Wood* 10752 (P).



## 2. HYMENOPHYLLUM

Sm., Mém. Acad. Roy. Sci. (Turin) 5: 418. 1793; Tagawa & K. Iwats., Fl. Thailand 3(1): 74. 1979.

Rhizomes slender, wiry. Frond pinnately compound margin of segment entire or tooth, false veinlet wanting; involucre bilabiate, deeply cleft nearly halfway to base, receptacle extrudes or included.

### Key to the species

- 1a. Margin of lobed entired
  - 2a. All axes glabrous
    - 3a. Involucre shape triangular or sub deltoid, longer than wide. **4. *H. polyanthos***
    - 3b. Involucre shape wider than long..... **1. *H. badium***
  - 2b. Stipe, rachis, and pinna-rachis persistent hairy..... **3. *H. exertum***
- 1b Margin of lobed toothed..... **2. *H. barbatum***

- 1. *Hymenophyllum badium*** Hook. & Grev., Icon. Filic.: t. 76. 1828; Tagawa & K. Iwats., Fl. Thailand 3(4): 611. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 72. 2000. — *Mecodium badium* (Hook. & Grev.) Copel., Philipp. J. Sci. 67: 23. 1938; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 38. 1967; Tagawa & K. Iwats., Fl. Thailand 3: 72. 1979. **Fig. 5.15: E-F.**

Rhizomes creeping, brown, 0.4-0.5 mm in diam., with sparse rootlets. Stipe remote 1.2-4.7 apart, brown or green-brown, 2.6-6 cm long, 0.5-0.6 cm in diam., winged nearly to base, entire, wings flat to crisped. Rachis and costae brown, winged, glabrous. Lamina tripinnate to quadripinnatifid usually lanceolate, ovate-lanceolate or ovate, 5.9-10.7 cm long, 3.7-6.0 cm wide, glabrous; pinnae 7-13 pairs, alternate, ovate, lanceolate or oblong, 1.7-2.8 cm long, 1.2-1.5 cm wide, apex acute; pinnule 4-6 pairs, sessile, 5.9-9.6 mm long, 4.3-7.1 mm wide; ultimate segments simple or forked, oblong to linear, round to obtuse at apex, margin entire. Vein dichotomous, false veinlet absent. Sori mostly apical on upper part; involucre bilabiate, orbicular-

reniform, divided to the very base, wider than long, lips round, entire; receptacle included.

Thailand. — NORTHERN: Chiang Mai (Doi Chiang Dao, Doi Suthep, Doi Inthanon, Doi Phahom Pok), Phitsanulok (Phu Miang); NORTHEASTERN: Loei (Phu Luang, Phu Kradung); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao, Pong Namron); PENINSULAR: Nakhon Si Thammarat (Khao Luang, Thap Chang, Khiriwong), Krabi (Khao Phanom Bencha), Pattalung (Khao Luang).

Distribution. — N India (type from Nepal) and S China, southwards throughout Malesia, north to S Japan.

Ecology. — On mossy tree trunks in lower montane rainforest at 1,600 m alt.

Specimens examined. — *K. Punchay 099* (BCU); *K. Iwatsuki & N. Fukuoka T7202*, *G. Murata, K. Iwatsuki, C. Phengkklai & C. Charamphol T16072*, *K. Larsen & S. S. Larsen 34383*, *E. Hennipman 3448*, *M. Tagawa, K. Iwatsuki & N. Fukuoka T2672*, *T3020*, *K. Punchay 133* (BKF); *T. Shimizu, K. Iwatsuki, N. Fukuoka, M. Hutoh, D. Chaiglom & A. Nalampoon T11445* (P)

2. *Hymenophyllum barbatum* (Bosch) Baker, Syn. Fil.: 68. 1867; Copel., Philipp. J. Sci. 64: 84. 1937; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 37. 1967; Tagawa & K. Iwats., Fl. Thailand 3(1): 74. 1979; Tagawa & K. Iwats., Fl. Thailand 3(4): 611. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 72. 2000. — *Leptocionium barbatum* Bosch, Ned. Kruidk. Arch. 5(2): 146.1863. **Fig. 5.15: G-H.**

Rhizomes creeping about 0.2-0.3 mm diam., covered with brown hairs. Stipe remote 2.4-6.8 apart, 0.7-1.8 cm long, 0.2-0.3 mm in diam., narrowly winged in the upper part, densely hairy, Laminae bipinnatifid to tripinnatifid, lanceolate to oblong, acute at apex, broadly cuneate at base, 2.5-3.7 cm long, 1.4-2.4 cm wide; rachis winged, hairy lower side; pinnae 5-6 pairs, ovate or lanceolate, apex acute, unequal cuneate at base, 8-12 mm long, 3-8 mm wide, distinctly toothed and flat or crisped at margin like the wings of the rachis every axis rather distinct, hairy on the underside.

Sori usually in the upper part; involucre bilabiate almost to the base, lips round to acute, serrate at margin; receptacles included.

Thailand. — NORTHERN: Chiang Mai (Doi Hua Mot, Doi Suthep, Doi Inthanon, Doi Phahom Pok), Tak (Ban Musoe), Phitsanulok (Phu Miang); NORTHEASTERN: Loei (Phu Luang,); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao), Prachinburi (Khao Yai); SOUTH-WESTERN: Prachuap Khiri Khan (Khao Luang).

Distribution. — N India to Japan (type) south to Taiwan and Vietnam.

Ecology. — On mossy tree trunks and mixed with other species in lower montane rainforest at 1,700 m alt.

Specimens examined. — *K. Punchay 068, J.F. Maxwell 97-1387, M. Tagawa, K. Iwatsuki & N. Fukuoka T1502, T2670, T2673, K. Iwatsuki, N. Fukuoka & A. Chinatayungkun T9636, T. Shimizu, K. Iwatsuki, N. Fukuoka, M. Hutoh & D. Chaiglom T11595 (BKF); E.H. Wilson 5264, G. Murata, K. Iwatsuki, C. Phengkklai & C. Charamphol T15753, M. Tagawa 2721(P).*

- 3. *Hymenophyllum exsertum*** Wall. ex Hook., Sp. Fil. 1: 109, t. 38A. 1844; Tagawa & K. Iwats., Fl. Thailand 3(4): 611. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 73. 2000. — *Mecodium exsertum* (Wall. ex Hook.) Copel., Philipp. J. Sci. 67: 23. 1938; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 38. 1967; Tagawa & K. Iwats., Fl. Thailand 3(1): 73, f. 5.13. 1979. **Fig. 5.16: A.**

Rhizomes wiry, brown hairy throughout, about 0.2 mm diam. Stipe remote, hairy on the lower surface, wingless, 2.5-3.8 cm long, 0.2 mm diam., Laminae oblong or oblong lanceolate, round to acute at apex, bipinnatifid to tripinnatifid, broadest near middle, 6-13 cm long, 2.7-2.9 cm wide; rachis winged, wing flat, hairy on abaxial side; pinnae 11-14 pairs, 1.3-1.6 cm long, 0.8-1 cm wide, oblong to lanceolate, round to acute at apex, unequal cuneate at base; pinnules with a few to several segments. Sori usually on upper side of pinnae; involucre bilabiate; lips subtriangular, moderately acute, entire and flat, to 1.7-2.0 mm long, 1.3-1.4 mm broad; receptacles clavate, include.

Thailand. — NORTHERN: Chiang Rai (Doi Tung, Doi Phacho), Chiang Mai (Doi Chang, Doi Suthep, Doi Inthanon, Doi Phahom Pok), Mae Hong Son (Doi Khun Huai Pong), Lamphun (Doi Khun Tan), Phitsanulok (Phu Miang); NORTHEASTERN: Loei (Phu Luang, Phu Kradung); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); SOUTH-WESTERN: Kanchanaburi (Khao Ri Yai); PENINSULAR: Nakhon Si Thammarat (Khao Luang, Thap Chang, Khiriwong), Krabi (Khao Phanom Bencha), Ranong (Khao Phota Chongdong), Trang (Khao Sung, Khao Chong).

Distribution. — N India (type from Nepal), S China., Upper Burma, Indochina, south to Peninsular Malaysia.

Ecology. — On mossy tree trunks in lower montane rainforest at 1,600 m alt.

Specimens examined. — *K. Punchay* 275, *E. Hennipman* 3941B, *M. Tagawa*, *K. Iwatsuki* & *N. Fukuoka* T2883, T4841, *T. Shimizu*, *K. Iwatsuki*, *N. Fukuoka*, *M. Hutoh*, *A. Nalampoon* & *A. Chintayungkun* T9312, *K. Iwatsuki*, *H. Koyama*, *N. Fukuoka* & *A. Nalampoon* T9393 (BKF).

4. *Hymenophyllum polyanthos* (Sw.) Sw., Schrad. J. Bot. 1800(2): 102. 1801; Tagawa & K. Iwats., Fl. Thailand 3(4): 611. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 30, 74. 2000. — *Mecodium polyanthos* (Sw.) Copel., Philipp. J. Sci. 67: 19. 1938; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 37. 1967; Tagawa & K. Iwats., Fl. Thailand 3(1): 70. 1979. — *Trichomanes polyanthos* Sw., Prod. Fl. Ind. Occ.: 137. 1788. **Fig. 5.16: B-C.**

Rhizomes creeping, ca 0.2 mm in diam., with hairy rootlets. Stipe 1.0-4.6 cm long, 0.2-0.3 mm in diam., winged except the lower part. Laminae lanceolate, oblong-lanceolate or oblong, acute to acuminate at apex, base broadly cuneate or acute, usually tripinnate, 4.0-7.2 cm long, 1.9-4.1 cm wide; rachis slightly zigzag, winged, wings narrow, entire and flat; pinnae 7-11 pairs, the largest one near the middle of frond, reducing in size both upward and downward the larger one ovate to lanceolate or oblong-lanceolate; pinnules ultimate segments linear or narrowly lanceolate, round to obtuse at apex, the margin entire and flat. Sori usually on the upper parts of fronds;

involucre bilabiate, ovate, 1.0-19 mm long, 0.5-1.4 wide, usually longer than wide, deeply divided; lips round or moderately acute, entire; receptacle included.

Thailand. — NORTHERN: Chiang Mai (Doi Chang, Doi Suthep, Doi Inthanon, Doi Phahom Pok); NORTHEASTERN: Loei (Phu Luang, Phu Kradung, Phu Tong); CENTRAL: Nakhon Nayok (Khao Khieo); SOUTH-EASTERN: Chanthaburi (Khao Sabap); SOUTH-WESTERN: Kanchanaburi (Khao Ri Yai); PENINSULAR: Chumphon (Langsuan, Pang Wa), Nakhon Si Thammarat (Khao Luang), Surat Thani (Khao Nong, Ban Don).

Distribution. — Tropics or subtropics throughout the world (type from Jamaica), north to central Japan.

Ecology. — On mossy tree trunks in lower montane rainforest at 1,700 m alt.

Specimens examined. — *K. Punchay* 069, 108 (BCU); *E. Hennipman* 3386, 3667, 3938, *J. F. Maxwell* 93-1393, *M. Tagawa*, *K. Iwatsuki* & *N. Fukuoka* T2653, *K. Punchay* 135 (BKF); *Kakotondrainibe* *F.* 6119 (P).

### 3. VANDENBOSCHIA

Copel., Philipp. J. Sci. 67(1): 51. 1938. J.L. Tsai & W.C. Shieh, Fl. Taiwan, ed. 2. 127. 1994.

Rhizomes long creeping bearing distant fronds. Lamina pinnately compound, entire, not thickened at margin; stipe winged or not winged. Sori terminal on veinlets; involucre, entire at mouth; receptacles long extruded, filiform.

*Vandenboschia birmanica* (Bedd.) Ching, Acta Phytotax. Sin. 8: 135. 1959; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 44. 1967. — *Trichomanes birmanicum* Bedd., Suppl. Ferns S. Ind.: 3, pl. 349. 1876; Tagawa & K. Iwats., Fl. Thailand 3(1): 84. 1979. — *Crepidomanes birmanicum* (Bedd.) K. Iwats., J. Fac. Sci. Univ. Tokyo, Sect. 3, Bot. 13: 530. 1985; Tagawa & K. Iwats., Fl. Thailand 3(4): 613. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 69. 2000. **Fig. 5.16: D-E.**

Rhizomes long creeping, 0.6-0.8 mm diam., densely covered with dark brownish hairs. Stipes winged almost to the base, hairy when young, 2.3-4.5 cm long, 0.3-0.4 mm in diam. Laminae broadly lanceolate, acute at apex, round to cordate at base, 6.1-7.9 cm long, 2.9-4.4 cm wide, tripinnate to quadripinnatifid; rachis winged throughout, entire and flat; pinnae 8-10 pairs, alternate, ovate or lanceolate, moderately acute at apex, broadly cuneate to subtruncate at base, stalks shortly winged, in larger ones 1.7-2.9 cm long, 0.9-1.3 cm wide; pinnules 3-5 pairs, alternate, sessile, ovate, 7-10 mm long, 3-6 mm wide apex obtuse sometimes moderately acute; ultimate segments narrow acute at apex; dark green in color. Sori usually on basal acroscopic portions of pinnules or on secondary pinnules; involucre tubular, 1.1-1.5 mm long, 0.6-0.8 mm wide, slightly dilated mouth and stalked, about 1.5 mm long up to 2.8 mm long.

Thailand. — NORTHERN: Chiang Rai (Doi Phacho), Chiang Mai (Doi Suthep, Doi Inthanon), Mae Hong Son (Mae La Noi), Lampang (Mae Tia), Phrae; NORTHEASTERN: Loei (Phu Luang); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); SOUTH-WESTERN: Kanchanaburi (Khao Ri Yai).

Distribution. — Myanmar (type from Moulmein), S China, N Indochina and Japan.

Ecology. — On mossy rock near streamlet in lower montane rainforest at 1,600 m alt.

Specimens examined. — *K. Punchay* 276, *E. Hennipman* 3425, 3437, *C.F. van Beusekom* & *C. Phengkklai* 403, *K. Iwatsuki* T4460, *T. Smitinand* 3219, 5026, *Winit* 1208 (BKF).

### LINDSAEACEAE

*C. Presl* ex *M.R. Schomb.*, *Reis. Br.-Guiana* 3: 883, 1048. 1848; *Tagawa* & *K. Iwats.*, *Fl. Thailand* 3(2): 129. 1985.

Terrestrial, climbing or epiphytic. Rhizomes creeping, covered with scales and hairs; Lamina pinnate to decompose, herbaceous to papyraceous, veins free or anastomosing without included veinlets. Sori marginal or submarginal, terminal on a

single, linear or oblong, always indusiate; indusia basally adnate, laterally free or adnate, opening toward margin; spore monolete.

### SPHENOMERIS

Maxon, J. Wash. Acad. Sci. 3(5): 144. 1913; W.C. Shieh, Fl. Taiwan. ed. 2. 180. 1994.

Terrestrial. Rhizomes creeping, with shining dark brown scale. Lamina bipinnate to quadripinnate, the ultimate pinnules or segment usually cuneate, glabrous; vein free sori sub marginal, terminal on vein; indusial attached at base, opening toward margin.

*Sphenomeris chinensis* (L.) Maxon, J. Wash. Acad. Sci. 3: 144. 1913; Tagawa & K. Iwats., Fl. Thailand 3(2): 147. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 44, 96. 2000. — *Trichomanes chinense* L. Sp. Pl. 2: 1099. 1753. **Fig. 5.16: F-H.**

#### var. *chinensis*

Rhizomes short creeping, bearing fronds close together, densely scaly; scales dark brown, up to 2 mm long, 2-3 cells broad at base, stiff and transparent. Stipes stramineous, brownish in lower part, scaly at base, grooved on abaxial surface of upper part, about 15 cm long. Laminae oblong to narrower, 13-24 cm by 5-11 cm, acuminate at apex, finely divided to quadripinnate; pinnae alternate, the large one up to 6 cm long, 2-4 cm wide, subtriangular, attenuately acuminate at apex, cuneate and stalked at base, gradually become smaller upwards, tertiary segments cuneate, lobed, subcoriaceous or thinner; veins usually one or two in each ultimate lobe, hardly visible. Sori terminal on a veinlet or uniting the apices of 1-2 veinlets, close to apex of lobes; indusia attached at base and basal part of both sides, nearly as long as laminae, toothed.

Thailand. — NORTHERN: Chiang Mai (Doi Chiang Dao, Mae Tuen, Bo Luang, Doi Inthanon), Nan; NORTH-EASTERN: Phetchabun (Phu Miang), Loei (Phu Luang Phu Kradung); SOUTH-WESTERN: Kanchanaburi SOUTH-EASTERN:

Trat (Ko Chang); PENINSULAR: Surat Thani (Ban Don), Nakhon Si Thammarat (Khao Luang, Khiriwong), Trang.

Distribution. — Warmer part of the Old World, Madagascar to Polynesia, north to Japan and Korea (type from China).

Ecology. — On dry slope in light exposed area at 1,600 m alt.

Specimens examined. — *K. Punchay 074* (BCU); *E. Hennipman 3369*, *J.F. Maxwell 93-131*, *R. Geesink*, *P. Hiepko & C. Phengkklai 8266*, *T. Shimizu*, *H. Toyokuni*, *H. Koyama*, *T. Yahara & C. Niyondham 22844*, *K. Punchay 178* (BKF).

### LOMARIOPSIDACEAE

Alston, *Taxon* 5: 25. 1956; Tagawa & K. Iwats., *Fl. Thailand* 3(3): 303. 1988

Terrestrial or epiphytic. Rhizomes erect or ascending or scandent, scaly at apex. Fronds monomorphic or dimorphic, imparipinnate; stipes densely scaly at base; lateral pinnae articulate to rachis; margin entire or serrate; veins free or anastomosing. Sori dorsal on veinlets or sporangia acrostichoid, with or without indusium.

### NEPHROLEPIS

Schott, *Gen. Fil.*, pl. 3. 1834; Tagawa & K. Iwats., *Fl. Thailand* 3(2): 170. 1985.

Rhizomes erect or suberect, usually short, bearing scale, wiry root with stolons; scale peltate, appressed, bicolor, pale at edge, Lamina pinnate, lanceolate or narrower in outline, pinnae sessile, articulated to rachis, unequal at base, vein all free, Sori arranged in one row or continuous, indusia round-reniform, or continuous.

*Nephrolepis cordifolia* (L.) C. Presl, *Tent. Pterid.*: 79. 1836; Tagawa & K. Iwats., *SouthE. Asian Stud.* 5: 77. 1967; Tagawa & K. Iwats., *Fl. Thailand* 3(2): 172. 1985; Boonkerd & Pollawatn, *Pterid. Thailand*: 173, 237. 2000. — *Polypodium cordifolium* L., *Sp. Pl.* 2: 1089. 1753. **Fig. 5.17: A-B.**

Rhizomes short, ascending to suberect, bearing a tuft of fronds, numerous wiry roots and stolons, densely scaly; scales acuminate at basal edge and long-tailed at



apical edge, narrowly lanceolate, up to 7 by 0.8 mm broad, thin, pale brown. Stipes terete, about 14 cm long, scaly with narrow scales, stramineous or darker. Laminae linear-lanceolate moderately acute at apex, gradually narrowing to auricle towards base, 100 cm long, 8.5 cm wide, pinnate; rachis grooved on upper surface, scaly above; lateral pinnae up to 100 pairs; middle ones larger, patent, acute, to moderately acute at apex, truncate at base, auricled at anterior base, sessile, 4-4.5 cm by 1 cm, slightly serrate at margin, papyraceous; veins visible on lower surface, forked near costa. Sori at middle to submarginal position between costa and margin of pinna, in one row; indusia broad, thin but stiff, large, brown, glabrous, 1.2-1.4 mm broad.

Thailand. — NORTHERN: Chiang Mai (Doi Chaing Dao, Doi Suthep), Phitsanulok (Thung Saleang Luang, Phu Miang); NORTH-EASTERN: Loei (Phu Luang Phu Kradung); SOUTH-EASTERN: Chantaburi (Khao Soi Dao).

Distribution. — Pantropical (type from America), north to Japan and south to New Zealand.

Ecology. — Epiphytic on tree fern trunk in lower montane rainforest at 1,600 m alt.

Specimens examined. — *K. PUNCHAY 193* (BCU); *E. HENNIPMAN 3545*, *J.F. MAXWELL 93-1220*, *T. SHIMIZU*, *H. TOYOKUNI*, *H. KOYAMA*, *T. YAHARA* & *C. NIYONDHAM 23172*. *M. TAGAWA*, *K. IWATSUKI* & *N. FUKUOKA T633* (BKF).

### OLEANDRACEAE

Ching ex Pic. Serm., *Webbia* 20(2): 745. 1965; Tagawa & K. Iwats., *Fl. Thailand* 3(2): 170. 1985.

Epiphytic. Rhizomes long, creeping, erect, or scandent; scales appressed, blackish brown. Stipes articulate, forming phyllopodia. Laminae simple, entire, lanceolate to linear-lanceolate, herbaceous, papery, or leathery, glabrous or pubescent; costa with small scales beneath; veins free. Sori in a single often irregular row on either side of costa; indusia persistent, reniform or orbicular-reniform.

## OLEANDRA

Cav., Anales Hist. Nat. 1(2): 115, 1799; Tagawa & K. Iwats., Fl. Thailand 3(2): 179. 1985.

Rhizomes long creeping, cover with appressed scale, bearing frond remote or close together. Stipe with articulation, phyllopodia distinct. Lamina simple, entire, linear-lanceolate, vein free, Sori dorsal on anterior branches of vein, close to midrib, indusial reniform.

*Oleandra musifolia* (Blume) C. Presl, Epimel. Bot.: 42. 1851; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 78. 1967; Tagawa & K. Iwats., Fl. Thailand 3(2): 181. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 175, 239. 2000. — *Aspidium musifolium* Blume, Enum. Pl. Javae: 141. 1828. **Fig. 5.17: D-F.**

Rhizomes long creeping with long stiff prop roots, about 4 mm diam., bearing a few fronds in scattered tufts, densely scaly throughout; scales appressed, lanceolate, round to moderately acute at basal edge, gradually narrowing from the broadest attached portion to tailed apex, about 7 by 1.2 mm, brown with dark attached point, paler and hairy at margin of apical portion. Fronds simple. Stipes usually short, 2-4 cm including phyllopodia 1.7-4 cm, tall, bearing both scales and hairs. Laminae linear-lanceolate, caudately acuminate at apex, gradually narrowing towards narrow and cuneate base, 36-50 cm long, 3-3.5 cm wide, the margin entire and usually plane; midrib raised below, scaly with peltate, lanceolate, pale brown scales of up to 3 mm long, herbaceous, light green; veins once or twice forked near midrib, all free, ending just inside narrow cartilaginous margin; glabrous to sparsely hairy above and beneath, glabrous to densely hairy at margin. Sori irregular row near midrib; indusia up to 2 mm in breadth, glabrous or sparsely hairy.

Thailand. — NORTHERN: Chiang Mai (Doi Chaing Dao, Doi Inthanon), Lamphun (Doi Khun Tan), Phrae (Mae Sai); NORTH-EASTERN: Phetchabun (Phu Miang), Loei (Phu Laung, Phu Kradung); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); SOUTH-WESTERN:

Kanchanaburi (Khriti); PENINSULAR: Ranong (Khao Phota Chongdon), Phangnga (Khao Phra Mi).

Distribution. — Sri Lanka, Indochina to Malesia (type from Java).

Ecology. — Lithophytic on dry or moist rocks at 1,700 m alt.

Specimens examined. — *K. Punchay 103, 211* (BCU); *E. Hennipman 3092, 3568, 3655, T. Smitinand 1915, K. Punchay 269* (BKF).

### OPHIOGLOSSACEAE

Martinov, Tekhno-Bot. Slovar. 438. 1820; Tagawa & K. Iwats., Fl. Thailand 3(1): 35. 1979.

Terrestrial, epiphytic or lithophytic. Rhizomes short erect, or creeping. Laminae simple or pinnate, not circinate, fertile segment branching from sterile frond, succulent herb; venation reticulate. Sporangia born in simple or compound spike, eusporangiate.

### OPHIOGLOSSUM

L., Sp. Pl. 2: 1062. 1753; Tagawa & K. Iwats., Fl. Thailand 3(1): 35. 1979.

Rhizomes erect, trophophyll simple or forked few time nearly apex; vein anastomosing, spike simple or two rows of sporangia which are joint together almost completely, each opening by transverse slit.

*Ophioglossum petiolatum* Hook., Exot. Fl. 1: 56, pl. 56. 1823; Tagawa & K. Iwats., Fl. Thailand 3(1): 37. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 25, 66. 2000.

#### **Fig. 5.17: C.**

Rhizomes cylindrical, short, erect, 2-4 mm in diameter, bearing many roots. Frond simple with stalk, 1 or 2 on a rhizome; stalk 9-15 cm long, 1.1-1.4 mm in diameter; sterile lamina ovate to broadly ovate, round or moderately acute at apex, round at base, 4 cm long, 2.2-2.4 cm wide; costae not differentiated; vein reticulate, areole visible, many, included free veinlets present, veinlet simple or branched;

texture herbaceous, fleshy or thicker, green, glabrous; sporophyll simple with sporophore arising from base of sterile lamina; sporophore 6-12 cm long, 0.8-0.9 mm in diameter; spike 3-4 cm long, 2.2-2.5 mm in diameter; sporangia up to 1 mm in diameter.

Thailand. — NORTHERN: Chiang Rai (Doi Tung), Chiang Mai (Doi Chaing Dao, Doi Suthep, Doi Phahom Pok), Mae Hong Son, Lampang (Ngao), Kamphangphet; NORTH-EASTERN: Loei (Phu Kradung); CENTRAL: Krung Tep ; SOUTH-EASTERN: Chanthaburi (Khao Soi Dao, Pong Namron); SOUTH-WESTERN: Kanchanaburi (Hindat); PENINSULAR: Surat Thani (Ban Don).

Distribution. — Pantropical (type cult. at Liverpool, originated from W. India)

Ecology. — Terrestrial on moist area mixed with grasses at 1,600 m alt.

Specimens examined. — *K. Punchay 164, J.F. Maxwell 86-316, 86-1005, T. Smitinand 6123, T. Smitinand & Seidenfaden 4641, Winit 1107* (BKF).

### PLAGIOGYRIACEAE

Bower, *Ann. Bot. (Oxford)* 40: 484. 1926; Tagawa & K. Iwats., *Fl. Thailand* 3(1): 47. 1979. W.C. Shieh, C.E. Devol & C.Y. Lu. *Fl. Taiwan*. ed. 2: 134. 1994.

Terrestrial. Rhizomes usually short erect, or ascending, cover with old leaves base. Stipe swollen at base, usually triangular or tetragonal at base, aerophore present at base. Laminae pinnatifid to pinnate, dimorphic, tufted, fertile usually longer than sterile laminae, aerophore present or absent at base of pinnae ; vein free, simple or fork. Sori protected by reflexed margin, covering whole under surface, paraphyses present, annulus oblique, spore tetrahedral.

### PLAGIOGYRIA

(Kunze) Mett., *Abh. Senckenberg. Naturf. Ges.* 2: 1, 268. 1858; Tagawa & K. Iwats., *Fl. Thailand* 3(1): 47. 1979; W.C. Shieh, C.E. Devol & C.Y. Lu. *Fl. Taiwan*. ed. 2: 134. 1994.

Morphological characters are the same as those of the family.

### Key to the species

- 1a. Lower pinnae adnate, forming wing of rachis; aerophore absent at base of each pinnae.....**1. *P. adnata***  
 1b. Lower pinnae petiolate, not forming wing of rachis; aerophore present as cushion-like at base of each pinnae.....**2. *P. euphlebica***

- 1. *Plagiogyria adnata*** (Blume) Bedd., Ferns Brit. India: t. 51. 1865; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 44. 1967; Tagawa & K. Iwats., Fl. Thailand 3(1): 47. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 37, 85. 2000. — *Lomaria adnata* Blume, Enum. Pl. Javae.: 205. 1828.**Fig. 5.18: A-C.**

Rhizomes short, erect or ascending, naked, bearing a tuft of fronds. Fronds simply pinnate, dimorphic. Sterile fronds: stipes about 20 cm long, stramineous or darker, flat on abaxial surface of upper part, wide and flat at base. Laminae oblong-lanceolate, about 30 cm long, 15 cm wide; rachis like the upper part of stipes; lateral pinnae 20-25 in pairs, ascending in upper ones, patent at middle and deflexed at basal ones, lanceolate, caudately acuminate at apex, form wings of rachis at base, entire to serrate at apical portion, up to 8 cm long, 1.3 cm wide; texture herbaceous, green, veins free, forked, reaching to the margin, distinct on both surfaces. Fertile fronds longer; stipes about 35cm long, quadrangular in section; pinnae about 15 in pairs, 1-1.5 cm apart, shortly stalked, linear, to 5 cm long, 3 mm broad; sporangia along veins, covering the whole under surface of fertile pinnae except for the midribs and thin edges, protected when young by the reflexed margin.

Thailand. — NORTH-EASTERN: Loei (Phu Luang, Phu Kradung); CENTRAL: Krung Tep ; SOUTH-EASTERN: Chanthaburi (Khao Soi Dao, Pong Namron).

Distribution. — Burma, S China, Vietnam, Malaysia, Sumatra to the Philippines, Java (type), extending north to southern edge of Japan through Taiwan and the Ryukyus.

Ecology. — Terrestrial on moist area near fresh water swamp at 1,600 m alt.

Specimens examined. — *K. Punchay* 203 (BCU); *E. Hennipman* 3583, *K. Iwatsuki & N. Fukuoka* T7208, *M. Tagawa, K. Iwatsuki & N. Fukuoka* T619, T1307, *T. Shimizu, H. Toyokuni, H. Koyama, T. Yahara & D. Phanichaphol* T23756 (BKF).

2. *Plagiogyria euphlebia* (Kunze) Mett., Abh. Senckenberg. Naturf. Ges. 2: 274. 1858; W.C. Shieh, C.E. Devol & C.Y. Lu. Fl. Taiwan. ed. 2: 134. 1994. — *Lomaria euphlebia* Kunze, Bot. Zeitung (Berlin) 6: 521. 1848. — *Plagiogyria grandis* Copel. Philipp. J. Sci. 38(4): 389, pl. 1. 1929. — *Plagiogyria euphlebia* var. *grandis* (Copel.) De Vol, Taiwania 17(3): 282. 1972. **Fig. 5.18: D-G.**

Rhizomes short to ascending about 2 cm in diam., cover with old base leaves; Stipe dark brown to stramineous; 18-24 cm on sterile frond, 34-36 cm on fertile frond; 2-3 mm in diam., glabrous, triangular at base in cross section; vascular bundle V-shaped to U-shaped; aerophore cushion-like at leaf base. Sterile lamina pinnate, broadly lanceolate in outline 27-44 cm long, 22-29 cm wide, not glaucous, rachises abaxially usually semiterete, lateral pinnae about 10-12 pairs, apically with a pinnalike segment, decumbent, alternate to subopposite, 1.8-2.5 cm apart, pinnae 13-15 cm long, 2 cm wide, shortly stalked to sessile in upper part, base round to acute, apex acuminate, margin serrate toward apex, basal pair shorter than next one, vein mostly simple to as many simple to fork. Fertile lamina pinnate, 43-57 cm long, 20-26 cm; pinnae 14-16 pairs, proximal pinnae not abbreviated or basal pair slightly shorter, shortly stalked up to 6 mm, 9-13 cm long, 2-3.8 mm wide, sporangia acrostichoid, spore trilete, yellow or brown with tubercles.

Thailand. — NORTH-EASTERN: Phetchabun (Phu Thab Boek).

Distribution. — Bhutan, India, Japan (including Ryukyu Islands), Korea, Myanmar, Nepal, Philippines, Vietnam.

Ecology. — Terrestrial on moist area near fresh water swamp at 1,600 m alt.

Specimens examined. — *K. Punchay* 206, 281 (BCU); *A.D.E. Elmer* 10910, *F. Wang* 305, *G. Koidzumi S.N., M.G. Price* 1119 (L).

Note. — This species were new recorded in Thailand. It close to *Plagiogyria communis* Ching in Flora of Thailand but aerophore at base of each pinnae cushion-like not prominent as *P. communis* Ching.

### POLYPODIACEAE

J. Presl & C. Presl, Delic. Prag. 159. 1822; Tagawa & K. Iwats., Fl. Thailand 3(4): 486. 1989.

Plants mostly epiphytic or epilithic, rarely terrestrial. Rhizomes usually creeping, bearing scales. Fronds monomorphic or dimorphic, simple to pinnatifid or 1-pinnate; veins reticulate, sometimes with included veinlets, or veins free; Sori abaxial, round to oblong or elliptic, occasionally elongate, or sporangia acrostichoid, sometimes sunken, exindusiate, sometimes covered scales; frequently with paraphyses on sporangia or on receptacle; spore monolete or trilete.

#### Key to genera

- 1a. Fronds simple
  - 2a. Lamina covered with stellate hairs..... **11. Pyrrosia**
  - 2b. Lamina not covered with stellate hairs
    - 3a. Fronds bearing peltate scales on surface or in sori
      - 4a. Sori round or continuous along margin of fronds
        - 5a. Frond coriaceous; rhizome scale glabrous
          - 6a. Fronds usually more than 8 cm long, frond not dimorphic fertile frond not especially narrow..... **6. Lepisorus**
          - 6b. Fronds up to 8 cm long, dimorphic frond, fertile frond narrower than sterile frond..... **5. Lemmaphyllum**
        - 5a. Frond herbaceous; rhizome scale bearing few long hairs at base  
..... **10. Neochieropteris**
      - 4a. Sporangia acrostichoid on narrow apical portion of fronds..... **2. Belvisia**
    - 3b. Fronds not bearing any peltate scales
      - 7a. Frond dimorphic, sporangia acrostichoid or corruptly into coenosori...  
..... **7. Leptochilus**

- 7b. Frond monomorphic, sporangia not acrostichoid, sori distinct
- 8a. Sori round or nearly so
- 9a. At least middle part of scale clathrate.....**9. Microsorium**
- 9b. Scale not clathrate throughout.....**12. Selligiea**
- 8b. Sori elongate, oblique to midrib, continuous or broken lines
- 10a. Lamina thick, coriaceous, main vein distinct.....**12. Selligiea**
- 10b. Lamina thin, main vein not so distinct
- 11a. Stipe jointed to rhizome, texture papyraceous....**7. Leptochilus**
- 11b. Stipe not jointed to rhizome, texture chartaceous.....  
.....**8. Loxogramme**
- 1b. Fronds pinnatifid, pinnate or more compound
- 12a. Laminae tripinnate to quadrapinnatifid.....**4. Gymnogrammitis**
- 12b. Laminae not as above
- 13a. Pinnae jointed to rachis
- 14a. Included veinlet branched and variously directed.....**1. Arthromeris**
- 14b. Included veinlet simple and excurrent.....**3. Goniophegium**
- 13b. pinnae not jointed to rachis
- 15a. Sori terminal on distinct free vein.....**3. Goniophegium**
- 15b. Sori on reticulate veins
- 16a. At least middle part of scales clathrate.....**9. Microsorium**
- 16b. Scales not clathrate.....**12. Selligiea**

### 1. ARTHROMERIS

(T. Moore) J. Sm., Hist. Fil. 110. 1875; Tagawa & K. Iwats., Fl. Thailand 3(4): 563. 1989.

Rhizomes creeping, bearing densely scale, scale narrow, concolorous or bicolor. Stipe jointed to rhizome. Laminae pinnate; lateral pinnae articulated to rachis, usually oblong lanceolate, subentire or undulate at margin; vein anastomosing forming areole included veinlet, lateral vein distinct. Sori round one or more row in each side of costae; exindusiate.



### Key to the species

- 1a. Rhizome scale large about 12 mm long.....**1. *A. phuluangensis***  
 1b. Rhizome scale small up to 9 mm long.....**2. *A.***

#### *lehmannii*

- 1. *Arthromeris lehmannii*** (Mett.) Ching, Contr. Inst. Bot. Natl. Acad. Peiping 2: 96. 1933; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 60. 1967; Tagawa & K. Iwats., Fl. Thailand 3(4): 567. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 262. 2000. — *Polypodium lehmannii* Mett., Abhandl. Senckenb. Naturf. Ges. 2: 117, t. 3, f. 35. 1857 **Fig. 5.19: A-B.**

Rhizomes long creeping, about 5 mm diam., dirty brown, densely scaly throughout; scales ovate-oblong with long tails, round at peltate base, 9 mm long 1.2 mm broad, nearly concolorously brown or more or less paler towards margin, minutely toothed at apical portion. Stipes stramineous or pale castaneous, 11 cm long, glabrous, polished. Laminae ovate, 29 cm by 28cm, imparipinnate; rachis like the upper part of stipes; lateral pinnae 6 pairs, 3 cm apart, patent or slightly ascending, straight, sessile, oblong-lanceolate, caudately acuminate at apex, cuneate to round at acroscopic and round to subtruncate at basiscopic bases, about 14 cm long, 1.8 cm wide, subentire at wavy and more or less crisped at margin, cartilaginous at margin; terminal pinna larger, like the lateral ones; veins anastomosing copiously, lateral vein up to 40 pairs, more or less visible; herbaceous, green, glabrous. Sori at junction of reticulate veins, two rows between adjacent main veins, 3 or 4 rows at each side of costa, round, up to 2 mm diam., superficial.

Thailand. — NORTHERN: Chiang Rai (Doi Nang Ka), Chiang Mai (Doi Chiang Dao, Doi Suthep, Doi Inthanon, Doi Pha Hom Pok).

Distribution. — Himalayas (type from Bhutan) to Upper Burma, SW China, Taiwan and south of Philippines (Luzon).

Ecology. — Epiphytic on mossy tree trunk in lower montane rainforest at 1,700 m alt.

Specimens examined. — *K. Punchay* 117, *G. Murata*, *K. Iwatsuki* & *C. Phengkklai* T15055, *R. Geesink*, *P. Hiepko* & *C. Phengkklai* 7961, *M. Tagawa*, *K. Iwatsuki* & *N. Fukuoka* T2882 (BKF).

2. *Arthromeris phuluangensis* Tagawa & K. Iwats., Acta Phytotax. Geobot. 22: 100. 1967; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 61. 1967; Tagawa & K. Iwats., Fl. Thailand 3(4): 565. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 263. 2000. **Fig. 5.19: C-E.**

Rhizomes long creeping, about 6-8 mm diam., densely covered with scales; scales linear-lanceolate, 12 mm long, about 2 mm broad, with tiny teeth or hairs along margin, middle portion brown and white at margin. Stipes 11-13 cm long, glabrous, pale brown, polished. Laminae ovate-oblong in outline, 33-38 cm long, 26-14 cm wide; rachis like the upper part of stipes; lateral pinnae 11 pairs, about 3 cm apart, subopposite, the basal pairs the largest, patent or slightly falcate, slightly undulate on the margin, margined with cartilaginous membrane, deeply cordate at sessile base, long-acuminate and caudately prolonged at apex, 13-14 cm long, 3-3.5 cm wide; terminal pinna like the middle lateral ones, sometimes slightly auricled at base, up to 18 by 2 cm; costae distinct on both surfaces, lateral main veins 29-37 pairs in larger pinnae, visible on both surfaces; thinly papyraceous. Sori on veins or terminal on included veinlets, in two rows between adjacent main veins, round, in several rows on each side of costae, up to 1 mm diam., superficial.

Thailand. — NORTHERN: Phitsanulok (Phu Miang); NORTH-EASTERN: Loei (Phu Luang, type).

Distribution. — Endemic.

Ecology. — Epiphytic on mossy tree trunk in lower montane rainforest at 1,700 m alt.

Specimens examined. — *K. Punchay* 105 (BCU); *T. Shimizu*, *K. Iwatsuki*, *N. Fukuoka*, *M. Hutoh*, *D. Chaiglom* & *A. Nalampoon* T11438, *M. Tagawa*, *K. Iwatsuki* & *N. Fukuoka* T1488 (BKF).

## 2. BELVISIA

Mirb., Hist. Nat. Vég. 3: 473.1803; Tagawa & K. Iwats., Fl. Thailand 3(4): 519. 1989.

Rhizomes short creeping, scaly, frond close together. Stipes short. Laminae simple, joint to rhizome, entire, papery to leathery; vein hardly visible, reticulate; fertile portion on narrow part at apex of fronds, covered with sporangia beneath except midrib, sporangia protected by reflex margin.

*Belvisia henryi* (Hieron. ex C. Chr.) Raymond, Mém. Jard. Bot. Montréal 55: 32. 1962.; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 51. 1967; Tagawa & K. Iwats., Fl. Thailand 3(4): 520. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 263. 2000. — *Hymenolepis henryi* Hieron. ex C. Chr., Dansk Bot. Ark. 6(3): 67, f. 1. 1929. **Fig. 5.19: F-G.**

Rhizomes short creeping, about 3 mm diam., bearing fronds close together, densely scaly; scales narrowly subtriangular, gradually narrowing from base towards apex, with long tailed at apex, 3-4 mm long, 0.6-0.8 mm wide, broadest at basal portion, concolorously brown, clathrate, toothed at margin. Stipes short, castaneous, narrowly winged, scaly at base, 0.5-2 cm Laminae narrowly oblong, rather suddenly narrowing at apex, bearing linear fertile portion, narrowly cuneate at base, the sterile portion about 17-22 cm long, 3-4.3 cm wide, bearing small scales on midvein; chartaceous to subcoriaceous, veins hardly visible, the margin of laminae usually plane; fertile portion linear, not constricted at base, 3.5-12 cm long by 2-2.5 mm, sporangia occupying the whole under surface except the midrib and margin, the margin hardly revolute.

Thailand. — NORTHERN: Chiang Rai (Mae Talop), Chiang Mai (Doi Suthep, Doi Intanon), Mae Hong Son (Khun Kong San), Tak (Huai Krasa, Ban Musoe), Phitsanulok (Phu Miang); NORTH-EASTERN: Loei (Phu Luang, Phu Kradung, Phu Tong); EASTERN: Nakhon Ratchasima (Khao Yai).

Distribution. — Himalayas to SW China (Yunnan, type) and N Vietnam.

Ecology. — Epiphytic on mossy tree trunk in lower montane rainforest at 1,650 m alt.

