

ความหลากหลายของเทอร์โอฟต์แวร์ในอุทยานแห่งชาติภูกระดึง จังหวัดเลย

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ลิขสิทธิ์ของจุฬาลงกรณ์มหาวิทยาลัย

Diversity of pteridophytes in Phu Kradueng National Park, Loei province

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PRAPAPORN JADPRAJONG: Diversity of pteridophytes in Phu Kradueng National Park, Loei province. ADVISOR: ASST. PROF.ROSSARIN POLLAWATN, Dr.rer.nat., 287 pp.

Phu Kradueng National Park, Loei province, is the place that has richness species of pteridophytes which 24 families, 62 genera and 147 species have been reported in Flora of Thailand since 1989. This study aimed to investigate the diversity of pteridophytes in Phu Kradueng National Park from December 2014 to February 2016. We collected samples along the nature trails at 260 - 1,316 meters above sea level (mASL). A total of 288 samples were identified into 26 families, 60 genera and 138 species. Among these, 2 families, 4 genera and 16 species were lycophytes and 24 families, 56 genera and 122 species were monilophytes. The most common family was Polypodiaceae with 25 species. Pteridaceae was the second most common family with 18 species. Among these, three species, e.g., *Asplenium siamense* Tagawa & K. Iwats., *Dryopteris rheophila* Mitsuta ex Darnaedi, *Elaphoglossum dumrongii* Tagawa & K. Iwats. and *Selliguea trisecta* (Baker) Fraser-Jenk. were endemic to Thailand. Moreover, *Selaginella* sp., *Asplenium* sp. and *Oleandra* sp. were founded as new records to Thailand and may be new species to science.

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CHAPTER I

INTRODUCTION

Thailand is located at the center of Southeast Asia. It occupies about 514,000 square kilometers. It is bordered to the north by Myanmar and Laos, bordered to the east by Cambodia and Laos, bordered to the west by the Andaman Sea and Myanmar and bordered to the south by the Gulf of Thailand and Malaysia. Thailand is located in the tropic region since its location is not far from the equator: latitude from 5° 37' to 20° 37' north and longitude from 97° 21' to 106° east. The plants community is tropical rain forest or deciduous forest (Santisuk, 2007). The floristic regions in Thailand can be separated into seven floristic regions: Northern (N), North-Eastern (NE), Eastern (E), Central (C), South-Eastern (SE), South-Western (SW) and Peninsular (PEN), according to followed (Smitinand, 1958)

The northeastern region is the largest region of Thailand, located on the Khorat Plateau. The north and the east are bordered by the Mekong River that bordered Laos, the southeast bordered by Cambodia, the south bordered with the Sankamphaeng Range and the west bordered by the Phetchabun Mountains that separated the northeastern region from northern and central of Thailand. Loei province is located in southeast of the northeastern region. The neighboring provinces are Nong Khai, Udon Thani and Nongbua Lamphu in the east, Khon Kaen and Phetchabun in the south, Phitsanulok on west side. Moreover, it is bordered by Xaignabouli and Vientiane Province of Laos in the north.

Phu Kradueng National Park is located in Si-than sub-district, Phu Kradueng district, Loei province. This place is the second national park of Thailand. The topography is like the leaves of Elephant Ear or heart-shaped sandstone mountain, covers the area of 348.12 square kilometers, and including a huge plateau on top of 60 square kilometers in size. The elevation ranged from 260–1,316 meters above sea level (mASL.), the highest summit is Kok Moei. There are plenty of forest which can be classified into five types: deciduous dipterocarp forest, mixed deciduous forest, dry

evergreen forest, lower-montane forest and lower-montane coniferous forest (Santisuk, 1994). This is suitable for pteridophyte's growth.

Pteridophytes are seedless vascular plants that have leaves, roots and sometimes true stems, and tree ferns have full trunks. They can be separated into two groups: lycophytes and monilophytes (Smith *et al.*, 2008). These plants can be found in many types of forests. Some species can be used as food, ornamental plants, and medicinal plants. Moreover, they are used as indicators of the richness of forests, moist tropical rain forest in particular because pteridophytes are plants that can grow and spread in many types of forest and in various elevations.

Nowadays, this place is popular for tourists which can disturb and decrease some pteridophyte populations. The number of tourists visiting Phu KraDueng National Park from January, 2007 to September, 2016 are 551,964 people, averaged as 55,197 people per year (Forest and Plant Conservation Research Office National Park Wildlife and Plant Conservation Department, 2016). Furthermore, due to the wild fires, the habitats of pteridophytes are lost and some pteridophytes are destroyed. So, these may cause the risk of pteridophytes extinction, especially the endemic species.

Aim of this thesis

To investigate the diversity of pteridophytes in Phu KraDueng National Park, Loei province.

Benefit of this research

The information of the number of pteridophytes in Phu KraDueng National Park is known and the key to identify pteridophytes in this area is constructed. Moreover, this would be important information for the national park to manage ecotourism and monitoring about pteridophytes especially the endemic species in Phu KraDueng.

CHAPTER II

LITERATURE REVIEW

The taxonomic study of Thai plants has been continuing for more than 200 years, but they were often focused mainly on economically important crops and flowering plants (Schmidt, 1901). The first formal study about the diversity of pteridophytes in Thailand was done by Motozi Tagawa and Kunio Iwatsuki during 1975–1989. They reported 34 families 134 genera and 633 species of pteridophytes in Thailand (Tagawa and Iwatsuki, 1979; 1985; 1988; 1989). After that, Thaweesakdi Boonkerd and Rossarin Pollawatn (2000) were studied and compiled the data of pteridophytes in Thailand. They reported 35 families 139 genera and 671 species. Among these, 28 genera and 217 species can be found in Loei province. This helps indicate that Loei province is rich of pteridophytes species.

The reports from the National Parks and Wildlife Sanctuaries nearby Phu Kra-dueng National Park about the diversity of pteridophytes had been published. In 1993, Seree Phromkaew (1993) surveyed and collected pteridophytes family polypodiaceae in Phu Rua National Park, Loei province, 13 genera and 14 species were reported. Besides, Wilawan Rattanathirakul (2002) reported 23 families, 55 genera and 112 species of ferns and fern allies in Phu Hin Rong Kla National Park, Phitsanulok province and *Acrorumohra diffracta* (Baker) H. Itô was a new record for Thailand. After that, Siridarut Jujia (2003) studied the diversity of fern and fern allies at Thung Salaeng Laung National Park, Phitsanulok and Phetchabun province, 22 families, 40 genera and 72 species were reported.

In addition, Kitima Makgomol (2006) studied ferns in Phu Phan National Park, Sakon Nakhon province, 21 families, 34 genera and 66 species of pteridophytes were reported and *Ophioglossum reticulatum* L. was reported as a new record for Thailand. Furthermore, Wasinee Khwaiphon and Thaweesakdi Boonkerd (2008) reported 25 families, 59 genera and 113 species of pteridophytes in Khao Khiao area in Khao Yai National Park. In the same year, Kitima Makgomol and Jakkrapong Thangthong (2008) surveyed the pteridophytes in four nature trails of Nam Nao National Park, Petchaboon

province and reported 15 families, 23 genera and 41 species. Among them, an endemic species, *Polystichum attenuatum* Tagawa & K. Iwats., was found.

Furthermore, Wasinee Kwaiphan and the others (2011) surveyed the pteridophytes in Phu Pha Man National Park, Khon Kaen and Loei province, 13 families, 23 genera and 38 species were reported. The common families found were Polypodiaceae, Adiantaceae and Pteridaceae. After that, Kittiyut Punchay (2014) studied pteridophytes in Phu Thub Boek area in Phu Hin Rong Kla National Park, 20 families, 53 genera and 108 species of pteridophytes were reported. Moreover, *Pteris mcclurei* Ching and *Plagiogyria euphlebica* (Kunze) Mett. were found as new records of Thailand. Moreover, Sumon Masuthon studied the diversity of ferns in the Mountain Ecosystem of Phu Luang Wildlife Sanctuary. She reported 24 families, 51 genera and 115 species of ferns and classified to terrestrial ferns 70 species, epiphytic ferns 27 species and lithophytic ferns 18 species (Masuthon, n.d.).

First study of diversity of pteridophyte in Phu Kradueng National Park started in 1979 by Tagawa and Iwatsuki. They reported 24 families, 62 genera and 147 species of pteridophyte in Phu Kradueng National Park in the Flora of Thailand Volume 3, 3 species were reported as endemic species to Phu Kradueng National Park, including *Asplenium siamense* Tagawa & K. Iwats., *Elaphoglossum dumrongii* Tagawa & K. Iwats. and *Dryopteris rheophila* Mitsuta ex Darnaedi. In Thailand, 10 species can be found only at Phu Kradueng National Park, including *Arachniodes cavalerii* (Christ) Ohwi, *Dicranopteris linearis* (Burm.f.) Underw. var. *tetraphylla* (Rosenst.) Nakai, *Diplazium mettanium* (Miq.) C. Chr., *D. subsinuatum* (Wall. ex Hook. & Grev.) Tagawa, *Gleichenia blotiana* C. Chr., *Lepisorus suboligolepidus* Ching, *Lindsaea odorata* Roxb., *Loxogramme lankokiensis* (Rosenst.) C. Chr., *Osmunda cinnamomea* L., and *Tectaria laotica* Tardieu & C. Chr. (Tagawa and Iwatsuki, 1979; 1985; 1988; 1989)

Moreover, Sompong Dhammathawon and Achara Dhammathawon (1983) studied sunny ferns in Phu Kradueng National Park with 16 genera and 19 species reported in this area. Moreover, in 1986, Hiroshige Koyama listed 228 species of pteridophytes in “A preliminary check list of the pteridophytes and dicotyledons of Phu

Kradueng in Thailand” but in this report there was no description, key for identification and the locations of the plants, including some expected species in this area (Koyama, 1986).

After the Flora of Thailand was published, Thaweesakdi Boonkerd and Rossarin Pollawatn found the new records for Thailand in 2002 and 2013 from Phu Kradueng National Park; there are *Pteridium aquilinum* Kuhn var. *latiusculum* (Desv.) Underw.ex A. Heller (Boonkerd and Pollawatn, 2002) and *Adiantum hispidulum* Sw. (Boonkerd and Pollawatn, 2013). These cause the number of species of pteridophytes changed from the past and the new records are not accounted.

In addition, the surveys of pteridophytes in Thailand have been continually studied. From the reasons above, there are less information about diversity of pteridophytes in Phu Kradueng National Park and the researchers continuously found new data of pteridophytes in Thailand especially in Phu Kradueng National Park. These lead to the question “Have the number of species changed from 30 years past?” Therefore, Phu Kradueng National Park is a suitable place for the purpose of diversity exploration and this will increase the information about pteridophytes in Thailand

CHAPTER III

STUDY SITE

3.1 Location and history

Phu Kradueng National Park is located in Si-than sub-district, Phu Kradueng District, Loei province. The western side borders to Nam Nao District of Phetchabun Province, near the mountain range of Phetchabun. The area of Phu Kradueng National Park is approximately 348.12 square kilometers (217,575 rai). The name of Phu Kradueng came from the Thai words, “Phu” comes from “phu-kao”, meaning mountain. The name “Kradueng” or “Kradung” means large bell. Its name came from the townsfolk heard the sound of a large bell from this mountain (Figure 3.1).

Phu Kradueng National Park was known from the period of King Vajiravudh, the sixth monarch of Siam under the House of Chakri or the King Rama VI. The intendant reported to the Ministry of Interior about the geographical of Phu Kradueng and legislate the Royal decree for Phu Kradueng forest to be a national forest.

In 1943, Phu Kradueng was declared a forest reserve from the Department of Forestry because the forest abundant with beautiful grasslands, waterways and rocks. Moreover, many kinds of the wild animals were there. After that, in 1962, the Department of Forestry was announced Phu Kradueng becomes the second national park of Thailand for conservation, research studies and the recreational area for people.