Specimens examined. — *K. Punchay 116* (BCU); *K. Larsen, S.S. Larsen, W. Nanakorn, W. Ueachirakan & P. Sirirugsa 41842, M. Tagawa, K. Iwatsuki & N. Fukuoka T1832, Winit 1024, K. Punchay 196* (BKF).

### 3. GONIOPHLEBIUM

(Blume) C. Presl, Tent. Pterid. 185. 1836.

Rhizomes long creeping, densely scaly, bearing fronds remote, stipe stramineous or brown glabrous. Lamina pinnatifid or pinnate, oblong in outline, glabrous or pubescent, margins; veins anastomosing to form areoles included simple veinlet, Sori round, in 1 row on either side of costa, more or less sunken, sori on acroscopic branches of fork vein or terminal on included free veinlets, bearing paraphyses or absent.

#### Key to the species

- 1a. Pinnae confluent at base
- 2a. Vein all free.....**2. *G. manmeiense***
- 2b Vein anastomosing.....**1. *G. amoenum***
- 1b. Pinnae pinnate, articulate to rachis
- 3a. Sori superficial; base of pinnae deeply cordate.....**3. *G. mengtzeense***
- 3b. Sori more or less sunk in cavities, base of pinnae cuneate to subbruncate.....**4. *G. subauriculatum***

- 1. *Goniophlebium amoenum*** (Wall. ex Mett.) Bedd., Ferns. Brit. India 1: 5, pl. 5. 1866; Boonkerd & Pollawatn, Pterid. Thailand: 270. 2000. — *Polypodium amoenum* Wall. ex Mett., Farngatt. Polypod.: 80. 1857; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 56. 1967; Tagawa & K. Iwats., Fl. Thailand 3(4): 569. 1989. **Fig. 5.20: A-B.**

Rhizomes long creeping, about 5-6 mm diam., dark brown, densely scaly throughout; scales narrow with ovate peltate base 2.4-3.7 cm long, about 0.7 mm wide, slightly toothed at margin, light brown to greyish, more or less clathrate. Stipes stramineous, 15-30 cm long, scaly at base, glabrescent upwards. Laminae usually oblong to oblong-lanceolate, deeply pinnatifid, 20-45 cm long, 10-20 cm wide; rachis stramineous to castaneous, usually minutely scaly beneath, hairy above, winged about 2 mm wide; lobes up to 25 pairs, basal pairs a little shorter than the next above, deflexed, middle and lower ones patent or slightly falcate, linear-lanceolate, acuminate at apex, 7-10 cm long, 1.2-1.5 cm wide, continuous to the next ones by narrow wings, margin dentate; veins forming a row of costal areoles, visible on both surfaces; papyraceous to subcoriaceous. Sori terminal on included veinlets in costal areoles, thus in a single row at each side of costa, about 1 mm diam., superficial or slightly sunken.

Thailand. — NORTHERN: Chiang Mai (Doi Chiang Dao, Doi Suthep, Doi Inthanon, Doi Pha Hom Pok), Phitsanulok (Phu Miang); NORTH-EASTERN: Loei (Phu Luang); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao).

Distribution. — Himalayas (type) to Burma, S China, Indochina and Taiwan.

Ecology. — On mossy tree trunk or mossy rocks in lower montane rainforest at 1,700 m alt.

Specimens examined. — *K. Punchay* 106, 129 (BCU); *E. Hennipman* 3300, *G. Murata*, *K. Iwatsuki* & *C. Phengkklai* 15112, *R. Pooma* & *M. Tamura* 7117, *Winit* 1200, *K. Punchay* 152 (BKF).

2. *Goniophlebium manmeiense* (Christ) Rödl-Linder, *Blumea* 34: 394. 1990. — *Polypodium manmeiense* Christ, *Bull. Herb. Boiss.* 6: 870. 1898; Tagawa & K. Iwats., *SouthE. Asian Stud.* 5: 56. 1967; Tagawa & K. Iwats., *Fl. Thailand* 3(4): 568. 1989; Boonkerd & Pollawatn, *Pterid. Thailand*: 284. 2000. — *Metapolypodium manmeiense* (Christ) Ching, *Acta Phytotax. Sin.* 16(4): 29. 1978. **Fig. 5.20: C-D.**

Rhizomes long creeping, about 2 mm diam., dark brown, densely scaly; scales narrowly subtriangular, acuminate at apex, entire, 1.8-2.4 mm long, 0.5-0.8 mm wide. Stipes stramineous, 3-4 cm long, densely scaly at base. Laminae deeply pinnatifid, narrowly oblong, usually decurrent to the next lobes by very narrow wings of rachis less than 1 mm in breadth, acuminate at apex, 16-20 cm long, about 3 cm wide; lobes up to 50 pairs, narrowly oblong, patented, about 1.5 cm by 0.3 cm, acute to round at apex, incised to undulate at edge at least at distal portion, upper ones rather gradually smaller, costa 5-7 mm from the next one, raised on both surfaces, glabrous, stramineous to darker, veins free; texture herbaceous, glabrous. Sori terminal or subterminal on acroscopic veinlets, medial, less than 1 mm diam., superficial or immersed in cavities.

Thailand. — NORTHERN: Chiang Mai (Doi Chiang Dao, Doi Suthep, Doi Inthanon, Doi Pha Hom Pok), Chiang Rai (Doi Tung), Phitsanulok (Phu Miang); NORTH-EASTERN: Loei (Phu Luang).

Distribution. — Sikkim, Upper Burma, SW China (Yunnan, type) and Laos.

Ecology. — On mossy tree trunk in lower montane rainforest at 1,700 m alt.

Specimens examined. — *K. Punchay* 134, *J. F. MAXWELL* 92-609, 95-698, *R. Pooma* & *M. Tamura* 7118, *T. Shimizu*, *K. Iwatsuki*, *N. Fukuoka*, *M. Hutoh*, *D. Chaiglom* & *A. Nalampoon* T11434 (BKF)

3. *Goniophlebium mengtzeense* (Christ) Rödl-Linder, Philipp. J. Sci. 116: 154. 1987. — *Polypodium mengtzeense* Christ, Bull. Herb. Boissier 6: 869. 1898. — *Polypodiastrum mengtzeense* (Christ) Ching, Acta Phytotax. Sin. 16: 28. 1978. — *Polypodium argutum* Wall. ex Hook. Sp. Fil. 5: 32. 1864; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 57. 1967; Tagawa & K. Iwats., Fl. Thailand 3(4): 572. 1989.

Rhizomes long creeping, 2-3 mm diam., dark brown with glaucous, densely scaly at least at apex; scales narrowly subtriangular, 2-8-3 mm long, 0.3 mm wide, irregularly toothed at margin, light brown to blackish, clathrate. Stipes 7-8 cm long, stramineous to brown at base, scaly at base, glabrous upwards. Laminae pinnate with

distinct terminal pinnae, herbaceous, broadly lanceolate, 28-32 cm long, 14-22 cm wide; rachis like the upper part of stipes; free lateral pinnae 6 pairs, the basal the longest, the upper ones gradually become smaller upwards, slightly ascending, lower ones patent, straight or falcate, sessile to adnate, usually deeply cordate and more or less roundly auricled at base, acuminate at apex, serrate at margin, the lobes toothed, the larger pinnae 12-15 cm long, 1.5-1.7 cm wide; terminal one usually longer, sometimes deeply lobed at basal portion, 12 cm long, sparsely scaly between pinnae-rachis; veins anastomosing to form 1-2 rows of areoles at each side of costa, each costal areole usually contain a simple free veinlet although sometimes forked, the other veins free, ending inside the margin of lobes, visible on both surfaces. Sori terminal on included veinlets of costal areoles, up to 2 mm diam., superficial or slightly sunken and then lamina slightly rose above.

Thailand. — NORTHERN: Chiang Mai (Doi Pha Hom Pok, Doi Suthep, Doi Hua Mot, Pha Mon, Doi Inthanon), Lampang; NORTH-EASTERN: Phetchabun (Phu Miang), Loei (Phu Laung, Phu Kradung); SOUTH-WESTERN: Kanchanaburi (Si Sawat, Khao Ri Yai).

Distribution. — Himalayas (type) to China, Indochina, Taiwan and the Philippines.

Ecology. — On mossy tree trunks in lower montane rainforest at 1,700 m alt.

Specimens examined. — *K. PUNCHAY 136* (BCU); *Winit 1186*, *T. Smitinand 1757*. *K. Larsen & S.S. Larsen 33868*, *C. Phengkklai et al. 7146*, *K. PUNCHAY 128* (BKF).

4. *Goniophlebium subauriculatum* (Blume) C. Presl, Tent. Pterid. 186. 1836; Boonkerd & Pollawatn, Pterid. Thailand: 252, 271. 2000. — *Polypodium subauriculatum* Blume, Enum. Pl. Javae: 133. 1828; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 57. 1967; Tagawa & K. Iwats., Fl. Thailand 3(4): 573. 1989. **Fig. 5.20: E-G.**

Rhizomes long creeping, 2.5 mm diam., distinctly glaucous, densely scaly; scales brown, deltoid to linear, 2.3 by 0.6 mm clathrate, toothed at margin. Stipes

stramineous or brown, 6-10 cm long, densely scaly at base, glabrescent in upper part. Laminae pinnate, lanceolate, 30-44 cm long, 22-27 cm, widest at the base to around the middle, rachis pale brown, minutely scaly throughout, lateral pinnae 9-10 pairs, a few basal pairs usually a little shorter than the next above, deflexed or patent, subopposite, sessile, linear, subcordate or subtruncate, roundly auricled on both sides at base, gradually narrowing from base to long attenuate apex, serrate at margin, patent or slightly ascending, straight or a little falcate, 12-13 cm by 1-2 cm, upper pinnae gradually become smaller; terminal pinna not so large, 3-10 cm long, irregularly lobed at basal portion; veins anastomosing to form 1-3 rows of areoles at each side of costa, more or less visible; herbaceous to subcoriaceous, deep green, glabrous or hairy on both surfaces. Sori terminal on simple included veinlets in costal areoles, in one row at each side of costa, costular, more than 1.5 mm diam., distinctly immersed and rose on the upper surface.

Thailand. — NORTHERN: Chiang Rai, (Doi Phacho, Mae Lao, Pang Pa Phon), Chiang Mai (Fang, Doi Chiang Dao, Doi Suthep, Doi Inthanon), Mae Hong Son (Doi Pha Dam), Lampang (Doi Luang), Tak (Mae Sot); NORTH-EASTERN: Phetchabun (Phu Miang), Loei (Phu Luang, Phu Kradung); SOUTH-EASTERN: Prachin Buri (Khao Yai), Chanthaburi (Khao Soi Dao) ; SOUTH-WESTERN: Kanchanaburi (Sai Yok, Khao Nam Tok).

Distribution. — NE. India, SW. China, Burma, Laos, Vietnam, throughout Malesia (type from Java) to Australia (Queensland).

Ecology. — On mossy tree trunks in lower montane rainforest at 1,700 m alt.

Specimens examined. — K. Panchay 107 (BCU); J.F. Maxwell 95-525, 97-832, M. Tagawa, K. Iwatsuki, & N. Fukuoka T782, T2430 K. Panchay 114 (BKF).

#### 4. GYMNOGRAMMITIS

Griff., Icon. Pl. Asiat. 2: 608. 1849; Tagawa & K. Iwats., Fl. Thailand 3(4): 616. 1989.

Rhizomes long creeping, scaly, scale attached at base, concolorous brown, Stipe with articulation, scaly at base, Lamina oblong tripinnate to quadrapinnatifid,



thin, rachis grooved above. Sori round, dorsal on veinlet, one per segment, indusia wanting.

*Gymnogrammitis dareiformis* (Hook.) Ching ex Tardieu & C. Chr., Fl. Indo-Chine 7(2): 117. 1939; Tagawa & K. Iwats., Fl. Thailand 3(4): 616. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 235. 2000. — *Araiostegia dareiformis* (Hook.) Copel., Univ. Calif. Publ. Bot. 12: 398. 1931; Tagawa & K. Iwats., Fl. Thailand 3(2): 151. 1985. — *Polypodium dareiforme* Hook., Sec. Cent. Ferns: t. 24. 1860. **Fig. 5.21: A-B.**

Rhizomes long creeping, about 5 mm diam., densely scaly; scales gradually narrowing from base towards tailed apex, 2.5-3 mm long, about 1 mm broad, pale brown or brown in age with dark brown central portion, thin and ferrugineous. Stipes stramineous to brown, scaly at base, glabrous upwards, 5-5.5 cm long. Laminae oblong, acute to acuminate at apex, tripinnate to quadripinnatifid, 16-18 cm long 13-15 cm wide; costae like the upper part of pinnae, winged in upper portion; pinnae about 14 pairs, alternate, oblong-subdeltoid, gradually narrowing towards acute apex, falcate, 7-10 by 3.5-5 cm, distinctly stalked; pinnules subdeltoid on short stalks, acute at apex, broadly cuneate at base, 1.5-1.7 cm long, 0.6-0.8 cm wide; ultimate segments simple or forked, one-nerved, entire, acute at apex; herbaceous to softly papyraceous, deep green, glabrous. Sori dorsal on veinlets, one for each segment, exindusiate.

Thailand NORTHERN: Chiang Mai (Doi Chiang Dao, Doi Suthep, Doi Inthanon, Doi Pha Hom Pok, Doi Hua Mot), Phitsanulok (Phu Miang).

Distribution. — Himalayas (type from Khasia Hills), SW China, Hainan and Vietnam.

Ecology. — On mossy tree trunk in semi-shade and high humidity area in lower montane rainforest at 1,750 m alt.

Specimens examined. — *K. Punchay* 118, 138 (BCU); *T. Smitinand* & *H. SLEUMER* 1074, *T. Shimizu*, *K. Iwatsuki*, *N. Fukuoka*, *M. Hutoh*, *D. Chaiglom* & *A. Nalampoon* T11464, *G. Murata*, *K. Iwatsuki*, *C. Phengklai* & *C. Charamphol* T15969, *H.B.G. Garrett* 674, *K. Punchay* 150 (BKF); *J.F. Maxwell* 92-942 (P).

## 5. LEMMAPHYLLUM

C. Presl, Abh. Königl. Böhm. Ges. Wiss., ser. 5. 517. 1851; Tagawa & K. Iwats., Fl. Thailand 3(4): 515. 1989.

Rhizomes creeping, slender, scaly, bearing frond remote; scales irregularly toothed, clathrate. Stipes usually short or hardly distinct. Lamina monomorphic or dimorphic; sterile lamina more broad, obovate, elliptic, lanceolate, or oblanceolate, hard leathery when dried, glabrous or sparsely scaly, margin entire; fertile lamina narrower, linear; veins reticulate included free veinlets. Sori linear or round, continuous along midrib,

*Lemmaphyllum carnosum* (J. Sm. ex Hook.) C. Presl, Epimel. Bot.: 158. 1851; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 51. 1967; Tagawa & K. Iwats., Fl. Thailand 3(4): 518. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 273. 2000. — *Drymoglossum carnosum* J.Sm. ex Hook., Gen. Fil.: pl. 78A. 1841 **Fig. 5.21: C-D.**

Rhizomes long creeping, slender, about 0.5 mm diam., bearing fronds more than 1.5-2.5 mm apart, densely scaly throughout; scales ovate, dark brown, about 1 mm in diameter. Fronds simple, dimorphic. Sterile fronds: stipes very short, 1.5-3 cm long, densely scaly at base; laminae ovate to ovate-oblong, acuminate at apex, cuneately attenuate at base, 4-8 cm long, 1.5-3 cm wide; coriaceous, midrib distinct, veins more or less visible, copiously anastomosing, the margin cartilaginous. Fertile fronds: stipes 3-6 cm long, slender; laminae about 8 cm long, about 5-8 mm broad; sporangia covering the whole undersurface of laminae except midrib and margin.

Thailand. — NORTHERN: Chiang Mai (Doi Chiang Dao, Doi Suthep), Chiang Rai; NORTH-EASTERN: Loei (Phu Luang).

Distribution. — Himalayas (type from Nepal) to SW China (Yunnan & Guangxi) and N Vietnam.

Ecology. — On mossy tree trunks or moist rocks in lower montane rainforest at 1,600-1,700 m alt.

Specimens examined. — *K. Panchay 040* (BCU); *M. Tagawa, T. Shimizu, H. Koyama, M. Hutoh, & A. Nalampoon T9975, M. Tagawa, K. Iwatsuki & N. Fukuoka T1908, M. Tagawa & K. Iwatsuki 4393, Winit 4, K. Panchay 058* (BKF); *J.E. Vidal 5447A* (P).

## 6. LEPISORUS

(J. Sm.) Ching, Bull. Fan Mem. Inst. Biol. 4: 56. 1933; Tagawa & K. Iwats., Fl. Thailand 3(4): 518. 1989.

Rhizomes creeping bearing fronds closely; scale peltate. Stipe has articulation, sometimes not distinct, scaly at base. Laminae simple, entire, coriaceous, have peltate scale or glabrescent; vein reticulate, usually included veinlets. Sori at junction of vein, round or rarely elongate, superficial or sunken, exindusiate cover when young with umbrella-shaped peltate paraphyses.

### Key to the species

- 1a. Frond annual, texture herbaceous to chartaceous.....**3. *L. scolopendrium***
- 1b. Frond persistent, texture subcoriaceous to coriaceous
  - 2a. Frond linear-lanceolate up to 2 cm wide or even broader.....**2. *L. nudus***
  - 2b. Frond linear at most 1.5 cm wide
    - 3a. Rhizome scale brown, clathrate, with narrow band.....**1. *L. contortus***
    - 3b. Rhizome scale dark brown to black clathrate only marginal portion with irregular teeth.....**4. *L. subconfluens***

- 1. *Lepisorus contortus*** (Christ) Ching, Bull. Fan Mem. Inst. Biol. 4: 90. 1933; Tagawa & K. Iwats., Fl. Thailand 3(4): 513. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 273. 2000. — *Pleopeltis contorta* (Christ) Alston & Bonner, Candollea 15: 209. 1956; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 49. 1967. — *Polypodium lineare* var. *contortum* Christ, Nuovo Giorn. Bot. Ital., n.s. 4(1): 98, pl. 1, f. 3. 1897.

Rhizomes creeping, about 3.6 mm diam., bearing fronds close together, densely scaly throughout; scales dark brown, slightly clathrate, toothed at margin, oblong-subdeltoid, apex attenuate, 3.3-3.7 mm long, 1.1-1.5 mm wide. Stipes very short, indistinct. Laminae linear, attenuate towards both ends, in mature large laminae about 6-14 cm by 0.7-1.5 cm, the margin more or less recurved; main vein distinct in both surface, coriaceous; lateral veins hardly visible, copiously anastomosing. Sori round or oblong, about 3 mm in diam., up to half of fronds, medial. Spores monolete.

Thailand. — NORTHERN: Chiang Mai (Doi Inthanon).

Distribution. — Himalayas, Tibet and China (type).

Ecology. — On mossy tree trunks in lower montane rainforest at 1,600-1,700 m alt.

Specimens examined. — *K. Panchay 112* (BKF); *G. Raldi G. 19, Luo-linbo 234* (P).

2. *Lepisorus nudus* (Hook.) Ching, Bull. Fan Mem. Inst. Biol. 4: 83. 1933; Tagawa & K. Iwats., Fl. Thailand 3(4): 512. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 274. 2000. — *Pleopeltis nuda* Hook., Exot. Fl. 1: t. 63. 1823; Tagawa, J. Jap. Bot. 38: 326. 1963; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 50. 1967. **Fig. 5.21: G.**

Rhizomes long creeping, about 2 mm diam., green on surface, bearing fronds rather remotely 5-6 mm apart, scaly throughout; scales ovate-oblong with gradually narrowing attenuate apex, up to 4 by 1 mm, concolorously light brown, clathrate, entire. Stipes about 2 cm long, stramineous, castaneous or dark, winged on the upper part, scaly at base. Laminae linear, broadest at middle, linear-lanceolate, gradually narrowing towards both long-attenuate ends, 22-27 cm long by 1.7-1.5 cm, entire or slightly crenate at margin; subcoriaceous, minutely and sparsely scaly underneath. Sori medial, round or oblong, up to 2-3 mm broad, superficial and hollowing on above, cover with peltate scales. Spores monolete.

Thailand. — NORTHERN: Chiang Mai (Doi Nang, Doi Luang, Doi Chiang Dao, Doi Suthep, Doi Inthanon, Doi Hua Mot), Chiang Rai (Doi Tung, Doi Phacho), Tak (Khao Phra Wo, Ban Musoe); NORTH-EASTERN: Loei (Phu Kradung); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao).

Distribution. — Sri Lanka, S India, Himalayas (type), Upper Burma to SW China (Yunnan) also record from Sumatra.

Ecology. — On mossy tree trunks in lower montane rainforest at 1,600-1,700 m alt.

Specimens examined. — *K. Punchay 113, E. Smith 1291, 1299, s.n., E. Hennipman 2151, A. Phuakea 10, J.F. Maxwell 01-688 (BKF).*

3. *Lepisorus scolopendrium* (Ching) Mehra & Bir, Res. Bull. Panjab Univ. Sci. 15: 168. 1964; Tagawa & K. Iwats., Fl. Thailand 3(4): 511. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 253, 274. 2000. — *Pleopeltis scolopendrium* (Ching) Alston & Bonner, Candollea 15: 207. 1956; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 49. 1967. — *Lepisorus excavatus* var. *scolopendrium* (Buch.-Ham. ex D. Don) Ching, Bull. Fan Mem. Inst. Biol. 4(3): 69. 1933.

Rhizomes creeping, about 2.5 mm in diam., bearing a few closely spaced fronds 6-10 mm apart, dark brown on surface, scaly; scales dense, thin, acuminate at apex, 6-7 mm long, 1.5-2 mm wide, concolorously light brown, clathrate. Stipes short, up to 2 cm long. Laminae, linear-lanceolate, broadest below middle, about 33 cm long, 2.3 cm wide, gradually narrowing towards both ends, entire or waved at margin; midrib raised beneath; papyraceous to herbaceous, light green; veins, copiously anastomosing with branched included veinlets. Sori round to oblong, between adjacent main veins, medial, 3.8-4 mm broad, never fused to the next ones, the receptacles raised with hollows on upper surface. Spores monolete.

Thailand. — NORTHERN: Chiang Mai (Doi Chiang Dao, Doi Suthep, Doi Inthanon, Doi Pha Hom Pok, Pong Pho, Doi Hua Mot, Huai Mae Pan), Chiang Rai (Doi Tung), Lamphun (Doi Khun Tan), Phitsanulok (Phu Miang); NORTH-

EASTERN: Loei (Phu Luang); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); PENINSULAR: Surat Thani (Ban Don).

Distribution. — Himalayas (type) and Tibet, SW China, Upper Burma and Indochina.

Ecology. — On branches of mossy trees in open places at 1,600 m alt.

Specimens examined. — K. Panchay 167, G. Murata, K. Iwatsuki & C. Phengkklai T15104, T. Smitinand 1744, E. Hennipman 3151A, M. Tagawa, K. Iwatsuki, & N. Fukuoka T1512, T. Shimizu, K. Iwatsuki, N. Fukuoka H, M. Hutoh, D. Chaiglom & A. Nalampoon T11441 (BKF).

4. *Lepisorus subconfluens* Ching, Bull. Fan Mem. Inst. Biol. 4: 85. 1933; Tagawa & K. Iwats., Fl. Thailand 3(4): 514. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 275. 2000. — *Pleopeltis subconfluens* (Ching) Tagawa & K. Iwats., Acta Phytotax. Geobot. 22: 100. 1967; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 49. 1967. **Fig. 5.21: E-F.**

Rhizomes creeping, about 1.2 mm diam., bearing fronds rather closely spaced near apex, scaly; scales oblong-subtriangular with round base and long-attenuate apex, about 2 mm long, 0.8 mm wide, sharply toothed at margin, dark brown to nearly black, the basal marginal portion brown and more or less clathrate. Stipes 2-3 cm long, indistinct from the base of laminae, scaly at base, dark stramineous to nearly black. Laminae linear, 13.5 cm long, 1.1 cm, attenuate towards both ends; leathery. Sori medial, round, about 3 mm broad, sometimes fusing to the next ones; the sterile portion of laminae usually revolute, in contrast to the remaining soriferous portion.

Thailand. — NORTHERN: Chiang Mai (Doi Chiang Dao, Doi Suthep, Doi Inthanon, Doi Pha Hom Pok), Chiang Rai (Doi Tung).

Distribution. — Bhutan and SW China (Yunnan, type).

Ecology. — On mossy tree trunk in lower montane rainforest at 1,650 m alt.

Specimens examined. — K. Panchay 160, E. Hennipman 3141, 3375, K. Iwatsuki, N. Fukuoka H, M. Hutoh, & D. Chaiglom T11096, T. Smitinand 4667, G.

Murata, K. Iwatsuki & C. Phengklai T15050 , G. Murata, K. Iwatsuki C. Phengklai & C. CHARAMPHOL T15649 (BKF).

## 7. LEPTOCHILUS

Kaulf., Enum. Filic. 147. 1824; Tagawa & K. Iwats., Fl. Thailand 3(4): 541. 1989.

Terrestrial, or epiphytic with rhizomes long creeping; scales entire or toothed. Fronds remote, articulate, monomorphic or dimorphic; lamina simple, entire or lobed to pinnatifid, or pinnate with pinnae adnate to rachis, herbaceous to thinly leathery; veins anastomosing more or less visible; fertile fronds similar to sterile ones or sometimes contracted with lamina. Sori usually between adjacent secondary veins, orbicular or elongate to linear, sometimes sporangia acrostichoid.

### Key to species

- 1a. Frond simple
- 2a. Frond monomorphic, sori round to shortly elongate.....**3. *L. hemionitideus***
- 2b. Frond dimorphic
- 3a. Sori elongate, oblique, sporangia not acrostichoid.....**4. *L. pedunculatus***
- 3b. Sori linear, sporangia acrostichoid.....**1. *L. decurrens***
- 1b. Frond pinnatifid to pinnate.....**2. *L. ellipticus***

- 1. *Leptochilus decurrens*** Blume, Enum. Pl. Javae: 206. 1828; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 55. 1967; Tagawa & K. Iwats., Fl. Thailand 3(4): 542.1989; Boonkerd & Pollawatn, Pterid. Thailand: 276. 2000. **Fig. 5.22: A.**

Rhizomes long creeping, 2.5 mm diam., scaly throughout; scales brown, linear-lanceolate, about 2.7 mm, 0.8 mm wide, clathrate, concolorously, margin minutely toothed. Fronds dimorphic. Sterile fronds: stipes 1-3 cm long, winged at least in the upper part, sparsely scaly at base, stramineous; laminae oblong to oblong-lanceolate, broadest near base, round or broadly cuneate at base and decurrent downwards to form wings of stipes, acuminate at apex, 19-38 cm long, 3.3-6.5 cm

wide, margin entire; midrib raised on both surfaces; lateral veins distinct and other veins visible, forming areoles with free or forked veinlets; Fertile fronds: stipes 20-25 cm long, stramineous, wingless; laminae linear, 10-16 cm long, 0.3cm broad, sporangia acrostichoid except on the midrib.

Thailand. — NORTHERN: Chiang Rai (Doi Phacho), Chiang Mai, (Doi Chiang Dao, Doi Suthep, Doi Inthanon, Doi Pha Hom Pok), Mae Hong Son (Doi Loi Bian, Ban Pasui) , Lamphun (Doi Khun Tan), Lampang (Mar Ta), Phrae (Huai Hom Noi); NORTH-EASTERN: Phetchabun (Phu Miang); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao Tai, Khao Ram); SOUTH-WESTERN: Uthai Thani (Noen Pradu), Kanchanaburi (Kha Thalai); PENINSULAR: Nakhon Si Thammarat (Khao Luang).

Distribution. — Sri Lanka, S India, N India, S China and Taiwan, Vietnam, throughout Malesia (type from Java).

Ecology. — On moist rocks near stream in lower montane rain forest at 1,600 m alt.

Specimens examined. — *K. Punchay 174, E. Hennipman 3048, 3836A, J.F. Maxwell 96-589, C.F. van Beusekom & C. Phengklai 1362, D.J. Middleton, P. Karaket, S. Lindsay, T. Phutthai & S. Suddee 5167* (BKF).

2. *Leptochilus ellipticus* (Thunb.) Noot., *Blumea* 42: 283. 1997; Nootboom, *Fl. Males.*, Ser. II, *Ferns and Fern Allies* 3: 85. 1998. — *Colysis pothifolia* (D. Don) C. Presl, *Epimel. Bot.*: 148. 1851; Tagawa & K. Iwats., *SouthE. Asian Stud.* 5: 55. 1967; Tagawa & K. Iwats., *Fl. Thailand* 3(4): 540. 1989; Boonkerd & Pollawatn, *Pterid. Thailand*: 265. 2000. — *Colysis pentaphylla* (Baker) Ching, *Bull. Fan Mem. Inst Biol.* 3: 332. 1933; Tagawa & K. Iwats., *SouthE. Asian Stud.* 5: 55. 1967; Tagawa & K. Iwats., *Fl. Thailand* 3(4): 540. 1989; Boonkerd & Pollawatn, *Pterid. Thailand*: 265. 2000. — *Polypodium ellipticum* Thunb. *Fl. Jap.* 335. 1784. **Fig. 5.22: B-C.**

Rhizomes creeping, about 3.5 mm diam., bearing fronds about 2 cm apart, scaly; scales lanceolate, toothed at margin, 3-4 mm long, 1-1.2 mm wide,



concolorously brown, clathrate. Stipes stramineous to brown at base, sparsely scaly on lower portion, 17-40 cm long. Laminae pinnatifid, slightly dimorphic, broadly ovate-subdeltoid in outline, 22-26 cm long, 18-29 cm; lateral pinnae 3-4 pairs, nearly equal in size, narrowly lanceolate to oblong-lanceolate, broadest near middle, caudate or acuminate at apex, narrowly cuneate at base, 12-15 cm long, about 3 cm broad, with narrow wing on rachis; veins more or less obscure, forming two rows of areoles between adjacent main veins; herbaceous. Sori linear, 7-9 mm long; continuous along a line between two rows of areoles, exindusiate.

Thailand. — NORTHERN: Chiang Mai (Doi Chiang Dao, Doi Suthep, Doi Inthanon, Doi Pha Hom Pok, Doi Khun Huai Pong), Lampang, Phitsanulok (Phu Miang, Thung Saleang Luang); NORTH-EASTERN: Loei (Phu Luang, Phu Kradung); SOUTH-WESTERN: Kanchanaburi (Khao Ri Yai).

Distribution. — NE. India, Nepal, S, China (Yunnan), Korea (Quelpart Island), S Japan, Burma, Thailand, Laos, Vietnam, Philippines.

Ecology. — On mountain slope under shaded area in lower montane rain forest at 1,600 m alt.

Specimens examined. — *K. Punchay* 024, 171, *E. Hennipman* 3048, 3836A, *J. F. MAXWELL* 93-903, 93-119, *K. Larsen*, *T. Smitinand* & *E. Warncke* 958, *S. CHONGKO* 123, *G. Murata*, *K. Iwatsuki* & *C. Phengklai* T15053 (BKF).

3. *Leptochilus hemionitideus* (C. Presl) Noot., *Blumea* 42: 285. 1997. — *Colysis hemionitidea* C. Presl, *Epimel. Bot.*: 147. 1851; Tagawa & K. Iwats., *South E. Asian Stud.* 5: 54. 1967; Tagawa & K. Iwats., *Fl. Thailand* 3(4): 536. 1989; Boonkerd & Pollawatn, *Pterid. Thailand*: 264. 2000. **Fig. 5.22: D-E.**

Rhizomes creeping, 2.5 mm diam., scaly throughout; scales clathrate, oblong-subtriangular, gradually narrowing from base towards long-acuminate apex, about 3 mm, 0.7-1.2 mm wide, slightly toothed at margin. Stipes 5.5-6.5 cm long. Laminae simple, oblong to oblong-lanceolate, broadest at middle portion of laminae, gradually narrowing towards acute apex, roundly narrowing and then broadly decurrent downwards forming broad wings of stipes, 44-60 cm long, 5-7.5 cm wide; lateral

main veins raised, veins distinct, forming areoles with included veinlets; herbaceous, dark green. Sori round to shortly elongate, arranged in one usually regular row between adjacent main veins.

Thailand NORTHERN:, Chiang Mai (Doi Inthanon), Chiang Rai (Doi Phacho), Mae Hong Son (Mae La Noi), Phrae (Mae Sai), Tak (Mu Soe), Phitsanulok (Phu Miang); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao).

Distribution. — N. India, Nepal, Bhutan, S. China, Taiwan and the Ryukyus.

Ecology. — On wet rocks usually in stream in lower montane rainforest at 1.600 m alt.

Specimens examined. — *K. Punchay 080* (BCU); *E. Hennipman 3388*, *M. Tagawa*, *K. Iwatsuki*, & *N. Fukuoka T2657*, *K. Iwatsuki*, & *N. Fukuoka T7158*, *C.F. van Beusekom* & *T. Smitinand 2226*, *K. Punchay 173* (BKF).

4. *Leptochilus pedunculatus* (Hook. & Grev.) Fraser-Jenk., Taxon. Revis. Indian Subcontinental Pteridophytes : 62. 2008. — *Colysis pedunculata* (Hook. & Grev.) Ching, Bull. Fan Mem. Inst. Biol. 4: 321. 1933; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 55. 1967; Tagawa & K. Iwats., Fl. Thailand 3(4): 538. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 246, 247, 265. 2000. — *Ceterach pedunculatum* Hook. & Grev., Icon. Filic.: t. 5. 1827. — *Colysis wui* (C. Chr.) Ching, Bull. Fan Mem. Inst. Biol. 4: 322. 1933; Tagawa & K. Iwats., Fl. Thailand 3(4): 539. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 266. 2000. **Fig. 5.22: F-H.**

Rhizomes long creeping, 2.2 mm wide, very dark, bearing fronds usually 1-3 cm apart, scaly; scales narrowly subtriangular, apex acuminate, 2-2.4 mm long, 0.6-0.8 mm, dark brown, clathrate and toothed at margin. Fronds dimorphic. Sterile fronds: stipes very short with narrowly winged ; laminae oblong, usually gradually narrowing towards acute to acuminate apex, cuneate at base, 23-27 cm long, about 3 cm wide; lateral veins distinct, veins forming areoles included veinlets; herbaceous, green, dark in dried specimens. Fertile fronds: stipes 14 cm long, stramineous, wingless; laminae linear, acute at apex, narrowly cuneate at base, about 14 cm by 0.3

cm broad. Sori up to 4 mm broad, elongate, oblique from midrib to margin, not acrostichoid.

Thailand. — NORTHERN: Chiang Mai; SOUTH-WESTERN: Phetchaburi; SOUTH-EASTERN: Chon Buri, Chanthaburi; PENINSULAR: Surat Thani, Krabi, Nakhon Si Thammarat, Trang, Satun.

Distribution. — N. India, S.W. China (Yunnan), Burma, Vietnam, Peninsular Malaysia, Sumatra, Java.

Ecology. — On climbing on mossy tree trunk near stream under shaded area at 1,600-1,700 m alt.

Specimens examined. — *K. Punchay 075* (BCU); *K. Iwatsuki & N. Fukuoka T7316*, *M. Tagawa, K. Iwatsuki, & N. Fukuoka T6805*, *T. Smithinand & 476*, *Ch. Charoenphol, K. Larsen & E. Warncke 3706*, *K. Punchay 249* (BKF)

## 8. LOXOGRAMME

(Blume) C. Presl, Tent. Pterid. 214. 1836; Tagawa & K. Iwats., Fl. Thailand 3(4): 575. 1989.

Rhizomes short or long creeping bearing clathrate scales. Lamina simple, monomorphic to dimorphic, usually oblanceolate, thinly to thickly papery, surface glabrous or hairy. Veins anastomosing more or less visible or hidden. Sori exindusiate, elongate, oblique or subparallel to costa, superficial or slightly sunken. Spore tetrahedral.

*Loxogramme chinensis* Ching, Sinensia 1: 13. 1929; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 56. 1967; Tagawa & K. Iwats., Fl. Thailand 3(4): 578. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 277. 2000. **Fig. 5.23: A-B.**

Rhizomes long creeping, slender, about 3 mm diam., densely scaly throughout; scales ovate with rather broad tails, dark brown about 1.5 mm long, 0.6-0.7 mm broad, deeply cordate, entire, clathrate. Stipes indistinct, densely scaly at base, pale green, narrowly winged to the very base. Laminae linear-lanceolate,

acuminate at apex, close together, gradually narrowing and decurrent downwards to the wings of indistinct stipes, 13-18 cm long, 0.7-1.3 cm wide, broadest near middle, edges entire; midrib raised on both surfaces, dark; thick, coriaceous, fleshy, deep green on upper surface, paler beneath, glabrous. Sori oblique, usually in a single row, linear coenosori, usually 7 mm long, 2-3 mm wide, naked, superficial.

Thailand. — NORTHERN: Chiang Mai (Doi Suthep, Doi Chiang Doa, Doi Intanon), Chiang Rai (Phu Lan Ka), Nan (Doi Phu Kha); NORTH-EASTERN: Loei (Phu Luang); EASTERN: Chaiyaphum.

Distribution. — India (Assam), Bhutan, Upper Burma, S. & SW. China (type) and N Vietnam.

Ecology. — On mossy tree trunks in lower montane rainforest at 1,600 m alt.

Specimens examined. — *K. Panchay 035, D.J. Middleton, P. Karaket, S. Lindsay, T. Phutthai & S. Suddee 5165, E. SMITH 1294, 1295, P. Srisanga 2325 (BKF); E. Hennipman 3378 (P).*

## 9. MICROSORUM

Link, Hort. Berol. 2. 110. 1833; Tagawa & K. Iwats., Fl. Thailand 3(4): 523.

Epiphytic or lithophytic, rarely terrestrial. Rhizomes creeping, thick or slender, with peltate and clathrate scales. Laminae simple or pinnatifid, coriaceous or herbaceous, vein anastomosing with free included veinlets. Sori small, round, scattered and forming many irregular rows between veins, rarely fuse, superficial or sunken, exindusiate.

### Key to species

- 1a. Frond simple, rhizome slender.....**2. *M. superfiaciale***  
 1b. Frond deeply lobed to pinnatifid rhizome thick.....**1. *M. insigne***

- 1. *Microsorium insigne*** (Blume) Copel., Univ. Calif. Publ. Bot. 16: 112. 1929; Boonkerd et al., Thai For. Bull. (Bot.) 32: 9. 2004. — *Polypodium insigne* Blume, Enum. Pl. Javae: 127. 1828. — *Microsorium dilatatum* (Bedd.) Sledge,

Bull. Brit. Mus. (Nat. Hist.) Bot. 2: 143. 1960; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 53. 1967; Tagawa & K. Iwats., Fl. Thailand 3(4): 530. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 279. 2000. **Fig. 5.23: C-E.**

Rhizomes creeping, thick, 10 mm diam., dark and scaly; scales oblong-subtriangular, long-acuminate at apex, round at base, toothed at margin, 2.2-2.4 mm long, 0.8-0.9 mm, brown to dark brown, finely to strongly clathrate, decaying from outside, round to oblong-ovate on older rhizome. Stipes about 16 cm long, distinctly about 2 mm winged nearly to the base. Laminae pinnatifid with 3-11 pairs of lateral lobes and winged rachis, 33-50 cm long, 30 cm wide, the lower lateral lobes adnate at base, oblong to narrowly oblong-lanceolate, caudate at apex, entire, 14-16 cm long, 3 cm wide, the upper ones gradually becoming smaller, the terminal lobes oblong, gradually narrowing towards apex, undulate at margin, those of pinnate large fronds smaller; rachis and midrib raised, main lateral veins distinct, the other veins visible, copiously anastomosing; papyraceous, light green. Sori round, smaller, irregularly scattered on the lower surface, about 1.5 mm diam. at maturity.

Thailand. - NORTHERN: Chiang Rai (Doi Phacho), Chiang Mai (Doi Inthanon, Doi Khun Huai Pong), Mae Hong Son (Mae La Noi), Phrae (Mae Sai); NORTH-EASTERN: Loei (Phu Luang); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); PENINSULAR: Nakhon Si Thammarat (Khao Luang).

Distribution. — Himalaya (type) to Indochina, Taiwan, Japan and throughout W Malesia.

Ecology. — On muddy rocks near stream in shaded area at 1,600 m alt.

Specimens examined. — *K. Punchay* 257, *K. Iwatsuki* & *N. Fukuoka* T7172, *R. Geesink*, *P. Hiepko* & *C. Phengklai* 8072, *M. Tagawa*, *K. Iwatsuki*, & *N. Fukuoka* T1301, *D.J. Middleton*, *P. Karaket*, *S. Lindsay*, *T. Phutthai* & *S. Suddee* 5146 (BKF).

2. *Microsorium superficiale* (Blume) Ching, Bull. Fan Mem. Inst. Biol. 4: 299. 1933; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 52. 1967; Tagawa & K. Iwats., Fl. Thailand 3(4): 525. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 281. 2000. — *Neocheiropteris superficialis* (Blume) Bosman, Leiden Bot. Ser.

14: 121. 1991. — *Polypodium superficiale* Blume, Fl. Javae Fil.: 136, t. 56, f. 1.1828. **Fig. 5.23: F.**

Rhizomes very long creeping, scandent on tree, 2-3 mm diam., usually scaly throughout; scales narrowly oblong-subtriangular, round at base, entire, 2.4-2.7 mm long, 1-1.2 mm wide, brown. Stipes 10-15 cm long, winged only on the upper portion, scaly at base, stramineous or dark brown in basal portion. Laminae oblong-lanceolate, broadest at middle, gradually narrowing towards both ends, acuminate at apex, attenuate or narrowly cuneate at base, entire and flat at margin, 26-33 cm long by 2.5-3.2 cm; midrib distinctly raised beneath, veins more or less visible, copiously anastomosing, forming areole included 1-2 veinlets; thin chartaceous. Sori round, superficial, at junction of veinlets, scattered on the whole of the under surface of laminae, up to 2 mm diam.

Thailand. — NORTHERN: Chiang Mai (Doi Chiang Dao, Doi Inthanon), Phitsanulok (Phu Miang); NORTH-EASTERN: Loei (Phu Luang).

Distribution. — Himalayas and throughout Malesia (type from Java).

Ecology. — On mossy tree trunks in dense evergreen forests at high altitudes, locally abundant.

Specimens examined. — *K. Punchay 056* (BCU); *G. Murata, K. Iwatsuki & C. Phengkklai T15198, H.B.G. Garrett 863, M. Tagawa, T. Shimizu, H. Koyama, M. Hutoh, D. Chaiglom & A. Nalampoon T9971, T11466, M. Tagawa, K. Iwatsuki, & N. Fukuoka T2643, K. Punchay 172* (BKF).

## 10. NEOCHEIROPTERIS

Christ, Bull. Soc. Bot. France 52(Mém. 1): 21. 1905; Tagawa & K. Iwats., Fl. Thailand 3(4): 522. 1989.

Rhizomes long creeping, rather thick, densely scaly; scales brown peltate, more or less clathrate, with tuft of setose hair, bearing frond distant. Stipe joint to rhizome. Lamina simple, entire or lobed, papery, glabrous; vein reticulate forming

areole included veinlet. Sori round, superficial, irregularly arranged 1-2 rows, between midrib and margin, with paraphyses

*Neocheiropteris normalis* (D. Don) Tagawa, J. Jap. Bot. 27: 217. 1952; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 51. 1967; Tagawa & K. Iwats., Fl. Thailand 3(4): 523. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 255, 281. 2000. — *Tricholepidium normale* (D. Don) Ching, Acta Phytotax. Geobot. 29: 43. 1978. — *Polypodium normale* D. Don, Prodr. Fl. Nepal.: 1. 1825. **Fig. 5.23: G-H.**

Rhizomes long creeping, about 2 mm diam., bearing fronds 1-3 cm apart, densely scaly throughout; scales ovate, round at base, moderately acute at apex, entire, about 2 by 1 mm, pale brown, concolorous, bearing a tuft of setose hairs, dark brown, up to 4 mm in length. Stipes 1-4 cm long, winged in upper part, scaly in lower portion, stramineous. Laminae narrowly lanceolate, attenuately long-acuminate at apex, broadest at middle portion, gradually narrowing downwards towards attenuate base, entire and flat or slightly undulate at margin, 22-46 cm long, by 2-3 cm wide; midrib stramineous, distinctly raised on both surfaces; lateral veins more or less visible, copiously anastomosing; herbaceous, the margin of laminae cartilaginous. Sori rather irregular in one row closer to midrib than margin of laminae, round, 2-2.5 mm diam.

Thailand. — NORTHERN: Chiang Mai (Doi Khun Huai Pong, Doi Inthanon), Phitsanulok (Phu Miang); NORTH-EASTERN: Loei (Phu Luang); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); SOUTH-WESTERN: Kanchanaburi (Khao Ri Yai).

Distribution. — Himalayas (type from Nepal), Upper Burma, S China, Vietnam and W Malesia (Peninsular Malaysia & Sumatra).

Ecology. — Climbing on mossy tree trunk under slightly shaded area in lower montane rainforest at 1,600 m alt.

Specimens examined. — *K. Punchay 057* (BCU); *F. Konta*, *C. Phengkklai* & *S. Khao-iam 4934*, *K. Larsen & S.S. Larsen 34421*, *T. Shimizu*, *K. Iwatsuki*, *N. Fukuoka*, *M. Hutoh*, *D. Chaiglom* & *A. Nalampoon T11466*, *M. Tagawa*, *K. Iwatsuki*, & *N.*

*Fukuoka T2457, G. Murata, K. Iwatsuki, C. Phengklai & C. Charamphol T15958, K. Punchay 011 (BKF).*

## 11. PYRROSIA

Mirb., Hist. Nat. Vég. 3: 471, 1803; Tagawa & K. Iwats., Fl. Thailand 3(4): 491. 1989

Rhizomes long creeping, scaly, scale not clathrate, hairy or entire, bearing frond closed or remoted. Lamina simple or lobed, rarely dimorphic, more or less stellate hair on surface; vein anastomosing, Sori round to large, one row or more, sometime acrostichoid, exindusiate, but protected by stellate hairs when young.

### Key to the species

- 1a. Lamina linear, up to 7 mm broad.....**2. *P. porosa***  
 1b. Lamina oblong-lanceolate, or ovate oblong, more than 7 mm broad....**1. *P. lingua***

- 1. *Pyrrosia lingua*** (Thunb.) Farw., Blumea 30: 208. 1984; Boonkerd & Pollawatn, Pterid. Thailand: 286. 2000. — *Acrostichum lingua* Thunb., Amer. Midl. Naturalist 12(8): 302. 1931.

var. *heteractis* (Mett. ex Kuhn) Hovenkamp. — *Pyrrosia heteractis* (Mett. ex Kuhn) Ching, Bull. Chin. Bot. Soc. 1: 57. 1935; Tagawa & K. Iwats., Fl. Thailand 3(4): 506. 1989. — *Pyrrosia eberhardtii* (Christ) Ching, Bull. Chin. Bot. Soc. 1: 59. 1935; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 48. 1967; Tagawa & K. Iwats., Fl. Thailand 3(4): 505. 1989. — *Pyrrosia heteractis* (Mett. ex Kuhn) Ching var. *minor* (C. Chr.) Ching, Bull. Chin. Bot. Soc. 1: 58. 1935; Tagawa & K. Iwats., Fl. Thailand 3(4): 507. 1989. — *Polypodium heteractis* Mett. ex Kuhn, Linnaea 36: 140. 1869.

### Fig. 5.24: A-B.

Rhizomes long creeping, bearing fronds 3-8 cm apart, scaly throughout; scales appressed or patent when young, narrowly subtriangular, lanceolate or oblong-lanceolate, apex attenuate, 2.2-2.6 mm long by 0.7 mm, usually black at basal and central portion and brown marginal portions, apex with hairs. Stipes 5-14 cm long,



scaly at base with those like rhizome scales, densely hairy throughout with grayish hairs and dark stellate hairs. Laminae simple, oblong-lanceolate, oblong, ovate or elliptic, apex round to acuminate, rounded at base, 12-18 cm long 3-4 cm, coriaceous; fertile fronds hardly different or a little taller; midrib and main veins distinct, raised beneath, other veins hardly visible, anastomosing; rigidly coriaceous, upper surface stellate hairy or glabrescent, with scattered hydathodes, the lower surface densely covered with hairs in two kinds, the lower layer grey ferruginous hairs and needle-like arms. Sori round, distinct, scattered on all the lower surface and embedded in stellate hairs.

Thailand. — NORTHERN: Chiang Mai (Doi Chiang Dao, Doi Inthanon, Doi Suthep, Doi Pha Hom Pok, Pha Mon), Chiang Rai (Doi Tung), Tak (Doi Pae Poe), Phitsanulok (Phu Miang, Thung Saleang Luang); NORTH-EASTERN: Loei (Phu Luang, Phu Kradung, Phu Paek); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao), Trat (Khao Kuap); SOUTH-WESTERN: Kanchanaburi (Si Sawat); PENINSULAR: Phangnga (Khao Phota Luang Kaeo), Nakhon Si Thammarat (Khao Luang, Khao Phra Mi), Trang (Khao Ching).

Distribution. — N. India, Nepal, Bhutan, S. China, Burma, Cambodia, Laos, Vietnam.

Ecology. — On mossy or dry rock in lower montane rainforest at 1,600 m alt.

Specimens examined. — *K. Punchay 071* (BCU); *T. Shimizu*, *K. Iwatsuki*, *N. Fukuoka*, *M. Hutoh*, *D. Chaiglom* & *A. Nalampoon T11448*, *B Hansen*, *G. Seidenfaden* & *T. Smitinand 11152*, *T. Smitinand* & *J.A.R. Anderson 7328*, *K. Punchay 148* (BKF).

2. *Pyrrrosia porosa* (C. Presl) Hovenkamp, *Blumea* 30: 208. 1984; Hovenkamp, *Leiden Bot. Ser.* 9: 29. 1986. — *Niphobolus porosus* C. Presl *Tent. Pterid.* 202. 1836.

var. *tonkinensis* (Giesenh.) Hovenkamp — *Pyrrrosia tonkinensis* (Giesenh.) Ching, *Bull. Chin. Bot. Soc.* 1: 55. 1935; Tagawa & K. Iwats., *SouthE. Asian Stud.* 5: 48. 1967; Tagawa & K. Iwats., *Fl. Thailand* 3(4): 501. 1989; Boonkerd & Pollawatn,

Pterid. Thailand: 288. 2000. — *Niphobolus tonkinensis* Giesenh., Farng. Niph. 144–145. 1901. **Fig. 5.24: C-D.**

Rhizomes creeping, about 1.7 mm diam., fronds close together, densely scaly excepted in older portion; scales oblong, long-tailed at apex, 2-3 mm long, 0.7-1 mm wide, dark brown to nearly black in central portion, brown and ciliate at margin, thin. Stipes not distinct with wings decurrent from laminae. Laminae, simple, linear, 11-14 cm long, 4-7 mm broad, gradually narrowing towards both apex and base; midrib grooved or planate on upper surface, raised beneath, glabrescent; texture leathery, veins invisible, upper surface stellate hairy or glabrescent, lower surface covered with two kinds of hairs, the lower grey appressed hairs and the upper pale stellate hairs with short stalks. Sori on the whole lower surface of upper half of fronds, covered with stellate hairs when young.

Thailand. — NORTHERN: Chiang Rai (Doi Tung), Chiang Mai (Doi Chiang Dao), Lamphun (Doi Khun Tan); NORTH-EASTERN: Loei; EASTERN: Chaiyaphum (Man Prom, Chulaphon Dam), Nakhon Ratchasima (Khao Lotueng); SOUTH-WESTERN: Kanchanaburi (Si Sawat).

Distribution. — From India to Japan, Taiwan, Indochina and the Philippines.

Ecology. — On mossy tree trunk in lower montane rain forest at 1,600 m alt.

Specimens examined. — *K. Punchay 014*, *W.N. 1128*, *C.F. van Beusekom & C. Phengklay 2983*. *T. Shimizu & M. Hotoh 10207* (BKF).

## 12. SELLIGUEA

Bory, Dict. Class. Hist. Nat. 6: 587. 1824; Tagawa & K. Iwats., Fl. Thailand 3(4): 562. 1989.

Rhizomes long creeping, rather thick, bearing frond remote. Stipes glabrous. Lamina simple, palmately or pinnately divided, monomorphic or dimorphic, herbaceous or leathery, glabrous or pubescent. Lobes entire or serrate, apex acuminate or obtuse, lateral vein distinct, vein reticulate. Sori orbicular, in 1 row or more on either side of costa, usually superficial, rarely sunken

### Key to species

- 1a. Frond simple, not deeply lobed.....**2. *S. rhyncophylla***  
 1b. Frond simple, deeply lobed.....**1. *S. oxyloba***

- 1. *Selliguea oxyloba*** (Wall. ex Kunze) Fraser-Jenk., Taxon. Revis. Indian Subcontinental Pteridophytes 44. 2008. — *Crypsinus oxylobus* (Wall. ex Kunze) Sledge, Bull. Brit. Mus. (Nat. Hist.) Bot. 2: 145. 1960; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 60. 1967; Tagawa & K. Iwats., Fl. Thailand 3(4): 559, f. 56.6. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 248, 267. 2000. — *Polypodium oxylobum* Wall. ex Kunze, Linnaea 24: 255. 1851. **Fig. 5.24: E.**

Rhizomes long creeping, 4-5 mm diam., densely scaly throughout; scales gradually narrowing from round peltate base to long-tailed apex, 5-7 mm long, 1.3 mm wide, brown in broader basal portion, paler in narrow tails, toothed at margin. Stipes dark stramineous or brown, phyllopodia short, scaly, glabrous upwards, polished, about 20 cm long. Laminae lobed, with 3-4 pairs of lateral lobes and a terminal one, very rarely simple and fertile, 15-18 cm long, 12-14 cm wide; rachis brown beneath, paler on upper surface, winged with lobes about 7 mm in breadth; lateral lobes usually longest near base, becoming smaller upwards, ascending, oblong, acute to acuminate at apex, 6-8 cm long, 1.5-2 cm wide, entire, terminal lobes longer; midrib raised on both surfaces, main veins distinct, ascending, the other veins obscure, more or less zigzag, reticulate, forming irregular areoles with included free or fork veinlets; papyraceous, deep green to paler, paler on lower surface, glabrous. Sori one between adjacent main veins, in a single row along both sides of midrib, subcostular or medial, round, 3-5 mm diam., hardly raised on upper surface.

Thailand. — NORTHERN: Chiang Mai (Pong Pho, Doi Chiang Dao, Doi Suthep, Doi Inthanon, Doi Pha Hom Pok, Huai Kaeo, Doi Hua Mot), Chiang Rai (Phu Lang Ka), Lamphun (Doi Khun Tan), Phitsanulok (Phu Miang); NORTH-EASTERN: Loei (Phu Luang, Phu Kradung); SOUTH-EASTERN: Prachin Buri.(Khao Yai) SOUTH-WESTERN: Ratchaburi (Khao Luang).

Distribution. — N India, Upper Burma, SW China (Yunnan & Szechuan) and Indochina.

Ecology. — On mossy tree trunks or mossy rocks in lower montane rainforest at 1,600-1,700 m alt.

Specimens examined. — *K. Punchay* 170 (BCU); *K. Iwatsuki, H. Koyama, N. Fukuoka & A. Nalampoon* T9405, *C. Phengkklai et al.* 7142, *H.B.G. Garrett* 683, *K. Punchay* 263 (BKF).

2. *Selliguea rhynchophylla* (Hook.) Fraser-Jenk., Taxon. Revis. Indian Subcontinental Pteridophytes : 48. 2008. — *Crypsinus rhynchophyllus* (Hook.) Copel., Gen. Fil.: 20. 1947; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 59. 1967; Tagawa & K. Iwats., Fl. Thailand 3(4): 556. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 268. 2000. — *Polypodium rhynchophyllum* Hook., Icon. Pl. 6: t. 954. 1854. **Fig. 5.24: G-H.**

Rhizomes long creeping, slender, about 1 mm diam., densely scaly throughout, frond remoted about 7 mm apart; scales ovate with long tails up to 4 by 0.8-1 mm, membranous, entire at margin, light brown, dark brown at attach point. Fronds two forms; smaller sterile fronds on short stipes about 7-20 mm in length, oval or ovate-oblong, round to moderately acute at both the base and apex, 1.5-3 cm long, 1-1.5 cm wide, ;larger fertile fronds: stipes 4-6 cm long, scaly at base, glabrescent upwards; laminae lanceolate, cuneate at base, broadest at 1/5-1/4 way from the base, narrowing at the soriferous portion of upper 1/4-1/2, acute to round at apex, 3-11.5 cm long, 1-1.5 cm wide, the soriferous portion less than 1 cm in breadth; main lateral veins obscure at 1.5 cm inside the margin, other veinlets hardly visible, anastomosing to form irregular areoles with included free veinlets; coriaceous, green, paler beneath, glabrous; cartilaginous margin notched, thick and dark brown or black. Sori one between adjacent main veins, a single row at each side of midrib, half-way or a little closer to midrib, round , 1.6-2.6 mm in diam.

Thailand. — NORTHERN: Chiang Mai (Doi Suthep, Doi Inthanon), Phitsanulok (Phu Miang); NORTH-EASTERN: Loei (Phu Luang, Phu Kradung);

SOUTH-EASTERN: Chanthaburi (Khao Soi Dao). SOUTH-WESTERN: Kanchanaburi (Khao Ri Yai).

Distribution. — N. India, Burma, SW. China, and Indochina.

Ecology. — On mossy tree trunks in lower montane rainforest at 1,600-1,700 m alt.

Specimens examined. — *K. Punchay 111* (BCU); *C.F. van Beusekom & C. Phengkklai 1287*, *D.J. Middleton*, *P. Karaket*, *S. Lindsay*, *T. Phutthai & S. Suddee 5099*, *5154*, *M. Tagawa*, *K. Iwatsuki*, & *N. Fukuoka T1511*, *K. Punchay 131* (BKF).

### PTERIDACEAE

E.D.M. Kirchn., Schul-Bot. 109. 1831; Tagawa & K. Iwats., Fl. Thailand 3(2): 231. 1985.

Terrestrial, epiphytic or lithophytic, rarely aquatic, small to large. Rhizomes erect to creeping with a tufted frond, scaly, scale entire. Stipe dark or stramineous, dull or glossy, grooved above, glabrous, hairy, or scaly. Lamina entire 1-4-pinnate, herbaceous to papery; veins free or anastomosing, if anastomosing then areoles without free included veinlets. Sori elongate along veins or sori marginal, sometimes immersed in grooves, sometimes acrostichoid indusiate or exindusiate.

#### subfam. PTERIDOIDEAE

- 1a. Sporangia along veins throughout the lower surface, exindusiate.....  
 .....1. **Pityrogramma**
- 1b. Sori elongate along margin, indusiate.....2. **Pteris**

### PITYROGRAMMA

Link, Handbuch 3: 19. 1833; Tagawa & K. Iwats., Fl. Thailand 3(2): 193. 1985

Rhizomes short, ascending, scaly, scale narrow, articulate, brown. Stipe dark, polished. Lamina pinnately compound, herbaceous to papyraceous, lower surface cover with white powder, vein all free. Sori along vein, exindusiate.

*Pityrogramma calomelanos* (L.) Link, Handbuch 3: 20. 1833; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 109. 1967; Tagawa & K. Iwats., Fl. Thailand 3(2): 193. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 103, 124. 2000. — *Acrostichum calomelanos* L., Sp. Pl. 2: 1072. 1753. **Fig. 5.25: A-B.**

Rhizomes short, erect, bearing a tuft of fronds, covered with scales; scales bright brown, narrow, 3-6 mm long, thin, entire. Stipes 22-28 cm long, dark and polished, scaly on lower part, glabrous upwards, covered with white powder in young stage. Laminae oblong with acuminate apex, bipinnate-tripinnatifid, 14-16 by 8-9 cm; rachis grooved on upper surface; lateral pinnae gradually smaller upwards; lower ones stalked, linear-subtriangular, acuminate to long-tailed at apex, up to 6 by 1.3 cm; pinna-rachis slender, grooved; grooves decurrent to those on rachis; pinnules oblong to oblong-lanceolate, cuneate at base, acute to acuminate at apex, lobed or pinnatisect in larger ones, up to 7 by 3 mm; lobes ovate, acute and dentate at apical portion, herbaceous, light green, glabrous but coated with white waxy powder; veins free, pinnate in larger ones, to several times forked. Sporangia placed along veins throughout the lower surface, without any protection, exindusiate.

Thailand. — NORTHERN: Mae Hong Son (Mae Sariang), Chiang Mai (Wang Tao), Tak (Ban Musoe); SOUTH-WESTERN: Kanchanaburi (Wangka, Bang Kasi); SOUTH-EASTERN: Trat (Ko Chang); PENINSULAR: Nakhon Si Thammarat (Khao Luang, Wat Khiriwong), Phangnga (Khao Khata Khwum), Trang (Khao Chong), Satun (Khuan Kalong), Yala (Buki, Betong, Bannang Sta), Narathiwat (Bacho Falls).

Distribution. — Pantropic; this may have been spread to the palaeotropics by humans.

Ecology. — On dry mountain slope in lower montane rainforest at 1,590-1650 m alt.

Specimens examined. — *K. Punchay 267, Ch. Chareonphol, K. Larsen & E. Warkcke 3560* (BKF).

## PTERIS

L., Sp. Pl. 2: 1073, 1753; Tagawa & K. Iwats., Fl. Thailand 3(2): 250. 1985.

Rhizomes erect or creeping, scaly, Stipe, rachis and costa grooved above, stramineous or brown or chestnut. Frond bipinnatisect in opposite pairs, or tripartite each basal pinnae branched with pinnatisect, vein pinnate free or some species with costal and costules areole, sori elongate along margin, indusiate by formed reflex margin of lobe.

### Key to the species

- 1a. Frond trifoliolate or tripartite..... **6. *P. wallichiana***
- 1b. Frond pinnate or pinnately compound
- 2a Pinnae all simple..... **5. *P. vittata***
- 2b Pinnae deeply lobed
- 3a Vein anastomosing to forming costal areole
- 4a Stipe stramineous, frond subcoriaceous..... **2. *P. biaurita***
- 4b Stipe chestnut or reddish brown, frond thinly herbaceous... **3. *P. mcclurei***
- 3b Vein free
- 5a Lateral pinnae 4-6 cm wide..... **4. *P. tokioi***
- 5b Lateral pinnae about 2 cm wide..... **1. *P. bella***

- 1. *Pteris bella*** Tagawa, Acta Phytotax. Geobot. 8: 166. 1939; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 81. 1967; Tagawa & K. Iwats., Fl. Thailand 3(3): 250. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 126. 2000. **Fig. 5.25: C-D.**

Rhizomes erect or ascending, bearing a tuft of fronds at apex, densely scaly; scales up to 10 by 0.8 mm, concolorously brown, entire. Stipe with basal part castaneous-brown, upper part and rachis castaneous-red, shining, scaly at base, glabrescent upwards, 17-40 cm long. Laminae oblong with acute apex, deeply bipinnatisect, 25-27 by 17-19 cm; lateral pinnae 5 or 6 pairs, opposite, 3-4 cm apart lanceolate, caudately acuminate at apex, slightly narrowing towards subtruncate

sessile base, about 10 by 2 cm; costa pale castaneous, shining, glabrescent; pinnules oblique, rounded at apex, entire at margin, adnate at base and decurrent to the costa with wings less than 0.5 mm broad, up to about 10 by 3 mm, softly papyraceous, green; veins forked, raised beneath. Sori marginal, usually less than 7 mm long; indusia pale brown, thin.

Thailand. — NORTHERN: Mae Hong Son (Khun Mae Lan), Chiang Mai (Doi Khu Huai Pong, Doi Inthanon, Doi Pha Hom Pok); NORTH-EASTERN: Loei (Phu Luang); SOUTH-WESTERN: Kanchanaburi (Khao Rai Yai); PENINSULAR: Nakhon Si Thammarat (Khao Luang).

Distribution. — Taiwan (type).

Ecology Terrestrial, usually on mountain slopes in lower montane rainforests at 1,700 m alt.

Specimens examined. — *K. Punchay 050* (BCU); *M. Tagawa, K. Iwatsuki, & N. Fukuoka T1281, T4799, K. Punchay 120* (BKF).

2. *Pteris biaurita* L., Sp. Pl.: 1076. 1753; Tagawa & K. Iwats., Fl. Thailand 3(3): 237. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 106, 127. 2000. **Fig. 5.25: E.**

Rhizomes short, erect, bearing a few fronds in a tuft, densely scaly at apex; scales to 4 by 0.8 mm, brown and paler edges with toothed margin. Stipes 60-77 cm long, stramineous, slightly polished, glabrous, scaly, rarely with a few scales, adaxially narrowly grooved; rachis straw-colored, glabrous, narrowly grooved adaxially; laminae deeply bipinnatifid, 48-82 cm, 30-60 cm wide, subcoriaceus. Pinnae opposite or nearly so, up to 15 pairs, straight, ascending, linear-lanceolate, broadly cuneate at base, gradually narrowing towards acuminate apex, 16-30 by 3-7 cm, deeply lobed to 5/6 way towards costa, basal pinnae bearing 1-2 basiscopic pinnule just like lateral ones; segment up to 30 pairs, 2-3 mm apart, sometimes up to 6 mm in fertile one; ultimate segments oblong, falcate, rounded or moderately acute at apex, with rounded sinus, firm, green, glabrous; basal veinlets uniting with those of opposite groups forming arches close to costa, bearing a few branches on posterior



side, the other veinlets forked, all free. Sori marginal, usually continuous along segments except at bottom of sinus and at apex; indusia thin, pale.

Thailand. — NORTHERN: Chiang Mai (Doi Pha Hon Pok, Doi Chiang Dao, Wang Tao, Doi Suthep, Ban Mae Kom, Ban Nong Lu, Ban Yang), Chiang Rai (Mae Lao, Doi Tung, Mae Kok, Pang Kia, Doi Pacho), Lamphun (Doi Khun Tan), Tak (Huai Krasa, Mae Sot, Doi Musoe, Lan Sang); NORTH-EASTERN: Phetchabun (Phu Miang), Loei (Phu Luang, Phu Kra Dueng); SOUTH-WESTERN: Kanchanaburi (Wangga, Sai Yok, Kroeng Kawia); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chon Buri (Si Racha), Chanthaburi (Khao Sabap), Trat (Ko Chang); PENINSULAR: Surat Thani (Khao Luang), Phangnga (Khao Thong Lang), Nakhon Si Thammarat (Thung Song), Trang (Khao Chong).

Distribution. — Pantropical.

Ecology. — On mountain slopes in lower montane rainforest at 1,700 m alt.

Specimens examined. — *K. Punchay* 221 (BCU); *K. Iwatsuki*, & *N. Fukuoka* T7381, *C. Phengkklai* 12418, *E. Hennipman* 2128, *E. Smith* 989, *O. Petrmitr* 224, *K. Punchay* 235 (BKF).

3. *Pteris mcclurei* Ching, Bull. Dept. Biol. Sun Yatsen Univ., 6: 28. 1933. —  
*Pteris nakasimae* Tagawa, Acta Phytotax. Geobot. 7(2): 84-85. 1938. **Fig. 5.25: F-G.**

Rhizomes erect to ascending 1-2 cm in diam., cover with brown scales, Stipe dark chestnut or reddish brown, shiny, 44-105 cm 3-4 mm in diam., glabrous, grooved adaxially; lamina 2 or 3-pinnatipartite, broadly ovate in outline, 45-58 cm long, 42-50 cm wide; lateral pinnae 5-7 pairs, decumbent, opposite or nearly opposite, 3-6 cm apart, shortly stalked with narrow wing or sessile, broadly lanceolate, 16-21 cm long, 4-7 cm wide, base cuneate, costa wing 3-4 mm each side, apex lobate to long caudate 2-5 cm, basal pinnae with 1-2 basiscopic pinnules similar the main pinna but smaller; segments 14-19 pairs, alternate or subopposite, sinuses obtuse 2-3 mm wide, margin serrate or crenate, apex of each segment acute or obtuse; terminal pinna similar lateral pinnae; costae abaxially prominent, light brown to stramineous in upper part, adaxial

groove with needlelike spine, winged on both sides, wing 3-5 mm wide each sides of costules; veins anastomosing, forming areoles along costules, areoles 1/3-2/3 as wide as costule wing veinlets outward from areole free, veinlet of segment usually free forked; lamina brown-green, thinly herbaceous when dried, glabrous.; Sori marginal, usually continuous along segment except bottom of sinus and apex, indusial thin, pale.

Thailand. — NORTHESTERN: Phetchabun (Phu Thab Boek).

Distribution. — Fujian, Guangdong, Guangxi, S. Hunan, S Jiangxi, S Japan and N. Vietnam.

Ecology. —Terrestrial, usually on mountain slopes in lower montane rainforest at 1,700 m alt.

Specimens examined. — *K. Punchay* 055, 126, 127 (BCU); *K. Iwatsuki* 2004 (P).

Note. — This is a new recorded species for Thailand.

4. *Pteris tokioi* Masam., Trans. Nat. Hist. Soc. Formosa 25: 13. 1935; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 82. 1967; Tagawa & K. Iwats., Fl. Thailand 3(2): 248. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 132. 2000. **Fig. 5.26: A-B.**

Rhizomes short creeping, thick, bearing closely spaced fronds, densely scaly at apex; scales shining-brown, concolorous, linear, up to 8 by 0.7 mm, entire. Stipes shining, deep castaneous to dark purple, 30-80 cm long, sparsely hirsute or glabrescent. Laminae oblong-ovate, bipinnatifid, 40-60 by 30-40 cm; lateral pinnae 6 pairs, opposite; oblong-lanceolate, rounded at base, the base with broadly winged stalks, cordately acuminate at apex, up to 25 by 6 cm, basal ones the largest, each bearing a large deeply lobed basal basicopic branch just like upper lateral pinnae; ultimate segments narrowly oblong, falcate, rounded at apex, serrate at margin, up to 25 mm long, 5-9 mm wide, papyraceous, dark green; veins forked, the basicopic branch of basal ones running to sinus between ultimate segments, free except in soral

commissure, visible on both surfaces. Sori continuous along margin of segments from base towards apex; indusia pale, thin, entire.

Thailand. — NORTHEASTERN: Phetchabun (Phu Miang), Loei (Phu Luang); SOUTH-EASTERN: Chantaburi (Khao Soi Dao).

Distribution. — Indochina, Taiwan (type) and southern edge of Japan.

Ecology. — On mountain slopes in lower montane rainforest at 1,700 m alt.

Specimens examined. — *K. Punchay* 20 (BCU); *E. Hennipman* 3232, *T. Smitinand* 1088 *T. Shimizu*, *K. Iwatsuki*, *N. Fukuoka*, *M. Hutoh*, *D. Chaiglom* & *A. Nalampoon* T11697, *K. Iwatsuki* & *N. Fukuoka* T7190 (BKF).

5. *Pteris vittata* L., Sp. Pl.: 1074. 1753; Tardieu & C. Chr., Fl. Indo-Chine 7(2): 143. 1939; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 79. 1967; Tagawa & K. Iwats., Fl. Thailand 3(2): 233. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 132. 2000. **Fig. 5.26: C-D.**

Rhizomes short, ascending, bearing a tuft of fronds, scaly; scales light brown, narrow, 2-3 mm long, 0.2 mm wide. Stipes up to 20 cm long, densely scaly on lower part, stramineous. Laminae imparipinnate, oblanceolate, widest at upper portion 44 cm long, 18 cm wide; pinnae simple, lateral pinnae 23 pairs, lower ones gradually becoming smaller downwards to mere auricles, middle or upper ones linear, nearly straight, up to 15 cm by 8-12 mm, sessile and cordate at base, caudately long-acuminate at apex, serrate at non-soriferous margin; terminal pinnae usually much longer, up to 20 cm or more long, about 1 cm broad; rachis grooved on upper surface, minutely scaly; veins forked, free except when connected by soral commissure. Sori marginal, continuous along margin of pinnae; indusia thin, pale.

Thailand. — NORTHERN: Mae Hong Son (Mae Sareang), Chiang Mai (Doi Chiang Dao, Keang Ka, Mae Klang), Chiang Rai (Doi Tung), Lampang, Tak (Lan Sang, Mae Sot, Dao Musoe); NORTH-EASTERN: Loei (Ban Nong Noen Thong); SOUTH-WESTERN: Kanchanaburi (Sai Yok, Erawan Falls, Son Tho, Chedi Sam Ong); CENTRAL: Saraburi (Muek Lek); SOUTH-EASTERN: Chanthaburi, Trat (Ko

Chang); PENINSULAR: Surat Thani (Ban Don), Phangnga (Tham Put), Krabi, Nakhon Si Thammarat (Ron Pibul), Phatthalung, Trang, Satun, Songkhla, Yala (Bannang Sata).

Distribution. — Tropics and subtropics of the Old World, north to S Japan.

Ecology. — On dry ground along road at 1,600 m alt.

Specimens examined. — *K. PUNCHAY 185, T. VONGTHAVON 142, D.J. MIDDLETON, S. LINDSAY & R. POOMA 2141* (BKF).

6. *Pteris wallichiana* J. Agardh, Recens. Spec. Pter.: 69. 1839; Tagawa & K. Iwats., South E. Asian Stud. 5: 81. 1967; Tagawa & K. Iwats., Fl. Thailand 3(2): 236. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 133. 2000; **Fig. 5.26: E-G.**

Rhizomes thick, short, erect, densely scaly at apex; scales ovate, oblong-subtriangular, up to 1 cm long, 4 mm broad at base, brown, concolorous, entire. Stipes thick 1.5 cm in diam., 90-110 cm long, dark brown and scaly at base, polished, pale castaneous or stramineous upwards, puberulous or glabrescent. Laminae tripartite, middle branch deeply bipinnatisect, 78-83 cm by 30 cm, lateral branches nearly as long as middle one, each bearing a large secondary bipinnatifid branch on lower side towards base; secondary branch sometimes with bipinnatifid branch, 46 cm long, 27 cm wide; lateral pinnae up to 20 pairs in middle branch and about 15 pairs in lateral branch, linear-lanceolate, caudately acuminate at apex, broadly cuneate at sessile base, about 21 cm by 3-4.5 cm, deeply lobed almost to costa leaving wings about 1.5 mm broad; ultimate segments narrowly oblong, falcate, acute at apex, serrate at margin, herbaceous or thicker, yellow-green, glabrous; veins forming narrow costal areoles, the other veins forked, free, more or less visible on both surfaces. Sori continuous along margin from base to midway or sometimes to apical part of segments; indusia rather thick, pale green outside and paler inwards, entire.

Thailand. — NORTHERN: Chiang Mai (Doi Chiang Dao, Kaeng Ka, Doi Suthep, Doi Inthanon), Chiang Rai (Mae Kok), Phrae (Mae Sai), Phitsanulok (Thung

Salaeng Luang); NORTH-EASTERN: Phetchabun (Phu Miang), Loei; SOUTH-EASTERN: Chanthaburi (Khao Soi Dao).

Distribution. — N India (type), S China, Laos, S Japan to Taiwan, south to Java, Sulawesi, and a variety in Samoa.

Ecology. — On ground under light shade or exposed places at 1,600-1,700 m alt.

Specimens examined. — *K. Punchay 076* (BCU); *Winit 952*. *M. Tagawa & I. Yamada T61*, *K. Punchay 083* (BKF).

### subfam. VITTARIOIDEAE

#### Key to the genera

- 1a. Lamina linear, sori immersed in deep groove almost at margin.....  
 .....**2. Haplopteris**
- 1b. Lamina oblanceolate, broadest above middle sori linear ..... **1. Antrophyum**

#### 1. ANTROPHYUM

Kaulf., Enum. Filic. 197, 282. 1824; Tagawa & K. Iwats., Fl. Thailand 3(2): 217. 1985.

Rhizomes short-creeping, with clathrate scale. Stipe very short. Lamina simple, broadly lanceolate, or broader, vein reticulate. Sori elongate along vein, sometimes reticulate, exindusiate.

**Antrophyum parvulum** Blume, Enum. Pl. Javae 110. 1828; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 111. 1967; Tagawa & K. Iwats., Fl. Thailand 3(2): 220. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 133. 2000. Fig. 5.27: A-B.

Rhizomes short, creeping, bearing a mass of roots and several fronds, densely scaly; scales very narrowly subtriangular, gradually narrowing towards caudate apex, greyish-brown, clathrate, irregularly toothed at margin, up to 2 by 0.3 mm Stipes very short, indistinctly merged with the basal portion of frond; sparsely scaly, green. Frond oblanceolate, broadest above middle, rounded to caudate at apex, gradually narrowing

downwards to narrowly cuneate base and decurrent to stipe forming very narrow wings, up to 7 cm or more long, 1 cm broad, leathery, green to paler; costa distinct only in the lowest portion of fronds, veins copiously reticulated without included veinlets. Sori linear along the veins.

Thailand. — NORTHERN: Chiang Mai (Doi Chiang Dao), Lamphun (Doi Khun Tan); NORTH-EASTERN: Loei (Phu Kradung); PENINSULAR: Trang (Khao Chong), Yala (Bannang Sata).

Distribution. — India, Hainan, Taiwan, Vietnam, Malesia (type from Java).

Ecology. — On mossy tree trunks in lower montane rainforest at 1,600 m alt.

Specimens examined. — *K. Punchay* 202, *P.J. Edward* 3528, *T. Smitinand* 1359, *T. Smitinand & F. Floto* 6098, *D.J. Middleton*, *P. Karaket*, *S. Lindsay*, *T. Phutthai & S. Suddee* 5544, *T. Shimizu & M. Hutoh* 10203 (BKF).

## 2. HAPLOPTERIS

C. Presl, Tent. Pterid. 141. 1836.

Rhizomes short creeping. Stipe short or not distinct. Fronds simple, linear, entire, glabrous; vein anastomosing. Sori elongate marginal or submarginal, groove on each side of lamina or immersed.

*Haplopteris angustifolia* (Blume) E.H. Crane, Syst. Bot. 22: 514. 1998. — *Vittaria angustifolia* Blume, Enum. Pl. Javae.: 199. 1828; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 111. 1967; Tagawa & K. Iwats., Fl. Thailand 3(2): 225. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 106, 107, 135. 2000. **Fig. 5.27: C.**

Rhizomes short creeping, 1.2 mm diam., densely scaly throughout; scales narrow, gradually narrowing from base towards hair-pointed apex, up to 6 mm long 0.7 mm wide, brown to greyish-brown, clathrate, minutely toothed at margin. Stipes short or indistinct, green or dark at the very base. Laminae linear, often slightly broader in upper part, 24-37 cm long, 2.8-4.4 mm wide, usually curved, acute at apex, gradually narrowing downwards and merging into very narrow wings of stipe,

leathery; costa visible on upper surface or indistinct, the margin flat or revolute, veins anastomosing to form narrow areoles. Sori immersed in deep groove almost at margin of fronds, occupying most of frond length or limited to the upper half.

Thailand. — SOUTH-EASTERN: Chanthaburi (Khao Soi Dao, Khao Sabap); PENINSULAR: Nakhon Si Thammarat (Khao Luang), Krabi (Khao Phanom Bencha), Trang (Khao Chong), Yala (Khao Kalakhiri, Bla Hat).

Distribution. — N and NE India, S China, Vietnam, and throughout Malesia east to New Caledonia.

Ecology. — On mossy tree trunks in lower montane rainforest at 1,600 m alt.

Specimens examined. — *K. PUNCHAY 200, E. HENNIPMAN 3940, J.F. MAXWELL 86-663, T. SHIMIZU, K. IWATSUKI, N. FUKUOKA & M. HUTOH 13249* (BKF).

### THELYPTERIDACEAE

Pic.Serm., *Webbia* 24: 709. 1970; Tagawa & K. Iwats., *Fl. Thailand* 3(3): 393, 1988.

Rhizomes erect, ascending, or creeping. Fronds clustered or remote; stipes slender, usually scaly at bases. Laminae monomorphic, usually unipinnate to tripinnatifid; pinnae with dense grayish acicular hairs, with or without aerophores at bases of pinnae; vein free or anastomosing herbaceous, papery or coriaceous. Sori round, indusiate or exindusiate; indusia orbicular-reniform.

#### Key to the genera

- 1a Veins anastomosing.....**1. Cyclosorus**  
 1b Veins all free  
   2a. Veinlets not reaching very margin of lobes  
     3a. Lamina pinnate to bipinnatifid.....**3. Thelypteris**  
     3b. Lamina tripinnate to quadripinnate.....**2. Macrothelypteris**  
   2b. Veinlets reaching very margin of lobes  
     4a. Callous membrane hardly present.....**3. Thelypteris**  
     4b. Callous membrane present.....**1. Cyclosorus**

## 1. CYCLOSORUS

Link, Hort. Berol. 2: 128. 1833; J.L. Tsai & W.C. Shieh, Fl. Taiwan. ed. 2. 364. 1994.

Rhizomes erect or creeping. Frond pinnate-bipinnatifid, vein free or anastomosing, pinnae suddenly reduced or suddenly reduced, bearing aerophore. Sori round, indusial round-reniform, with or without hair.

### Key to the species

#### 1a. Vein all free

2a Lower pinnae suddenly reduced into auricle along stipe.....**5. *C. tylodes***

2b. Lower pinnae gradually reduced, the lowest pairs being butterfly-shaped.....

.....**1. *C. canus***

#### 1b. Vein anastomosing

3a. Pinnae variously lobed with callous membrane

4a. Pinnae up to 23 cm long, about 2.3 cm broad.....**3. *C. papilio***

4b. Pinnae 4-5 cm long, about 1 cm wide.....**4. *C. siamensis***

3b. Pinnae subentire without callous membrane.....**2. *C. lakhimpurens***

- 1. *Cyclosorus canus*** (Baker) S. Linds., Edinburgh J. Bot. 66: 359. 2009. — *Nephrodium canum* Baker, Syn. Fil. 267. 1867. — *Thelypteris repens* (C. Hope) Ching, Bull. Fan Mem. Inst. Biol. 6: 304. 1936; Tagawa & K. Iwats., Fl. Thailand 3(3): 422. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 230. 2000. **Fig. 5.28: A-B.**

Rhizomes short creeping, about 3 mm diam.; scales 4-8 mm long, 1.5-2 mm wide, pale brown, membranous, appressed, hairy. Stipes stramineous, with reduced pinnae, or auricled, nearly to base, 30-50 cm to first full-sized pinnae. Laminae oblong-lanceolate, acute at apex, narrowing towards base, 110 by 30 cm; pinnae 30 pairs, middle pinnae sessile, patent, 23 cm long, 1.5 cm wide, 6-10 pairs, linear-lanceolate, acute at apex, truncate and more or less auricled at base, deeply lobed; basal pinnae rather remote, reduced; segments oblong, oblique, round to moderately acute at apex, entire and somewhat involute at margin, 40 pairs in largest pinnae;



softly chartaceous, green; costa and rachis hairy; veins pinnate, veinlets simple, hairy. Sori medial, round; indusia persistent, hairy.

Thailand. — Chiang Mai (Doi Pha Hom Pok, Ban Yang), Chiang Rai (Doi Phacho); EASTERN: Chaiyaphum (Thung Kamang).

Distribution. — Himalaya (Himalaya) to SW China and N Vietnam.

Ecology. — On wet ground by streams at 1,600 m alt.

Specimens examined. — *K. Punchay* 238, *C.R. Das* 48, *J.F. Maxwell* 93-132 (BKF).