Phu Kradueng National Park is one of the most famous tourist attraction of Thailand because the beautiful nature and fresh air. The famous landscape is Lom Sak cliffs when the sunset and Nok An cliff with the sun rise. The route from the office of national park (Si-Than) to Lang Pae have local shops at the “Sam” means the water absorbent area, the distance is 5.5 km. and from Lang Pae to the Wang Kwang visitor center is about 3.6 km (Figure 3.1). During June, 1 to September, 30 every year, only the summit of Phu Kradueng is closed.

3.2 Geological data

The topography is a sandstone mountain, occupies an area of 348.12 square kilometers, including a huge heart-shaped plateau on top of 60 square kilometers in size. The elevation ranged from 260 meters at Si-Than to 1,316 meters at Kok Meoi on the top. The summit is sandstone high and steep cliffs. The slope of north-western parts are slightly more than others, this is a watershed for the Pong River.

The structure of rocks in Phu Kradueng happened in Mesozoic era; a sedimentation area formed and deposited the sediments of the Khorat Group. The rock in Phu Kradueng is the northwest of Khorat group, near the eastern slope of the mountain range of Phetchabun.

Phu Phan Formation found at above 990 mASL, from Sam Khrae to the summit. This formation occurred in Lower Cretaceous period. There are sandstone and conglomerate with greyish-white, medium to coarse grained and cross-bedded sandstones, siltstones and mudstones with minor conglomerates.

Sao Krua Formation, older than Phu Phan Formation, found around Sam Kok Koak, the altitudes from 600 meters and above. The formation occurred in Upper Jurassic period. The rocks usually consist of an alternation of decay siltstone; the others are reddish-brown sandstone and igneous rocks.

Phra Wihan Formation found at the altitudes ranging from 400–600 meters. This formation occurred around Middle Jurassic period. Its crops up Phu Phan Range and also vastly distributed around the western and the southern rims of the Khorat Plateau. The rocks consist of light yellowish-brown to grey, fine- to coarse-grained quartzite sandstones and a lesser range of siltstones and mudstones with occasional occurrences of conglomerates.

The oldest formation is Phu Kradueng Formation, found between Si-Than to Sam Haek. The precipitation started in Lower Jurassic period or about 190 million years ago. The formation included sandstones, mixed with brown to red-brown shale; the

others are siltstones, greyish brown sandstones and conglomerate (Tourism Authority of Thailand, 2000).

3.3 Climate

As Phu Kradueng is the monadnock mount, it makes the climate varies between foothills and the summit. The temperature is cool and comfortable all year round, average about 26 °C but the summit is lower. The average rainfall and the average humidity were collected (Figure 3.4). (Office of National Park. Department of National Parks Wildlife and Plant Conservation, 2016; Thai Meteorological Department, 2016) The wild fire occurs in Phu Kradueng every year, the numbers of wild fires from 2006 to 2015 were 455 times and the area was damaged about 10.57 square kilometers or 6,609 rai. (Phu Kradueng National Park, 2016).

3.4 Vegetation

Phu Kradueng National Park is not only a destination for tourists to take advantage of the pleasures of their own climbing to the summit, but it remains a place of invaluable natural heritage for next generations and a knowledge source for everyone. There are plenty of forests which can be classified into five types, there are deciduous dipterocarp forest, mixed deciduous forest, dry evergreen forest, lower-montane forest and lower-montane coniferous forest (Figure 3.2), (Santisuk, 1994).

Deciduous forest

Deciduous dipterocarp forest can be found on the flat hill and on the mountain slopes at the altitude ranging from 260 to about 600 meters. The vegetation consists of Taeng (*Shorea obtusa* Wall.), Rang (*Shorea siamensis* Miq.), Hiang (*Dipterocarpus obtusifolius* Teijsm. ex Miq.), Pluang (*Dipterocarpus tuberculatus* Roxb.) and others.

Some areas insert with bamboo trees (Santisuk, 19). The route from Si-Than to Sam Haek has this type of forest (Figure 3.2).

Mixed deciduous forest can be found at altitude ranging from 600–800 meters (Figure 3.2). This type of forest most found in the northern and the central of Thailand and patchy spread in the north-eastern. Many areas insert with bamboo trees (Santisuk, 1994). From Sam Haek to Sam Kok Phai contain this type of forest. The forest fire can be easily occurred in dry seasons and happened in every year.

Evergreen forest

Dry evergreen forest can be found at the mountain slope or foothills at the altitudes from 950 meters or more. This can be found at Sam Kok Don to the lower part of Sam Krae (Figure 3.2). Plants in dry evergreen forest mixed with more or less deciduous plants pending on the weather and soil moisture. There are common species in this forest e.g. Yang-Na (*Dipterocarpus alatus* Roxb.), Yang-Dang (*Dipterocarpus turbinatus* C. F. Gaertn.), Ta-khian (*Hopea odorata* Roxb.) and others (Santisuk, 1994).

Lower-montane forest can be seen at the upper part of the mountain. The altitudes are ranging from 950 meters at Sam Krae to about 1,200 meters around the waterfalls on the summit e.g. Pen Pob waterfall, Tham Yai Waterfall and Sor Neua waterfall (Figure 3.2). It was verdantly crown forest and densely undergrowth plants similar to evergreen forest (Santisuk, 1994).

Lower-montane coniferous forest can be seen on the mountaintop, the temperate tree such as two-needled pine, three-needled pine and maple were here. The altitudes are from 1,000 meter or more (Figure 3.2). Some plants are also exists by season, for example White and Red Roses (*Rhododendron* spp.), Kradum Ngoen (*Eriocaulon henryanum* Ruhle) and Krachieo (*Curcuma parviflora* Wall.) (Santisuk, 1994). The forest fire can be easily occurred in dry seasons and happened in every year because the forest floor vegetation is mostly grassland.

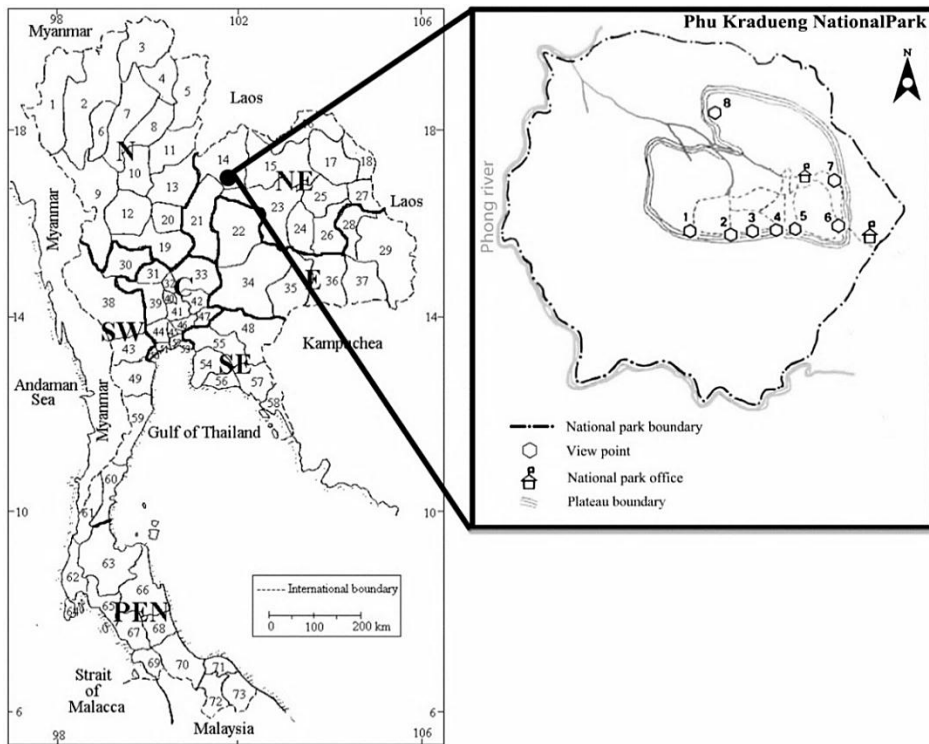


Figure 3. 1 Location of Phu Kradueng National Park, Loei province.

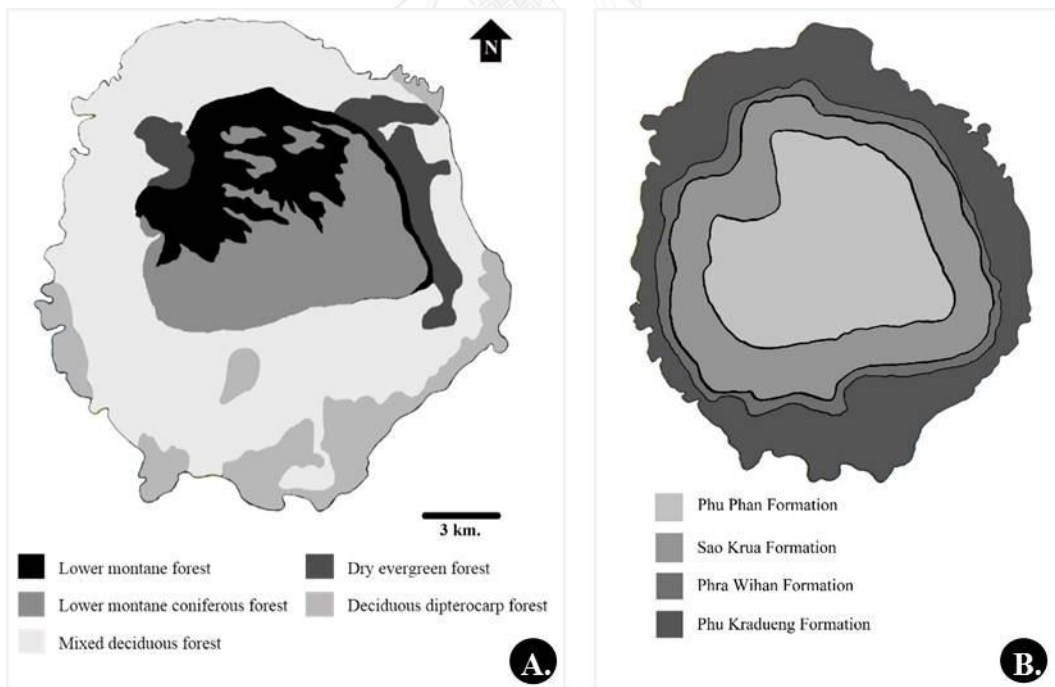


Figure 3. 2 A: Forest types of Phu Kradueng National Park, B: Soil formation in Phu Kradueng.