2. *Cyclosorus lakhimpurens* (Rosenst.) Copel., Gen. Fil. 142. 1947. — *Thelypteris lakhimpurens* (Rosenst.) K. Iwats., Mem. Coll. Sci. Univ. Kyoto B. 31: 194. 1965; Tagawa & K. Iwats., Fl. Thailand 3(2): 412. 1988. — *Pronephrium lakhimpurens* (Rosenst.) Holttum, Blumea 20: 110. 1972; Boonkerd & Pollawatn, Pterid. Thailand: 226. 2000. — *Dryopteris lakhimpurens* Rosenst., Meded. Rijks-Herb. 31: 7. 1917. **Fig. 5.27: D-E.**

Rhizomes creeping, 6-8 mm diam., blackish; scales oblong-ovate with tails, up to 5 by 1.3 mm, brown, hairy. Stipes 66-78.5 cm long, stramineous with dark scaly base. Laminae oblong, 40-105 by 25-50 cm; lateral pinnae 6-12 pairs, sessile, ascending, narrowly oblong, cuspidate at apex, rounded to broadly cuneate at base, subentire or irregularly undulate, 22-27 by 4-5.5 cm, aerophores present at rachis-costa junction, basal pinnae reduced or not; thin, papyraceous to herbaceous, green to dark green, tinted red in dried specimens, glabrous to densely minutely pubescent beneath; venation meniscioid, or excurrent veins interrupted. Sori in two rows usually close to excurrent veinlets, round to oblong, often confluent at maturity, exindusiate; sporangia not setose, sometimes glands on sporangial body.

Thailand. — NORTHERN: Mae Hong Son, Chiang Mai (Doi Chaing Dao, Doi Suthep, Doi Inthanon, Ban Yang), Chiang Rai (Mae Lao, Doi Tung), Tak, Phitsanulok (Phu Miang, Thung Salaeng Laung); NORTH-EASTERN: Loei (Phu Luang); SOUTH-WESTERN: Kanchanaburi (Song Tho).

Distribution. — Himalaya (type) to SW China and N Vietnam.

Ecology. — On mountain slopes under shade or light shaded area at 1,600 m alt.

Specimens examined. — *K. Panchay 054 (BCU)*; *T. Vongthavon 150, M. Tagawa, K. Iwatsuki, & N. Fukuoka T1296, T2038, T2411, T2412, K. Larsen 9472, K. Panchay 240 (BKF)*.

3. *Cyclosorus papilio* (C. Hope) Ching, Bull. Fan Mem. Inst. Biol. 8: 214. 1938. — *Thelypteris papilio* (C. Hope) K. Iwats., Mem. Coll. Sci. Univ. Kyoto B. 31: 175. 1965; Tagawa & K. Iwats., Fl. Thailand 3(3): 428. 1988. — *Christella papilio* (C. Hope) Holttum in B.K. Nayar & S. Kaur, Companion Handb. Ferns Brit. India: 208. 1974; Boonkerd & Pollawatn, Pterid. Thailand: 221. 2000. — *Nephrodium papilio* C. Hope, J. Bomb. Nat. Hist. Soc. 12: 625, t. 12. 1899.

Rhizomes massive, erect; stipe about 20 cm long, 3.6 mm in diam., minutely hairy, basal scales thin, 7 mm by 1 mm Laminae 90 cm long, 40 cm wide; about 30 pairs of pinnae with terminal pinna, the lowermost about 10 pairs gradually decrescent, broadly triangular, strongly auricled on acroscopic base, broadly truncate on basisopic, margins above base shallowly lobed, apex acuminate; the lowest pinnae 1-3 cm long, largest pinnae to 23 cm long, 2.3 cm wide, aerophore present at base of pinnae, base subtruncate or broadly cuneate, apex acuminate; edges lobed 1/4-1/3 towards costa and more deeper in fertile pinnae, lobes slightly falcate and rounded at their tips with callous membrane at sinus; costules 4-4.5 mm apart; veins 7-9 pairs, first pairs of vein anastomosing and second pairs ending beside the sinus-membrane; lower surface of all parts bearing very short erect hairs, some thick orange glandular hairs sometimes present on veins in pinna-lobes; upper surface of costae covered with hairs 0.3-0.5 mm long, scattered shorter hairs on costules, minute erect hairs on surface between veins. Sori medial; indusia 1-1.5 mm in diam., thin, with short hairs as lamina.

Thailand. — Chiang Mai (Doi Inthanon, Doi Suthep), Tak, Phitsanulok;  
SOUTH-WESTERN: Kanchanaburi (Khao Ngi Yai), Prachuap Khiri Khan.

Distribution. — Sri Lanka, Himalaya, Taiwan, and Peninsular Malaysia.

Ecology. — On moist ground in lower montane rainforest at 1,700 m alt.

Specimens examined. — *K. Punchay* 123, *K. Bunchuai* & *B. Nimanong* 1438, *E. Hennipman* 3074, 3126, *Winit* 986, 1123 (BKF).

4. *Cyclosorus siamensis* (Tagawa & K. Iwats.) Panigrahi, Res. J. Pl. Environ. 9: 67. 1993. — *Thelypteris siamensis* Tagawa & K. Iwats., Acta Phytotax. Geobot. 22: 101, f. 5. 1967; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 65. 1967; Tagawa & K. Iwats., Fl. Thailand 3(3): 426, 1988. — *Christella siamensis* (Tagawa & K. Iwats.) Holttum, Kew Bull. 31: 332. 1976; Boonkerd & Pollawatn, Pterid. Thailand: 221. 2000. **Fig. 5.28: C-D.**

Rhizomes erect; scales linear-lanceolate with long tails, 6-11 mm long by 1.2 mm, sparsely hairy at margin. Stipes brown, densely scaly at base, hirsute throughout, 7.5-15 cm long. Laminae oblong-lanceolate, acute at apex, 27-37 cm long, 8-11 cm wide; a few lower pinnae slightly reduced, deflexed, auricled at acroscopic base, middle larger ones falcate, sessile, linear-lanceolate, long-acuminate at apex, broadly cuneate to truncate at base, alternate to subopposite, about 15 pairs, 4.5-5 cm long by 1 cm, lobed to 2/3 way to costa; segments oblong, oblique, rounded to moderately acute at apex, entire; papyraceous, hairy on surface; basal veinlets uniting to form goniopteroid venation. Sori medial to supramedial; indusia round-reniform, persistent.

Thailand. — NORTHERN: Chiang Mai, Nan; NORTH-EASTERN: Phetchabun (Phu Miang), Loei (Phu Luang, type).

Distribution. — Endemic to Thailand.

Ecology. — On dry ground in lower montane rainforest at 1,600-1,700 m alt.

Specimens examined. — *K. Punchay* 156, 157 (BCU); *J.F. Maxwell* 96-1697, 98-816, *L.M. Dence* 33, *K. Punchay* 157 (BKF).

5. *Cyclosorus tylodes* (Kunze) Panigrahi, Res. J. Pl. Environ. 9: 67. 1993. — *Aspidium tylodes* Kunze, Linnaea 24: 283. 1851. — *Thelypteris tylodes* (Kunze) Ching, Bull. Fan Mem. Inst. Biol. 6: 296. 1936; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 67. 1967; Tagawa & K. Iwats., Fl. Thailand 3(3): 421. 1988. **Fig. 5.28: E-G.**

Rhizomes short, ascending to suberect; scales small, caducous, up to 2 by 1.3-1.9 mm, brown, hairy. Stipes 40-80-(130) cm long, variable in size, groove above, bearing auricles of reduced pinnae nearly to the base. Laminae oblong-lanceolate, acute to acuminate at apex, 30-110 by 16-50 cm, variable in size, chartaceous or subcoriaceous; pinnae 20-30 pairs, 8-26 cm long, by 1-2.5 cm, lower pinnae suddenly reduced to auricles, lowest normal pinna often reduced and deflexed, middle pinnae linear-lanceolate, gradually narrowing towards long-acuminate apex, broadly cuneate at sessile base, basiscopic lobes at base of pinnae larger, deeply lobed to 3/4 way to costa; segments narrowly oblong, oblique, acute at apex, entire or crenate, about 10 mm long, 3.5 mm wide; deep green; veins pinnate, veinlets simple, basal ones running to callous-membrane in sinus between segments; costa hairy above and glabrous beneath, lamina and veinlets glabrous above and beneath, small hairs around margin. Sori round, medial to costular; indusia persistent, glabrous.

Thailand. — NORTHERN: Chiang Mai (Doi Suthep, Doi Inthanon, Doi Chiang Dao, Ban Yang, Sob Aep), Chiang Rai (Doi Tung, Doi Pacho), Tak, Phitsanulok (Phu Miang).

Distribution. — Sri Lanka, S India (type), Himalaya, S & SW China and Vietnam.

Ecology. — On wet sandy ground along road in light shade at lower montane rainforest at 1,600-1,700 m alt.

Specimens examined. — K. Punchay 179 (BCU); E. Hennipman 3358, S. Sankamethawee 410, M. Tagawa, K. Iwatsuki & N. Fukuoka T3165, K. Iwatsuki & N. Fukuoka T3443, Winit 1172, K. Punchay 180 (BKF).

## 2. MACROTHELYPTERIS

(H. Itô) Ching, Acta Phytotax. Sin. 8: 308. 1963.

Rhizomes erect, with brown scales. Stipes stramineous. Laminae large, ovate-triangular, 3- or 4-pinnate-pinnatifid, texture herbaceous to softly papyraceous; pinna-rachis hairy on upper surface; veins and surfaces hairy with unicellular or multicellular hairs. Sori small, attached near ends of veinlets, indusiate.

*Macrothelypteris torresiana* (Gaudich.) Ching, Acta Phytotax. Sin. 8: 310. 1963; Boonkerd & Pollawatn, Pterid. Thailand: 224. 2000. — *Polystichum torresianum* Gaudich. in Freyc., Voy. Bot.: 333. 1817. — *Thelypteris torresiana* (Gaudich.) Alston, Lilloa 30: 111. 1960; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 64. 1967; Tagawa & K. Iwats., Fl. Thailand 3(3): 398. 1988. **Fig. 5.29: A-B.**

Rhizomes short creeping to suberect; scales narrow, brown, up to 7 by 1.5 mm, hairy on dorsal and ventral surface as well as margin, the base often a few cells thick. Stipes 30-68 cm long, about 1 cm diam. near base, terete when fresh but grooved when dry, sometimes spiny in lower part. Laminae oblong to oblong-ovate, deeply tripinnatifid, 30-67 cm by 25-67 cm; pinnae 12-15 pairs, oblong, acuminate at apex, basal pair 14-38 cm by 7-17 cm; larger pinnules sessile, oblong-subdeltoid, acuminate at apex, 4-9 cm by 1-3 cm; ultimate segments oblong, oblique, rounded to moderately acute at apex, lobed to 3/4 way towards midrib, each segment about 1.5 mm long, 0.5 mm wide; lobes oblong to subdeltoid, entire, sometimes involute; rachis terete, glabrous; pinna-rachis hairy on upper surface, costules winged throughout, hairy; veins and surfaces hairy with unicellular or multicellular hairs about 1.75 mm long; texture herbaceous to softly papyraceous, green but often brownish when dried. Sori round, usually close to midrib of ultimate segments; indusia small, often covered by mature sporangia, round-reniform, with long hairs.

Thailand. — NORTHERN: Chiang Mai (Doi Chiang Dao, Bo Luang, Doi Saket, Mae Kang, Pha Mon), Chiang Rai, Lamphun (Doi Khun Tan), Lampang, Tak (Ban Musoe); SOUTH-WESTERN: Kanchanaburi (Sai Yok); CENTRAL: Nakhon

Nayok (Khao Yai); SOUTH-EASTERN: Trat (Ko Chang); PENINSULAR: Chumphon, Surat Thani (Ban Don), Nakhon Si Thammarat (Khao Luang), Satun, Yala (Betong).

Distribution. — Mascarene Islands, throughout tropical Asia (type from Marina Islands), Polynesia, Hawaii, north to Japan and south to Australia; also naturalized in the New World.

Ecology. — On wet ground under light shade in lower montane rainforest at 1,600 m alt.

Specimens examined. — *K. Panchay 155* (BCU); *D.J. Middleton, P. Karaket, S. Lindsay & S. Suddee 4778, D.J. Middleton, S. Suddee, S. J. Devies & C. Hemrat 1072, Winit 1067 K. Panchay 229* (BKF).

### 3. THELYPTERIS

Schmidel, Icon. Pl., Ed. Keller 3, 45. 1763; Tagawa & K. Iwats., Fl. Thailand 3(3): 393. 1988.

Rhizomes erect or creeping, bearing scale and hair. Stipe stramineous or brown. Lamina pinnate to bipinnatifid; pinnae stalk or sessile; costa hairy or with scale, more or less winged. veinlets forked or simple, reaching the margin of lobes or not. Sori round, indusial round reniform, hairy.

#### Key to the species

- 1a. Vein not reaching the very margin of lobes.....**2. *T. flaccida***  
 1b. Vein reaching the very margin of lobes.....**1. *T. confluens***

- 1. *Thelypteris confluens*** (Thunb.) C.V. Morton, Contr. U.S. Natl. Herb. 38: 71. 1967; Tagawa & K. Iwats., Fl. Thailand 3(3): 410. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 230. 2000. — *Pteris confluens* Thunb., Prodr. Pl. Cap.: 171. 1800.

Rhizomes long creeping, with distant fronds; scales oblong with long tails, sparsely hairy at margin, 2 by 0.8 mm, pale brown. Stipes stramineous with dark base,

about 20 cm long. Laminae oblong-lanceolate, acute at apex, up to 25 by 8 cm wide, pinnate; lateral pinnae lanceolate, acute at apex, shortly stalked, pinnatisect, up to 7 by 1.2 cm; segments oblong, oblique, moderately acute at apex; rachis and costa scaly underneath with broad pale brown membranous scales; veins pinnate, veinlets forked or simple, reaching the margin of lobes. Sori dorsal on veinlets, round, sometimes adhering to the next at maturity; indusia round-reniform, hairy at margin.

Thailand. — NORTHERN: Chiang Mai (Doi Inthanon, Doi Suthep).

Distribution. — Africa (type), S India, Burma, Laos, Sumatra, New Guinea, and New Zealand.

Ecology. — On wet ground under light shade in lower montane rainforest at 1,600 m alt.

Specimens examined. — *K. Panchay 156, Th. Sorensen, K. Larsen & B. Hansen 2727 (BKF); Beddome R.H. s.n., Colenso, W. 119 (K); Rakotondrainibe F. 435 (P).*

2. *Thelypteris flaccida* (Blume) Ching, Bull. Fan Mem. Inst. Biol. 6: 336. 1936; Tagawa & K. Iwats., Fl. Thailand 3(3): 399. 1988. — *Aspidium flaccidum* Blume, Enum. Pl. Javae.: 161. 1828. — *Metathelypteris flaccida* (Blume) Ching, Acta Phytotax. Sin. 8: 306. 1963; Boonkerd & Pollawatn, Pterid. Thailand: 224. 2000. **Fig. 5.29: C-D.**

Rhizomes short, erect; scales brown, narrow, thin and usually crisped, up to 3-4 by 0.6 mm, brown, hairy on dorsal surface and at margin. Stipes 9-20 cm long., stramineous to pale castaneous, scaly on basal portion, hairy throughout. Laminae oblong-lanceolate, pinnate-bipinnatifid, about 30 cm long by 15 cm, fertile frond slightly longer than sterile frond; pinnae about 3 cm apart, falcate, basal one or two smaller, all sessile, middle larger ones lanceolate, acuminate at apex, up to 8 by 2 cm; costa hairy throughout, winged; pinnules patent, narrowly oblong, rounded at apex, decurrent at base towards the wings of costa, deeply lobed to 2/3 way towards costule, up to 10 by 4-5 mm; lobes oblong to subdeltoid, moderately acute at apex, serrate; papyraceous, green; veins pinnate, veinlets usually forked, not reaching the very

margin of lobes; hairs all unicellular, simple, patent or sometimes hooked on laminar surface. Sori dorsal on veinlets, medial; indusia caducous, small, pale brown, hairy.

Thailand. — NORTH-EASTERN: Phetchabun (Phu Miang).

Distribution. — Sri Lanka, India, SW China (Yunnan and Guizhou), N Vietnam, and Java (type).

Ecology. — On moist or dry area with half-shaded in lower montane rainforest at 1,600-1,740 m alt.

Specimens examined. — *K. PUNCHAY 088* (BKF).

## WOODSIACEAE

Herter, *Revista Sudamer. Bot.* 9: 14. 1949. — Athyriaceae Alston, *Taxon* 5: 25. 1956; Tagawa & K. Iwats., *Fl. Thailand* 3(3): 436. 1988; W.C. Shieh, C.E. Devol & C.M. Kuo, *Fl. Taiwan. ed. 2*: 414. 1994.

Rhizomes erect, ascending or creeping, bearing scale; scale concolorous or black at margin, entire or toothed. Lamina simple, pinnate or more compound, sometime having small horn-shape outgrowth at junction between rachis and costa; vein free. Sori elongate along vein, linear, horse shoes shaped or J-shaped, indusiate or exindusiate, indusia usually on both side and one side of vein.

### Key to the genera

1a. Sori indusiate, No fleshy horn-shape out growth at junction of rachis and its branches

2a. Indusia rarely on both side, sori horse shoes shaped or J-shaped.. **1. Athyrium**

2b. Indusia usually on both side..... **3. Diplazium**

1b. Sori exindusiate fleshy horn-shape out growth present at junction of rachis and its branches..... **2. Cornopteris**

### 1. ATHYRIUM

Roth, *Tent. Fl. Germ.* 3(1): 31. 1800; Tagawa & K. Iwats., *Fl. Thailand* 3(3): 445. 1988.



Rhizomes erect, scaly at apex; scale brown, concolorous. Lamina pinnate to pinnately compound; rachis grooved above, bearing horn-like appendage; vein pinnate, all free. Sori oblong, horse-shoes shape, J-shaped or curved, indusiate.

#### Key to species

- 1a. Frond pinnate to bipinnatifid, lowest pairs of pinnae falcate.....**2. *A. sp.***  
 1b. Frond bipinnate to tripinnatifid, lowest pairs of pinnae deflexed**1. *A. mackinnonii***

- 1. *Athyrium mackinnonii*** (C. Hope) C. Chr., Index Filic.: 143. 1905; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 102. 1967; Tagawa & K. Iwats., Fl. Thailand 3(3): 446. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 189. 2000. — *Asplenium mackinnonii* C. Hope, J. Bot. 34:124. 1896. **Fig. 5.29: E-F.**

Rhizomes erect, with a few fronds at apex, scaly; scales narrow with long-tailed apex, up to 8 by 2.5 mm, dark brown, entire. Stipes 20-25 cm long, stramineous, dark brown and scaly at base. Laminae broadly oblong, acute at apex, 28-31 cm long, 22-24 cm, bipinnate-tripinnatifid; pinnae about 10 pairs, lowest pairs deflexed, lower pinnae 3-5 mm stalked, ascending, oblong-lanceolate, 12-14 cm long by 3-5 cm, the upper pinnae becoming smaller upwards; pinnules up to 20 pairs, anadromous, sessile or shortly stalked, oblong, oblique, moderately acute to rounded at apex, truncate to auricled at anterior and cuneate at posterior bases, bearing spine at junction between costa and pinnule, 2.0-2.4 cm long, 1-1.3 cm wide; ultimate segments oblong, rounded at apex, distinctly toothed; papyraceous to subcoriaceous; veins pinnate, veinlets simple or rarely forked, ending in teeth at margin of segments. Sori oblong, usually closed to costules; indusia opening toward costules, oblong, crenate at margin.

Thailand. — NORTHERN: Chiang Mai (Doi Pha Hom Pok, Doi Inthanon), Phitsanulok (Phu Miang); NORTH-EASTERN: Loei (Phu Kradung); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao).

Distribution. — Wider Distribution India (type), SW China and Indochina.

Ecology. — Terrestrial on humus-rich moist ground in lower montane rainforest at 1,700 m alt.

Specimens examined. — *K. Punchay* 019 (BCU); *B. Hansen*, *G. Seidenfaden* & *T. Smitinand* 10914, *E. Hennipman* 3419, *T. Shimizu*, *K. Iwatsuki*, *N. Fukuoka*, *M. Hutoh* & *D. Chaiglom* T11615, *G. Murata*, *K. Iwatsuki*, *C. Phengkklai* & *C. Charamphol* T16071 (BKF).

## 2. *Athyrium* sp. Fig. 5.30: A-C.

Rhizomes erect, about 10 mm in diam., bearing tuft of frond; scale concolorous brown, lanceolate with long acuminate apex, up to 13 mm long 1-2 mm wide. Stipes stramineous, brown and densely scale at base, sparsely scale on upper part, grooved, 18-34 cm long. Laminae ovate to subdeltoid in outline. pinnate to bipinnatifid, papyraceous green, about 34 cm long, 26 cm wide; pinnae lanceolate to oblong, apex acuminate, base subtruncate to broadly cuneate, falcate, 13-15 cm long, 3-4.2 cm wide, stalked, lowest pinnae slightly shorter than next one, gradually reduced toward apex; rachis and costa sometimes tinted red, bearing short hairs; pinnules oblong, base cuneate, round at apex, 2.2-2.5 cm long, 0.8-1 cm wide, catadromous except lowest pinnae anadromous, 1/3 lobed to costules, horn-like outgrowth present at base of costules; vein free, forked, reaching to margin; Sori elongate along veinlet, oblong, curved, 3-5 mm long; indusial pale, thin, margin slightly crenate and undulate.

Thailand. — NORTHERN: Phetchabun (Phu Thab Boek).

Distribution. — N/A.

Ecology. — Terrestrial on mountain slope in lower montane rainforest at 1,700 m alt.

Specimens examined. — *K. Punchay* 227, 243 (BCU).

Note. — This species have bipinnatifid lamina, ovate to subdeltoid in outline and sori usually curved, it's different from the previous known *Athyrium* ferns in Thailand.

## 2. CORNOPTERIS

Nakai, Bot. Mag. (Tokyo) 44. 7. 1930; Tagawa & K. Iwats., Fl. Thailand 3(3): 441. 1988

Rhizomes ascending to suberect, scale narrow, concolorous, entire. Lamina bipinnate to tripinnatifid; rachis grooved above; veins pinnate with simple or rarely forked veinlets reaching margin of lobes. Sori dorsal on veins, oblong or V-shaped, exindusiate

*Cornopteris opaca* (D. Don) Tagawa, Acta Phytotax. Geobot. 8: 92. 1939; Tagawa & K. Iwats., Fl. Thailand 3: 441. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 190. 2000. — *Hemionitis opaca* D. Don, Prodr. Fl. Nepal.: 13. 1825. **Fig. 5.30: D-E.**

Rhizomes ascending to suberect, bearing a few fronds near apex; scales narrow, up to 8 by 1-2 mm, entire, brown, membranous. Stipes 25-45 cm long, stramineous to brown, densely scaly at base. Laminae bipinnate to tripinnatifid, lanceolate with acute apex and round base, about 52-65 cm long about 28 cm wide; pinnae 9-11 pairs, subopposite, ascending, sessile or shortly stalked in larger ones; rachis grooved above, the grooves decurrent to those of pinnae, cluster of small outgrowths at junction of rachis and costae, sometimes also at junction of costae and costules with a linear brown scale; pinnules of the larger pinnae narrowly oblong-subdeltoid, acute to acuminate at apex, truncate or broadly cuneate at sessile base, up to 10 cm long by 2.5 cm wide, acroscopic pinnules much smaller than basiscopic pinnules ;lobed nearly to costule with subquadrangular lobes with obtuse apex and subentire or crenate margin of about 1 by 0.5 cm; texture herbaceous to thin-papyraceous, usually blackish when dry; veins pinnate with simple or rarely forked veinlets reaching or almost reaching the very margin of lobes. Sori dorsal on veins, oblong or V-shaped, exindusiate.

Thailand. — NORTHERN: Mae Hong Son, Chiang Mai, Lampang; SOUTH-WESTERN: Phetchaburi.

Distribution. — N India, Nepal (type) to SW Japan, south to Vietnam; also in Java

Ecology. — Terrestrial on mountain slope in lower montane rainforest at 1,700 m alt.

Specimens examined. — *K. Punchay* 247, 248 (BCU); *J.F. Maxwell* 97-137 (BKF); *M. Tagawa* 868, 2204, 2213, 3403, *J.F. Maxwell* 91-250 (P).

### 3. DIPLAZIUM

Sw., *J. Bot.* (Schrader) 1800(2). 61. 1801; Tagawa & K. Iwats., *Fl. Thailand* 3(2): 449. 1988.

Rhizomes erect, ascending or creeping bearing scale; scale concolorous or black at margin, entire or toothed Laminae simple to pinnately compound; vein free or rarely reticulate. Sori elongate along vein, diplaziod, indusiate.

#### Key to species

- 1a. Frond unipinnate.....**4. *D. lobatum***
- 1b. Frond bipinnate
- 2a. Rhizome creeping
- 3a. Scale brown, black at margin
- 4a. Sori submarginal; Vein 4-5 pairs.....**1. *D. conterminum***
- 4b. Sori close to costule; Vein 5-6 pairs.....**3. *D. griffithii***
- 3b. Scale concolorous brown.....**6. *D. procumbens***
- 2b. Rhizome erect or ascending
- 5a. Scale brown, black at margin
- 6a. Sori oblong less than 3 mm long.....**5. *D. polypodioides***
- 6b. Sori linear more than 5 mm long.....**2. *D. dilatatum***
- 5b. Scale concolorous dark brown .....**7. *D. sp.***

- 1. *Diplazium conterminum*** Christ, *J. Bot.* 19: 67. 1905; Tagawa & K. Iwats., *SouthE. Asian Stud.* 5: 105. 1967; Tagawa & K. Iwats., *Fl. Thailand* 3(3): 462. 1988; Boonkerd & Pollawatn, *Pterid. Thailand*: 191. 2000. **Fig. 5.30: F-G.**

Rhizomes creeping about 6 mm in diam.; scales dark brown, up to 15 by 1 mm, toothed and blackish at margin. Stipes up to 50 cm long, glabrous, brown. Lamina bipinnate, subdeltoid in outline, about 50 by 40 cm, softly papyraceous; lower pinnae with stalks up to 5 cm long, lanceolate, gradually narrowing towards acute apex, about 20 by 8 cm, basal pairs slightly reduced; larger pinnules oblong-subdeltoid, acute at apex, cordate to round at base, shortly stalked, lobed halfway to costule, about 8 by 2 cm; lobes crenate, up to 7 mm broad; dark green, paler beneath; veins pinnate with 5-8 pairs of simple veinlets. Sori oblong, usually along posterior half of veinlets, thus submarginal, 1- 2 mm long; indusia thin but firm, persistent.

Thailand. — NORTHERN: Phitsanulok (Phu Miang); PENINSULAR: Nakhon Si Thammarat (Khao Luang).

Distribution. — Vietnam (type), S China, Ryukyu, and SW Japan.

Ecology. — Terrestrial on mountain slope in lower montane rainforest at 1,700 m alt.

Specimens examined. — *K. Punchay* 207 (BCU); *L. Cadere* 89, *J. & M.S. Clemens* 3944 *T. Shimizu*, *K. Iwatsuki*, *N. Fukuoka*, *M. Hutoh* & *D. Chaiglom* T11603 (P).

2. *Diplazium dilatatum* Blume, Enum. Pl. Javae: 194. 1828; Holttum, Gard. Bull. Straits Settlements. 11: 85. 1940; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 106. 1967; Tagawa & K. Iwats., Fl. Thailand 3(3): 464. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 191. 2000. **Fig. 5.31: A-C.**

Rhizomes massive, erect, sometimes formed trunk; scales to about 15 mm long, 2 mm wide, more commonly narrower, dark brown, margin black and distinctly toothed. Stipes 53-78 cm or more high, about 7 mm in diam. at base, densely scaly near base, dark brown to stramineous. Laminae 65-110 cm long, 60-64 cm wide, bipinnate to tripinnatifid; pinnae 8-14 pairs, narrowly oblong, acuminate at apex, basal pinnules slightly reduced, 30-60 cm long, 14-30 cm wide; larger pinnule oblong-subtriangular, gradually narrowing towards attenuate apex, basal lobes a little

reduced, cordate at stalked base, lobed halfway to costa, 9-17 cm long, about 2.5 cm; lobes subentire, up to 7 mm in breadth; veins pinnate with 5-9 pairs of simple or forked veinlets. Sori along veinlets usually more than 5 mm long.

Thailand. — NORTHERN: Chiang Mai (Doi Chaing Dao, Doi Khun Huai Pong, Doi Suthep, Kang Kat, Doi Inthanon), Chiang Rai (Doi Pacho, Mae Kok), Tak (Ban Musoe), Phitsanulok (Thung Saleang Laung, Phu Rom Rot); NORTH-EASTERN: Phetchabun (Phu Miang), Loei (Phu Laung, Phu Kradung); EASTERN: Chaiyaphum (Thung Kamang), Nakhon Ratchasima (Khao Laem); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); PENINSULAR: Surat Thani (Khao Khieo range), Trang (Khao Chong).

Distribution. — India, Burma, S China, Taiwan, Ryukyu, S Japan, Indochina (type from Java), throughout Malesia to N Australia.

Ecology. — On moist area in lower montane rainforest at 1,600-1,740 m alt.

Specimens examined. — *K. Punchay* 039, 065, 072 (BCU); *Winit* 28-897 *T. Shimizu*, *K. Iwatsuki*, *N. Fukuoka*, *M. Hutoh* & *D. Chaiglom* T11360, *K. Iwatsuki*, *N. Fukuoka*, *M. Hutoh* & *D. Chaiglom* T10916, *J.F. Maxwell* 98-383, *K. Punchay* 072 (BKF); Blume s.n. (TYPE!), *HENDERSON*, *M.R.* 23620 (K)

3. *Diplazium griffithii* T. Moore, Index Fil. 330. 1861. — *Allantodia griffithii* (T. Moore) Ching, Acta Phytotax. Sin. 9(1): 52. 1964. — *Athyrium griffithii* (T. Moore) Milde, Bot. Zeitung (Berlin) 28: 354. 1870.

Rhizomes creeping, black-brown, up to 1 cm in diam., apex densely scaly; scales dark brown, lanceolate, about 25 mm long, 2 mm wide, toothed and black at margin. Stipe dark brown at base, upward stramineous, about 50 cm long, 2-3 mm in diam., base with sparse scales similar to those on rhizome, upward glabrous, grooved adaxially. Laminae bipinnate to tripinnatifid, about 100 cm long, subdeltoid in outline, apex acuminate, scale attached sparsely on rachis and costae, firmly herbaceous when dry, glabrous on both surfaces; pinnae 8-10 pairs, 34-40 cm long, about 15 cm wide, alternate, stalked, base cuneate, apex caudate or long acuminate; pinnules about 7.5 cm long by 2 cm wide, margin serrate, apex shortly acuminate or

rounded; veins visible on abaxial side, free forked. Sori shortly linear, elongate along veinlet, near costules, about 4 mm long or less; indusial membranous, entire.

Thailand. — NORTHERN: Chiang Mai (Doi Chaing Dao, Doi Inthanon), Tak (Um Phang), Tak (Doi Musoe); NORTH-EASTERN: Loei (Phu Luang).

Distribution. — China, India (type from Assam) and Vietnam.

Ecology. — On moist mountain slopes in shade area in lower montane rainforest at 1,700 m alt.

Specimens examined. — *K. Panchay 144* (BCU); *Griffith, W. s.n.* (TYPE!) (K); *B. Balansa 1841* (P).

4. *Diplazium lobatum* (Tagawa) Tagawa, Acta Phytotax. et Geobot. 20: 215. 1962. — *Diplazium donianum* var. *lobatum* Tagawa, Acta Phytotax et Geobot 10(4): 290. 1941. **Fig. 5.31: D-G.**

Rhizomes creeping up to 10 mm in diam., bearing wiry roots, cover with scale at apex; scales about 8 mm long, 1 mm wide, narrowly lanceolate with long tail apex, concolorous, dark brown, toothed at margin. Stipes 30-40 cm long, black at base and stramineous in upper part, glabrous, scaly at base. Laminae, oblong or oblong-lanceolate, 1-pinnate, 35-47 cm long, 22-25 cm wide, terminal pinna distinct, papyraceous; lateral pinnae 7-9 pairs, lanceolate to oblong, broadly cuneate to round at base, apex moderately long acuminate, 12-16 cm long, 2-3 cm wide, alternate, 4-6 cm apart, lower pairs stalked about 2-3 mm long, margin crenate to serrate at apex; terminal pinna like lateral one, sometimes with auricle at base; vein all free, 2-3 forked, reaching to margin. Sori long linear, oblique or slightly oblique, on all veinlet, often from midrib to laminar margin; indusial thin.

Thailand. — NORTHERN: Phitsanulok (Phu Hin Rong Kla)

Distribution. — Japan and Taiwan.

Ecology. — On moist mountain slopes under shade area in lower montane rainforest at 1,700 m alt.

Specimens examined. — *K. Punchay* 066 (BCU); *M. Tagawa* & *K. Iwatsuki* 4823, 4754, 4833, *T.U. Faury* 165, *R. Oldman* 32 (P).

5. *Diplazium polypodioides* Blume, Enum. Pl. Javae.: 194. 1828; Tagawa & K. Iwats., SouthE. Asian Stud. 5: 105. 1967; Tagawa & K. Iwats., Fl. Thailand 3(3): 465. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 194. 2000. Fig. 5.32: A-D.

Rhizomes massive, erect; scales narrow, about 20 by 1.5 mm, medium brown, black and toothed at margin. Stipes about 1.5 cm diam. near base, about 60 cm long, densely scaly near base, surface prickly due to scars of fallen scales. Laminae usually more than 1 m long, about 70 cm wide, bipinnate-tripinnatifid; lower pinnae about 58 cm long, 17 cm wide, acute at apex; larger pinnules oblong with acuminate apex and subtruncate base, sessile or shortly stalked, 7-10 by 2 cm, lobed nearly to costule; lobes oblong to subquadrangular, oblique, rounded to obtuse at apex, sharply serrate, about 4 mm broad, up to 1 cm long; papyraceous, deep green, paler below; veins pinnate, veinlets 5-9 pairs, mostly forked. Sori usually closed to costules, less than 2 mm long; indusia thin.

Thailand. — NORTHERN: Chiang Mai (Mae Klang, Doi Suthep, Doi Inthanon), Chiang Rai (Mai Lao), Phrae (Mae Sai), Tak, Phitsanulok (Phu Miang); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); PENINSULAR: Ranong (Phato), Surat Thani (Ban Don), Nakhon Si Thammarat (Khao Laung).

Distribution. — Wider Distribution Sri Lanka, S India, Himalaya, Indochina, throughout Malesia (type from Java), north to Taiwan.

Ecology. — On moist mountain slopes in lower montane rainforest at 1,700 m alt.

Specimens examined. — *K. Punchay* 142 (BCU); *M. Tagawa*, *K. Iwatsuki* & *N. Fukuoka* 3010, 3027, *E. Hennipman* 3434, *Winit* 960, 962 (BKF).

6. *Diplazium procumbens* Holttum, Gard. Bull. Straits. Settlem. 11(1): 95. 1940; Boonkerd et al., Thai For. Bull. (Bot.) 32: 7. 2004. **Fig. 5.32: E-H.**



Rhizomes creeping, 7-8 mm in diam.; scale lanceolate, brown, concolorous, toothed at margin, caduceus, 8-10 mm long, 1 mm wide. Stipes stramineous, dark brown at base, 30-40 cm long, glabrescent, slightly rough from the bases of fallen scales. Laminae deltoid, bipinnate, about 50 cm long and 30-40 cm wide, thinly papyraceous; largest pinnae 26 cm long, 16 cm wide; pinnules sessile or the lowest stalked, stalks up to 2 mm long, 7-9 cm long, 2-2.3 cm wide, base truncate, apex acuminate, sides lobed 3/4 way towards the costa; largest lobes 7 mm wide, oblong, apex rounded, edge slightly entire to dentate towards apex; veins all free, forked in the largest lobes, usually simple in smaller lobes, costae bearing few small narrow brown toothed scales. Sori close to costules linear, 2-4 mm long; indusial thin.

Thailand. — SOUTH-WESTERN: Phetchaburi (Kang Krachan National Park).

Distribution. — Malaysia.

Ecology. — On moist mountain slopes in lower montane rainforest at 1,700 m alt.

Specimens examined. — *K. PUNCHAY 038* (BCU); *R.E. Holtum 36503* (TYPE!) (US).

### 7. *Diplazium* sp.

Rhizomes creeping, thick, 1.5 cm in diam., bearing scale; scale dark brown, lanceolate about 3 mm, black and distinctly toothed at margin. Stipe stramineous and dark at base, grooved, 45-65 cm long. Laminae ovate, bipinnate to tripinnatifid, 54-56 cm long, 44 cm wide, papyraceous; largest pinnae lanceolate, 28.5-42 cm long and 15-20 cm wide, alternated, about 15 pairs bearing brown ovate-lanceolate scale with black and toothed margin; pinnules oblong-lanceolate, base truncate, acuminate at apex, 8.5 cm long about 3 cm wide, stalked, about 13 pairs; costules winged, base of costules bearing outgrowth; vein free, forked. Sori oblong, close to costules 3-4 mm long; indusial brown, thin.

Thailand. — NORTH-EASTERN: Phetchabun (Phu Thab Boek).

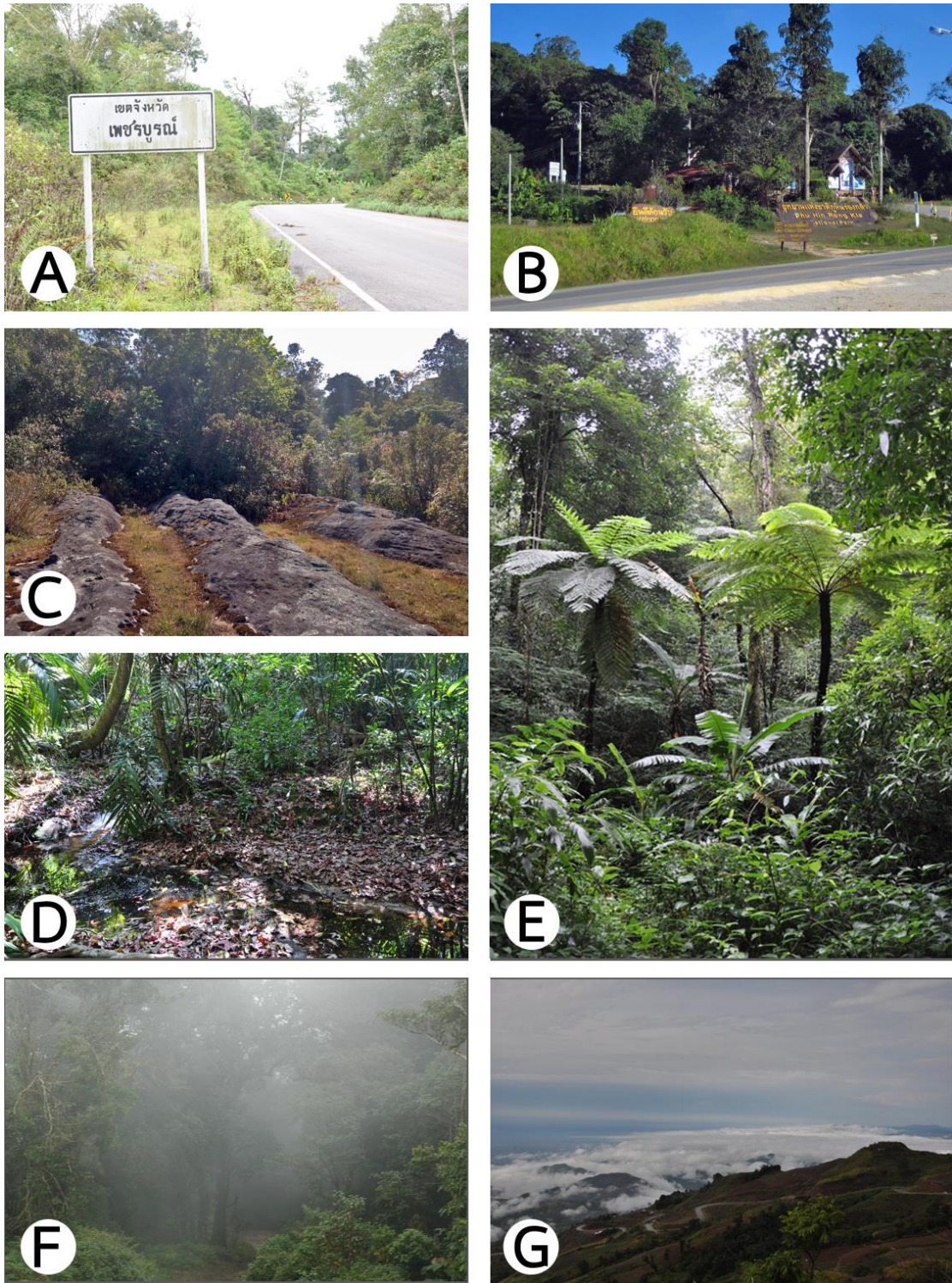
Distribution. — N/A

Ecology. — On moist mountain slopes in lower montane rainforest at 1,600 m alt.

Specimens examined. — *K. Panchay 122* (BCU).

Note. — This species close to *Diplazium muricatum* (Mett.) Alderw. but rhizome character is creeping not erect as *D. muricatum* (Mett.) Alderw





**Fig. 5.1** Phu Hin Rong Kla National Park; A: Main transect; B: Phu Thab Boek Protection Unit. C-F: Habitats in Phu Thab Boek area G: View from Phu Phaeng Ma.

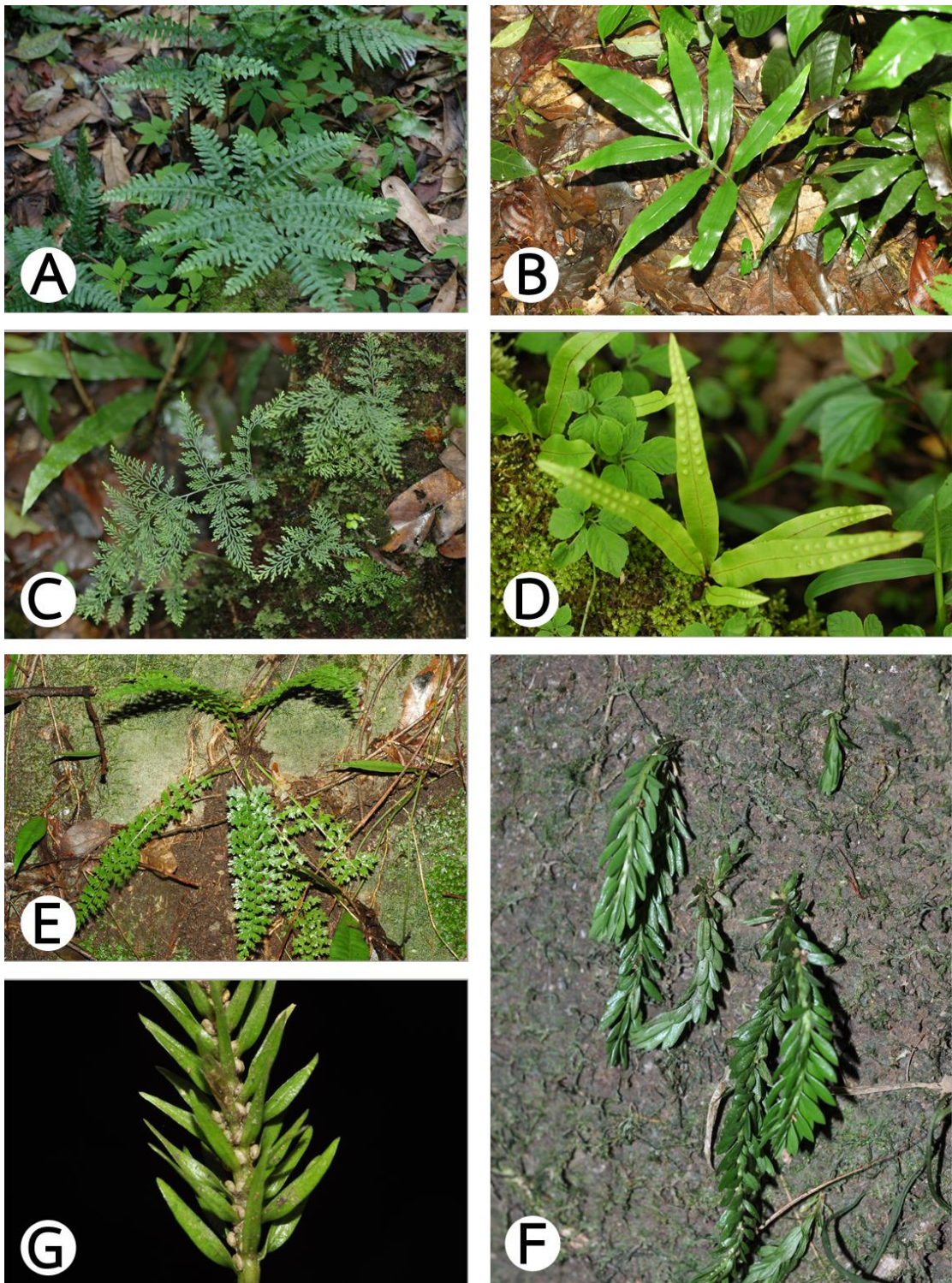
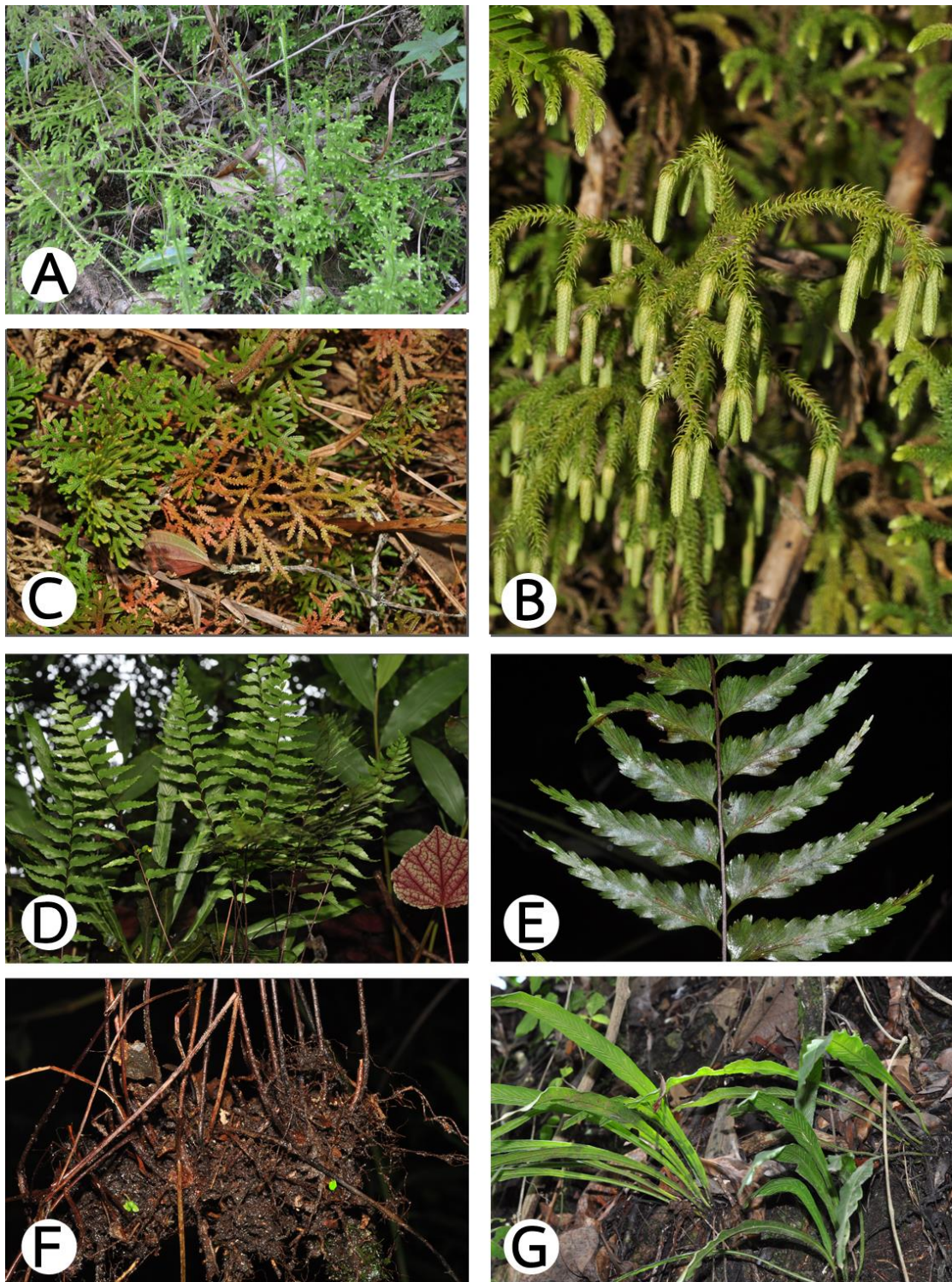
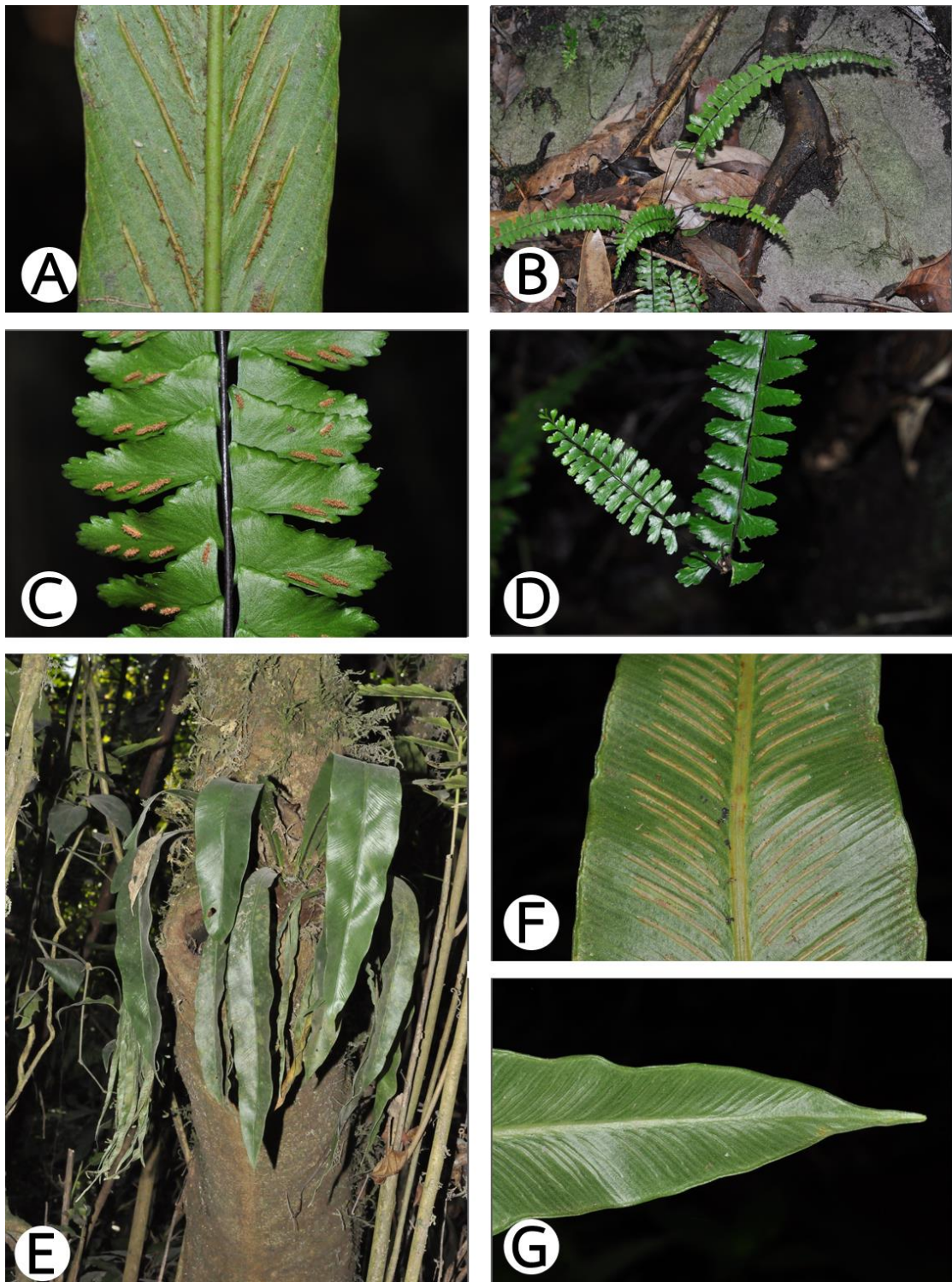


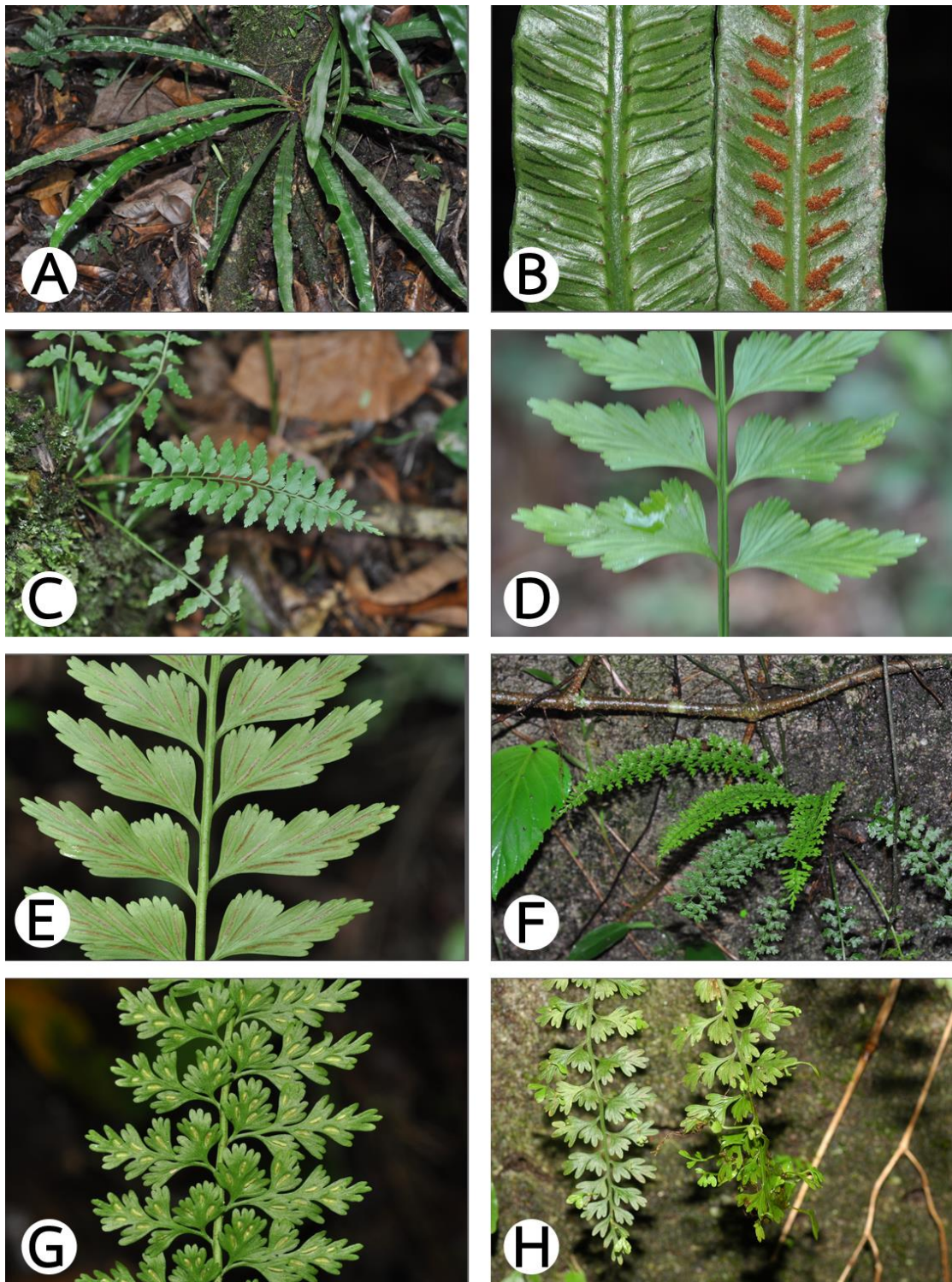
Fig. 5.2 Habitat of pteridophytes; A-B: Terrestrials; C-D: Epiphytes; E: Lithophyte; G-F: *Huperzia hamiltonii*, part of strobilus showing sporangia and habit.



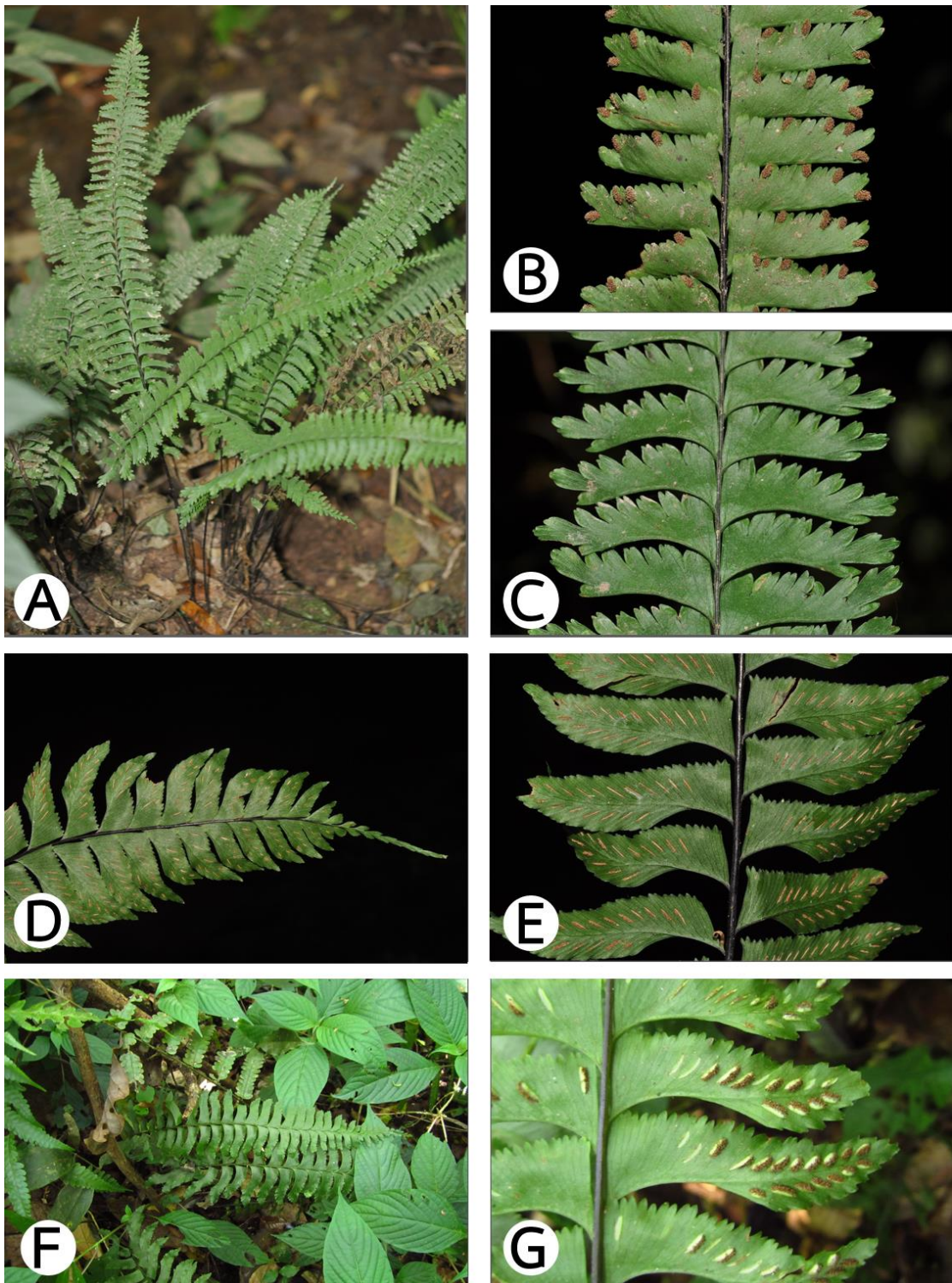
**Fig. 5.3** A-B: *Lycopodiella cernua*, habit and strobili; C: *Selaginella siamensis*, habit; D-F: *Asplenium contiguum*, fronds, sori and rhizome; G: *Asplenium ensiforme*, habit.



**Fig. 5.4** A: *Asplenium ensiforme*, part of lamina showing sori; B-D: *Asplenium normale*, habit, pinnae showing sori and a bulbil; E-F: *Asplenium phyllitidis* subsp. *phyllitidis*, habit, part of lamina showing sori and apex of lamina.

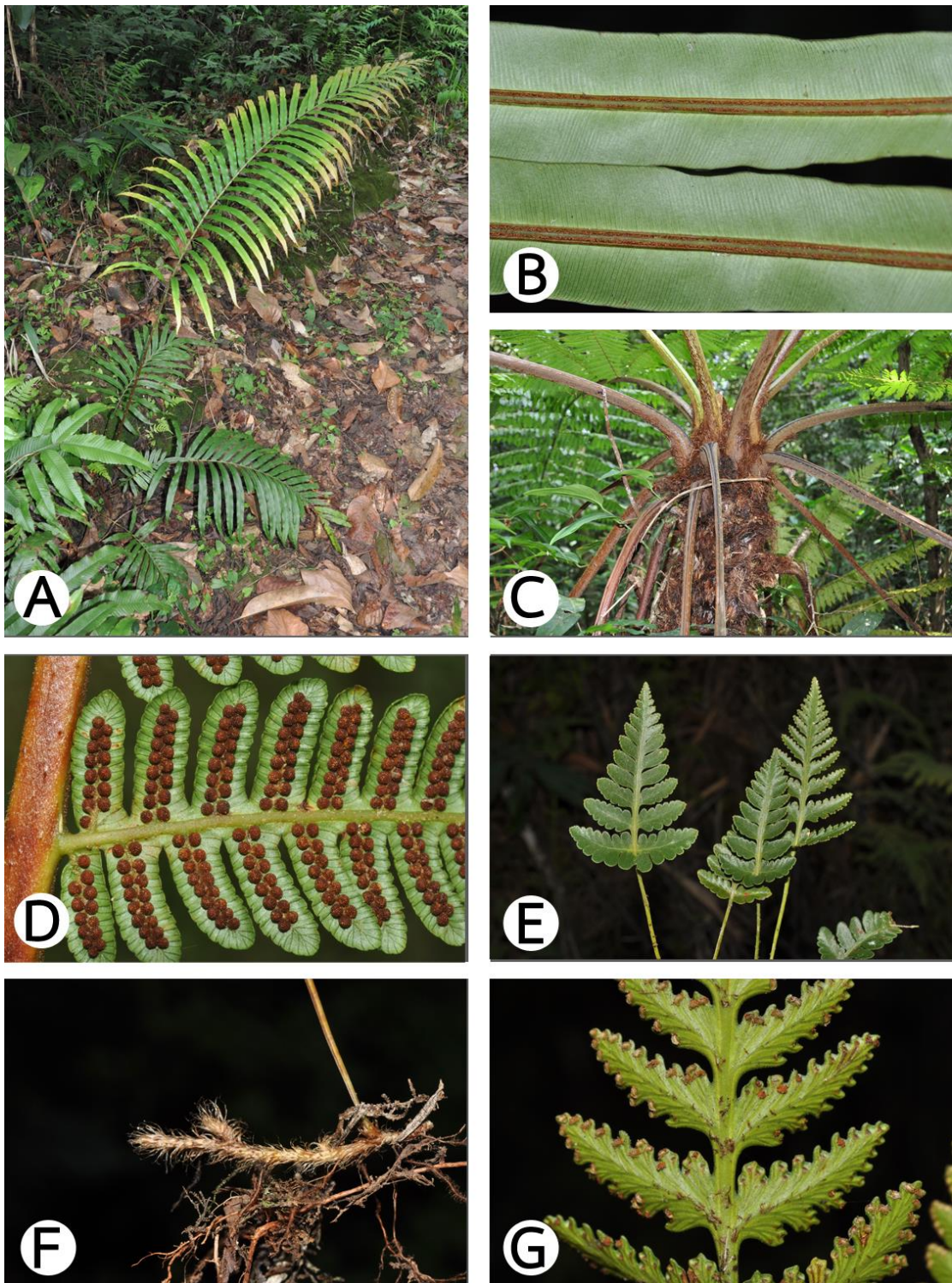


**Fig.5.5** A-B: *Asplenium scortechinii*, habit and part of lamina showing sori; C-E: *Asplenium yoshinagae*, habit, upper surface of pinnae and pinnae showing sori; F-H: *Asplenium* sp., habit, pinnae showing sori and bulbils on lamina.

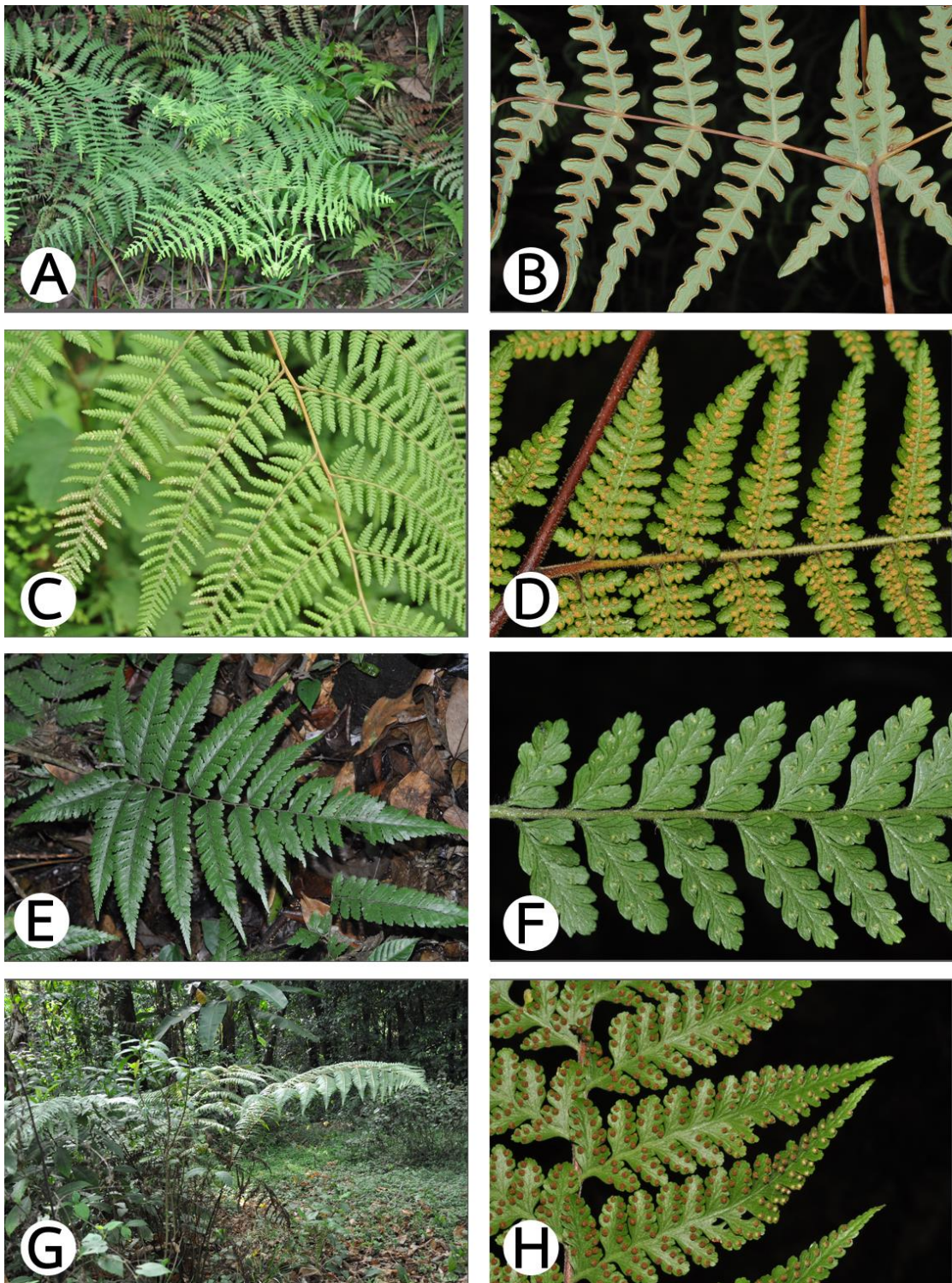


**Fig. 5.6** A-C: *Hymenasplenium cheilosorum*, habit, pinnae showing sori and upper surface of pinnae; D-E: *Hymenasplenium excisum*, part of lamina and pinnae showing sori; F-G: *Hymenasplenium obscurum*, habit and pinnae showing sori.

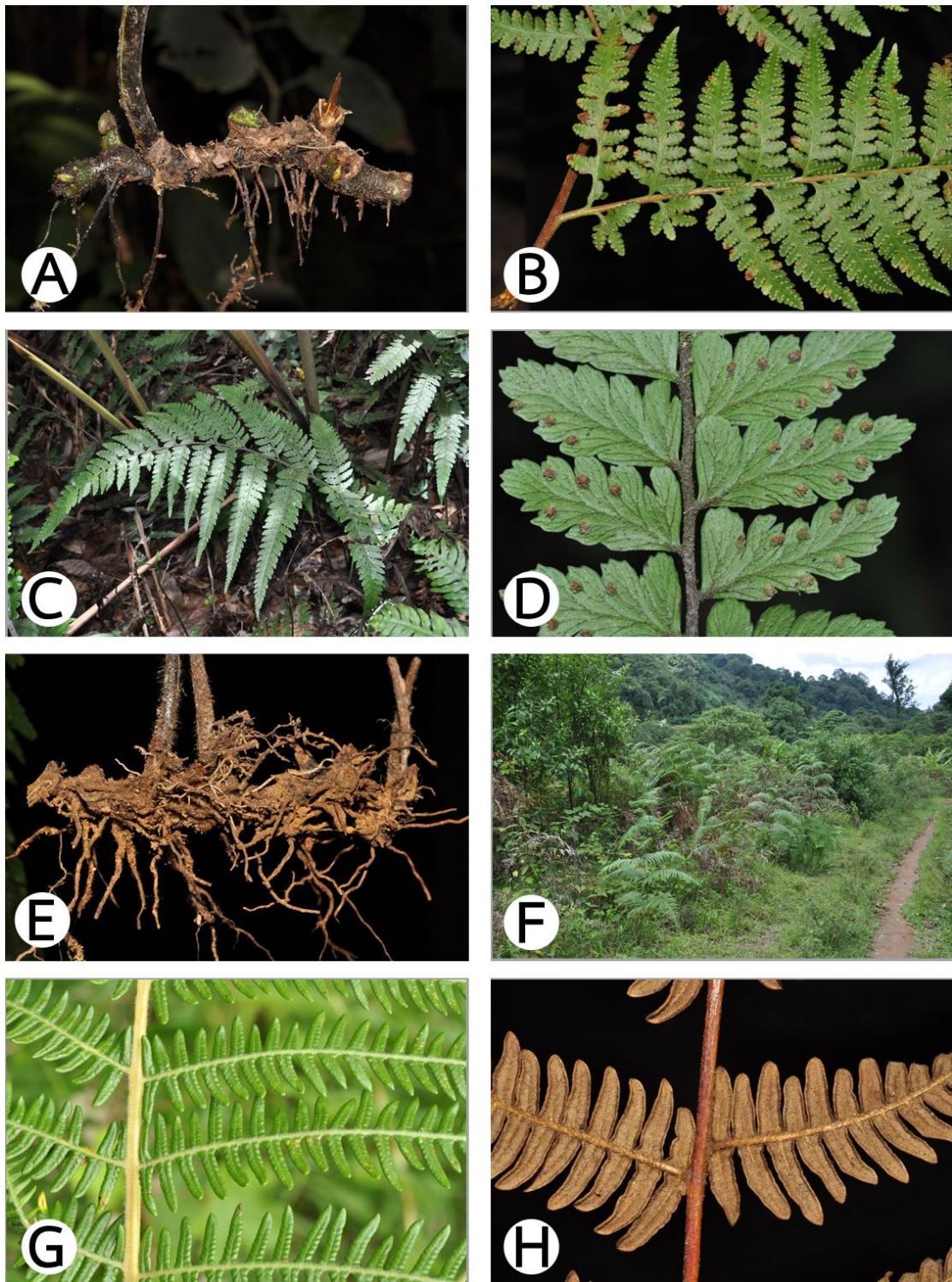




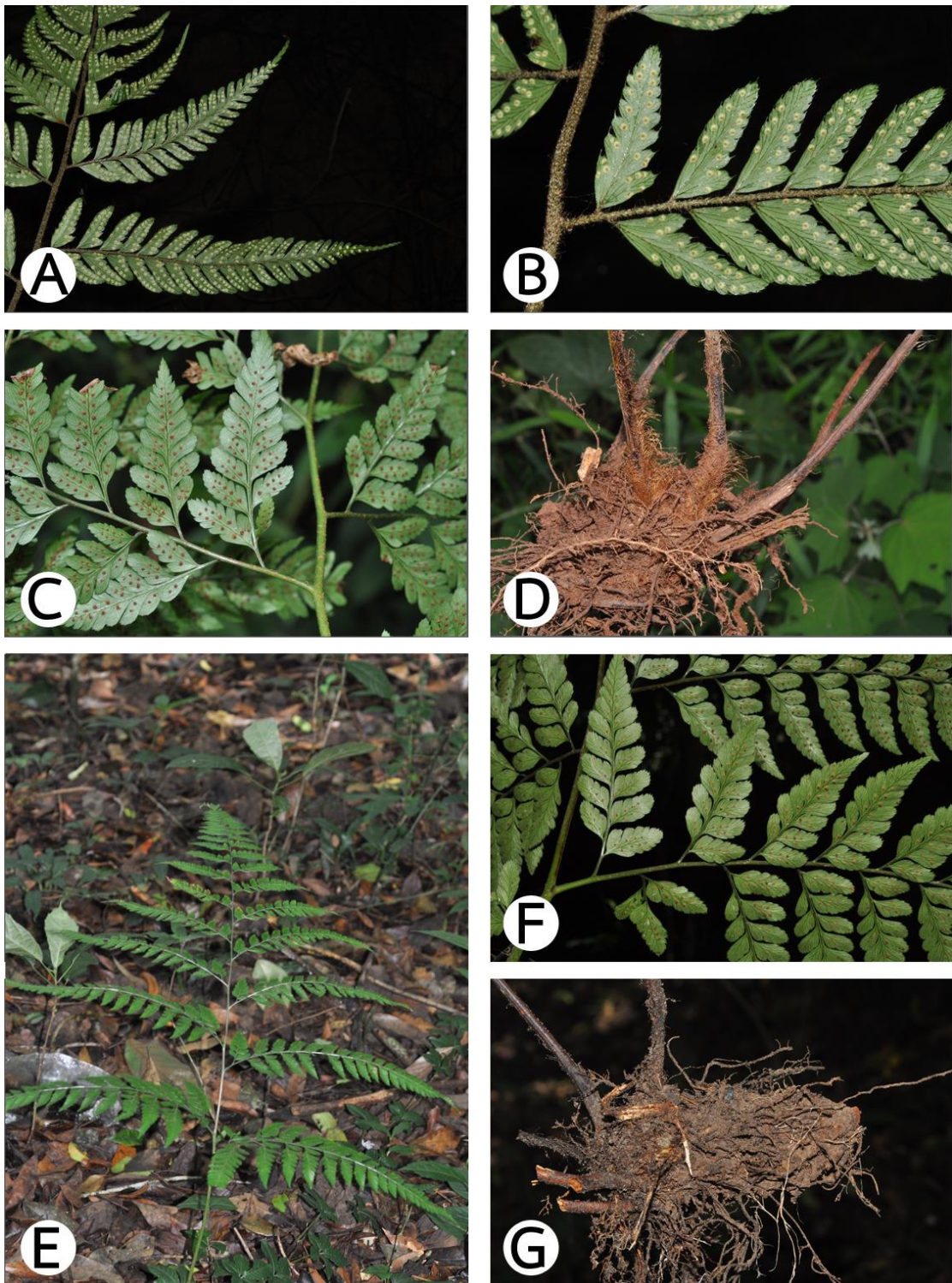
**Fig. 5.7** A-B: *Blechnum orientale*, habit and part of pinnae with sori; C-D: *Cyathea spinulosa*, base of fronds and part of pinnule showing sori; E-G: *Humata repens*, fronds, rhizome and part of lamina showing sori.



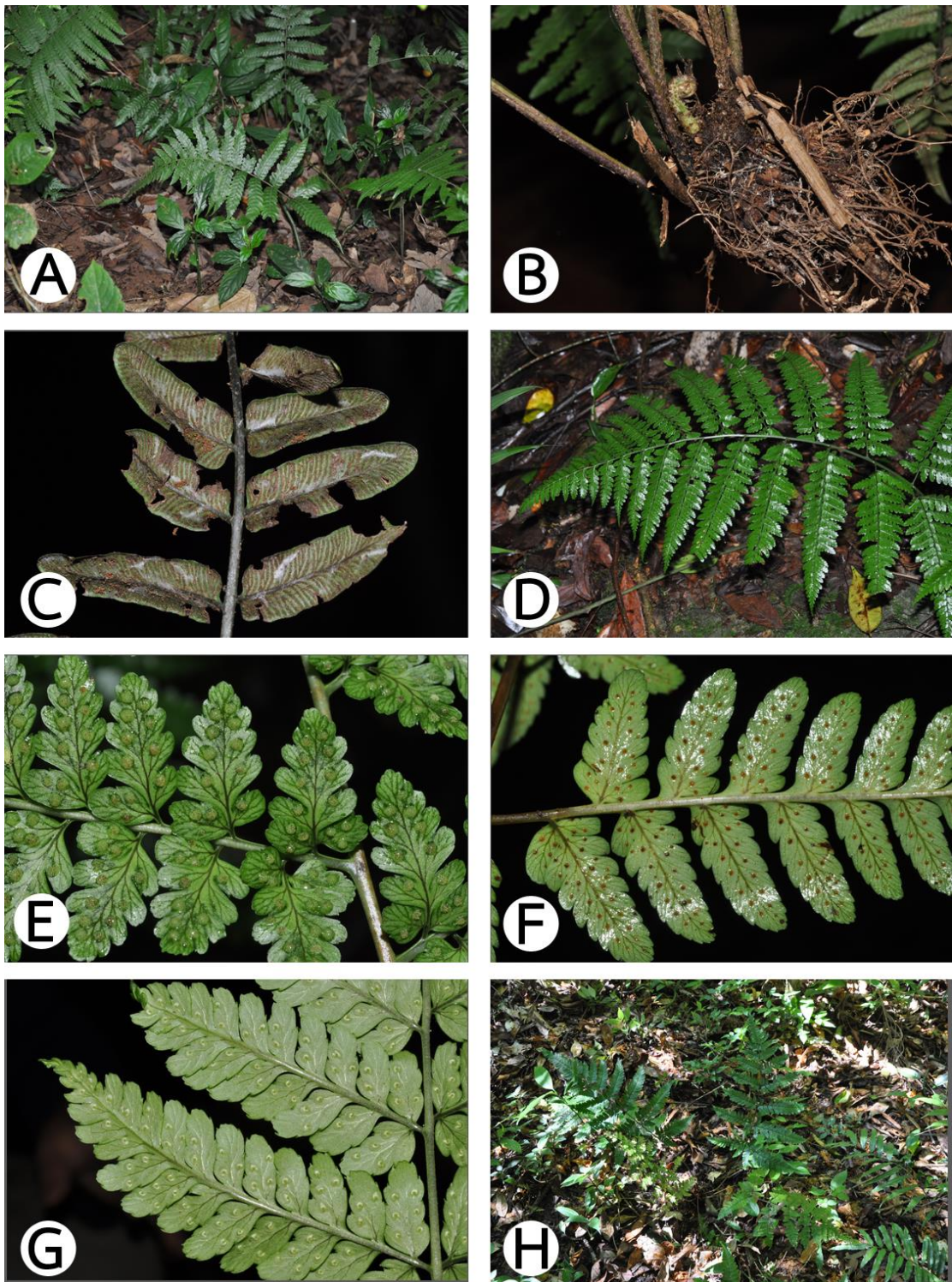
**Fig. 5.8** A-B: *Histiopteris incisa*, habit pinnules showing sori; C-D: *Hypolepis punctate*, upper part of lamina and pinnules showing sori; E-F: *Microlepia herbacea*, habit and pinnae showing sori; G-H: *Microlepia puberula*, habit and pinnules showing sori.



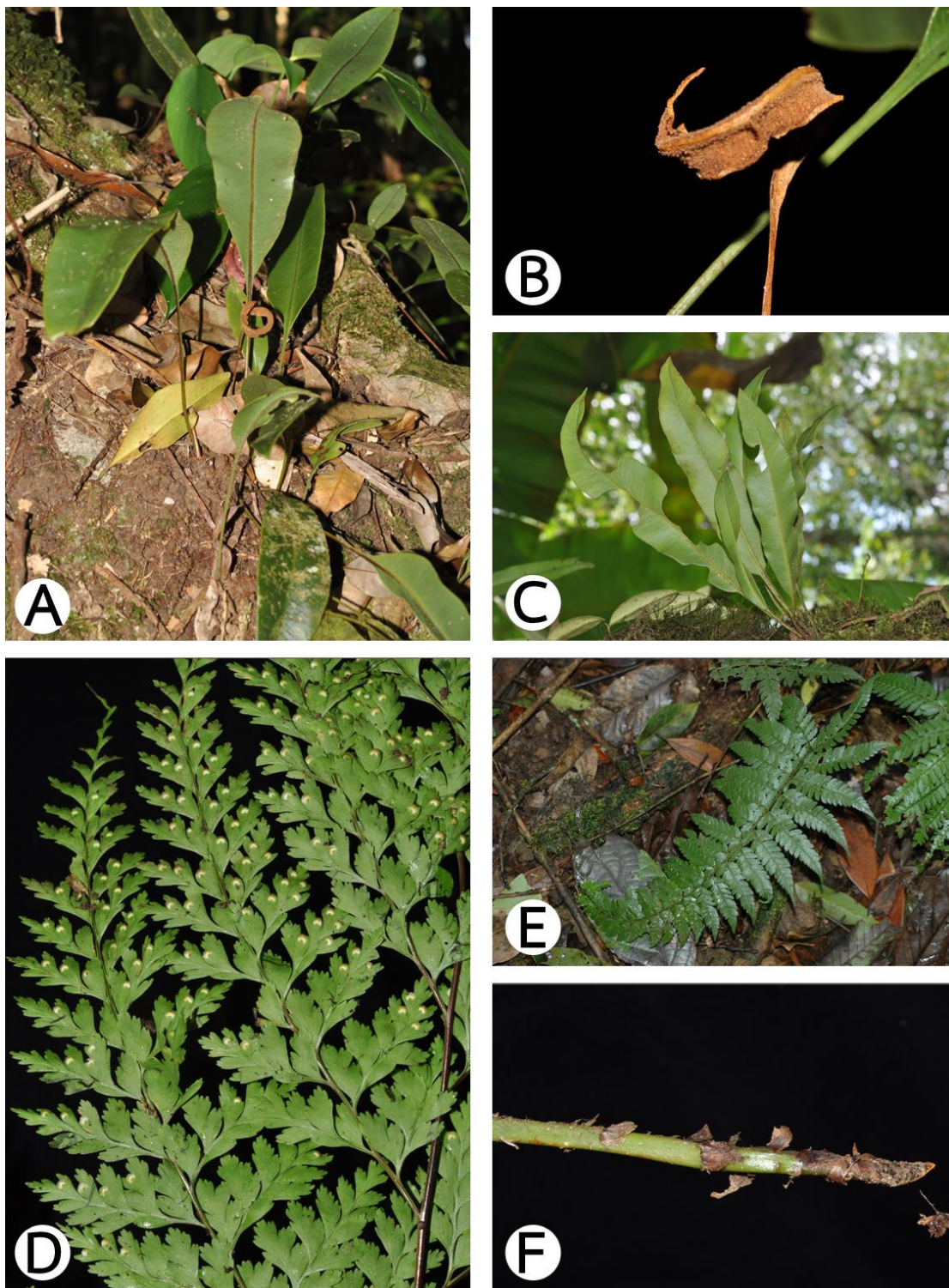
**Fig. 5.9** A-B: *Microlepidia speluncae*, rhizome and part of pinnae; C-E: *Microlepidia strigosa* habit and pinnules showing sori; F-H: *Pteridium aquilinum* subsp. *Wightianum*, habit, upper part of lamina and part of pinnule showing sori.