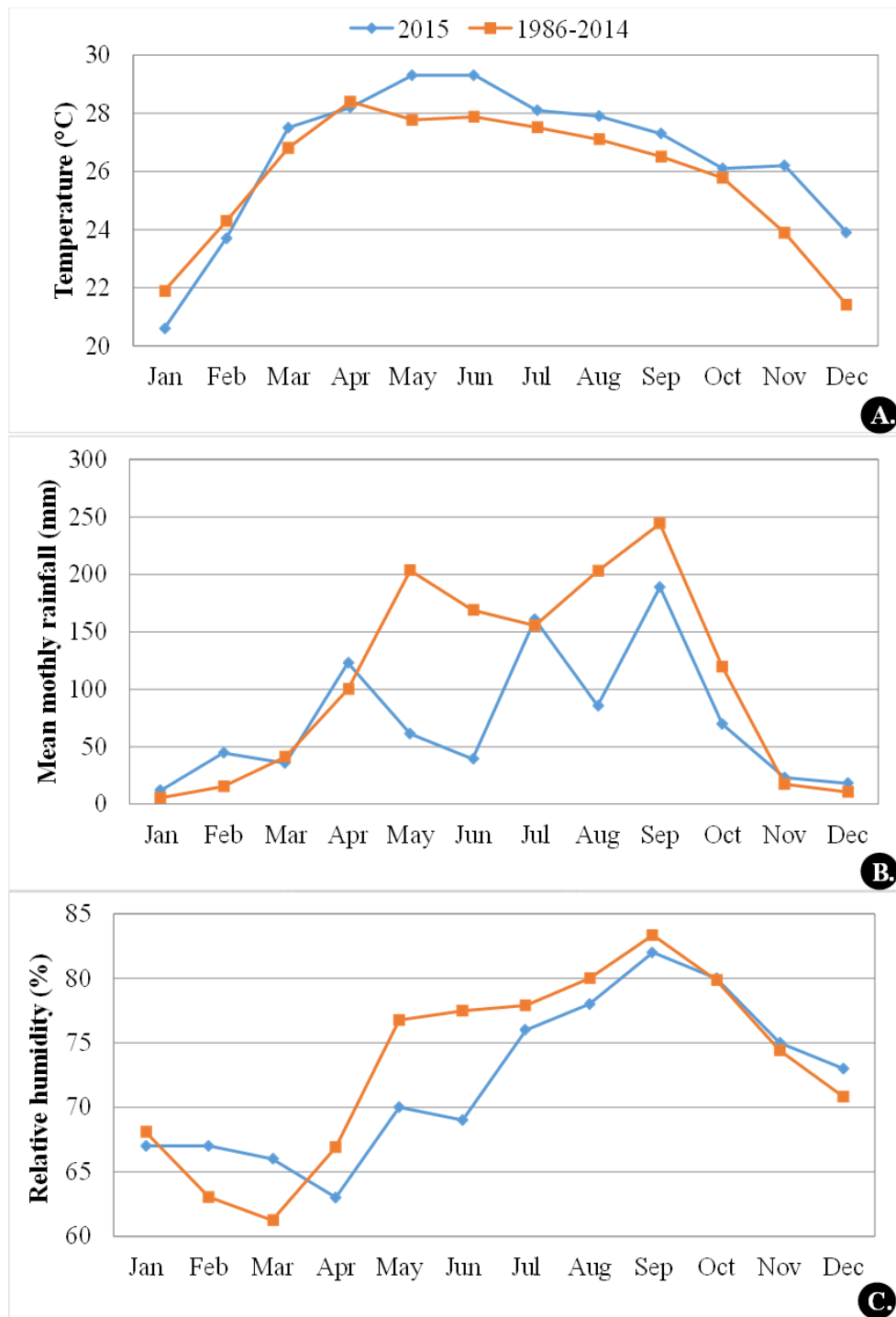


Figure 3.3 Climatic data at Phu Kradueng National Park between 1986-2014 and 2015; A: Mean temperature (°C), B: Mean monthly rainfall (mm), C: Relative humidity (%).

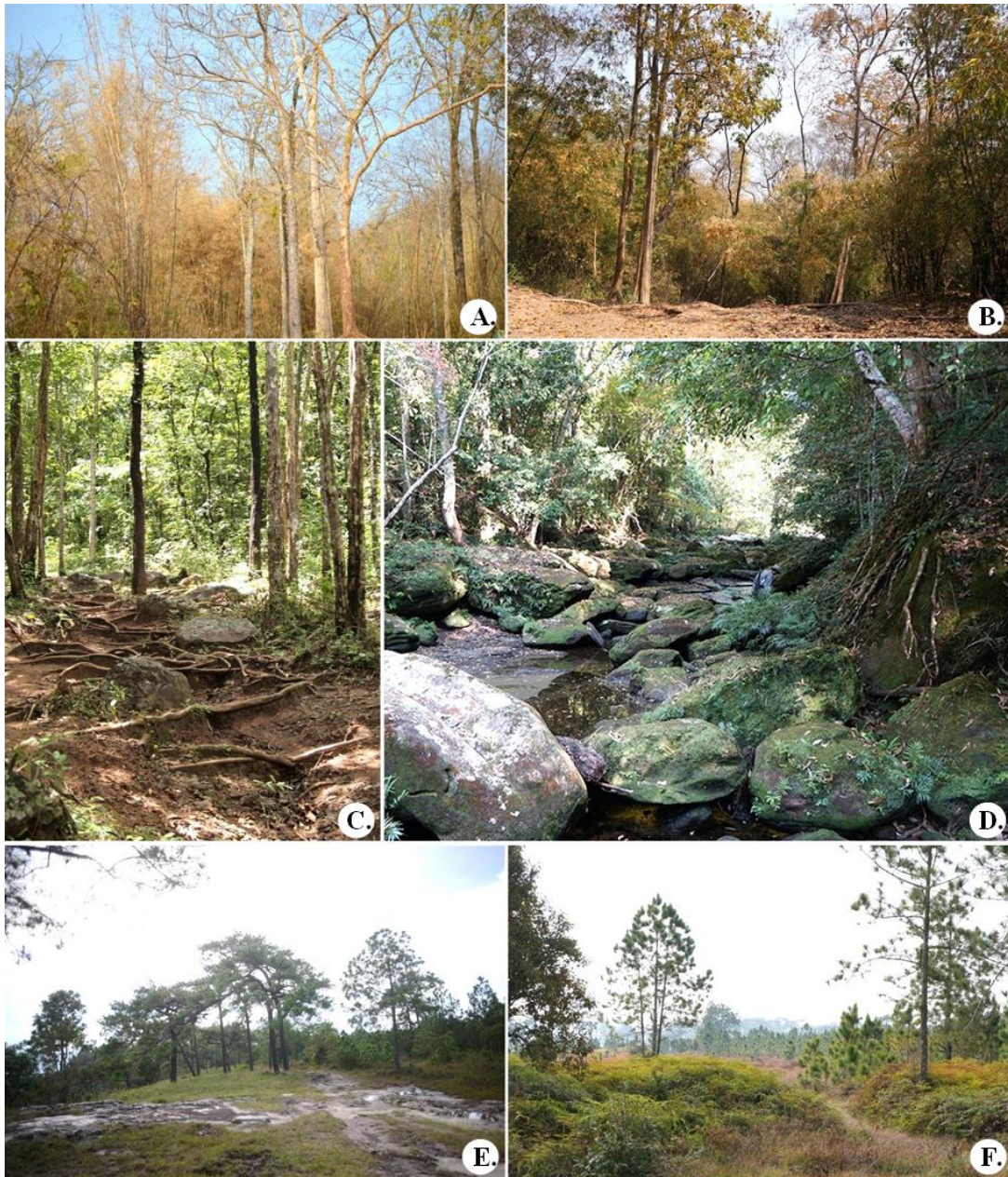


Figure 3.4 Vegetation types; A: Deciduous dipterocarp forest, B: Mixed deciduous forest, C: Dry evergreen forest, D: Lower montane forest, E.-F: Lower montane coniferous forest.

CHAPTER IV

MATERIALS AND METHODS

4.1 Materials

4.1.1 Specimen collecting equipments

- Pruning shears
- Hand pruner and Knife
- Plastic bags and zipper bags in any size
- Field note and pencils
- Digital camera
- The global positioning system (GPS) equipment type Garmin ETrex VISTA HCx
- Collector number cards

4.1.2 Herbarium specimen preparing equipments

- Plant presses or wooden rags, 30 × 45 cm and ropes
- Sheets of newspapers
- Corrugated cardboards
- Deep freezer (−30°C)
- Hot air oven (40°–55°C)
- Genus cover papers, 30 × 42 cm
- Species cover papers, 30 × 42 cm
- Mounting papers, 30 × 42 cm
- Herbarium label, 10.5 × 13.5 cm
- Mounting glue (latex glue)
- Needle and thread
- Sand bags

4.1.3 Identification equipments

- Light microscope and Dissecting microscope
- Microscopic slides and cover slips
- Dissecting needles
- Forceps
- Petri dishes
- Droppers
- Razor blades
- Taxonomic literatures about pteridophyte

4.2 Methods

4.2.1 Literature review

The information about Phu Kradueng National Park and nearby areas was searched for example location, boundary, topography, vegetation and climate. The data of Phu Kradueng National Park were studied from Department of National Parks, Wildlife and Plant Conservation. Moreover, the information of climate was supported by Thai Meteorological Department, Bangkok and Phu Kradueng National Park.

4.2.2 Field explorations and specimen collections

4.2.2.1 The field exploration of pteridophytes was performed in Phu Kradueng National Park, Loei province every 4–6 weeks from December 2014 to February 2016. Moreover, 6 transect lines were conducted from all routes (Figure 4.1) there are

- 1) The route from Si-Than to Lang Pae and Wang Kwang visitor center
- 2) The route from Wang Kwang visitor center to many waterfall e.g. Pen Pob Mai waterfall and Tham Yai waterfall

- 3) The route from Wang Kwang visitor center to Anodard pond, Sor Neua waterfall and Lomsak cliff
- 4) The route around Hong Thong waterfall to Khun Phong waterfall
- 5) The route from Wang Kwang visitor center to SongLok cliff
- 6) The route from Wang Kwang visitor center to LomSak cliff

4.2.2.2 Pteridophytes were collected along the nature trails or walking trails and extending about 5–10 meters on both sides of the routes. Photographs were taken, field notes were written and the global positioning system was recorded. Two to three duplicates of complete specimens (rhizome, fertile and sterile leaves) were collected in each transect lines.

4.2.3 Laboratory study

Laboratory study was performed at Plant of Thailand Research Unit, Department of Botany, Faculty of Science, Chulalongkorn University. Dry herbarium specimens were prepared followed Forman and Bridson (1991) and Thaweesakdi Boonkerd *et al.* (1987). The morphological characters of pteridophytes specimens were examined by light microscope and dissecting microscope. The specimens were identified by using many taxonomic keys and description from taxonomic literatures about pteridophytes, such as Flora of Thailand (Tagawa and Iwatsuki, 1979; 1985; 1988; 1989) and nearby countries Floras e.g. Flora of China (Zhang *et al.*, 2013), Flora of Malaya. Vol. 2. (Holltum, 1968) including monograph, research papers and the websites e.g. Taxonomic revision of the Lycopodiaceae in Southeast Asia (Boonkerd *et al.*, 2005), A monograph of the fern genus *Goniophlebium* (Polypodiaceae) (Rödl-Linder, 1990), Ferns of Thailand, Laos and Cambodia (Lindsay and Middleton, 2012). The classifications of pteridophytes in this thesis follow (PPGL, 2016). The dry pteridophyte specimens were preserved at Professor Kasin Suvatabhandhu Herbarium, Department of Botany, Faculty of Science, Chulalongkorn University (BCU) and the Forest Herbarium (BKF).

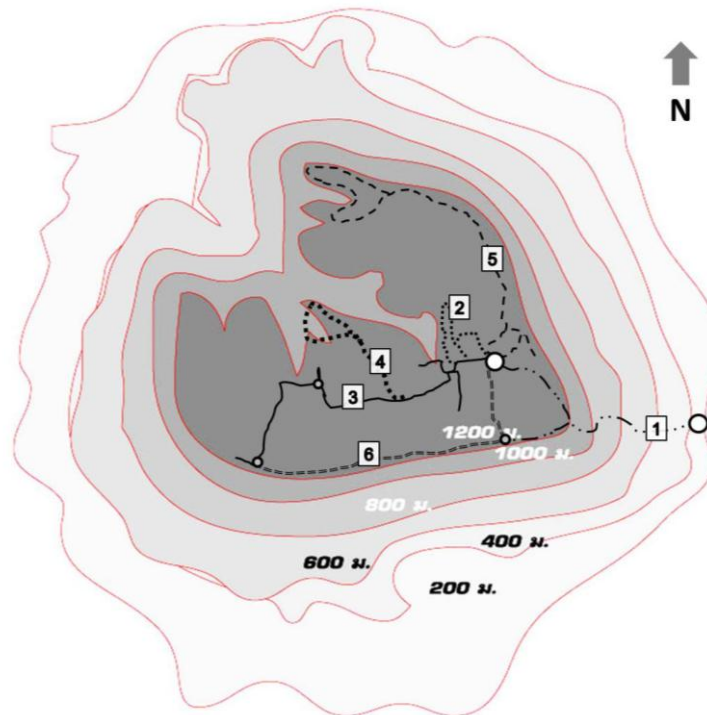


Figure 4.1 The surveying routes for field exploration in Phu Kradueng National Park; 1: The route from Si-Than to Lang Pae and Wang Kwang visitor center, 2: The route from Wang Kwang visitor center to many waterfall e.g. Pen Pob waterfall and Tham Yai waterfall, 3: The route from Wang Kwang visitor center to Anodard pond, Sor Neua waterfall and Lom Sak cliff, 4: The route around Hong Thong waterfall to Khun Phong waterfall, 5: The route from Wang Kwang visitor center to Song Lok cliff, 6: The route from Wang Kwang visitor center to Lom Sak cliff

CHAPTER V

RESULT

Two hundred and eighty eight specimens were collected during December 2014 to February 2016 from the nature trails. A total of 288 samples were collected and identified into 26 families, 60 genera and 138 species. Among these, 2 families, 4 genera and 16 species are lycophytes, while 24 families, 56 genera and 122 species are monilophytes.