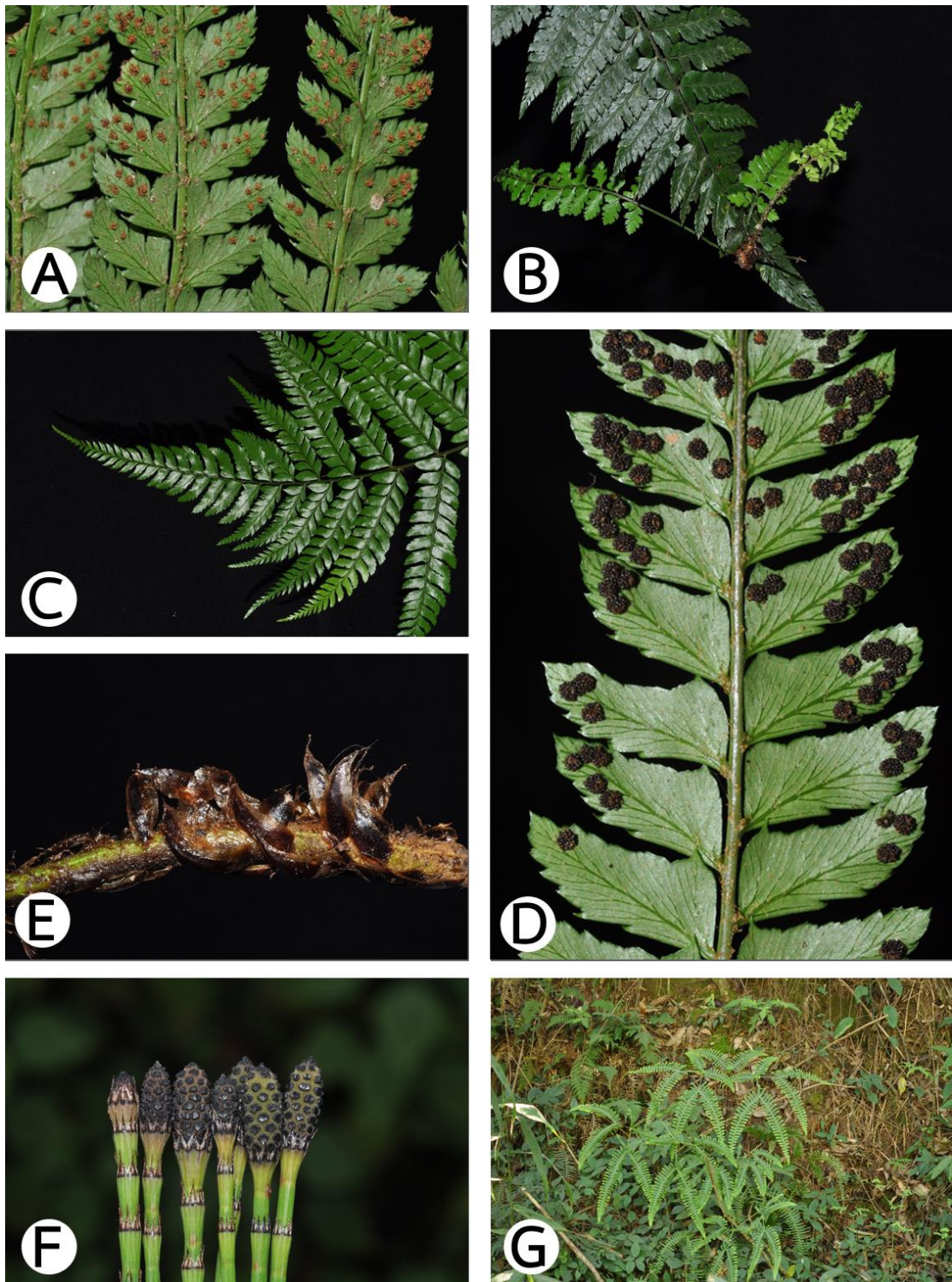
**Fig. 5.10** A-B: *Arachniodes chinensis*, part of lamina and pinnules showing sori; C-D: *Arachniodes speciosa*, part of fertile lamina and rhizome; E-G: *Arachniodes spectabilis*, a frond, part of fertile lamina and rhizome.



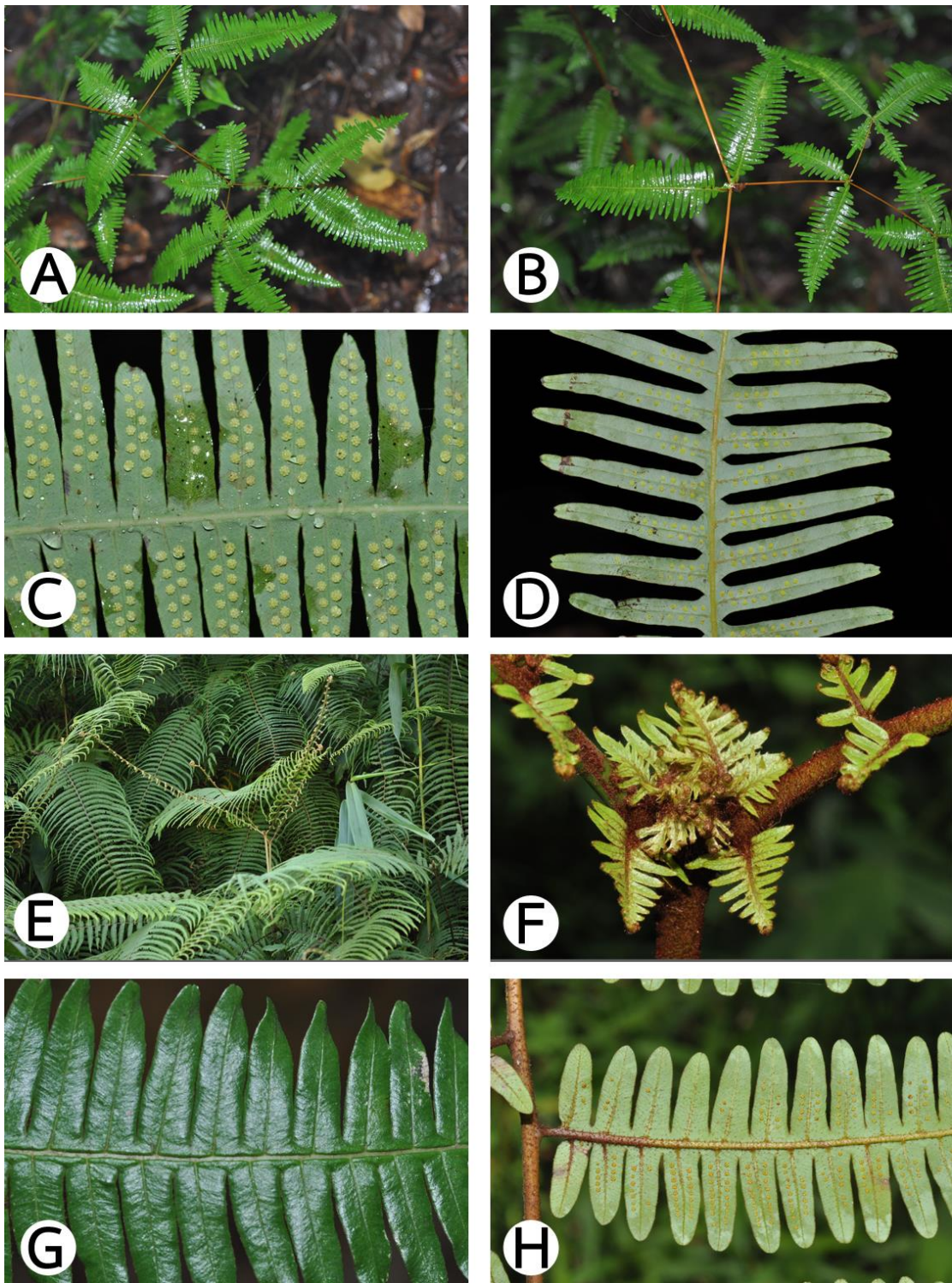
**Fig. 5.11** A-C: *Bolbitis sinensis*, habit, rhizome and fertile lamina; D-E: *Dryopteris hasseltii*, part of a frond and pinnules showing sori; F: *Dryopteris polita*, part of fertile pinnae.; G-H: *Dryopteris sparsa*, part of fertile lamina and habit.



**Fig. 5.12** A-B: *Elaphoglossum subellipticum*, habitat and part of fertile frond; C: *Elaphoglossum malayense*, habitat; D: *Leucostegia immerse*, part of pinnae showing sori; E-F: *Polystichum attenuatum*, habitat and lower part of stipe with scales.

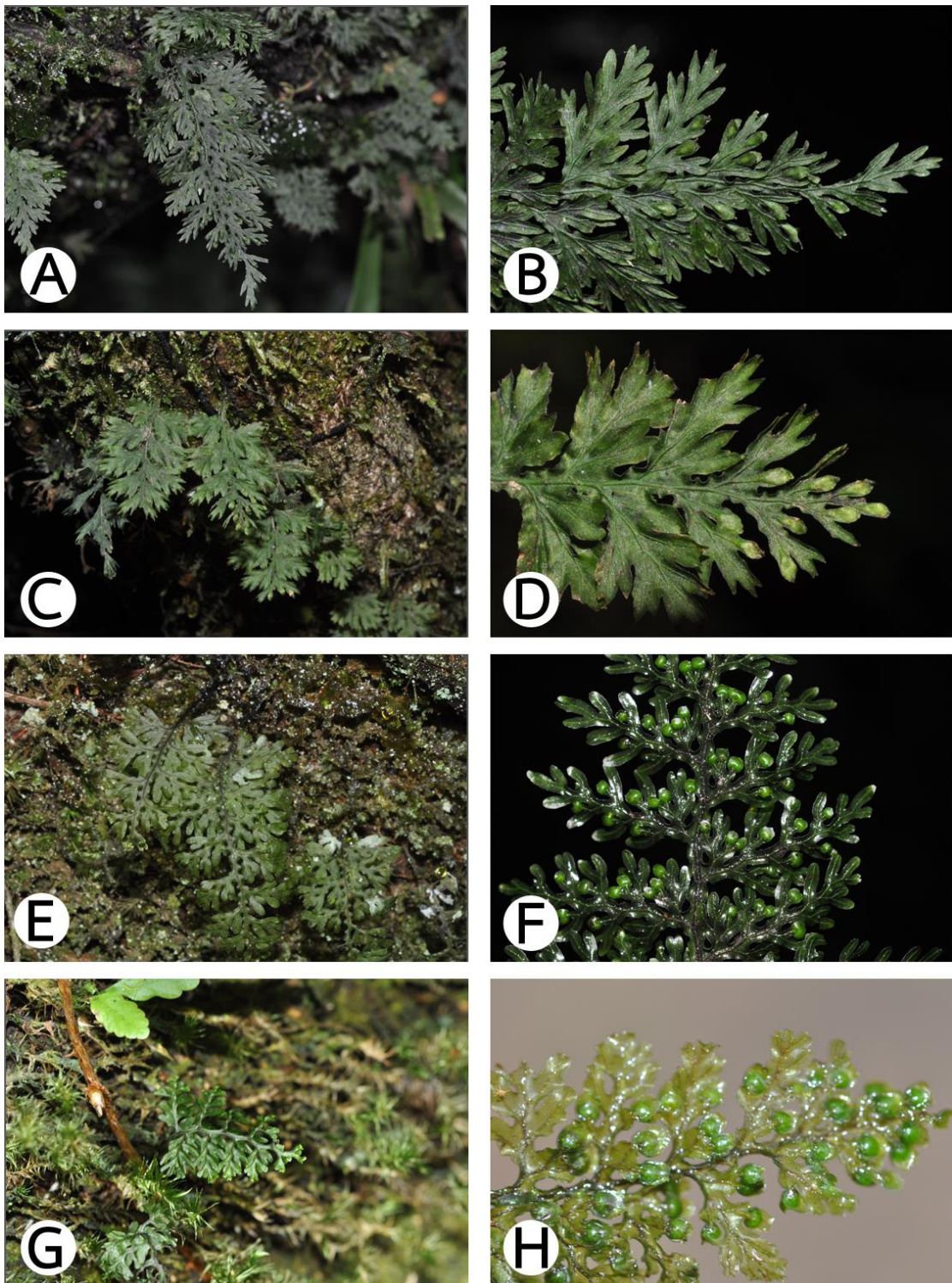


**Fig. 5.13** A-B: *Polystichum attenuatum*, part of pinnae showing sori and a bulbil; C-E: *Polystichum biaristatum*, apex of lamina, part of pinnae showing sori and part of lower stipe with scales; F: *Equisetum ramosissimum* subsp. *debile*, strobili; G: *Dicranopteris linearis* var. *linearis*, habitat.

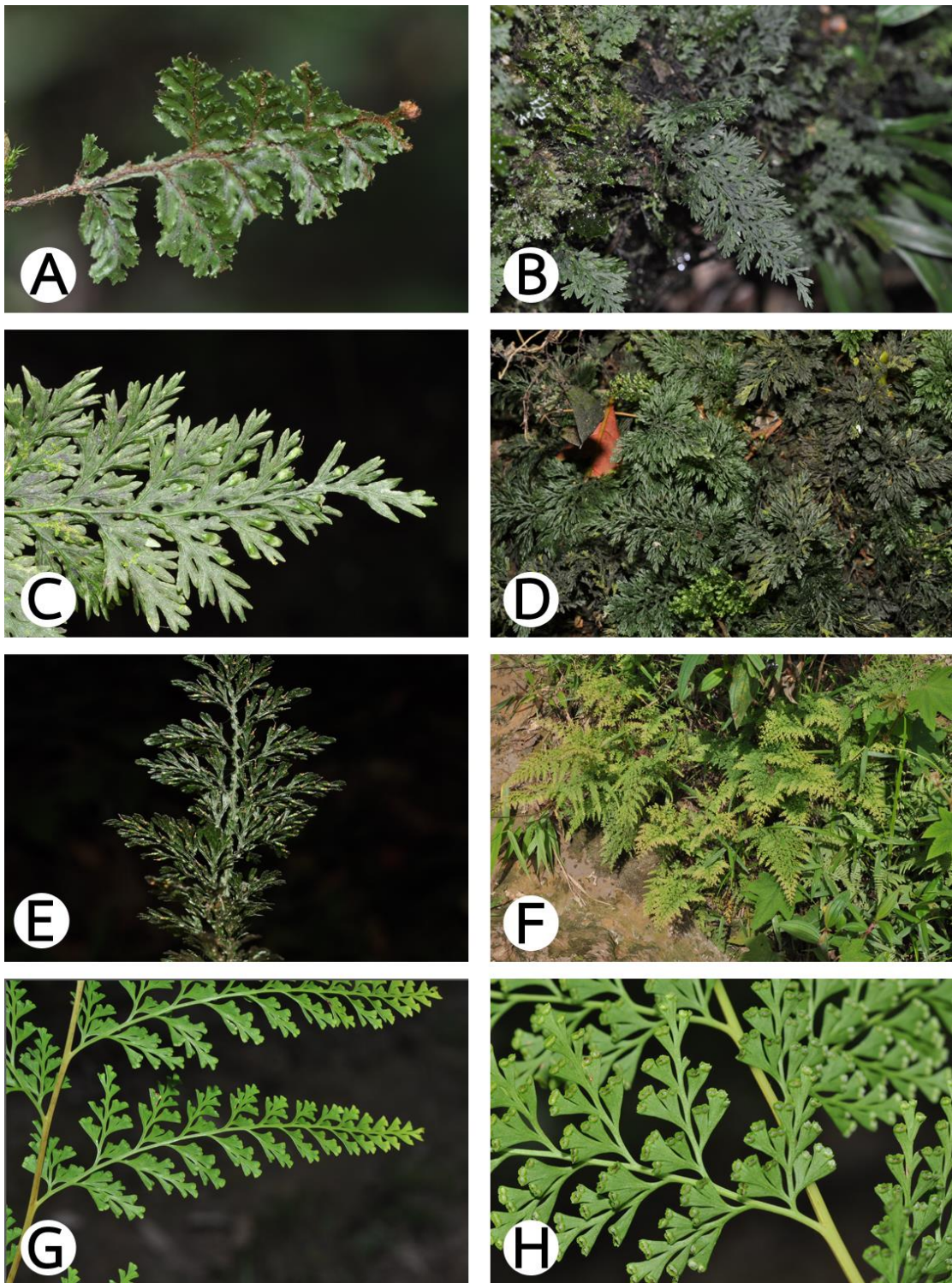


**Fig. 5.14** A-C: *Dicranopteris linearis* var. *tetraphylla*, unequal branching, accessory branch at fork and part of ultimate segment showing sori; D: *Dicranopteris splendida*, part of ultimate segment showing sori; E-H: *Diplopterygium norrisii*, frond, resting bud at fork, upper surface of pinnae and part of pinnae showing sori.

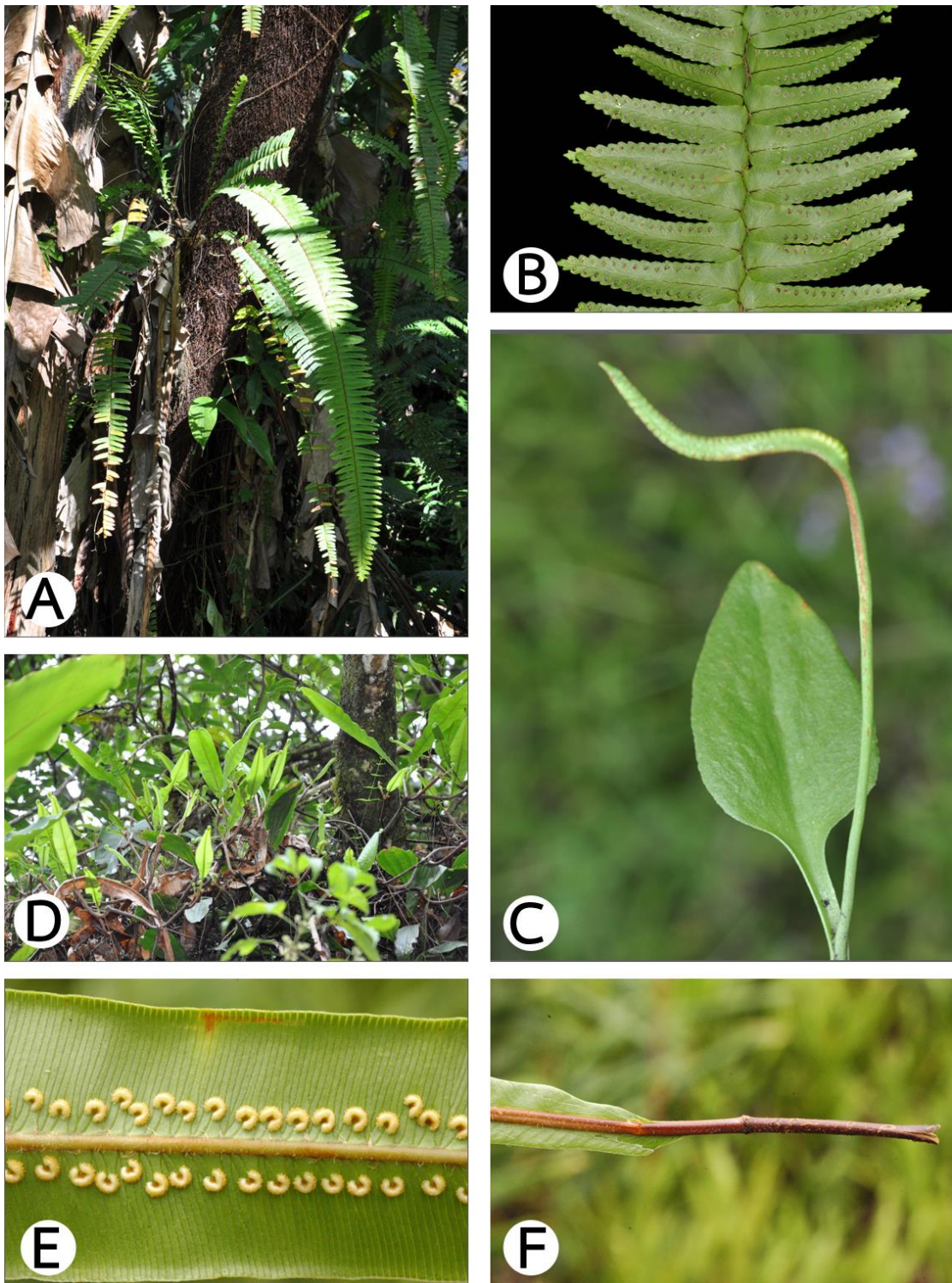




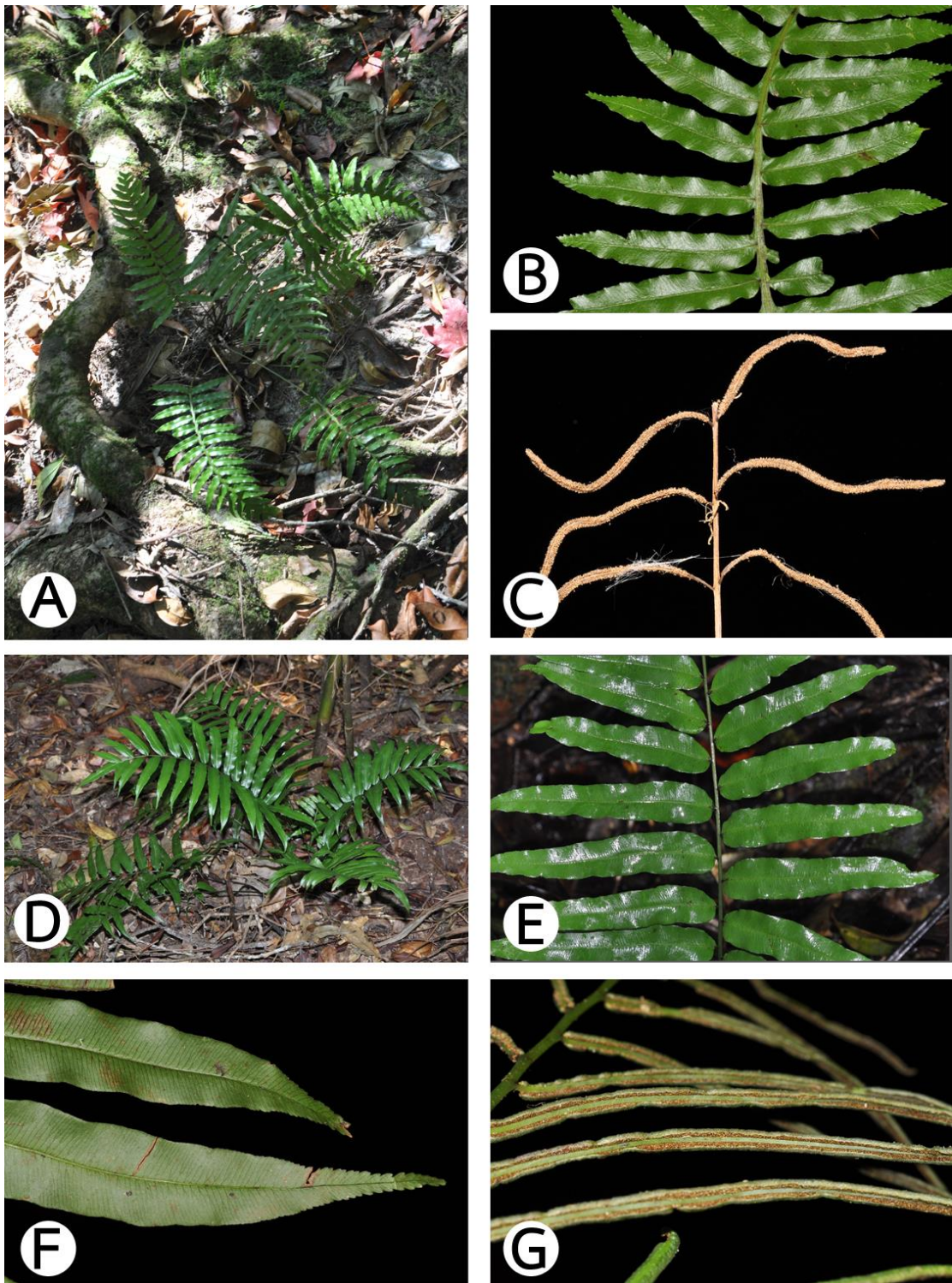
**Fig. 5.15** A-B: *Crepidomanes bipunctatum*, frond and part of lamina showing sori; C-D: *Crepidomanes latealatum*, habitat and part of lamina showing sori; E-F: *Hymenophyllum badium*, habitat and part of lamina with sori ;G-H: *Hymenophyllum barbatum*, habitat and part of lamina showing sori.



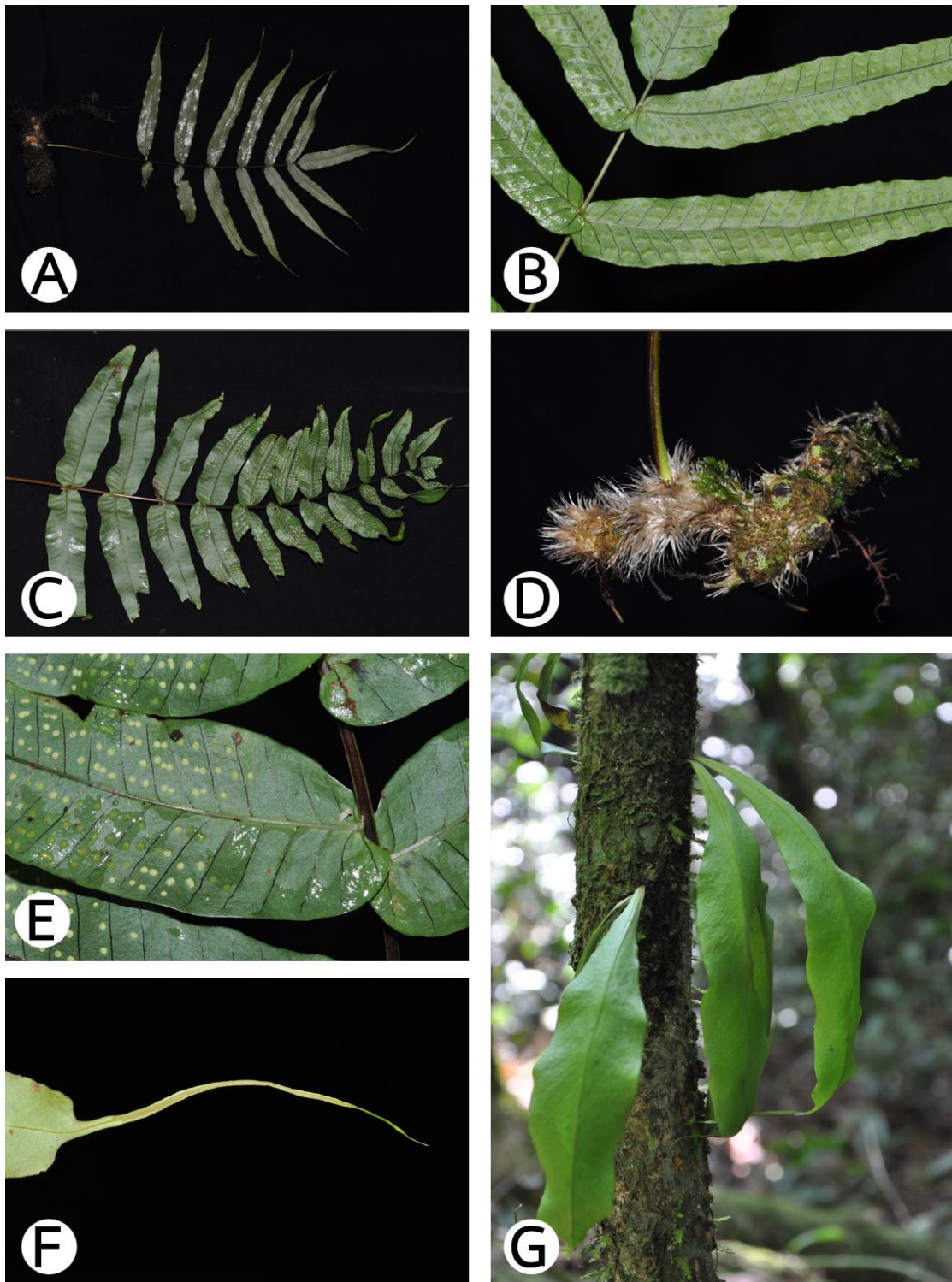
**Fig. 5.16** A: *Hymenophyllum exsertum*, frond; B-C: *Hymenophyllum polyanthus*, habitat and part of lamina showing sori; D-E: *Vandemboshia birmanicum*, fronds and part of fronds with sori; F-H: *Sphenomeris chinensis* var. *chinensis*, habitat, pinnae and part of pinnae showing sori.



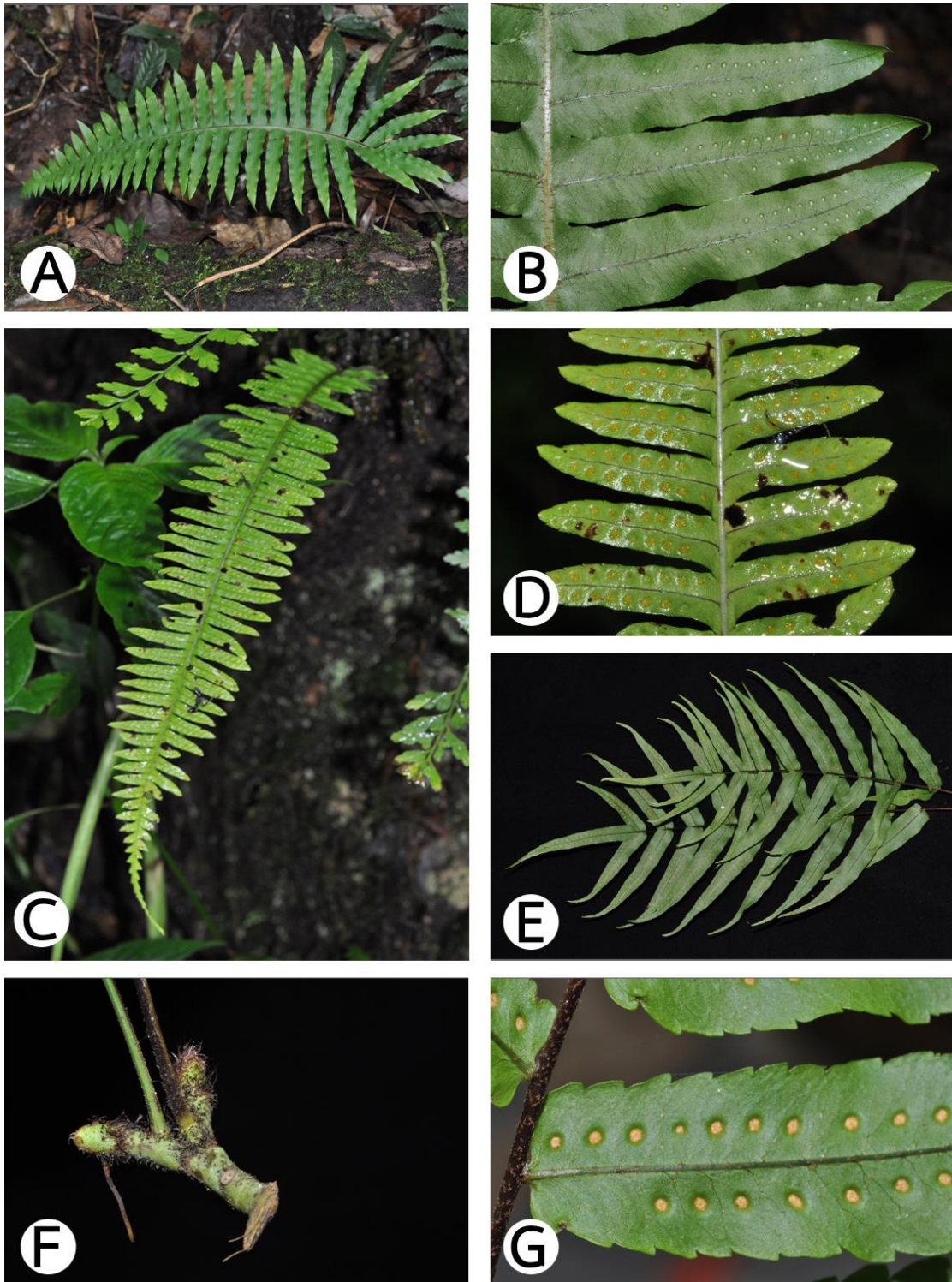
**Fig. 5.17** A-B: *Nephrolepis cordifolia*, habitat and part of pinnae showing sori. ; C: *Ophioglossum petiolatum*, part of tropophyll and sporophyll; D-F: *Oleandra musifolia*, frond, part of lamina showing sori and articulation between stipe and phyllopodium.



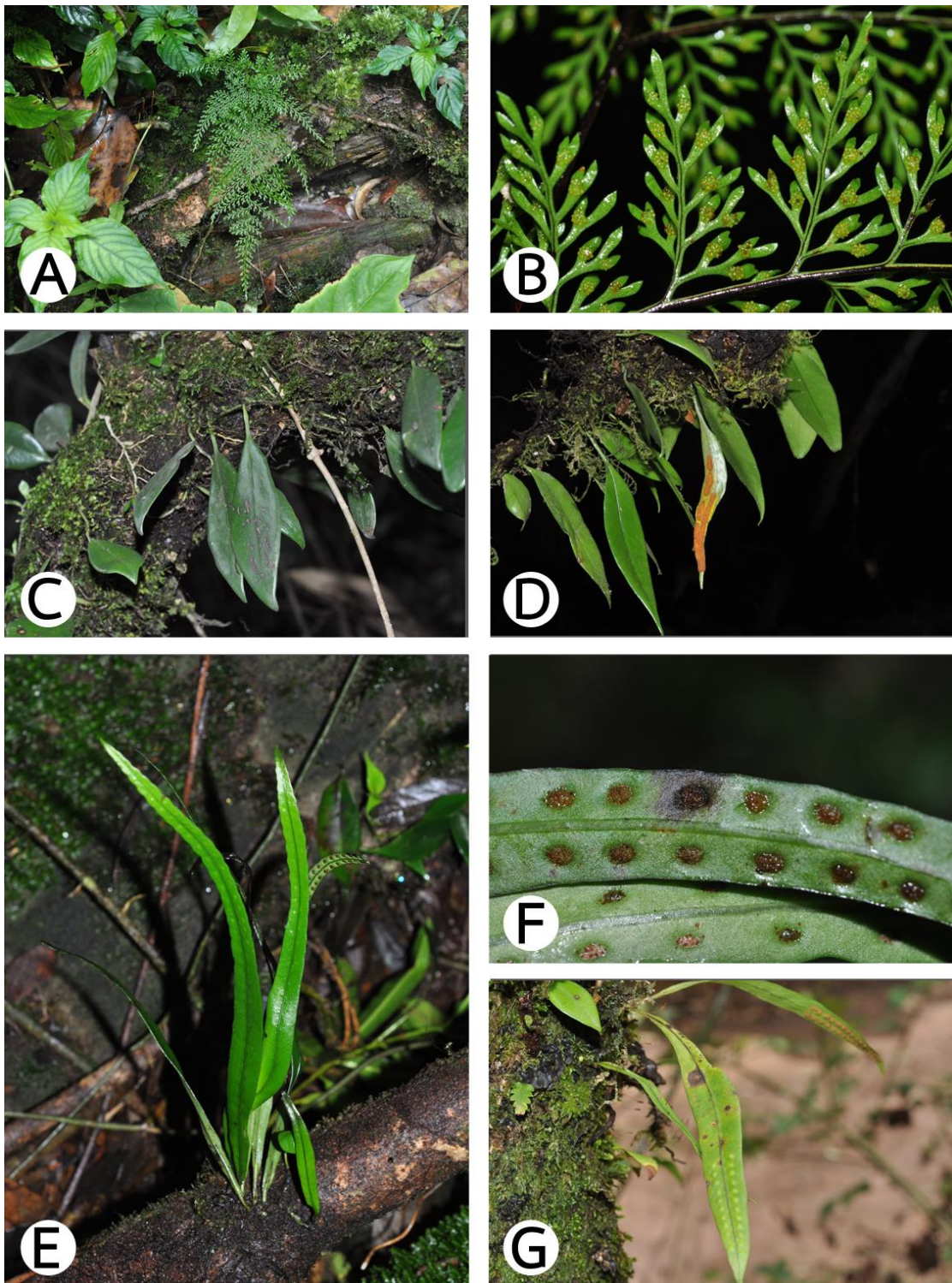
**Fig. 5.18** A-C: *Plagiogyria adnata*, habitat, part of sterile frond and part of fertile frond; D-G: *Plagiogyria euphlebia*, habitat, part of sterile frond, part of pinnae and part of fertile frond.



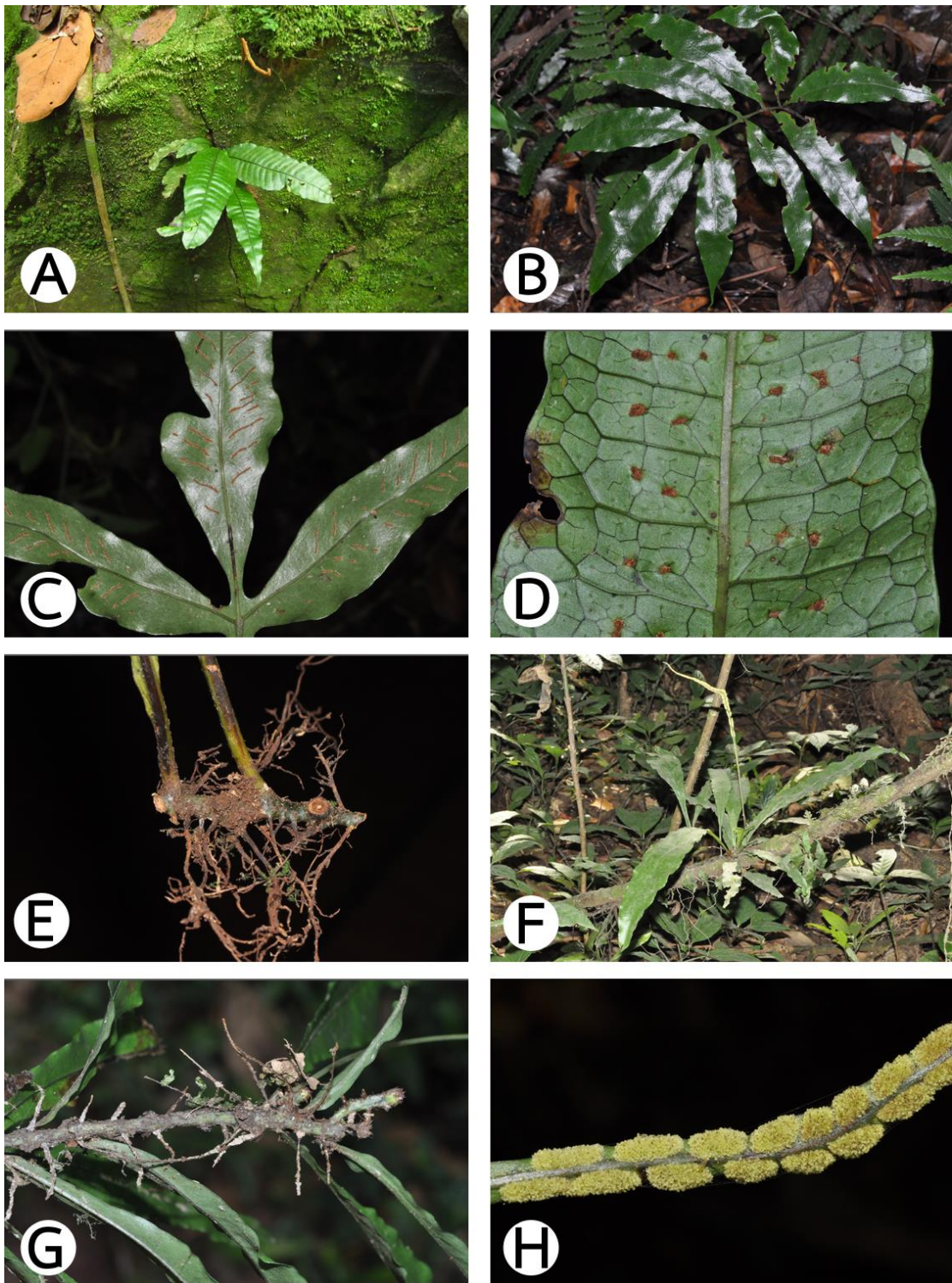
**Fig. 5.19** A-B: *Arthromeris lehmannii*, frond and part of pinnae showing sori; C-E: *Arthromeris phuluangensis*, frond, rhizome and part of pinnae showing sori; F-G: *Belvisia henryi*, part of lamina with sori and habitat.



**Fig. 5.20** A-B: *Goniophlebium amoenum*, frond and part of lamina showing sori; C-D: *Goniophlebium manmeiense*, frond and part of lamina showing sori; E-G: *Goniophlebium subauriculatum*, frond, rhizome and part of pinnae showing sori.