Table 5. 1 List of pteridophytes in Phu Kradueng National Park.

Habitat: T = Terrestrial; E = Epiphyte; L = Lithophyte.

Abundance: + = rare species; found in some area and with a few number in each population, ++ = uncommon species; found in many area and with a few number in each population or found in one area and with many number in each population, +++ = common species; found in many area and many of number.

Taxon	Habitat	Route no.	Altitudes (m.)	Abundance
LYCOPHYTES				
LYCOPODIACEAE				
1. <i>Huperzia serrata</i> (Thunb.) Trevis.	T	2, 3, 4	1,098-1,237	+++
2. <i>Palhinhaea cernua</i> (L.) Carv. Vasc & Franco	T	1, 2, 3, 4, 5, 6	1,000-1,300	+++
3. <i>Phlegmariurus hamiltonii</i> (Spreng. ex Grev. & Hook.) Li Bing Zhang	E, L	2, 3, 4	1,098-1,200	+++
4. <i>P. squarrosus</i> (G. Forst.) Á. Löve & D. Löve	E, L	4	450-1,098	++
SELAGINELLACEAE				
5. <i>Selaginella amblyphylla</i> Alston	T	1	1,094-1,230	+++
6. <i>S. biformis</i> A. Braun ex Kuhn	T	2, 3, 4	1,000-1,209	+++
7. <i>S. ciliaris</i> (Retz.) Spring	T	2	1,000-1,200	+
8. <i>S. intermedia</i> (Blume) Spring	L	2	1,000-1,200	+
9. <i>S. involvens</i> (Sw.) Spring	L	2, 4	800-1,200	+++

Taxon	Habitat	Route no.	Altitudes (m.)	Abundance
10. <i>S. monospora</i> Spring	L	2	1,000-1,200	++
11. <i>S. ostenfeldii</i> Hieron.	T	1	351-804	+++
12. <i>S. pennata</i> (D. Don) Spring	T	1	892	++
13. <i>S. repanda</i> (Desv. ex Poir.) Spring	T	1	646-900	+++
14. <i>S. siamensis</i> Hieron.	T	1, 2, 3, 4, 5, 6	1,183-1,304	+++
15. <i>S. tenuifolia</i> Spring	T	1	1,117	+
16. <i>Selaginella</i> sp.	T	1, 5	1,221-1,226	+++
MONILOPHYTES				
ASPLENIACEAE				
17. <i>Asplenium affine</i> Sw.	E	2	1,200	++
18. <i>A. confusum</i> Tardieu & Ching	E	2	1,098– 1,200	++
19. <i>A. crinicaule</i> Hance	E, L	1, 2	1,098-1,226	++
20. <i>A. nidus</i> L.	E, L	1, 2, 3, 4	350-1,200	+++
21. <i>A. normale</i> D. Don	E	2, 3	1,183-1,213	+++
22. <i>A. scortechinii</i> Bedd.	E	2, 4	1,150-1,209	+++
23. <i>A. siamense</i> Tagawa & K. Iwats.	L	6	1,296	++
24. <i>Asplenium</i> sp.	L	2	1,213	++
25. <i>Hymenasplenium cheilosorum</i> (Kunze ex Mett.) Tagawa	L	2	1,213	+
ATHYRIACEAE				
26. <i>Athyrium cumingianum</i> (C. Presl) Ching	T	1	893	++
27. <i>Diplazium dilatatum</i> Blume	T	2	1,200-1,237	++
28. <i>D. donianum</i> (Mett.) Tardieu	T	2	1,199-1,237	+++
29. <i>D. kappanense</i> Hayata	T	4	1,098	++
30. <i>D. mettenianum</i> (Miq.) C. Chr.	T	2	1,199-1,237	+++
BLECHNACEAE				
31. <i>Blechnum orientale</i> L.	T	2, 3	1,183-1,209	+++

Taxon	Habitat	Route no.	Altitudes (m.)	Abundance
32. <i>Brainea insignis</i> (Hook.) J. Sm.	T	1, 2, 3, 5, 6	1,100-1,200	+++
CIBOTIACEAE				
33. <i>Cibotium barometz</i> (L.) J. Sm.	T	2, 3	1,199-1,226	+++
CYATHEACEAE				
34. <i>Alsophila podophylla</i> Hook.	T	2, 3	1,199-1,237	+++
DAVALLIACEAE				
35. <i>Davallia denticulata</i> (Burm. f.) Mett. ex Kuhn	L	1, 2	584-1,221	+++
36. <i>D. repens</i> (L. f.) Kuhn	E, L	1, 2, 3, 4, 5, 6	1,098-1,233	+++
37. <i>D. trichomanoides</i> Blume var. <i>lorrainii</i> (Hance) Holttum	E, L	2, 3, 4, 5	1,183-1,237	+++
DENNSTREDTIACEAE				
38. <i>Histiopteris incisa</i> (Thunb.) J. Sm.	T	3	1,236	++
39. <i>Hypolepis punctata</i> (Thunb.) Mett. ex Kuhn	T	2	1,221	+++
40. <i>Microlepia hookeriana</i> (Wall. ex Hook.) C. Presl	T	3	1,183-1,200	++
41. <i>M. marginata</i> (Panz.) C. Chr. var. <i>marginata</i>	T	2	1,202	++
42. <i>M. marginata</i> (Panz.) C. Chr. var. <i>calvescens</i> (Wall. ex Hook.) C. Chr.	T	2	1,183-1,202	++
43. <i>M. speluncae</i> (L.) T. Moore	T	4	452	+
44. <i>Monachosorum henryi</i> Christ	L	2	1,207	+
45. <i>Pteridium aquilinum</i> (L.) Kuhn	T	1, 2, 3, 4, 5, 6	1,098-1,304	+++
DRYOPTERIADACEAE				
46. <i>Arachniodes cavalerii</i> (Christ) Ohwi	L	2	1,163	++
47. <i>Bolbitis sinensis</i> (Baker) K. Iwats.	L	1, 4	916-1,098	++
48. <i>B. virens</i> (Wall. ex Hook. & Grev.) Schott	L	1, 4	1,103-1,098	++

Taxon	Habitat	Route no.	Altitudes (m.)	Abundance
49. <i>Dryopteris polita</i> Rosenst.	T	2, 3	1,230-1,251	++
50. <i>D. pseudocaenopteris</i> (Kunze) Li Bing Zhang	T	2, 3	1,209-1,237	++
51. <i>D. rheophila</i> Mitsuta ex Darnaedi, M. Kato & K. Iwats.	T	2	1,200	++
52. <i>D. sparsa</i> (D. Don) Kuntze	T	2, 3, 4	1,098-1,209	+++
53. <i>Elaphoglossum dumrongii</i> Tagawa & K. Iwats.	L	2, 3	1,098-1,238	++
54. <i>E. stelligerum</i> (Wall. ex Baker in Hook. & Baker) T. Moore ex Alston & Bonner	L	2, 3	1,230-1,241	++
55. <i>E. subellipticum</i> Rosenst.	L	2, 3	1,226– 1,236	++
EQUISETACEAE				
56. <i>Equisetum ramosissimum</i> Desf. subsp. <i>debile</i> (Roxb. ex Vaucher) Hauke	T	4	461	++
GLEICHENIACEAE				
57. <i>Dicranopteris linearis</i> (Burm. f.) Underw. var. <i>linearis</i>	T	1, 2, 3, 4, 5, 6	1,150-1258	+++
58. <i>D. linearis</i> (Burm. f.) Underw. var. <i>tetraphylla</i> (Rosenst.) Nakai	T	3	1,183-1,304	++
59. <i>Diplopterygium blotianum</i> (C. Chr.) Nakai	T	2	1,199	++
HYMENOPHYLLACEAE				
60. <i>Hymenophyllum exsertum</i> Wall. ex Hook.	L	2, 3	1,000-1,238	+++
61. <i>H. polyanthos</i> (Sw.) Sw.	L	2, 3	1,100-1,236	+++
62. <i>Vandenboschia striata</i> (D. Don) Ebihara	L	2	1,182	++
HYPODERMATIACEAE				
63. <i>Hypodematium glanduloso- pilosum</i> (Tagawa) Ohwi	T	1	351	++

Taxon	Habitat	Route no.	Altitudes (m.)	Abundance
LINDSAEACEAE				
64. <i>Lindsaea chienii</i> Ching	T	3	1,237	+++
65. <i>L. ensifolia</i> Sw.	T	2	1,100-1,200	++
66. <i>L. javanensis</i> Blume	T	2, 3	1,200-1,237	+++
67. <i>Odontosoria chinensis</i> (L.) J. Sm. var. <i>chinensis</i>	L	2, 3, 4	1,098-1,226	+++
68. <i>Osmolindsaea odorata</i> (Roxb.) Lehtonen & Christenh.	L	2, 3	1,185-1,237	++
LYGODIACEAE				
69. <i>Lygodium japonicum</i> (Thunb.) Sw.	T	1	750-1,155	+++
70. <i>L. microphyllum</i> (Cav.) R. Br.	T	2, 3	1,200-1,236	++
MARATTIACEAE				
71. <i>Angiopteris evecta</i> (G. Forst.) Hoffm.	T	2	1,220	++
NEPHROLEPIDACEAE				
72. <i>Nephrolepis biserrata</i> (Sw.) Schott	L	4	1,100	+
73. <i>N. cordifolia</i> (L.) C. Presl	L	2, 3	1,200-1,236	++
74. <i>N. undulata</i> (Afzel.) J. Sm.	L	2, 3, 5	1,191-1,200	+++
OLEANDRACEAE				
75. <i>Oleandra cumingii</i> J. Sm.	L	5	1,191-1,237	++
76. <i>O. musifolia</i> (Blume) C. Presl	L	1, 2, 3, 4, 5, 6	1,100-1,304	+++
77. <i>O. undulata</i> (Willd.) Ching	L	1	1,247	++
78. <i>Oleandra</i> sp.	L	6	1,304	+
OPHIOGLOSSACEAE				
79. <i>Ophioderma pendula</i> (L.) C. Presl	E	1, 4	350	+
80. <i>Ophioglossum petiolatum</i> Hook.	T	3	1,202	+
OSMUNDACEAE				
81. <i>Osmunda angustifolia</i> Ching	T	2, 3	1,183-1,237	+++
POLYPODIACEAE				
82. <i>Aglaomorpha coronans</i> (Wall. ex Mett.) Copel.	E, L	1, 2, 3, 5	1,103-1,258	+++
83. <i>Drynaria bonii</i> Christ	E	1	350	++

Taxon	Habitat	Route no.	Altitudes (m.)	Abundance
84. <i>D. rigidula</i> (Sw.) Bedd.	E, L	1, 2, 3, 4, 5, 6	1,198-1,238	+++
85. <i>Goniophlebium subauriculatum</i> (Blume) C. Presl	L	1, 3, 5	1,233-1,259	+++
86. <i>Lepisorus bicolor</i> (Takeda) Ching	E, L	5	1,258	++
87. <i>L. henryi</i> (Hieron. ex C. Chr) L. Wang	E	1, 3	1,174-1,199	+
88. <i>L. nudus</i> (Hook.) Ching	L	5	1,258	+
89. <i>L. spicatus</i> (L. f.) L. Wang	E	2, 3	1,237-1,239	++
90. <i>Leptochilus decurrens</i> Blume	L	1	1,098-1,258	++
91. <i>Loxogramme duclouxii</i> Christ	L	1	1,232	++
92. <i>L. salicifolia</i> (Makino) Makino	L	1	1,174-1,232	++
93. <i>Microsorium insigne</i> (Blume) Copel.	L	2	1,200	++
94. <i>M. membranaceum</i> (D. Don) Ching	E	4	452	+
95. <i>M. pteropus</i> (Blume) Copel.	L	2	1,000-1,100	++
96. <i>M. punctatum</i> (L.) Copel.	L	1	575-584	++
97. <i>Neolepisorus zippelii</i> (Blume) L. Wang	L	4	1,098	++
98. <i>Paragramma longifolia</i> (Blume) T. Moore	E, L	3	1,239	+
99. <i>Platyserium wallichii</i> Hook.	E	1	300-750	+++
100. <i>Pyrrosia adnascens</i> (Sw.) Ching	E, L	1	1,130	+++
101. <i>P. lingua</i> (Thunb.) Farw. var. <i>heteractis</i> (Mett. ex Khun) Hovencamp	E, L	1, 2, 3, 4, 5, 6	1,150-1,236	+++
102. <i>P. porosa</i> (C. Presl) Hovencamp	E	1, 4, 5	1,212-1,228	++
103. <i>P. stigmosa</i> (Sw.) Ching	L	1	1,110	++
104. <i>Selliguea oxyloba</i> (Wall. ex Kunze) Fraser-Jenk.	L	6	1,304	++
105. <i>S. rhynchophylla</i> (Hook.) Fraser-Jenk.	L	2	1,233	++
106. <i>S. trisecta</i> (Baker) Fraser-Jenk.	L	1	1,228	++
PSILOACEAE				
107. <i>Psilotum nudum</i> (L.) P. Beauv.	T, E	1, 5	350-1,300	++

Taxon	Habitat	Route no.	Altitudes (m.)	Abundance
PTERIDACEAE				
108. <i>Adiantum caudatum</i> L.	T	1	452-709	++
109. <i>A. erylliae</i> C. Chr. & Tardieu	T	1	476	+
110. <i>A. hispidulum</i> Sw.	T	4	1,098	+
111. <i>A. philippense</i> L.	T	1	613-1,013	+++
112. <i>Aleuritopteris anceps</i> (Blanf.) Panigrahi	L	1	1,250	+
113. <i>Antrophyum callifolium</i> Blume	L	4	1,098	+
114. <i>A. parvulum</i> Blume	E	5	1,258	+
115. <i>Calciphlopteris ludens</i> (Wall. ex Hook.) Yesilyurt & H. Schneid.	T	4	452	+
116. <i>Haplopteris amboinensis</i> (Fée) X. C. Zhang	L	2, 3	1,199-1,236	+++
117. <i>H. elongata</i> (Sw.) E. H. Crane	L	2, 3	1,183-1,226	+++
118. <i>H. ensiformis</i> (Sw.) E. H. Crane	E, L	2	1,191-1,221	+++
119. <i>H. sikkimensis</i> (Kuhn) E. H. Crane	L	2	1,200-1,236	+++
120. <i>Pteris biaurita</i> L.	T	1	1,209	++
121. <i>P. cretica</i> L. var. <i>leata</i> (Wall. ex Ettingsh.) C. Chr. & Tardieu	T	4	1,098	+
122. <i>P. ensiformis</i> Burm. f.	T	1	750-1,013	+++
123. <i>P. longipes</i> D. Don	T	1	709-1,000	++
124. <i>P. venusta</i> Kunze	T	1	892	++
125. <i>P. wallichiana</i> J. Agardh	T	5	1,221-1,258	+
TECTARIACEAE				
126. <i>Tectaria fuscipes</i> (Wall. ex Bedd.) C. Chr.	T	1	1,103-1,174	++
127. <i>T. herpetocaulos</i> Holttum	T	1, 4	1,149-1,221	+++
128. <i>T. impressa</i> (Fée) Holttum	T	1	893-916	+++
129. <i>T. sagenioides</i> (Mett.) Christenh.	T	1	1,237	+
130. <i>T. simonsii</i> (Baker) Ching	T	4	1,098	+
131. <i>T. zeilanica</i> (Houtt.) Sledge	T	4	452	+

Taxon	Habitat	Route no.	Altitudes (m.)	Abundance
THELYPTERIDACEAE				
132. <i>Cyclosorus clarkei</i> (Bedd.) Ching	T	1	952	+++
133. <i>C. interruptus</i> (Willd.) H. Itô	T	1	280	++
134. <i>C. parasiticus</i> (L.) Farw.	T	1	893-900	++
135. <i>C. subelatus</i> (Baker) Ching	T	1	900-915	++
136. <i>C. terminans</i> (J. Sm. ex Hook.) K. H. Shing	T	1	750-900	+++
137. <i>Metathelypteris flaccida</i> (Blume) Ching	T	2	1,233	++
138. <i>Pronephrium triphyllum</i> (Sw.) Holtum	T	2	1,213	++



LYCOPHYTE

LYCOPODIACEAE

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

Plants terrestrial, epiphyte or lithophyte. *Stems* creeping, pendulous, climbing, or short erect. *Leaves* microphyllous, monomorphic, with a single vein, arranged in spirals, leaves appressed, ascending or spreading, linear, lanceolate, ovate, or scalelike, margin entire or serrate. *Sporangia* solitary, at base of the upper surface of sporophylls, yellow, reniform. *Spore* tetrahedral.

Key to the the genera

- 1a. Terrestrial plants, horizontal stems absent, strobili forming distinct cones
..... **2. Palhinhaea**
- 1b. Epiphytic or lithophytic plants, horizontal stems present, strobili not forming
distinct cones..... **2.**
- 2a. Stem erect or ascending; strobili homomorphic with sterile branches or
branchlets..... **1. Huperzia**
- 2b. Stem pendulous or ascending; strobili abruptly becoming much smaller than
sterile branches or branchlets or rarely similar in size..... **3. Phlegmariurus**

1. HUPERZIA

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

Plants usually lithophyte or epiphyte, small to medium-sized, *Stems* pendulous to recurved, erect or ascending. Branches all similar, dichotomously branching

throughout. *Leaves* linear, lanceolate or elliptic, papery, entire or serrate at margin. *Sporophylls* and trophophylls similar, gradually dimorphic. *Sporangia* reniform with short stalk, yellow, thick.

Huperzia serrata (Thunb.) Trevis., Atti Soc. Ital. Sci. Nat. 17: 247–248. 1874;
Boonkerd & Pollawatn, Pterid. Thailand: 13, 48. 2000. — *Lycopodium serratum*
Thunb. Syst. Veg. ed. 14: 944. 1784; Tagawa & K. Iwats., Fl. Thailand 3(1): 7. 1979.

Figure 5. 1: C-D.

Stems erect or ascending, 9–11 cm heights, 1–1.5 mm broad, dichotomously branched in upper parts. *Leaves* elliptic to narrow elliptic, patent, 1.5–3.0 cm long, 2–5 mm broad, apex acuminate or sometime cuspidate, broadest at middle portion, base cuneate, decurrent, stalked; vein distinct, raised above, margin serrate, texture thinly leathery, green. *Sporophylls* similar to trophophylls but smaller, up to 5 mm long, usually at the upper part of stems, strobili not forming distinct cones. *Sporangia* 1 mm long and broad, reniform, yellow.

Thailand. – NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng);
PENINSULAR: Nakhon Si Thammarat (Khao Luang).

Distribution. – India, Nepal, Myanmar, Sri Lanka, Fiji, Western Samoa, Peninsular Malaysia, Borneo, East Siberia, Taiwan, Cuba, Hispaniola, Mexico, China, Japan, Ryukyu Island, Korea, Vietnam, Hawaii, New Caledonia, North-East Queensland.

Ecology. – Terrestrial on sandy slope near stream in dense evergreen forest, at about 1,200 m alt.

Specimen examined. – P. Jadprajong 230, 307 (BKF).

2. PALHINHAEA

Franco & Vasc., Bol. Soc. Brot. ser. 2, 41: 24. 1967. — *Lycopodiella* Holub, Preslia 36: 20, 22. 1964. — *Lycopodium* L., Sp. Pl. 2: 1100. 1753; Tagawa & K. Iwats., Fl. Thailand 3(1): 7. 1979.

Stems erect and creeping, dichotomously branched, many-branched tree. *Leaves* sparsely, spirally arranged, not imbricate, monomorphic, lanceolate, linear-needlelike or scalelike, papery, midrib indistinct, base decurrent, sessile, margin entire, apex acuminate. *Strobili* solitary, pendulous, terete, sessile. *Sporophylls* sub-peltate to lanceolate, margin membranous with irregularly toothed, apex acute to acuminate, or obtuse. *Sporangia* yellowish, reniform to round-reniform.

Palhinhaea cernua (L.) Carv. Vasc & Franco, Bol. Soc. Brot. ser. 2, 41: 25. 1967. — *Lycopodiella cernua* (L.) Pic. Serm., Webbia 23(1): 166. 1968; Boonkerd & Pollawatn, Pterid. Thailand: 15, 49. 2000. — *Lycopodium cernuum* L., Sp. Pl. 2: 1103.1753; Tagawa & K. Iwats., Fl. Thailand 3(1): 12. 1979. **Figure 5. 1: G.**

Stems two types, erect and creeping form, creeping form indefinitely grow on the substrate, main erect stems about 68 cm or more tall, densely covered with leaves on many lateral branches in upper portion, leaves scatter in the lower part, 3–5 mm in diameters; lateral branches smaller 2–4 mm in diameters, 10 cm or more long. *Leaves* linear, pointed at apex, patent and recurved in the upper part, yellowish green, 2–4 mm long, up to 0.5 mm broad, entire, texture thick, strobili pendulous, solitary or sometime two at each of the branches, to 1.2 cm long, 0.3 mm in diameters. *Sporophylls* ovate with long acuminate at apex, margin ciliate at base or with minute projections.

Thailand. – NORTHERN: Chiang Rai (Doi Tung, Kiu Thap Yang, Mae Lao, Doi Phacho, Khun Khon), Chiang Mai (Doi Chiang Dao, Mae Rim, Doi Suthep, Doi Inthanon), Phitsanulok (Thung Salaeng Luang, Phu Hin Rong Kla), Tak (Doi Musoe); NORTH-EASTERN: Loei (Phu Luang, Phu Rua, Phu Kradueng), Buengkarn (Phu Wua); CENTRAL: Nakhon Nayok (Khao Yai, Khao Kiew); SOUTH-EASTERN: Trat

(Ko Chang); SOUTH-WESTERN: Kanchanaburi (Wang Ka, Thong Pha Phum), Prachuap Khiri Khan (Sam Roi Yod); PENINSULAR: Chumphon (Bang Son), Ranong, Surat Thani (Ban Don), Satun (Tarutao), Nakhon Si Thammarat (Khao Luang, Thung Song, Ron Phibun), Trang (Khao Chong, Thale Song Hong, Sam Roi Yot), Songkhla (Saba Yoi), Narathiwat (Bacho, Waeng), Yala (Gunong Ina, Ban To, Padang Besar).

Distribution. – Widespread in tropics and subtropics of the world.

Ecology. – Terrestrial on wet sandy soil along nature trails in coniferous forest at 1,000–1,300 m alt.

Specimen examined. – P. Jadprajong 31 (BKF); A. Sathapattayanon 35 (BCU), O. Ratana 41 (BCU); P. Ratchata 210 (BCU); T. Boonkerd 210 (BCU); D. J. Middleton, R. Namdang, R. Pooma, S. Suddee, S. Suwannachat and K. William 2959 (BKF); K. Larsen, C. Smitinan and E. Warncke 1665 (BKF).

3. PHLEGMARIURUS

Holub, *Preslia* 36(1): 17, 21. 1964; L. B. Zhang & K. Iwats., *Fl. China* 2–3: 24. 2013.