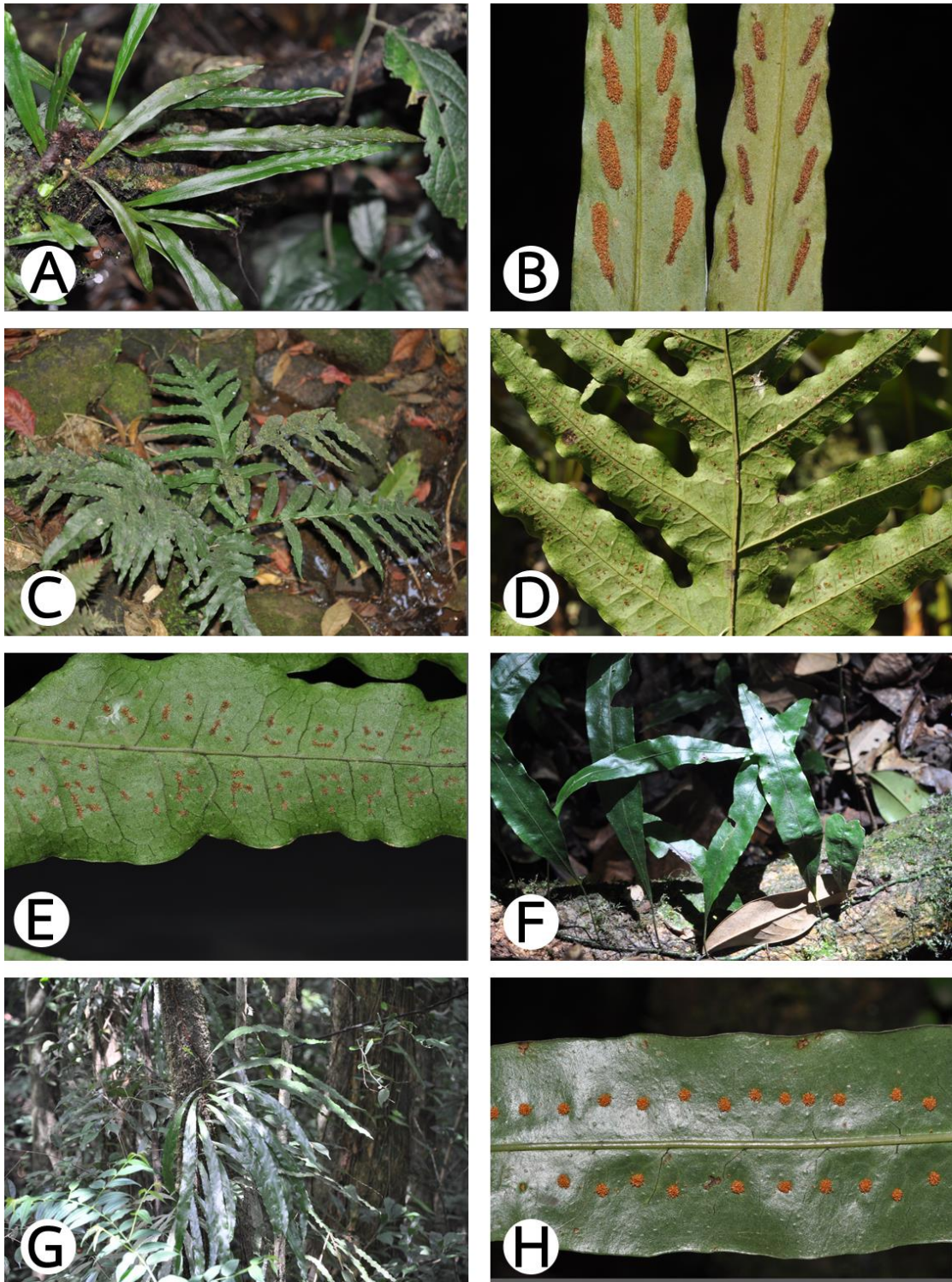


**Fig. 5.21** A-B: *Gymnogrammitis dareiformis*, habitat and part of pinnules showing sori; C-D: *Lemmaphyllum carnosum*, habitat and fertile frond; E-F: *Lepisorus subconfluens*, habitat, part of lamina showing sori; G: *Lepisorus nudus*, habitat.

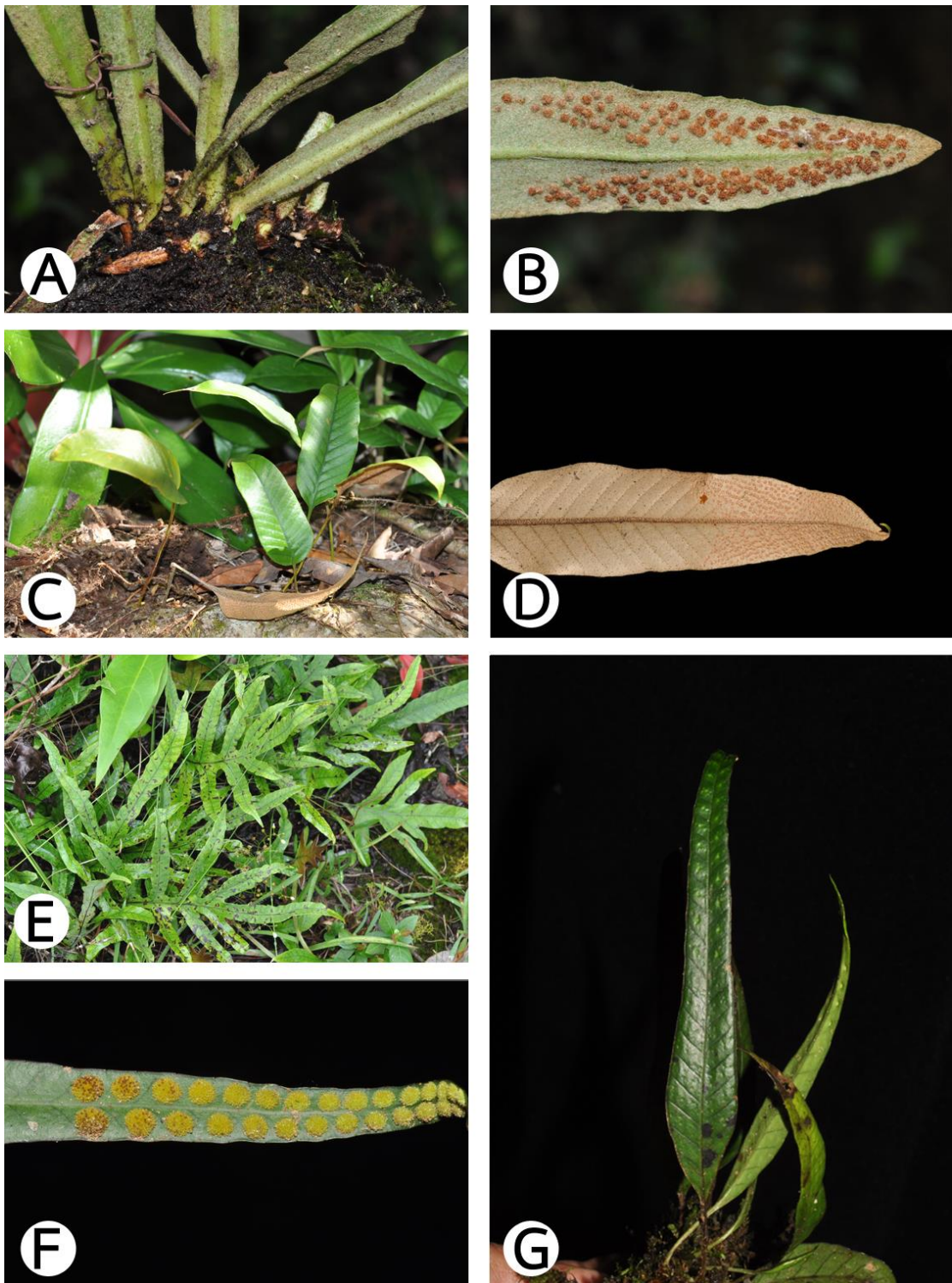


**Fig. 5.22** A: *Leptochilus decurrens*, habitat; B-C: *Leptochilus ellipticus*, frond and part of lamina showing sori; D-E: *Leptochilus hemionitideus*, part of lamina showing sori and rhizome; F-H: *Leptochilus pedunculatus*, habitat, rhizome and part of fertile frond.

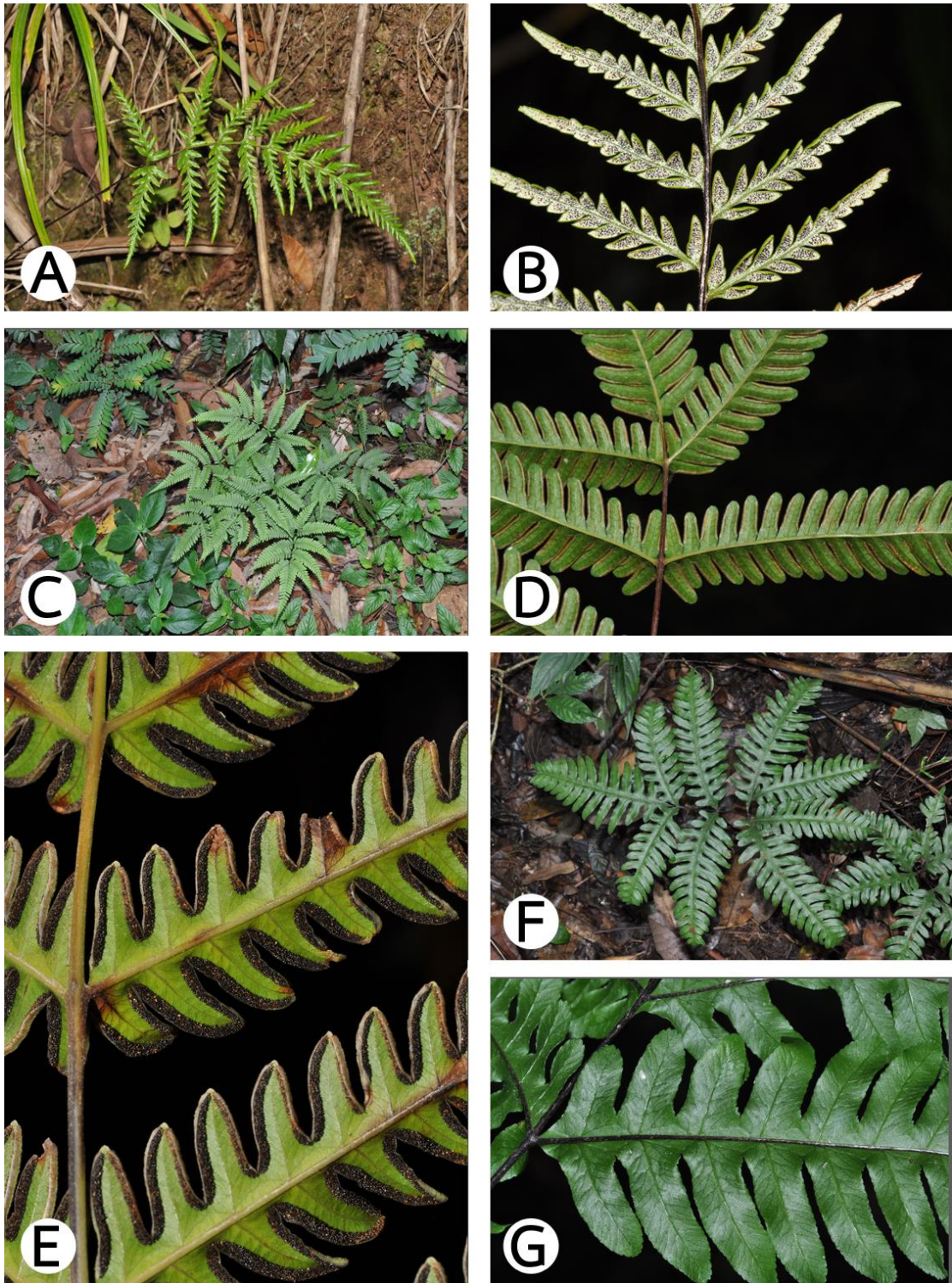




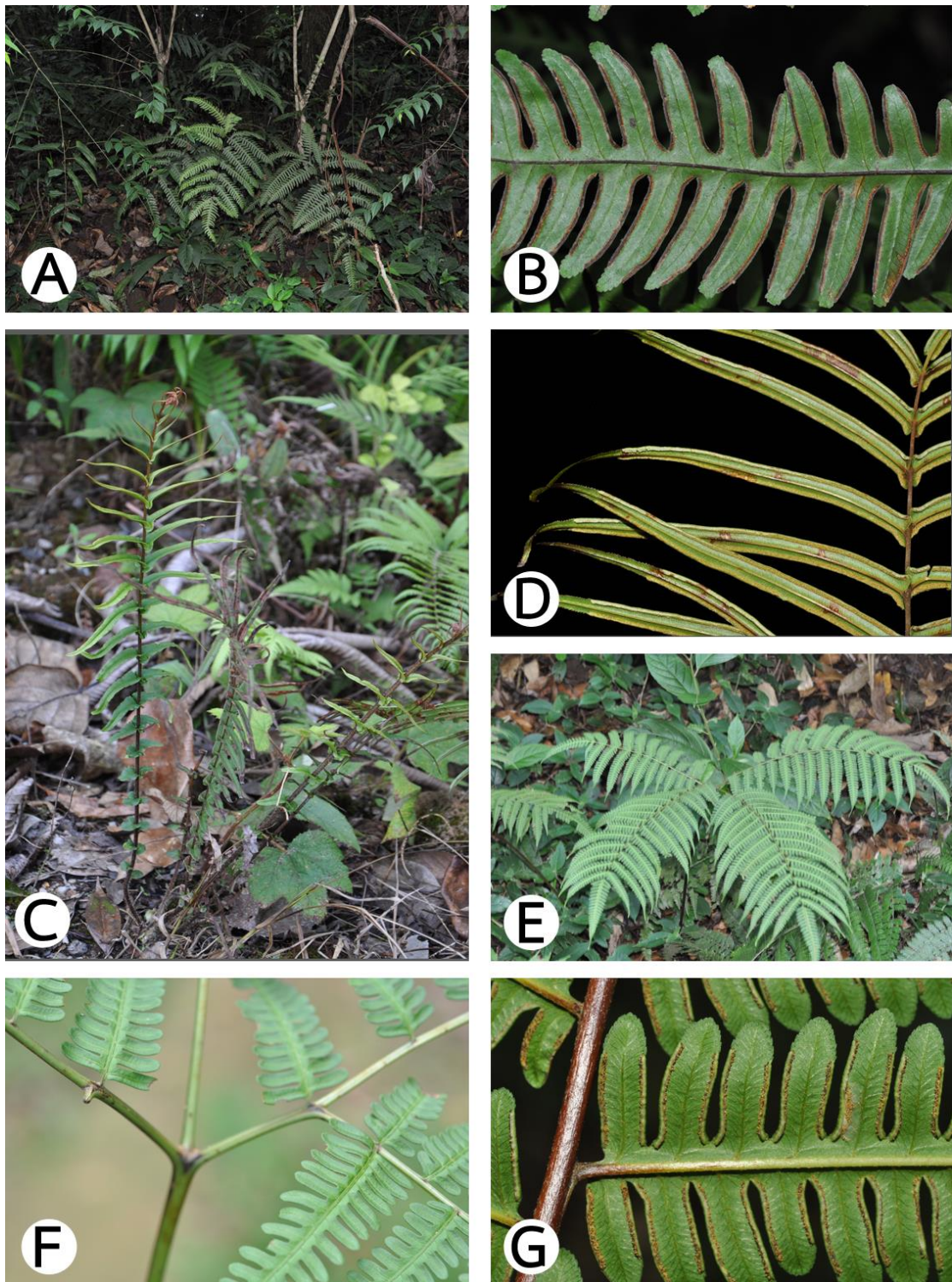
**Fig. 5.23** A-B: *Loxogramme chinensis*, habitat and part of lamina with sori; C-E: *Microsorium insigne*, habitat and part of lamina showing sori; F: *Microsorium superficiale*, frond; G-H: *Neocheiropteris normalis*, habitat and part of lamina showing sori.



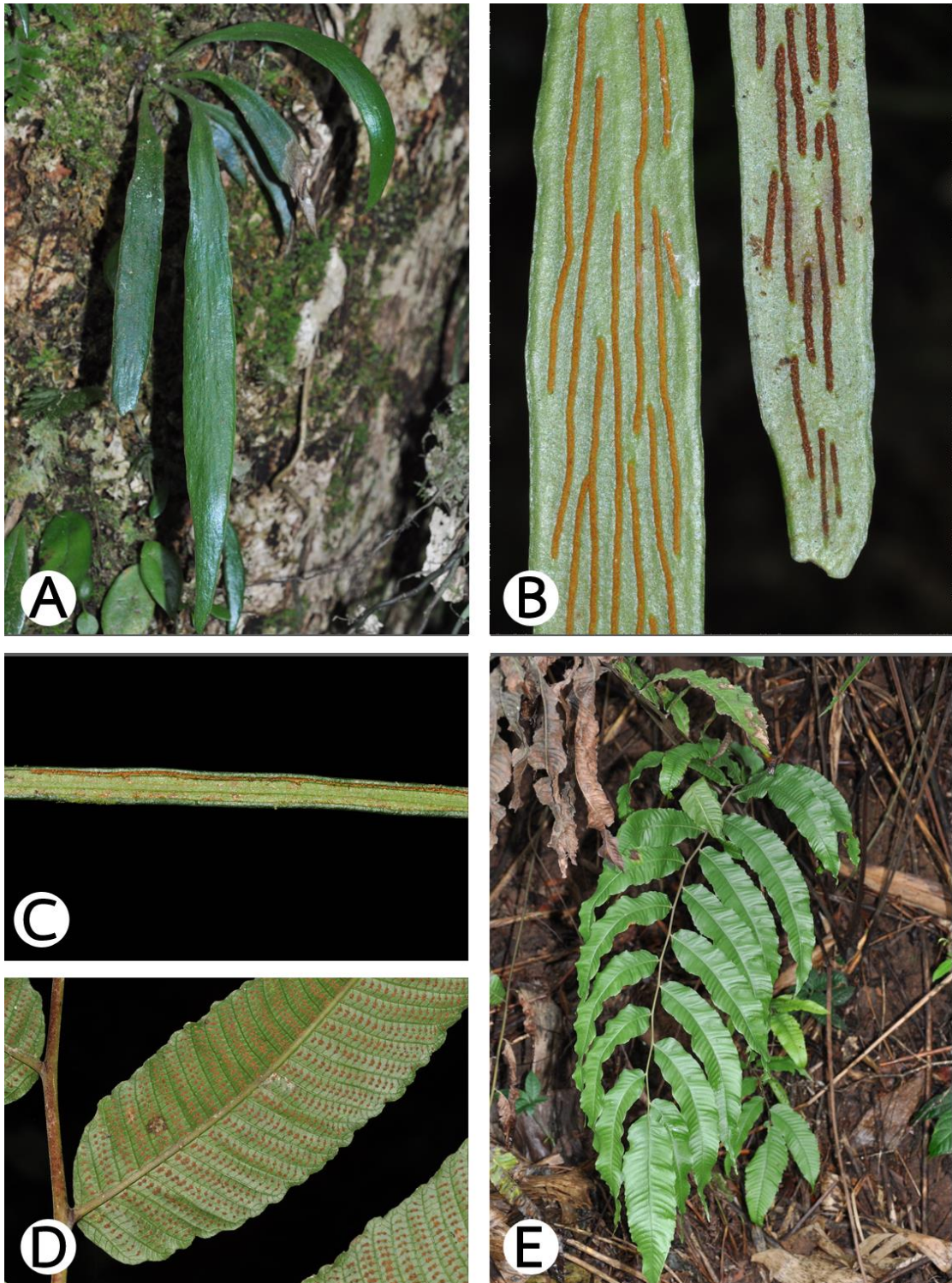
**Fig. 5.24** A-B: *Pyrrosia porosa* var. *tonkinensis*, rhizome, part of lamina showing sori; C-D: *Pyrrosia lingua* var. *heteractis*, habitat and part of lamina showing sori; E: *Selligiea oxyloba*, frond; G-H: *Selligiea rhynchophylla*, part of lamina showing sori and frond.



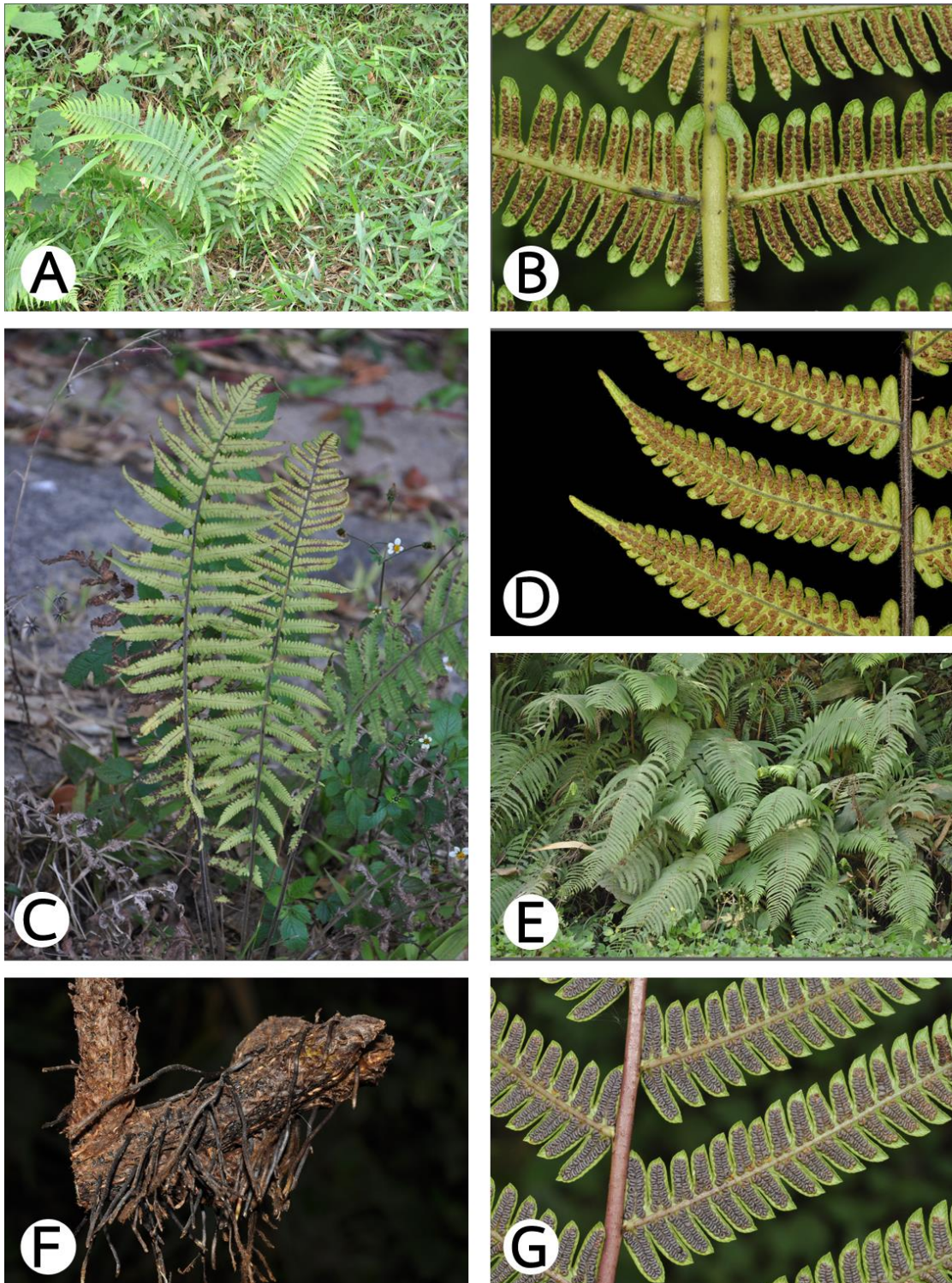
**Fig. 5.25** A-B: *Pityrogramma calomelanos*, frond and part of pinna showing sori; C-D: *Pteris bella*, habitat and part of pinnae showing sori; E: *Pteris biaurita*, part of pinnae with sori; F-G: *Pteris mcclurei*, habitat and part of pinnae.



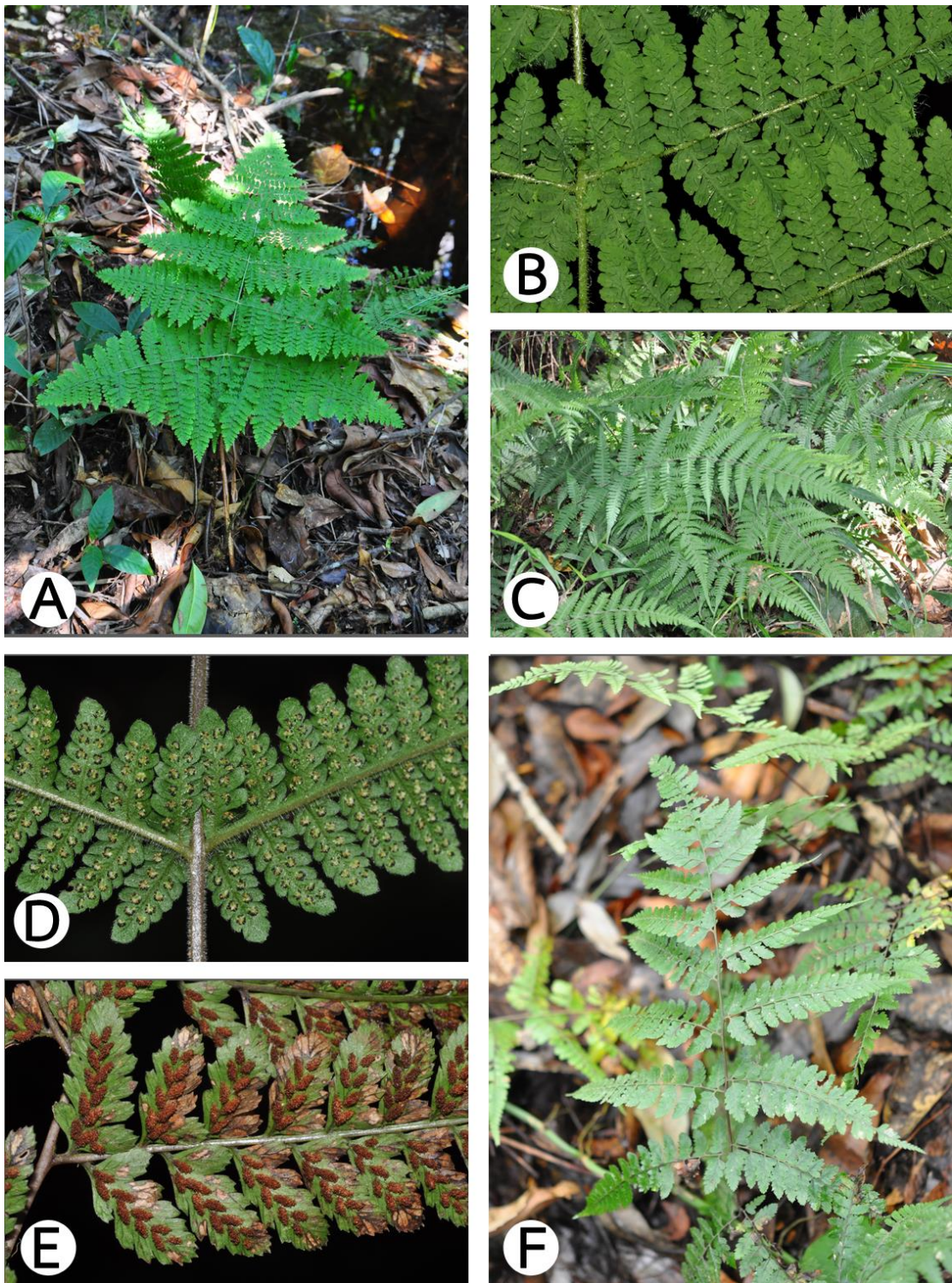
**Fig. 5.26** A-B: *Pteris tokioi*, habitat and part of pinnae showing sori; C-D: *Pteris vittata*, habitat, part of pinnae showing sori; E-G: *Pteris wallichiana*, habitat, part of lamina with tripartite and part of pinnae showing sori.



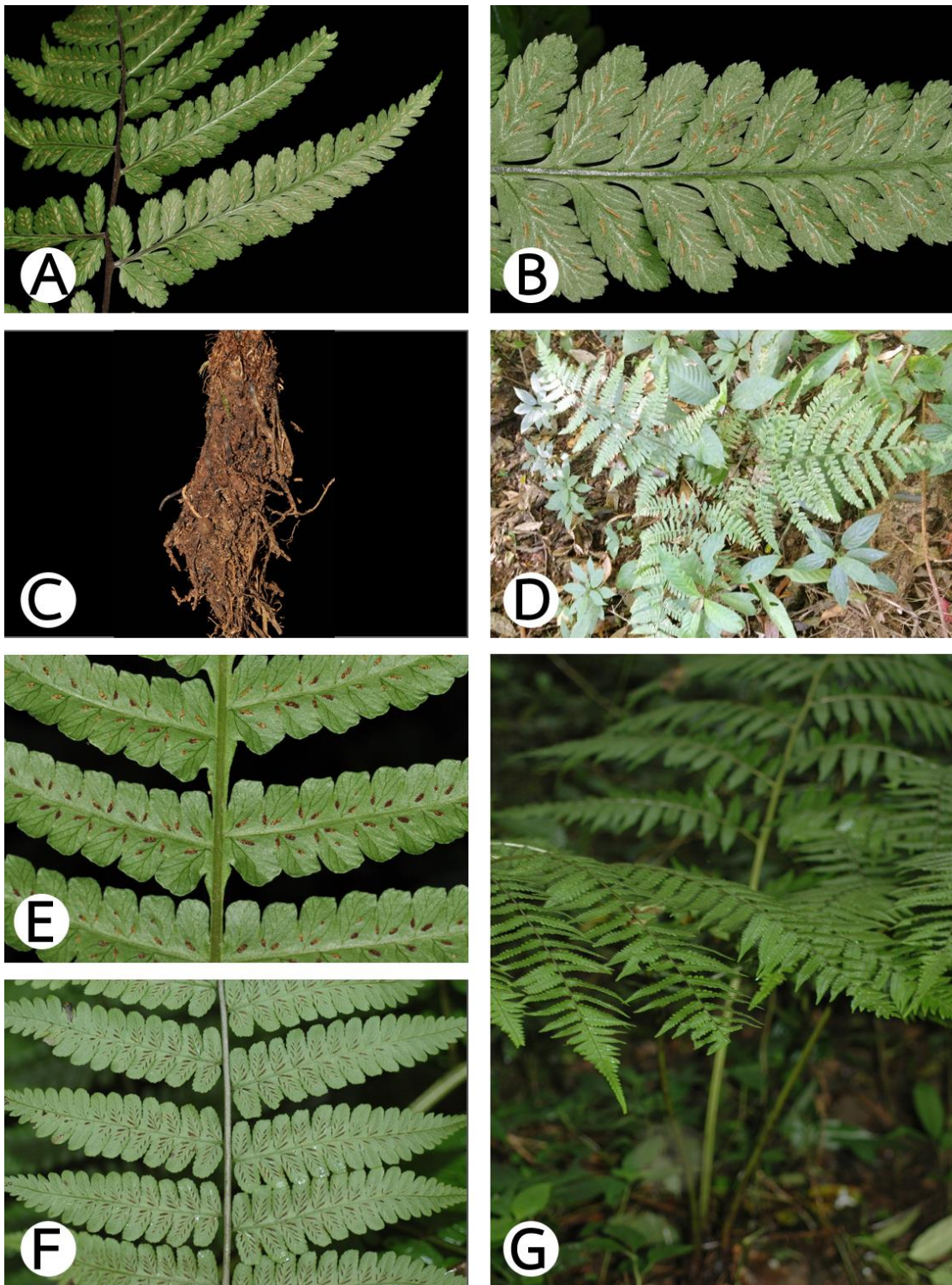
**Fig. 5.27** A-B: *Antrophyum parvulum*, habitat and part of lamina showing sori; C: *Haplopteris angustifolia*, part of lamina with sori; D-E: *Cyclosorus lakhimpurens*, part of pinnae showing sori and habitat.



**Fig. 5.28** A-B: *Cyclosorus canus*, habitat and part of lamina showing sori; C-D: *Cyclosorus siamensis*, frond and part of pinnae showing sori; E-G: *Cyclosorus tylodes*, frond, rhizome and part of pinnae showing sori.

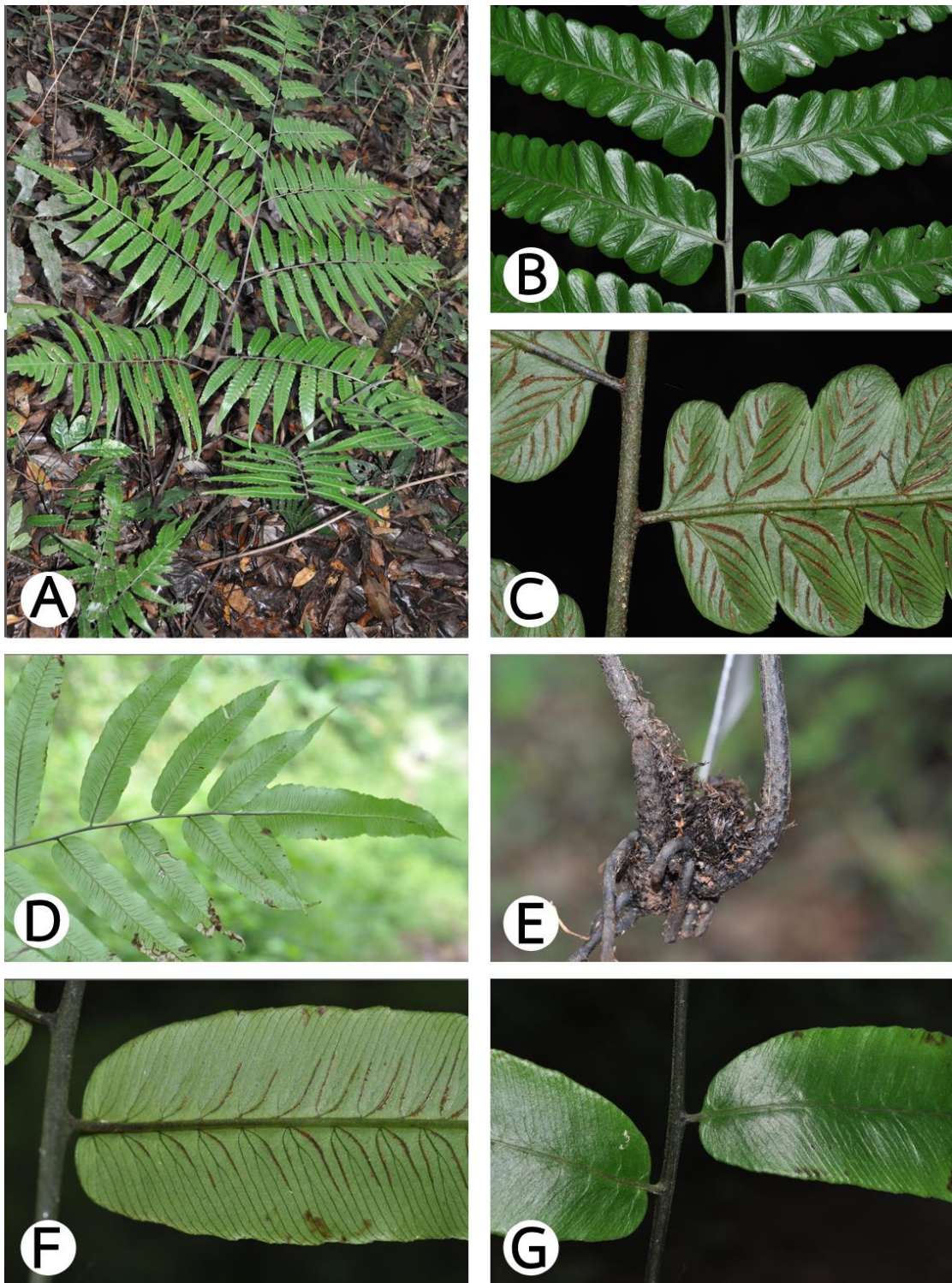


**Fig. 5.29** A-B: *Macrothelypteris torresiana*, habitat and part of pinnae showing sori; C-D: *Thelypteris flaccida*, frond and part of pinnae showing sori; E-F: *Athyrium mackinnonii*, part of pinnules showing sori and frond.

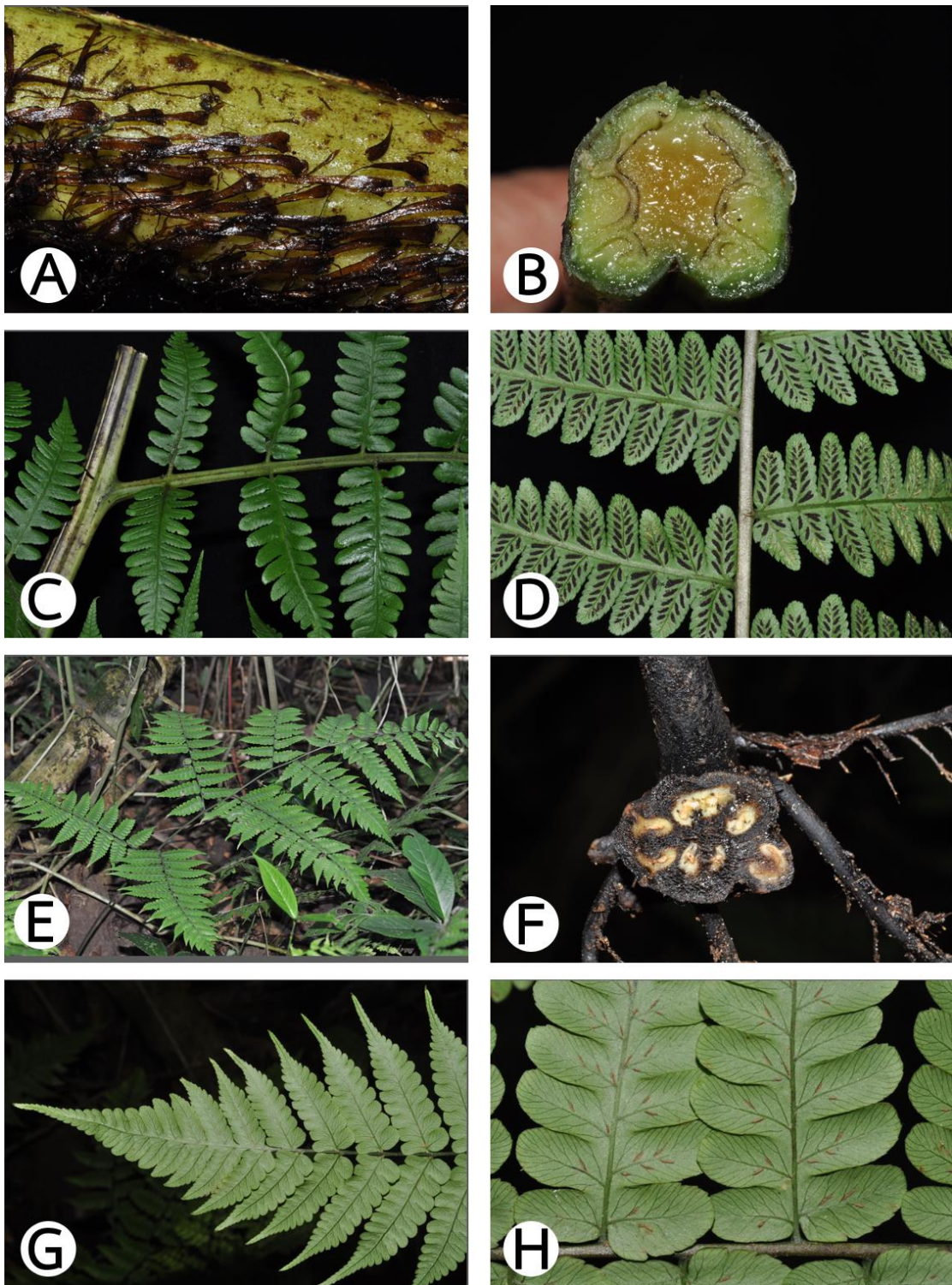


**Fig. 5.30** A-C: *Ahyrium* sp., part of lamina, part of pinnae showing sori and rhizome; D-E: *Cornopteris opaca*, habitat and part of pinnae showing sori; F-G: *Diplazium conterminum*, part of pinnules showing sori and frond.





**Fig. 5.31** A-C: *Diplazium dilatatum*, habitat, part of pinnules and part of pinnules showing sori; D-G: *Diplazium lobatum*, part of frond, rhizome, part of pinnae with sori and part of pinnae with short stalk.



**Fig. 5.32** A-D: *Diplazium polypodioides*, part of stipe with scale, cross section of stipe, part of pinnules and part of pinnules showing sori; E-H: *Diplazium procumbens*, frond, rhizome, apex of pinnae and part of pinnules showing sori.

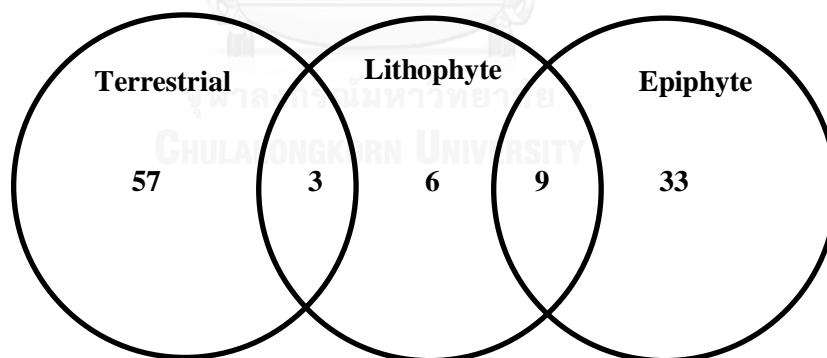
## CHAPTER VI

### DISCUSSION & CONCLUSION

The diversity of pteridophytes at Phu Thab Boek Area, Phu Hin Rong Kla National Park, Phetchabun province during March 2013 to June 2014 was explored. A total of 290 specimens were collected. Twenty families, 53 genera and 108 species were reported. Among these, 2 families, 4 genera and 4 species are lycophytes, while 18 families, 49 genera and 104 species are monilophytes. The families commonly found are Polypodiaceae (24 species), Dryopteridaceae (13 species) and Aspleniaceae (11 species).

#### 6.1 Habitat and diversity of pteridophytes

Pteridophytes can be divided into three main groups based on their habitat: terrestrials, epiphytes, and lithophytes. However, some species were found in more than one habitat (Fig. 6.1).