Plants epiphyte or lithophyte. *Stem* pendulous or ascending when mature, dichotomously branched multiple times, upper portion of stem and branchlets without bulbils. *Leaves* polished or not polished, lanceolate, ovate, or scalelike, leathery or thinly leathery, margin entire. *Strobili* abruptly becoming much smaller than sterile branches or branchlets or rarely similar in size. Sporophylls and trophophylls dimorphic or almost homomorphic. *Sporangia* in axils of sporophylls of upper portion of stem or branchlets, reniform, dehiscing from 2 valves.

Key to the species

- 1a. Leaves not dense, ascending to subadnate, elliptic to lanceolate, apex acute.....**1. P. hamiltonii**
- 1b. Leaves dense, patent and squarrose, linear-lanceolate, apex acuminate.....**2. P. squarrosus**

1. Phlegmariurus hamiltonii (Spreng. ex Grev. & Hook.) Li Bing Zhang, Fl. Reipubl. Popularis Sin. 6(3): 42. 2004. — *Huperzia hamiltonii* (Spreng.) 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. **Figure 5. 1: A-B.**

Stems pendulous sometime erect if shorter, dichotomously branching, 5–7 cm long, 1–1.5 mm broad. *Leaves* ascending to subadnate, 0.6–1.0 cm long, 2–3 mm broad, elliptic to lanceolate, widest at middle or lower part, apex acute, narrowing towards base, sessile or very shortly stalked, green, margin entire; vein more or less distinct on lower surface; texture softly chartaceous, green to yellowish-green. *Sporophylls* usually smaller than trophophylls, found at apical portion, strobili forming not distinct cones, up to 1 cm long, 1 mm broad, the thickness of fertile stems less than 1/3 of the sterile ones. *Sporangia* reniform, 0.8–1.0 mm long, about 1.0 mm broad, yellowish.

Thailand. – NORTHERN: Chiang Mai (Doi Chiang Dao, Khun Mae Lan, Khun Kong San, Doi Suthep, Doi Inthanon), Mae Hong Son (Doi Khun Huay Pong), Phitsanulok (Phu Miang); NORTH-EASTERN: Loei (Phu Luang, Phu Rua, Phu Kradueng); CENTRAL: Nakhon Nayok (Khao Yai, Khao Kiew); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao), Trat (Koh Chang); SOUTH-WESTERN: Kanchanaburi (Sisawat, Thong Pha Phum); PENINSULAR: Ranong (Khao Thalu, Muang Laen, Thung Kha), Surat Thani (Koh Samui), Phangnga, Nakhon Si Thammarat (Khao Luang).

Distribution. – Himalaya (Type), Bhutan, India, Nepal, South China and Japan, Indochina and Taiwan.

Ecology. – Lithophyte on mossy rocks or on moist muddy rocks in dense evergreen forest near stream, at 1,183–1,258 m alt.

Specimen examined. – P. Jadprajong 12, 37, 243 (BKF); T. Boonkerd & R. Pollawatn 61 (BCU); C. F. van Beusekom & C. Phengkhilai 982 (BKF); E. Hennipman 3865, 3943 (BKF); J. F. Maxwell 94–1012 (BKF).

2. *Phlegmariurus squarrosus* (G. Forst.) Á. Löve & D. Löve, *Taxon* 26(2–3): 324. 1977. — *Huperzia squarrosa* (G. Forst.) Trevis. *Atti Soc. Ital. Sci. Nat.* 17: 247, 1874; Boonkerd & Pollawatn, *Pterid. Thailand*: 14, 48. 2000. — *Lycopodium squarrosus* G. Forst. *Fl. Ins. Austr.* 86. 1786; Tagawa & K. Iwats., *Fl. Thailand* 3(1): 9–10. 1979.

Figure 5. 1: E-F.

Stems pendulous, 40–45 cm in length, 5 mm in diameters near base, usually dichotomously branching. *Leaves* dense, patent and squarrose, base sessile, linear lanceolate, apex acuminate, slightly narrowing towards base, up to 1.5 cm long, the broadest portion 1–2 mm broad, margin entire; vein visible on both surfaces; texture coriaceous, green and yellowish-green when dry. *Sporophylls* usually smaller than the trophophylls, sometimes slightly different, strobili not forming distinct cones but becoming slender at apical portion. *Sporangia* about 1 mm long and broad, reniform, yellow.

Thailand. – NORTHERN: Phitsanulok (Phu Miang, Phu Hin Rong Kla); NORTHEASTERN: Loei (Phu Luang, Phu Rua, Phu Kradueng); CENTRAL: Nakhon Nayok (Khao Yai, Khao Kiew); SOUTH-EASTERN: Chanthaburi (Phliew), Trat (Dan Chumphon); SOUTH-WESTERN: Kanchanaburi (Klang Dong, Song Tho, Thong Pha Phum); PENINSULAR: Surat Thani (Ban Kop Kaep), Phangnga (Bang To), Nakhon Si Thammarat (Khiri wong, Khao Luang).

Distribution. – India, Nepal, Myanmar, Bangladesh, Sri Lanka, Malesia, Philippines, Peninsular Malaysia, Borneo, Java, China, Taiwan, Japan, NE-Queensland, Madagascar, Mauritius, Réunion, Seychelles, Palau Isl., Micronesia, Tonga, New Caledonia, American Samoa, Western Samoa, Austral Isl.

Ecology. – Epiphyte on tree-trunks or sometime on moist rocks in dense evergreen forest, at low to medium altitudes, 450–1,098 m alt.

Specimen examined. – P. Jadprajong 182, 299 (BKF).

SELAGINELLACEAE

Willk., Anleit. Stud. Bot. 2: 163. 1854; Tagawa & K. Iwats., Fl. Thailand 3(1): 14. 1979; X. C. Zhang, H. P. Nooteboom & M. Kato, Fl. China 2–3: 37. 2013.

Stems erect, creeping, ascending, or scandent, branched, bearing leaves and rhizophores borne on axils of branches. *Roots* branching at the tip. *Leaves* monomorphic, microphyllous, spirally arranged or dimorphic, arranged in four rows, dorsal leaves with two rows on upper side of stem and branch, ventral leaves smaller, with two rows on lower side. *Sporophylls* uniform or dimorphic and form cylindrical spike, shape varied from ovate to ovate-lanceolate, margin entire, denticulate or ciliolate. *Sporangia* one per sporophyll, heterosporangiate. *Spores* heterosporous, megaspores larger, microspores many.

SELAGINELLA

P. Beauv., Prodr. Aethéogam. 101. 1805; Tagawa & K. Iwats., Fl. Thailand 3(1): 14. 1979; X. C. Zhang, H. P. Nooteboom & M. Kato, Fl. China 2–3: 37. 2013.

Stems elongate, creeping, dichotomously or pinnately branches, bearing leave and rhizophores. *Leaves* monomorphic or dimorphic, microphyllous, spirally arrange

or dimorphic arrange in four rows, the ventral two patent or ascending, the dorsal two adpressed to stem, smaller. *Sporophyll* uniform or dimorphic, various shape ranging from ovate to ovate-lanceolate, margin entire, denticulate, or ciliolate, arrange in four rows, dorsal and ventral rows unequal; sporangium one per sporophylls. *Spores* heterosporous, megaspores usually four, usually larger than microspore, tetrahedral, trilete, microspores many.

Key to the species

- 1a. Sporophylls of spikes uniform or nearly monomorphic..... 2.
- 2a. Stems and branches pubescent..... **2. S. biformis**
- 2b. Stems and branches glabrous..... 3.
- 3a. Stems not scandent nor growing indefinitely..... 4.
- 4a. Main erect stems branching dichotomously..... **7. S. ostefeldii**
- 4b. Main erect stems not branching dichotomously..... **5. S. involvens**
- 3b. Stems scandent or growing indefinitely..... 5.
- 5a. Stems growing indefinitely; ventral leaves ciliate..... **10. S. siamensis**
- 5b. Stems growing definitely; ventral leaves denticulate.... **4. S. intermedia**
- 1b. Sporophylls of spikes dimorphic..... 6.
- 6a. Main stems erect or suberect; rhizophores restricted to the base or lower portion of main stems..... 7.
- 7a. Dorsal leaves obovate, broadest above the middle..... **8. S. pennata**
- 7b. Dorsal leaves ovate, elliptic, or lanceolate, broadest below the middle.. **8.**

- 8a. Ventral leaves at base of main stems usually close to the next ones or sometimes overlapping, spreading..... **9. S. repanda**
- 8b. Ventral leaves at base of main stems distant, patent, erect..... **9.**
- 9a. ventral sporophylls denticulate..... **12. Selaginella sp.**
- 9b. ventral sporophylls ciliate, usually in the lower part
..... **11. S. tenuifolia**
- 6b. Main stems prostrate or at least lower part prostrate, branches creeping or erect; rhizophores borne on ventral side in axils of branches..... **10.**
- 10a. Stems and branches prostrate or fertile branches suberect, plants usually less than 20 cm..... **3. S. ciliaris**
- 10b. Stems long creeping, fertile branches not erect, plants up to 30 cm or more..... **11.**
- 11a. Ventral leaves densely ciliate; dorsal leaves long aristate
..... **1. S. amblyphylla**
- 11b. Ventral leaves denticulate; dorsal leaves acuminate or shortly aristate..... **6. S. monospora**

1. Selaginella amblyphylla Alston, Bull. Fan Mem. Inst. Biol., Bot. 5: 287. 1934; Tagawa & K. Iwats., Fl. Thailand 3(1): 27. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 51. 2000; X. C. Zhang, H. P. Nooteboom & M. Kato., Fl. China 2–3: 60. 2013. **Figure 5. 2: A-B.**

Stems ascending from decumbent base, up to 16 cm, rhizophores on ventral side restricted to the lower part of stem or creeping rhizomes and stolons. *Main stems* branched from base upward, pinnately branched, stramineous; ultimate branches 3–4.5

mm wide including leaves. *Axillary leaves* ovate or ovate-lanceolate, 1.1–3 by 0.5–1.4 mm, margin ciliate. *Dorsal leaves* approximate, ovate, 0.8–1.2 by 0.4–0.9 mm, not or slightly carinate, base subcordate, margin long ciliate or denticulate, apex long acuminate to long aristate, often reflexed. *Ventral leaves* spreading, oblong-falcate, 1.3–2.1 by 0.7–1.3 mm, margin minutely denticulate, apex acute; basispic base rounded, margin ciliate, base with a few long cilia, apex denticulate; acroscopic base rounded, margin ciliate at basal part, apex denticulate. *Strobili* compact, 3.4–5 by 1.3–2 mm; sometimes dorsal sporophylls longer, not obviously white-margined; dorsal sporophylls ovate, apex acuminate, margin ciliate; ventral sporophylls ovate, margin ciliate; megasporophylls in basal portion on lower side of strobilus or megasporophylls and microsporophylls randomly distributed on both sides; microspores orange-red, megasporophylls yellowish orange or white.

Thailand. – NORTHERN: Chiang Rai, Chiang Mai (Doi Chiang Mae Dao, Ban Klang, Doi Suthep, Doi Inthanon, Doi Chiang Dao,), Lampang (Mae Mo); Loei (Phu Luang, Phu Kradueng); EASTERN: Nakhon Ratchasima (Khao Yai); SOUTH. EASTERN: Trat (Ko Chang); PENINSULAR: Krabi (Ko Lanta), Satun.

Distribution. – China (Guangxi, Sichuan, Xizang, Yunnan), Myanmar, Thailand.

Ecology. – Terrestrial on humus-rich mountain grounds in dense evergreen forest at altitudes from 1,094–1,230 m.

Specimen examined. – P. Jadprajong 90, 122, 123, 143, 144, 198 (BKF).

2. *Selaginella biformis* A. Braun ex Kuhn, *Forschungs. Gazelle*. 4 (Bot. 6): 17. 1889; Tagawa & K. Iwats., *Fl. Thailand* 3(1): 17. 1979; Boonkerd & Pollawatn, *Pterid. Thailand*: 51. 2000; X. C. Zhang, H. P. Nooteboom & M. Kato., *Fl. China* 2–3: 52. 2013. **Figure 5. 2: C-D.**

Stems erect or decumbent, rooting only at base for the erect plants, plants about 25 cm tall, rhizophores restricted to creeping rhizomes and stolons. *Main stems* pinnately branched in the upper part, 1–2 mm in diameter near base, sparsely bearing leaves pubescent on lower surface or glabrescent in lower portion; lateral branches bipinnate to tripinnate, densely pubescent below; ultimate branches 1–3 mm in wide. Runners branching from the main stems, rooting and forming new erect plants at apex, bearing rhizophores throughout. *Leaves* on basal portion of stem uniform, sparse and not imbricate. *Ventral leaves* ascending, oblong subdeltoid, gradually narrowing and falcate towards acute apex, cordate at base, 1–3 mm long, 0.6–1 mm broad; edges dentate or ciliate near base, texture herbaceous to softly papyraceous, green. *Dorsal leaves* asymmetrically oblong, apex mucronate, margin dentate or ciliate. *Strobili* 7.3–9.3 or more long, 1.5–1.6 broad; sporophylls uniform, ovate subtriangular with long mucronate apex, 1.3–1.7 cm long, 1 mm broad, microspores yellowish orange, megaspores pale yellow, whitish, or dark brown.

Thailand. – NORTHERN: Chiang Rai, Chiang Mai (Doi Phu Pa, Huay Tong), Nan (Pha Sing), Phrae (Mae Sai), Phitsanulok (Phu Miang, Thung Salaeng Luang, Salaeng Haeng), Tak (Ban Musoe); NORTH-EASTERN: Phetchabun (Pine Grove), Loei (Phu Luang, Phu Kradueng); EASTERN: Nakhon Ratchasima (Si Kheu); CENTRAL: Nakhon Nayok (Khao Yai).

Distribution. – China (Guangdong, Guangxi, Guizhou, Hainan, Yunnan), India, Indonesia, Japan, Laos, Malaysia, Myanmar, Philippines, Sri Lanka, Thailand, Vietnam.

Ecology. – Plants terrestrial or lithophyte in shaded places or on rocks in lower-montane forests, at 1,000–1,209 m alt.

Specimen examined. – P. Jadprajong 1, 73, 196, 235 (BKF).

Notes. – *Selaginella biformis* are usually have two forms, main stems erect and creeping, creeping form are usually glabrous or less hairy.

3. *Selaginella ciliaris* (Retz.) Spring, Bull. Acad. Roy. Sci. Bruxelles. 10: 231. 1843; Boonkerd & Pollawatn, Pterid. Thailand: 52. 2000; X. C. Zhang, H. P. Nooteboom & M. Kato., Fl. China 2–3: 62. 2013. **Figure 5. 2: E-F.**

Stems shortly creeping, fertile erect stem 2–3 cm, rhizophores restricted to lower part or to middle of main stem, borne on ventral side in axils of branches. *Main stems* branched throughout, stramineous, 0.3–0.5 mm in diameter; main stem including leaves 3–4.6 mm wide. *Axillary leaves* ovate, 1.9–2 by 0.8–1 mm, margin ciliate in basal part and denticulate upward. *Dorsal leaves* ovate, 1.2–1.6 by 0.6–1 mm, base subcordate or obtuse, apex acuminate or aristate, margin minutely denticulate. *Ventral leaves* ovate or ovate-lanceolate, apex acute, 1.8–2.2 by 0.7–1.1 mm; basiscopic margin subentire or minutely denticulate; acroscopic base broader, margin ciliate. *Strobili* solitary, terminal, compact, dorsiventrally complanate, 6–12.6 by 2.7–4.3 mm; sporophylls strongly dimorphic, resupinate, white-margined; dorsal sporophylls minutely denticulate and ciliate, 1.4–1.7 by 0.5–0.9 mm; ventral sporophylls ovate-triangular, margin ciliate, 1–2.7 by 0.8–1 mm.

Thailand. – NORTHERN: Chiang Rai (Khun Korn Waterfall); NORTH-EASTERN: Loei (Phu Kradueng).

Distribution. – China (Guangdong, Guangxi, Hainan, Yunnan), Taiwan, India, Indonesia (Java), Nepal, New Guinea, Philippines, Sri Lanka, Thailand, Vietnam, Australia.

Ecology. – Terrestrial on sandy soil in the grasslands, at 1,245 m alt.

Specimen examined. – P. Jadprajong 304 (BKF).

4. *Selaginella intermedia* (Blume) Spring, Bull. Acad. Roy. Sci. Bruxelles 10: 144. 1843; Alston, Fl. Indo-Chine 7(2): 565. 1951; Tagawa & K. Iwats., Fl. Thailand 3(1): 21. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 18, 53. 2000. **Figure 5. 2: G-H.**

Stems creeping. *Main stems* 2–3 mm in diameter, bearing dorsal and ventral leaves, rather sparsely near base, subdichotomously branching; ultimate branches narrowing towards apex. *Axillary leaves* elliptic, 1–2.8 by 0.5–1.4 mm, margin denticulate. *Dorsal leaves* ovate-oblong with long acuminate apex, 1.3–2.1 mm long, include the needle-like apices, 0.4–1 cm wide, dentate at margin. *Ventral leaves* patent or slightly ascending, oblong, more or less falcate, apex acuminate or moderately acute in some cases, round at base, 2.3–4.3 mm long, 0.9–1.9 mm broad, with transparent edges, minutely denticulate at margin; false veins present at both sides of veins, but in some specimens obscure. *Strobili* 9.4–14.8 cm long, 1.9–2.4 mm in diameter; sporophylls oblong subdeltoid, acuminate at apex, about 1.5 mm long, 1 mm broad, dentate at margin.

Thailand. – NORTHERN: Lampang; NORTH-EASTERN: Loei (Phu Kradueng); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao), Trat (Ko Chang); PENINSULAR Chumpon (Khao Tong, Ranong (Khao Phota Chong Dong), Phangnga (Khao Katha Khwam, Khao Nang Hong), Nakhon Si Pattani (Buki), Narathiwat (Bajo Waterfall, Sg. Padi)

Distribution. – Myanmar (Tenasserim): Indochina, Malaya, Sumatra, Java, Borneo and Celebes.

Ecology. – Lithophyte on moist humus rocks near waterfalls 1,000–1,200 m alt.

Specimen examined. – P. Jadprajong 22, 59 (BKF); T. Boonkerd 1303, 1559 (BCU); E. Hennipman 3662 (BKF); C. Charoenphol, K. Larsen and E. Warncke 4411 (BKF)

5. *Selaginella involvens* (Sw.) Spring, Bull. Acad. Roy. Sci. Bruxelles 10(1): 136. 6. 1843; Tagawa & K. Iwats., Fl. Thailand 3(1): 24. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 53. 2000; X. C. Zhang, H. P. Nootboom & M. Kato., Fl. China 2–3: 53. 2013. **Figure 5. 3: A-B.**

Stems erect, with creeping subterranean rhizome and stolons, sparsely bearing brown leaves, 1–2 mm in diameter. *Main stems* erect 5–25 cm long, branched from middle upward; lateral branches tripinnate, glabrous; ultimate branches 1–2 mm wide including leaves. *Axillary leaves* ovate to triangular, 1.1–1.3 by 0.6–0.8 mm, margin denticulate. *Ventral leaves* elliptic or ovate-oblong with falcate in upper portion, apex acute, round to cordate at base, 1–2.2 mm long, 0.3–1.5 mm broad; margin entire or minutely denticulate near acroscopic base, texture papyraceous, yellowish green. *Dorsal leaves* elliptic or ovate-elliptic, apex long acuminate, margin minutely denticulate. *Strobili* 1–4 mm long, about 1 mm in broad; sporophylls ovate-subtriangular with long apex: 1–1.3 mm long, 0.7–1 mm in broad, with minute teeth at margin, microspores yellowish orange, megaspores whitish or brown.

Thailand. – NORTHERN: Chiang Mai (Doi Phahom Pok, Doi Chiang Dao, Doi Suthep, Doi Pha Mon, Mae Klang, Doi Inthanon), Phitsanulok (Phu Miang), Tak (Khao Phra Wo); NORTH-EASTERN: Loei (Phu Kradueng); EASTERN: Chaiyaphum; CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao), Trat (Ko Chang, Ko Kut); PENINSULAR: Trang (Khao Chong).

Distribution. – China (Anhui, Chongqing, Fujian, Gansu, Guangdong, Guangxi, Guizhou, Hainan, Henan, Hubei, Hunan, Jiangxi, Shaanxi, Sichuan, Xizang, Yunnan, Zhejiang), Bhutan, India, Japan, Korea, Taiwan, Laos, Malaysia, Myanmar, Nepal, Philippines, Sri Lanka, Thailand, Vietnam.

Ecology. – Lithophyte on rocks in light area near streams in lower-montane forest at 800–1,200 m alt.

Specimen examined. – P. Jadprajong 76, 139, 153, 294 (BKF).

6. *Selaginella monospora* Spring, Mém. Acad. Roy. Sci. Belgique. 24: 135. 1850; Tagawa & K. Iwats., Fl. Thailand 3(1): 28. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 54. 2000; X. C. Zhang, H. P. Nooteboom & M. Kato., Fl. China 2–3: 56. 2013. **Figure 5. 3: C-D.**

Stems long creeping, 25–49 cm or more, rhizophores borne on ventral side in axils of branches throughout length of main stem. *Main stems* branched throughout, pinnately branched, stramineous, 1–1.5 mm in diameter, primary leafy branches 9–11 pairs, 1–2 pinnately branched or 2 to 3 times forked; main stem including leaves 5–10 mm wide, ultimate branches 4–6 mm wide including leaves. *Axillary leaves* ovate or broadly ovate, base obtuse, 2.8–3.1 by about 1 mm, margin denticulate. *Dorsal leaves* ovate or elliptic, base obtuse, apex acuminate or shortly aristate, margin denticulate or subentire, 1.2–2.6 by 0.4–1 mm, carinate or strongly carinate. *Ventral leaves* slightly ascending or spreading, oblong, apex acute to obtuse, 2.2–4.7 by 0.9–2 mm; basiscopic base decurrent, margin subentire or entire; acroscopic base enlarged, broader, margin denticulate. *Strobili* solitary, terminal, compact, dorsiventrally complanate, 5.6–1.4 by 1.4–2.2 mm; sporophylls slightly dimorphic, resupinate, not white-margined; dorsal sporophylls lanceolate, margin minutely denticulate, apex long acuminate; ventral sporophylls ovate-lanceolate, wider at base, margin denticulate. *Strobili* with megasporophylls at basal part of strobilus, or megasporophylls and microsporophylls are combine, microspores yellowish orange or pale yellow, megaspores whitish.

Thailand. – NORTHERN: Chiang Mai (Doi Chiang Dao); NORTH-EASTERN: Loei (Phu Kradueng); PENINSULAR: Nakorn Si Thammarat (Khao Luang)

Distribution. – China (Guangdong, Guangxi, Guizhou, Hainan, Xizang, Yunnan), Bhutan, India, Myanmar, Nepal, Thailand, Vietnam.

Ecology. – Lithophyte on moist humus rocks near the waterfall in shady place at 1,000–1,200 m.

Specimen examined. – P. Jadprajong 284 (BKF).

7. *Selaginella ostenfeldii* Hieron., Bull. Herb. Boissier 2. 5: 721. 1905; Tagawa & K. Iwats., Fl. Thailand 3(1): 16. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 18, 55. 2000. **Figure 5. 3: E-F.**

Rhizome creeping, about 3 mm in diameters, densely covered with scaly leaves; leaves on rhizome oblong, apex round, margin fimbriate, brown. *Main stems* erect, forked at 13–17 cm above rhizome, 1–3 mm in diameters near base, sparsely bearing leaves, stramineous, glabrous; both branches of the forked stem pinnate; main lateral branches tripinnate, the ultimate branches 2–5 mm wide. *Dorsal leaves* narrowly ovate, acuminate at apex round to cuneate at base, ciliate at margin, 0.7–1.1 mm long, 0.2–0.3 mm broad. *Ventral leaves* patent or ascending, oblong subquadrangular, falcate, acute at apex, subcordate at base, 1–3.4.7 mm long, 0.7–0.95 mm wide; the margin more or less involute, bearing setae; texture soft herbaceous, green to deep green. *Strobili* about 1 mm in diameter; sporophylls ovate with long acuminate apex, densely ciliate.