**Fig. 6.1** Diversity of pteridophytes according to habitat

##### 6.1.1 Terrestrials

A total of 57 species were found in this study site. Terrestrial habitat in Phu Thab Boek includes exposed area, shady area, streamlet bank, swamp and mountain slopes. Common species are member of the families: Dryopteridaceae, Pteridaceae, Thelypteridaceae, Woodsiaceae. Characteristic species of the shady areas included

*Arachniodes chinensis*, *A. speciosa*, *Dryopteris hasseltii*, *D. polita*, *D. sparsa*, *Leucostegia immersa*, *Polystichum attenuatum*, *P. biaristatum*, *Leptochilus ellipticus*, *Pteris mcclurei*, *P. tokioi*, *Athyrium mackinonii*, *A. sp.*, *Diplazium conterminum*, *D. griffithii*, *D. lobatum*, *D. polypodioides* and *D. procumbens*.

The exposed areas are commonly found along road-side or at the edge of the lower montane rainforest. The sun-loving species includes *Lycopodiella cernua*, *Lycopodium clavatum*, *Equisetum ramosissimum* subsp. *debile*, *Blechnum orientale*, *Cyclosorus tyloides*, *Macrothelypteris torresiana*, *Dicranopteris linearis* var. *linearis*, *Histiopteris incisa*, *Hypolepis punctata*, *Pteridium aquilinum* subsp. *wightianum*, *Nephrolepis cordifolia* and *Sphenomeris chinensis* var. *chinensis*. Likewise, *Lycopodiella cernua*, *Blechnum orientale*, and *Dicranopteris linearis* var. *linearis* was also reported from disturbed forests in Nakhon Si Thammarat province likewise Pipat Nopsiriwong (2011) Those species are growing in semi-exposed or fully exposed areas, they usually have small or dissected leaves or lamina with coriaceous texture.

In contrast, habitats of the streamlet banks and the swampy areas usually contain soils with high water table and high relative humidity, especially during rainy season (Belsky, Matzke and Uselman, 1999). Characteristic species include *Hymenasplenium obscurum*, *Cornopteris opaca*, *Cyclosorus canus*, *Leptochilus ellipticus*, *L. hemionitideus*, *Plagiogyria adnata*, *P. euphlebia* etc. It is interesting to note that the swampy area of Phu Thab Boek harbors two rare mountain fern species, i.e. *Plagiogyria euphlebia* and *Cornopteris opaca*. The first species, *Plagiogyria euphlebia* has never been reported in Thailand and reports here as a new record (Boonkerd and Pollawatn, 2000; Lindsay et al., 2009; Tagawa and Iwatsuki, 1967, 1979, 1985, 1988, 1989). In contrast, *Cornopteris opaca* is previously found just only in Lampang, it seems likely that its occurrence at Phu Thab Boek, Phetchabun province is the southernmost known station of this mountain fern (Tagawa and Iwatsuki, 1988).

In shady mountain slopes where light is partially shaded by tree canopy, forest floors usually packed with humus rich soils. There are a number of fern species, examples included *Arachniodes spectabilis*, *Asplenium normale*, *Bolbitis sinensis*, *Cyclosorus nudatus*, *Diplazium dilatatum*, *D. griffithii*, *D. lobatum*, *D. polypodioides*, *D. procumbens*, *Peranema aspidioides*, *Pteris bella*, *P. mcclurei*, *P. wallichiana* etc.

Similarly, these characteristic species are also found at the summit of Khao Khiao, Khao Yai National Park (Khwaiphan and Boonkerd, 2008).

### 6.1.2 Epiphytes

With increasing altitude, the epiphytes are gaining in number of species and number of individuals, this incidence due mainly to the decrease in temperature and increase in relative humidity of the habitat (CardelÚS, Colwell and Watkins, 2006; Kluge, Kessler and Dunn, 2006). This study found 33 epiphytic species, they are growing on tree trunks, mossy tree trunks and tree branches. The common families included Aspleniaceae, Hymenophyllaceae and Polypodiaceae. Examples of epiphytes that grow merely in shaded or half-shaded and moist areas are *Asplenium scortechinii*, *A. yoshinagae*, *Belvisia henryi*, *Crepidomanes bipunctatum*, *Huperzia hamiltonii*, *Hymenophyllum badium*, *Goniophlebium subauriculatum*, *G. manmeiense*, *Gymnogrammitis dareiformis*, etc. It is relevant to note that ‘Kut long’, *Gymnogrammitis dareiformis*, an epiphytic mountain fern is found in common here, this species is usually found in the northern floristic region (Tagawa and Iwatsuki, 1985), especially on Doi Inthanon and Doi Chiang Dao (Iwatsuki, 1972). The primary lower montane rainforest of Phu Thab Boek is dominated by large trees. Naturally, after a tree was fallen there was a canopy gap, so sunlight can penetrate to the forest floors. This specific microhabitat usually occupied by some epiphytes, such as *Asplenium phyllitidis* subsp. *phyllitidis*, *Elaphoglossum malayense*, *Belvisia henryi* and *Lepisorus scolopendrium*. In dry season, some mountain species adapted to survive during dry months by curling or detaching their fronds for reducing water loss. Examples are *Goniophlebium* spp., *Lepisorus* spp., *Loxogramme chinensis* and many species of filmy ferns. They will recover from drought condition as soon as they obtain monsoon rain for the first time.

### 6.1.3 Lithophytes

It was found that 15 species are lithophytes. Some of them can also be found as epiphytes or terrestrials. They grow in both exposed and shady areas on mossy or muddy rocks. Examples included *Bolbitis sinensis* var. *sinensis*, *Elaphoglossum subellipticum*, *Humata repens*, *Leptochilus hemionitideus*, *Microsorium insigne*,

*Sphenomeris chinensis* and *Vandenboshia birmanicum*. Tagawa and Iwatsuki (1979) noted that *Vandenboshia birmanicum* was a rare species, can be found on moist muddy rocks near stream in evergreen forest. In contrast, it is rather common here. In addition, *Microsorium insigne* usually found at low to medium altitude (Tagawa and Iwatsuki, 1989; X. C. Zhang et al., 2013) but at Phu Thab Boek it is found on muddy rocks in streamlets at 1,600 m above mean sea level. It was reported that *Leptochilus decurrens* has altitudinal distribution from medium to high altitude throughout Thailand (Tagawa and Iwatsuki, 1989), this species was also found on mossy rocks at this study site. Some lithophytes, such as *Oleandra musifolia* has long creeping rhizome, it can thrive on exposed bare rocks very well. However, this species was reported as epiphyte on mossy tree trunk on Doi Chiang Dao (Piyakaset Suksathan, 1998).

#### **6.1.4 Ferns inhabit in many habitats**

It was found that 12 species of ferns can grow either on moist ground and on humus-rich rocks or mossy rocks at high altitude. Examples are *Asplenium normale*, *Hymenasplenium cheilosorum* and *Bolbitis sinensis* var. *sinensis* (Tagawa and Iwatsuki, 1985, 1988). These species can adapt to both habitats very well. Obviously, *Asplenium normale* and *Bolbitis sinensis* var. *sinensis*, are prolific species, they can reproduce asexually from bulbils either they grow on rocks or on forest floor.

It is common that some epiphytes can furthermore grow on rocks in shady and moist areas. Examples included *Asplenium contiguum*, *Asplenium ensiforme*, *Goniophlebium amoenum*, *Selliguea oxyloba* and *Elaphoglossum subellipticum*. However, in some exposed areas or at the edges of lower montane rainforest there are species with long creeping rhizome, such as *Pyrrosia lingua* var. *heteractis*, *Humata repens* and *Lemmaphyllum carnosum*. They inhabit on rocks as well as on mossy tree trunks.

#### **6.2 Rare and endemic species**

Some pteridophytes were collected only once from Phu Thab Boek area, such as *Polystichum attenuatum* and *Dryopteris hasseltii*, they grow on moist forest ground in shady areas. These two ferns are considered rare species in Thailand. Likewise, a

new record fern, *Plagiogyria euphlebia* was found only in swamp near a streamlet at 1,600 m elevation and can be assessed as a national rare species. Some locally rare species, i.e. *Microsorium insigne* and *Crepidomanes minutum* are furthermore reported here. These two species have wide distribution in Thailand (Tagawa and Iwatsuki, 1979, 1989). It is interesting to note that *Diplazium procumbens* was previously reported from mountains of Pahang, peninsular Malaysia and Sri Lanka. This fern is a high altitude plant, usually grow above 1,500 m elevation (Sledge, 1962). In Thailand, it was reported as a new record from Kaeng Krachan National Park, Phetchaburi province (Boonkerd, Lindsay, Middleton and Suddee, 2004). Phu Thab Boek tends to be the northernmost station of *Diplazium procumbens*.

Three preceding known endemic species, i.e. *Arthromeris phuluangensis*, *Cyclosorus siamensis*, and *Polystichum attenuatum* (Tagawa and Iwatsuki, 1988, 1989) are similarly reported here. The distribution areas are somewhat different according to the species. The first two species, so far have the same pattern of distribution at a high altitude of Phu Miang and Phu Luang (Tagawa and Iwatsuki, 1988, 1989). In contrast, *Polystichum attenuatum* is a mountain fern that has much wider distribution in northern, north-eastern and south-eastern floristic regions.

### 6.3 New records

The result from this study indicated that two fern species are new records for Thailand:-

-*Plagiogyria euphlebia* (Kunze) Mett is previously found in China, Taiwan, Bhutan, India, Japan, Korea, Myanmar, Nepal, Philippines and Vietnam, at 600-1,500 m or up to 2,500 m elevations (Shieh, Devol and Lu, 1994; Zhang and Nooteboom, 2013). This species confined to swamp, its existence in Phetchabun province, north-eastern Thailand is so far in agreement with its previous distribution.

-*Pteris mcclurei* Ching is found in China, south of Japan and north of Vietnam, it grows in dense wet forests at 600-700 m elevation (G. M. Zhang et al., 2013). Previously, *Asplenium cardiophyllum* that was reported from China, Japan and Vietnam also found as a new record for Thailand (Boonkerd and Pollawatn, 2012). So the finding of *Pteris mcclurei* implies that there might be some more species from the Far East can disperse downwards to NE Thailand.

#### 6.4 Dubious species

There are three species of pteridophytes i.e. *Asplenium* sp., *Athyrium* sp. and *Diplazium* sp., which cannot determine to species level. Many attempts have been made to use various keys from many neighboring countries.

-*Asplenium* sp. is a lithophyte grows on mossy rocks in shady area in lower montane rainforest. It is similar to *Asplenium gueinzianum* Mett. ex Kuhn by having bulbils on adaxial surface of pinnae but shape of pinnae and color of stipe are quite different.

-*Athyrium* sp. is a terrestrial plant, grows on mountain slope in shady area. This species has bipinnatifid lamina, ovate to subdeltoid in outline. Sori usually curve and having horn-like appendage at costae. These characters are different from the previous known species that were reported in the Flora of Thailand (Tagawa and Iwatsuki, 1988).

-*Diplazium* sp. is a terrestrial plant, grows on moist mountain slopes in lower montane rainforest. This species is comparable to *Diplazium muricatum* (Mett.) Alderw. in having bipinnate to tripinnatifid fronds and scales are concolorous. Sori are oblong, located close to costule but rhizome is creeping rather than erect as is found in *D. muricatum*.

#### 6.5 Pteridophytes diversity comparison

##### 6.5.1 Doi Inthanon

Doi Inthanon is a National Park, located in Chiang Mai province northern Thailand. It is a raised foot of the Himalayas. The total area is approximately 482 km<sup>2</sup>, starting from 800 m to the summit at 2,565 m above mean sea level. The vegetation included dry evergreen forest, pine-deciduous dipterocarp forest, lower montane rainforest, lower montane pine-oak forest, upper montane rainforest and montane peat bog. The mean temperature is 15-17 °C, the annual average rainfall is c. 2,000-2,100 mm per year and the average relative humidity is 80 percent (Santisuk, 2012; Yosita Nathi, 2009).



A total of 24 families, 67 genera and 171 species of pteridophytes were reported from Doi Inthanon (Koyama, 1986a). Among these 59 species are common with this study and can be further divided into 27 species of terrestrials and 22 species of epiphytes (Table 6.1).

### **6.5.2 Doi Chiang Dao**

Doi Chiang Dao is a Wildlife Sanctuary, located in Chiang Mai province. It covered an area of about 521 km<sup>2</sup> which consists of many mountain peaks. The highest peak is Doi Luang Chiang Dao, at an elevation of 2,175 m above mean sea level. The average temperature is in the range of 20-31° C, the relative humidity 50-90% and the annual average rainfall is 1,183.5 mm per year. The vegetation of Doi Chiang Dao Wildlife Sanctuary included lower montane rainforest, lower montane oak forest, upper montane rainforest and upper montane scrub (Santisuk, 2012).

Diversity of Pteridophytes at Doi Chiang Dao was listed by Tagawa and Iwatsuki (1979, 1985, 1988, 1989). Furthermore, epiphytic and lithophytic pteridophytes in Doi Chiang Dao were added (Piyakaset Suksathan, 1998). Among these, 49 species of pteridophytes are common with this study, they are 21 species of terrestrials and 18 species of epiphytes (Table 6.1).

### **6.5.3 Phu Kradung**

Phu Kradung National Park is located in Loei province in north-eastern Thailand, it covered an area of approximately 348 km<sup>2</sup>. The area ranges in elevation from 500 m to 1,200 m above mean sea level. The mean temperature is 26° C (Tourism Authority of Thailand, 2000a). The vegetation included dry dipterocarp forest, mix-deciduous forest, lower montane pine-oak forest, lower montane scrub, lower montane coniferous forest and montane peat bog (Santisuk, 2012). Regarding to pteridophytes diversity, 27 families, 78 genera and 228 species were reported from Phu Kradung (Koyama, 1986b). Sixty-four species are in common with this study and most of them are terrestrials (Table 6.1).

### 6.5.4 Phu Luang

Phu Luang Loei province is a Wildlife Sanctuary, with 848 km<sup>2</sup> in total area. Its highest peak is at Phu Khwang about 1,571 m above mean sea level. The average air temperature is 24° C, the relative humidity 60-83% and the average annual rainfall is 1,238 mm per year (Tourism Authority of Thailand, 2000b). The vegetation included lower montane rainforest, lower montane pine-oak forest, lower montane coniferous forest, lower montane scrub, montane peat bog (Santisuk, 2012). One hundred and thirty eight species were reported (Tagawa and Iwatsuki, 1979, 1985, 1988, 1989). In this study, 53 species are common with the records at Phu Luang. Among these, there are 20 terrestrial species and 33 epiphytic species (Table 6.1).

**Table 6.1 Comparison of pteridophytes diversity from Phu Thab Boek area, Doi Inthanon, Doi Chiang Dao, Phu Kradung and Phu Luang.**

Note: “✓” = present, “-” = absent

Taxon (this study)	Doi Inthanon	Doi Chiang Dao	Phu Kradung	Phu Luang
LYCOPODIACEAE				
<i>Huperzia hamiltonii</i> (Spreng. ex Grev. & Hook.) Trevis.	✓	✓	-	✓
<i>Lycopodiella cernua</i> (L.) Pic.Serm.	✓	✓	✓	-
<i>Lycopodium clavatum</i> L.	✓	-	✓	-
SELAGINELLACEAE				
<i>Selaginella siamensis</i> Hieron.	-	-	✓	✓
ASPLENIACEAE				
<i>Asplenium contiguum</i> Kaulf.	-	-	-	-
<i>Asplenium ensiforme</i> Wall. ex Hook. & Grev.	✓	✓	-	✓
<i>Asplenium normale</i> D. Don	✓	-	✓	✓
<i>Asplenium perakense</i> Matthew & Christ	✓	-	✓	-
<i>Asplenium phyllitidis</i> D. Don. subsp. <i>phyllitidis</i>	-	-	✓	-
<i>Asplenium scortechinii</i> Bedd.	-	-	✓	✓
<i>Asplenium yoshinagae</i> Makino	-	✓	-	✓
<i>Asplenium</i> sp.	-	-	-	-
<i>Hymenasplenium cheilosorum</i> (Kunze ex Mett.) Tagawa	✓	-	✓	-
<i>Hymenasplenium excisum</i> (C. Presl) S. Linds.	-	✓	-	-

Taxon (this study)	Doi Inthanon	Doi Chiang Dao	Phu Kradung	Phu Luang
<i>Hymenasplenium obscurum</i> (Blume) Tagawa	✓	✓	-	-
BLECHNACEAE				
<i>Blechnum orientale</i> L.	-	-	✓	✓
CYATHEACEAE				
<i>Cyathea spinulosa</i> Wall. ex Hook.	✓	-	-	-
DAVALLIACEAE				
<i>Humata repens</i> (L.f.) Diels	-	✓	✓	✓
DENNSTAEDTIACEAE				
<i>Histiopteris incisa</i> (Thunb.) J. Sm.	-	-	✓	✓
<i>Hypolepis punctata</i> (Thunb.) Mett. ex Kuhn	✓	✓	✓	✓
<i>Microlepia herbacea</i> Ching & C. Chr. ex Tardieu & C. Chr.	✓	-	✓	✓
<i>Microlepia puberula</i> Alderw.	-	-	-	-
<i>Microlepia speluncae</i> (L.) T. Moore	-	✓	✓	✓
<i>Microlepia strigosa</i> (Thunb.) C. Presl	✓	-	-	-
<i>Pteridium aquilinum</i> (L.) Kuhn subsp. <i>wightianum</i> (J.Agardh) W.C. Shieh	✓	✓	✓	-
DRYOPTERIDACEAE				
<i>Arachniodes chinensis</i> (Rosenst.) Ching	-	-	✓	-
<i>Arachniodes speciosa</i> (D. Don) Ching				
<i>Arachniodes spectabilis</i> (Ching) Ching	✓	-	✓	-
<i>Bolbitis sinensis</i> (Baker) K. Iwats. var. <i>sinensis</i>	✓	✓	✓	✓
<i>Dryopteris hasseltii</i> (Blume) C. Chr.			✓	✓
<i>Dryopteris polita</i> Rosenst.	-	✓	✓	✓
<i>Dryopteris sparsa</i> (D. Don) Kuntze	-	✓	✓	✓
<i>Elaphoglossum malayense</i> Holttum	-	-	✓	-
<i>Elaphoglossum subellipticum</i> Rosenst.	-	-	✓	✓
<i>Leucostegia immersa</i> C. Presl	✓	✓	✓	-
<i>Peranema aspidioides</i> (Blume) Mett.	✓	-	-	✓
<i>Polystichum attenuatum</i> Tagawa & K. Iwats.	✓	✓	✓	✓
<i>Polystichum biaristatum</i> (Blume) T. Moore	✓	-	-	-
EQUISETACEAE				
<i>Equisetum ramosissimum</i> Desf. subsp. <i>debile</i> (Roxb. ex Vaucher) Hauke	✓	✓	-	-

Taxon (this study)	Doi Inthanon	Doi Chiang Dao	Phu Kradung	Phu Luang
<b>GLEICHENIACEAE</b>				
<i>Dicranopteris splendida</i> Hand.-Mazz. ) Tagawa	-	-	-	-
<i>Dicranopteris linearis</i> (Burm.f.) Underw. var. <i>linearis</i>	-	✓	✓	✓
<i>Dicranopteris linearis</i> (Burm.f.) Underw. var. <i>tetraphylla</i> (Rosenst.) Nakai	-	-	✓	-
<i>Diplopterygium norrisii</i> (Mett. ex Kuhn) Nakai	-	-	-	-
<b>HYMENOPHYLLACEAE</b>				
<i>Crepidomanes bipunctatum</i> (Poir.) Copel.	-	-	✓	-
<i>Crepidomanes latealatum</i> (Bosch) Copel.	✓	✓	✓	✓
<i>Crepidomanes minutum</i> (Blume) K. Iwats.	-	-	✓	✓
<i>Hymenophyllum badium</i> Hook. & Grev.	✓	✓	✓	✓
<i>Hymenophyllum barbatum</i> (Bosch) Baker	✓	-	-	✓
<i>Hymenophyllum exsertum</i> Wall. ex Hook.	✓	-	✓	✓
<i>Hymenophyllum polyanthos</i> (Sw.) Sw.	✓	✓	✓	✓
<i>Vandenboshia birmanica</i> (Bedd.) Ching	✓	-	✓	-
<b>LINDSAEACEAE</b>				
<i>Sphenomeris chinensis</i> (L.) Maxon var. <i>chinensis</i>	✓	✓	✓	✓
<b>LOMARIOPSIDACEAE</b>				
<i>Nephrolepis cordifolia</i> (L.) C. Presl	-	✓	✓	✓
<b>OLEANDRACEAE</b>				
<i>Oleandra musifolia</i> (Blume) C. Presl	✓	✓	✓	✓
<b>OPHIOGLOSSACEAE</b>				
<i>Ophioglossum petiolatum</i> Hook.	✓	✓	✓	-
<b>PLAGIOGYRIACEAE</b>				
<i>Plagiogyria adnata</i> (Blume) Bedd.	-	-	✓	✓
<i>Plagiogyria euphlebia</i> (Kunze) Mett.	-	-	-	-
<b>POLYPODIACEAE</b>				
<i>Arthromeris lehmannii</i> (Mett.) Ching	✓	✓	-	-
<i>Arthromeris phuluangensis</i> Tagawa & K. Iwats.	-	-	-	✓
<i>Belvisia henryi</i> (Hieron. ex C. Chr.) Tagawa	✓	-	✓	✓
<i>Goniophlebium amoenum</i> (Wall. ex	✓	✓	-	✓

Taxon (this study)	Doi Inthanon	Doi Chiang Dao	Phu Kradung	Phu Luang
Mett.) Bedd. <i>Goniophlebium manmeiense</i> (Christ) Rödl-Linder	✓	✓	-	✓
<i>Goniophlebium mengtzeense</i> (Christ) Rödl-Linder	✓	-	✓	✓
<i>Goniophlebium subauriculatum</i> (Blume) C. Presl	-	✓	✓	✓
<i>Gymnogrammitis dareiformis</i> (Hook.) Ching ex Tardieu & C. Chr.	✓	✓	-	-
<i>Lemmaphyllum carnosum</i> (Hook.) C. Presl	-	✓	✓	✓
<i>Lepisorus contortus</i> (Christ) Ching	✓	-	-	-
<i>Lepisorus nudus</i> (Hook.) Ching	✓	✓	✓	-
<i>Lepisorus scolopendrium</i> (Ching) Mehra & Bir	✓	✓	✓	✓
<i>Lepisorus subconfluens</i> Ching	✓	✓	-	-
<i>Leptochilus decurrens</i> Blume	✓	✓	✓	✓
<i>Leptochilus ellipticus</i> (Thunb.) Noot.	✓	✓	✓	-
<i>Leptochilus hemionitideus</i> (C. Presl) Noot.	✓	-	✓	-
<i>Leptochilus pedunculatus</i> (Hook. & Grev.) Fraser-Jenk.	-	-	-	-
<i>Loxogramme chinensis</i> Ching	✓	✓	✓	-
<i>Microsorium insigne</i> (Blume) Copel.	✓	-	✓	✓
<i>Microsorium superficiale</i> (Blume) Ching	✓	✓	✓	✓
<i>Neocheiropteris normalis</i> (D. Don) Tagawa	✓	-	-	✓
<i>Pyrrosia lingua</i> (Thunb.) Farw. var. <i>heteractis</i> (Mett. ex Kuhn) Hovenkamp	-	✓	✓	✓
<i>Pyrrosia porosa</i> (C. Presl) Hovenkamp var. <i>tonkinensis</i> (Giesenh.) Hovenkamp	-	✓	✓	✓
<i>Selliguea oxyloba</i> (Wall. ex Kunze) Fraser-Jenk.	✓	✓	✓	✓
<i>Selliguea rhynchophylla</i> (Hook.) Fraser-Jenk.	✓	✓	✓	✓
PTERIDACEAE Subfam. PTERIDOIDEAE				
<i>Pityrogramma calomelanos</i> (L.) Link	-	-	✓	-
<i>Pteris bella</i> Tagawa	✓	-	-	✓
<i>Pteris biaurita</i> L.	✓	-	✓	✓

Taxon (this study)	Doi Inthanon	Doi Chiang Dao	Phu Kradung	Phu Luang
<i>Pteris mcclurei</i> Ching	-	-	-	-
<i>Pteris tokioi</i> Masam.	-	-	✓	✓
<i>Pteris vittata</i> L.	-	✓	-	-
<i>Pteris wallichiana</i> J. Agardh	✓	✓	✓	-
Subfam. VITTARIOIDEAE				
<i>Antrophyum parvulum</i> Blume	-	✓	-	-
<i>Haplopteris angustifolia</i> (Blume) E.H. Crane	-	-	-	✓
THELYPTERIDACEAE				
<i>Cyclosorus canus</i> (Baker) S. Linds.	-	-	-	-
<i>Cyclosorus lakhimpurens</i> (Rosenst.) Copel.	✓	✓	✓	✓
<i>Cyclosorus papilio</i> (C. Hope) Ching	✓	-	-	-
<i>Cyclosorus siamensis</i> (Tagawa & K. Iwats.) Panigrahi	-	-	✓	✓
<i>Cyclosorus tylodes</i> (Kunze) Panigrahi	✓	✓	-	-
<i>Macrothelypteris torresiana</i> (Gaudich.) Ching	-	✓	-	-
<i>Thelypteris confluens</i> (Thunb.) C.V. Morton	✓	-	-	-
<i>Thelypteris flaccida</i> (Blume) Ching	✓	-	-	-
WOODSIACEAE				
<i>Athyrium mackinnonii</i> (C. Hope) C. Chr.	-	-	✓	-
<i>Athyrium</i> sp.				
<i>Cornopteris opaca</i> (D. Don) Tagawa	✓	-	-	-
<i>Diplazium conterminum</i> Christ	-	-	✓	-
<i>Diplazium dilatatum</i> Blume	✓	✓	✓	✓
<i>Diplazium griffithii</i> T. Moore	-	✓	-	-
<i>Diplazium lobatum</i> (Tagawa) Tagawa	-	-	-	-
<i>Diplazium polypodioides</i> Blume	✓	-	-	-
<i>Diplazium procumbens</i> Holttum	-	-	-	-
<i>Diplazium</i> sp.	-	-	-	-

Table 6.1 shows a comparison of pteridophytes diversity in northern floristic region, i.e. Doi Inthanon National Park and Doi Chiang Dao Wildlife Sanctuary and north-eastern floristic region, i.e. Phu Kradung National Park and Phu Luang Wildlife Sanctuary. It seems likely that Phu Kradung has most species in common with Phu

Thab Boek Area. Nevertheless, it is expected that Pteridophyte Flora of Phu Luang and Phu Thab Boek will be the most comparable, not only in their closest location but also in their high elevation on mountains. Ever since terrestrials are the highest number of the collected pteridophytes. The difference in species composition of the two sites probably due to their difference in edaphic factors. Most areas of Phu Luang are composed of sandstone (Tourism Authority of Thailand, 2000b), while most areas of Phu Thab Boek are humus rich soil (observation from this study). It was found that the two sites have only 20 terrestrials in common (see section 6.5.4). In contrast, it was noted that the distribution of pteridophytes in Thailand is subjective mostly by the climatic factors rather than geohistorical data (Iwatsuki, 1972).

It can be seen from Table 6.2 that Phu Thab Boek area has the smallest total area. However, its species composition is rather high as compare with Phu Luang and the rest. The discrepancies between each protected area are probably due to their difference in edaphic factors of each habitat in each vegetation as well as their difference in topography. To sum up, Phu Thab Boek in the protected area of Phu Hin Rong Kla National Park is one of the mountainous sites that rich in pteridophytes diversity.

**Table 6.2 Area and number of taxa of pteridophytes from Phu Thab Boek, Doi Inthanon National Park, Doi Chiang Dao Wildlife Sanctuary, Phu Kradung National Park and Phu Luang Wildlife Sanctuary.**

Area	Total area (km <sup>2</sup> )	No. of family	No. of genera	No. of species
Phu Thab Boek	25	20	53	108
Doi Inthanon	482	24	67	171
Doi Chiang Dao	520	23	61	169
Phu Kradung	348	27	78	228
Phu Luang	848	26	61	146

## 6.6 Phytogeography and distribution

The relationship of the pteridophyte flora in northern Thailand and Sino-Himalayan mountains was examined by Iwatsuki (1972). He concluded that the Sino-

Himalayan elements are prevalent at higher elevation of the evergreen forests. Phu Thab Boek Area in Phu Hin Rong Kla National Park is in the northeastern floristic region of Thailand (Santisuk, 1989). The result from this study indicates that over 20 species are commonly distributed from Himalaya through Indochina or Japan. Examples include *Hymenasplenium cheilosorum*, *H. excisum*, *Cyathea spinulosa*, *Humata repens*, *Microlepia strigosa*, *Microsorium insigne*, *Plagiogyria euphlebia*, *Cyclosorus canus*, *C. lakhimpurens*, *C. tylodes* etc. Regarding to the vertical distribution of ferns, it was found that a lithophyte, namely *Microsorium insigne* was usually found at low to medium altitude in Thailand (Tagawa and Iwatsuki, 1989) and about 600-800 m in China (X. C. Zhang et al., 2013). In contrast, this species was found on rocks at rather high altitude of 1,730 m at Phu Thab Boek.

Moreover, there are 6 species, namely *Histiopteris incisa*, *Microlepia spelunca*, *Nephrolepis cordifolia*, *Ophioglossum petiolatum*, *Pityrogramma calomelanos* and *Pteris biaurita* are pantropical distribution. These species are noted as low to medium altitudinal species (Tagawa and Iwatsuki, 1979, 1985). However, those species were found at elevation ranging from 1,600-1,700 m.

From 108 species of pteridophytes in this study, there are 4 species i.e. *Asplenium perakense*, *Microlepia puberula*, *Diplopterygium norrisii* and *Diplazium procumbens*, that are found in peninsular Malaysia (Tagawa and Iwatsuki, 1979, 1985, 1988). However, *Asplenium perakense* was also reported from Doi Inthanon and Phu Kradung (Koyama, 1986a, 1986b). Likewise, a member of the Gleicheniaceae, *Diplopterygium norrisii*, is found in central and peninsular Thailand at about 1,100 m elevation, but at Phu Thab Boek it occurs at 1,600-1,720 m. Another species that occurs in northern Thailand is *Microlepia puberula*, it was found in Chiang Mai, Lampang and Nan provinces. It was also reported from Kanchaburi and Yala provinces (Tagawa and Iwatsuki, 1979). *Microlepia puberula* has wider distribution in peninsular Malaysia and Sarawak (Parris and Latiff, 1997). It is worth keeping track of the distribution of those species inside and outside Thailand in the future in order to understand their phytogeography.



### **6.7 Problems in this research**

1. Some areas, for example steep cliffs are difficult to access, and some small species may be overlooked.
2. Taking photograph of the living specimens during heavy rain is a hard job.
3. Voucher herbarium specimens are not available in some herbaria. So the comparison with the known specimens was not complete in some species.

### **6.8 Benefits of this research**

1. Basic information of pteridophyte diversity, such as ecology, distribution are added.
2. Key to genera and species of pteridophytes of Phu Thab Boek can be used for adjacent area, such as Nam Nao National Park.
3. Number of pteridophyte specimens were gain to Professor Kasin Suvatabhandu herbarium (BCU) and will be useful for further study in related work.
4. The status of each species is obtained and can be used as a basis for a suitable measure for conservation of this vulnerable protected area.



## REFERENCES

- Belsky, A.J., Matzke, A., and Uselman, S. 1999. Survey of livestock influences on stream and riparian ecosystems in The Western United States. Journal of Soil and Water Conservation, 54, 419-431.
- Boonkerd, T., Lindsay, S., Middleton, D.J., and Suddee, S. 2004. Additions to the Pteridophyte flora of Thailand. Thai Forest Bulletin (Botany), 32, 6-11.
- Boonkerd, T., and Pollawatn, P. 2000. Pteridophytes in Thailand. Bangkok: Office of Environmental Policy and Planning.
- Boonkerd, T., and Pollawatn, R. 2012. *Asplenium cardiophyllum*, a species of fern newly discovered in Thailand. ScienceAsia, 38, 125-128.
- Boonkerd, T., and Ratchata, P. 2002. Pteridophytes Flora of Khun Korn Waterfall Foresr Park, Chiang Rai Province,. Natural History Bulletin of the Siam Society, 50(2), 195-210.
- Boonkerd, T., Wacharapai, M., Trirattana, S., Maneerat, Y., Thaithong, O., and Laichuthai, N. 1987. Collecting and preserving herbarium specimens. Bangkok: Arunamarin Publishing.
- Brummit, P.K., and Powel, C.E. 1992. Authors of Plant Names. Great Britain: Whistable Litho Printers.
- CardelÚS, Catherine L., Colwell, Robert K., and Watkins, James E. 2006. Vascular epiphyte distribution patterns: explaining the mid-elevation richness peak. Journal of Ecology, 94(1), 144-156.
- Holttum, R.E. 1969. Flora of Malaya. Vol II. (Ferns). Singapore: Singapore: Government Printing Office.
- Iwatsuki, K. 1972. Phytogeography of the Pteridophytes in Northern Thailand. Acta Phytotaxonomica et Geobotanica, 25, 69-78.
- Khwaiphan, W., and Boonkerd, T. 2008. The pteridophyte flora of Khao Khiao, Khao Yai National Park, Thailand. . Natural History Journal of Chulalongkorn University, 8(2), 69-82.
- Khwaiphan, W., Chomboon, N., Chummak, P., Sangpakdee, K., Siriyan, S., Silprasit, K., Pangthai, D., and Leuangsakul, S. 2011. Diversity of Ferns and Fern allies in Phu Pha Man National Park, Khon Kaen Province and Loei Province:

- Environment and National Resource Institute, Srinakharinwirot University. (in Thai)
- Kitichate Sridith. 1987. Non-Flowering plants on rock platform of Phu Hin Rong Kla National Park. Special study, Chulaongkorn University, Bangkok. (in Thai)
- Kluge, J., Kessler, M., and Dunn, R. R. 2006. What drives elevational patterns of diversity? A test of geometric constraints, climate and species pool effects for pteridophytes on an elevational gradient in Costa Rica. Global Ecology and Biogeography, 15(4), 358-371.
- Koyama, H. 1986a. A preliminary check list of the pteridophytes and dicotyledons of Doi Inthanon in Thailand: Kyoto University.
- Koyama, H. 1986b. A preliminary check list of the pteridophytes and dicotyledons of Phu Kradung in Thailand: Kyoto University.
- Lindsay, S., Middleton, D.J., Boonkerd, T., and Suddee, S. 2009. Towards a stable nomenclature for Thai ferns. Thai Forest Bulletin (Botany) 37, 64-106.
- Makgomol, K. 2006. Survey of ferns in Phu Phan National Park. In 44th Kasetsart University Annual Conference : Science, Bangkok. (in Thai)
- Makgomol, K. 2009. Ferns in the waterfalls in Nam Nao National Park, Thailand. KKU Science Journal 37, 56-61.
- Masuthon, S. n.d. Diversity of Ferns in Mountain Ecosystem : Phuluang Wildlife Reserve. [Online]. Available from [http://www.rdi.ku.ac.th/kufair50/plant/42\\_1\\_plant/plant\\_42.1.htm](http://www.rdi.ku.ac.th/kufair50/plant/42_1_plant/plant_42.1.htm) [22 October, 2013] (in Thai)
- Pakeerun, A. 2000. Phu Hin Rong Kla National Park. Nonthaburi: Than Buakaew Print. (in Thai)
- Parris, B.S., and Latiff, A.. 1997. Towards a Pteridophyte Flora of Malaysia: A Provisional Checklist of Taxa. Malayan Nature Journal, 50, 235-280.
- Pipat Nopsiriwong. 2011. Diversity Of Pteridophytes In Khao Luang Area, Amphur Khanom, Nakhon Si Thammarat. Master's thesis, Chulalongkorn University. (in Thai)
- Piyakaset Suksathan. 1998. Taxonomy and ecology of epiphytic and lithophytic ptericophytes at Doi Chiang Dao, Chiang Mai. Master's thesis, Kasetsart University. (in Thai)

- Putthachart Sangarun. 1995. A survey of fern in Khao Luang forest, Ramkhamhaeng National Park, Sukhothai Province. Master's thesis, Naresuan University. (in Thai)
- Royal Instituted. 2002. The Royal Institute Thai Gazetteer (4 ed.). Bangkok. (in Thai)
- Santisuk, T. 1989. Flora of Thailand: past present and future. In the 7th Bioloical seminar: Biodiverity in Thailand, Chiang Mai. (in Thai)
- Santisuk, T. 2012. Thailand forest. Bangkok: Buddhapresss. (in Thai)
- Schmidt, J. 1901. Pteridophyta Flora of Koh Chang, Part III. Copenhagen: Bianco Luno.
- Seidenfaden, G. 1958. On a small Collection of Ferns from Thailand. Natural History Bulletin of the Siam Society, 19, 84-87.
- Seree Phromkaew. 1993. A survey of fern Polypodiaceae in Phu Rua National Park, Loei Province. Master's thesis, Naresuan University. (in Thai)
- Shieh, W.C., Devol, C.E., and Lu, C.Y. 1994. Plagiogyriaceae. In T. C. Huang (ed.), Flora of Taiwan. 2 ed., Vol. 1, pp. 134-139. Taipei: The Editorial Committee of Flora of Taiwan, Department of Botany, National Taiwan University.
- Siridarut Jujia. 2003. Taxonomy of ferns at Thung Salaeng Luang national park. Master's thesis, Kasetsart University. (in Thai)
- Sledge, W. A. 1962. The Athyrioid ferns of Ceylon. Bulletin of the Natural History Museum. Botany series, 2, 277-323.
- Smitinand, T. 1989. Thailand. In D. G. Campbell & D. H. Hammond (eds.), Floristic Inventory of Tropical Countries: Status of Plant Systematics, Collections and Vegetation, Plus Recommendations for the Future pp. 63-82. New York: New York Botanical Garden.
- Soil and forest resources part National Resource Conservation Office. 1997. The management model scheme of Phu Hin Rong Kla National Park, Phetchabun and Loei Provinces Vol. 1. Bangkok: National Resource Conservation Office. (in Thai)
- Sutheera Akarakraisri. 1986. Studies on the fern Dennstaedtiaceae in Thailand. Master's thesis, Chulalongkorn University. (in Thai)
- Tagawa, M., and Iwatsuki, K. 1967. Enumeration of Thai Pteridophytes Collected during 1965-66. Japanese Journal of Southeast Asian Studies, 5(1), 23-120.

- Tagawa, M., and Iwatsuki, K. 1979. Pteridophytes. In T. Smitinand & K. Larsen (eds.), Flora of Thailand (Vol. 3). Bangkok: The Tist Press.
- Tagawa, M., and Iwatsuki, K. 1985. Pteridophytes. In T. Smitinand & K. Larsen (eds.), Flora of Thailand (Vol. 3). Bangkok: Phonphan Printing Company.
- Tagawa, M., and Iwatsuki, K. 1988. Pteridophytes. In T. Smitinand & K. Larsen (eds.), Flora of Thailand (Vol. 3). Bangkok: Chutima Press.
- Tagawa, M., and Iwatsuki, K. 1989. Pteridophytes. In T. Smitinand & K. Larsen (eds.), Flora of Thailand (Vol. 3). Bangkok: Phonphan Printing Company.
- Thai Meteorological Department. 2014. Climatic data from Lomsak Station, Phetchabun Province, 1984-2013.
- Tourism Authority of Thailand. 2000a. Phu Kradung: The Legend of North-Eastern mountain. Bangkok: Amarin Printing and Publishing. (in Thai)
- Tourism Authority of Thailand. 2000b. Phu Luang: The Kingdom of Plant. Bangkok: Amarin Printing and Publishing. (in Thai)
- Tourism Authority of Thailand. 2000c. Thung Saleng Laung, Phu Hin Rong Kla, coniferous Forest, grassland and rock platform of Phetchabun mountains. Bangkok: Amarin Printing and Publishing. (in Thai)
- van Welzen, P.C., Madern, A., Raes, N., Parnell, J.A.N., Simpson, D.A., Byrne, C., Curtis, T., Macklin, J., Trias-Blasi, A., Prajaksood, A., Bygrave, P., Dransfield, S., Kirkup, D.W., Moat, J., Wilkin, P., Couch, C., Boyce, P.C., Chayamarit, K., Chantaranothai, P., Esser, H.-J., and Jebb, M.H.P. 2011. The current and future status of floristic provinces in Thailand. In Y. Trisurat, R. P. Shrestha & R. Alkemide (eds.), Land use, climate change and biodiversity modeling: Perspectives and applications. pp. 219-247. Hershey: IGI Global.
- Wilawan Rattanathirakul. 2002. Taxonomy of fern and fern allies at Phuhin Rongkla National Park, Phitsanulok Province. Master's thesis, Chulalongkorn University.
- Yosita Nathi. 2009. Mosses diversity in Kew Mae Pan and Ang Ka Areas, Doi Inthanon National Park, Chaing Mai Province. Master's thesis, Chulalongkorn University.
- Zhang, G.M., Liao, W.B., Ding, M.Y., Lin, Y.X., Wu, Z.H., Zhang, X.C., Dong, S.Y., Prado, J., Gilbert, M.G., Yatskievych, G., Ranker, T.A., Hooper, E.A.,

- Alverson, E.R., Metzgar, J.S., Funston, A.M., Masuyama, S., and Kato, M. 2013. Pteridaceae. In Z. Y. Wu, P.H. Raven & D.Y. Hong (eds.), Flora of China, (Pteridophytes) Vol. 2-3, pp. 169-256. Beijing; St. Louis: Science Press; Missouri Botanical Garden Press.
- Zhang, X.C., Lu, S.G., Lin, Y.X., Qi, X.P., Moore, S., Xing, F.W., Wang, F.G., Hovenkamp, P.H., Gilbert, M.G., Nootboom, H.P., Parris, B.S., Hafler, C., Kato, M., and Smith, A.R. 2013. Polypodiaceae. In Z.Y. Wu, P.H. Raven & D.Y. Hong (eds.), Flora of China (Pteridophytes) Vol. 2-3, pp. 758–850. Beijing; St. Louis: Science Press; Missouri Botanical Garden Press.
- Zhang, X.C., and Nootboom, H.P. 2013. Plagiogyriaceae. In Z.Y. Wu, P.H. Raven & D. Y. Hong (eds.), Flora of China, (Pteridophytes) Vol. 2-3, pp. 128-131. Beijing; St. Louis: Science Press; Missouri Botanical Garden Press.







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