Thailand. – NORTHERN: Chiang Mai (Doi Suthep, Mae Klang, Doi Inthanon, Ban Klang, Mae Lan, Bo Luang, Doi Saket), Mae Hong Son (Mae La Noi), Lampang (Doi Phalat, Huay Thak, Mae Ngao, Mae Mo), Lamphun (Doi Khun Tan), Phrae (Mae Ban), Tak (Lan Sang, Rahaeng, Wang Chao), Nakhon Sawan (Ban Takhli); NORTH-EASTERN: Loei (Phu Kradueng); SOUTH-WESTERN: Kanchanaburi (Khao Tong), Prachuap Khiri Khan (Khao Nam Tok, Hua Hin, Thap Sakae); PENINSULAR: Surat Thani (Khao Pak Chong).

Distribution. – Myanmar (Shan State and Moulmein) and Indochina

Ecology. – Terrestrial on rather dry slope in deciduous forest at 351–804 m alt.

Specimen examined. – P. Jadprajong 109, 209 (BKF).

8. *Selaginella pennata* (D. Don) Spring, Bull. Acad. Roy. Sci. Bruxelles. 10: 232. 1843; Tagawa & K. Iwats., Fl. Thailand 3(1): 20. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 55. 2000; X. C. Zhang, H. P. Nootboom & M. Kato., Fl. China 2–3: 56. 2013. **Figure 5. 3: G-H.**

Stems suberect or ascending from decumbent base, 10–30 cm, with rhizophores at the lower part; *Main stems* suberect, 2–3 mm in diameter, sparsely bearing leaves and bearing rhizophores usually only in lower part; main branches oblong, bisulcate. *Axillary leaves* ovate, 2.5–3.4 by 1–1.5 mm, margin ciliate at basal part, subentire upward. *Ventral leaves* patent, apex round or minutely mucronate, base round, 3.7–5 mm long, 1.2–1.8 mm broad, shortly ciliate at margin; texture thin, herbaceous, light green. *Dorsal leaves* obovate, broadest at upper 1/3, mucronate at apex, 0.5–0.6 mm in length, cuneate at base. *Strobili* up to about 6.1 cm or more long, about 5.5–6 mm broad; sporophylls dimorphic; ventral sporophylls oblong- subtriangular, apex acuminate, densely long ciliate with pale downy hairs of about 0.5 mm in long; dorsal sporophylls like the ventral trophophylls, smaller in size, acute to acuminate at apex, microspores pale yellow, megaspores whitish, gray, or dark brown.

Thailand. – NORTHERN: Chiang Mai (Doi Phahom Pok, Fang, Doi Chiang Dao, Doi Buak Ha, Doi Kiu Lom, Sop Aep), Mae Hong Son (Mae La Noi), Phrae (Mae Ban), Nan (Pha Sing), Phitsanulok (Thung Salaeng Luang), Tak (Doi Musoe); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng); CENTRAL: Nakhon Nayok (Khao Yati); SOUTH-WESTERN: Kanchanaburi (Bangkasi, Sai Yok).

Distribution. – China (Yunnan), North-East India, Myanmar, Nepal, Thailand.

Ecology. – Terrestrial on dry mountain slopes in mixed forests about 900 m alt.

Specimen examined. – P. Jadprajong 117, 251 (BKF).

9. *Selaginella repanda* (Desv. ex Poir.) Spring, Voy. Bonite, Bot. 3: 329. 1844; Tagawa & K. Iwats., Fl. Thailand 3(1): 22. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 56. 2000; X. C. Zhang, H. P. Nooteboom & M. Kato., Fl. China 2–3: 59. 2013. **Figure 5. 4: A-B.**

Stems erect or ascending, up to 16 cm tall, with rhizophores restricted to the base. *Main stems* bearing uniform brown leaves rather closely, branching throughout;

lateral branches largest in middle or upper portion, pinnate or bipinnate; ultimate branches 3–4.5 mm wide including leaves. *Axillary leaves* ovate or ovate-lanceolate, 1.1–3 by 0.5–1.4 mm, margin ciliate. *Dorsal leaves* oblong, or narrower, 0.8–1.2 by 0.4–0.9 mm, margin ciliate or denticulate, apex long acuminate. *Ventral leaves* oblong, narrowing towards moderately acute apex, 1.3–2.1 by 0.7–1.3 mm, margin minutely denticulate or ciliate near basal portion, white cartilaginous margin; *Strobili* compact, 3.4–4.5 by 1.3–1.8 mm; sporophylls ovate-subtriangular with long tails at apex, margin minutely denticulate and white-margined; microspores orange-red or red, megaspores yellowish orange.

Thailand. – NORTHERN: Chiang Mai (Doi Phahom Pok, Doi Chiang Dao Doi Suthep, Doi Phra Diang), Lamphun (Doi Khun Tan), Tak (Doi Musoe, Lan Sang, Rahaeng); NORTH EASTERN: Loei (Phu Kradueng); CENTRAL: Nakhon Nayok (Wang Djo, Nang Rong Waterfalls); SOUTH-EASTERN: Prachin Buri (Ban Ban Hills), Chon Buri (Si Racha); SOUTH-WESTERN: Kanchanaburi (Erawan Falls, Sai Yok)

Distribution. – China (Guangxi, Guizhou, Hainan, Yunnan), Taiwan, Cambodia, India, Indonesia, Laos, Malaysia, Myanmar, Nepal, Philippines, Thailand, Vietnam.

Ecology. – Terrestrial on dry slopes in deciduous forest at 646–900 m alt.

Specimen examined. – 110, 113, 118, 147, 207 (BKF).

10. *Selaginella siamensis* Hieron., Bot. Tidsskr. 24: 113. 1901; Tagawa & K. Iwats., Fl. Thailand 3(1): 18. 1979; X. C. Zhang, H. P. Nootboom & M. Kato., Fl. China 2–3: 47. 2013. **Figure 5. 4: C-D.**

Stems long creeping, scandent, growing indefinitely, climbing up bushes, 1–1.5 mm in diam, rhizophores borne on ventral side in axils of branches, bearing sparsely monomorphic leaves, glabrous, rhizophores borne on ventral side in axils of branches,

about 0.5 mm in diam; lateral branch tripinnate. *Leaves* papery, not iridescent, not white-margined, margin subentire, ovate to oblong-subtriangular in outline, ultimate branch 1.7–2.3 mm wide. Stem leaves brown, ovate, apex long aristate, 2.5–2.8 mm long, 1.6–1.9 mm. wide. *Dorsal leaves*, as same as or smaller than the ventral leaves in size, asymmetrically oblong to suborbicular with long pale tails at apex, 1.5–2.8 mm long, 0.6–1.6 mm wide, margin ciliate. *Ventral leaves* ascending, ovate-oblong, acute to mucronate with long aristate at apex, base cordate, 1.6–2.6 mm long, 0.7–1.9 mm wide, margin ciliate with white setae from base up to middle of leaves, papyraceous, green or sometimes reddish. *Strobili* 1.8–7.1 mm long, 1.1–2.1 mm in diameter; sporophyll uniform, ovate-subtriangular with long tail, 1.1–1.7 mm. long, 0.6–1.1 mm. wide; sporangia bisected about 0.5 mm. long and wide, microspores yellowish orange, megaspores brown.

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

Distribution. – Indochina and Malaya.

Ecology. – Terrestrial, usually found on rather dry ground in light shade between rock plain and forest at 1,100–1,200 m alt.

Specimens examined. – P. Jadprajong 35, 46, 51, 74, 78, 94, 95, 170 (BKF); M. Tagawa, K. Iwats., and N. Fukuoka T-636 (BKF), Ch. Charoenphol, K. Larsen and E. Warncke, 4234, 4289 (BKF).

11. *Selaginella tenuifolia* Spring, Mém. Acad. Roy. Sci. Belgique. 24 (2): 253. 1850; Tagawa & K. Iwats., Fl. Thailand 3(1): 29. 1979. Boonkerd & Pollawatn, Pterid. Thailand: 19, 57. 2000. **Figure 5. 4: E-F.**

Plants small, 5–10 cm tall. *Main stems* slender, with leaves spreading, about 5 mm apart, bearing branches from the middle upwards; lateral branches a few times forked; ultimate branches 2–5 mm wide. Axillary leaves ovate, 1.8 by 0.9 mm, margin ciliate. *Dorsal leaves* elliptic, apex long-acuminate, base cuneate, subentire, 1–1.3 by 0.3–0.5 mm. *Ventral leaves* patent, oblong subdeltoid, moderately acute apex, base unequally cordate, 1–2.1 mm long, 0.8–1 mm broad; margin dentate, narrowly cartilaginous, thin. *Strobili* 6.8–7.9 mm long, 3–3.5 mm wide; dorsal sporophylls elliptic, round at apex, about 1 mm long, 0.3–0.5 mm broad, similar to ventral trophophyll but smaller; ventral sporophylls subdeltoid, 1–2 mm long, 0.2–0.6 mm broad, round at base, apex long-acuminate, denticulate.

Thailand. – NORTHERN: Chiang Rai (Doi Phacho, Chiang Mai (Doi Phahom Pok, Doi Chiang Dao), Lamphun (Doi Khun Tan), Phrae (Mae Ban); NORTH-EASTERN: Loei (Phu Kradueng).

Distribution. – North India to Myanmar and Laos.

Ecology. – Terrestrial on dry sandy slopes in not so dense forest at 1,117 m alt.

Specimens examined. – P. Jadprajong 333 (BKF)

12. *Selaginella* sp., Figure 5. 4: G-H.

Stems erect, 1–8 cm tall, light green to light reddish, paler when dry, glabrous, rhizophores restricted to the base of stem. *Main stem* branched or sometime not branching in very smaller one, leaves on lower portion of main stems distant, with single vascular bundle; ultimate branches 2–3.5 mm wide including leaves. *Leaves* dimorphic throughout, herbaceous, not white-margined. *Axillary leaves* nearly symmetrical, ovate to ovate-lanceolate, base rounded, exauriculate, 1.53–1.75 by 0.93–1.21 mm, margin minutely denticulate *Dorsal leaves* asymmetrical, ovate with long-acuminate at apex, patent, base rounded, 0.57–0.80 by 1.38–1.94 mm, margin denticulate, carinate. *Ventral leaves* asymmetrical, ascending, approximate, oblong-

ovate, 1.41–2.25 by 0.90–1.37 mm, apex acute; base subcaudate, margin entire or minutely denticulate. *Strobili* solitary at terminal, compact, dorsiventrally complanate, 4.5–7 by 2.7 mm; sporophylls dimorphic, resupinate; dorsal sporophylls ovate, apex acuminate, base rounded, margin denticulate with ciliate at basal portion, 1.05–1.41 by 0.52–0.83 mm.; ventral sporophylls ovate, margin denticulate with ciliate at basal portion, 1.19–1.87 by 0.62–1.14 mm.; megasporangia usually in basal portion on lower side or both sides; microspores orange-red, megaspores pale yellow.

Thailand. – NORTH-EASTERN: Loei (Phu Kradueng).

Distribution. – N/A

Ecology. – Terrestrial on dry sandy soil along the nature trails in open places, in coniferous forest at 1,221–1,226 m alt.

Specimens examined. – P. Jadprajong 107, 224, 255, 334 (BKF); M. Tagawa, K. Iwats. & N. Fukuoka T-374 (BKF).



MONILOPHYTE
ASPLENIACEAE

Newman, *Hist. Brit. Ferns* 6. 1840; Tagawa & K. Iwats., *Fl. Thailand* 3(2): 288. 1985; Y. X. Lin & R. Viane, *Fl. China* 2–3: 267. 2013.

Plants small to medium-sized, terrestrial, lithophyte or epiphyte. *Rhizomes* creeping, ascending or erect; scales clathrate, *Fronde*s simple, pinnate or more compounds, various in shapes and sizes; veins free or anastomosing, bearing scales or hairs. *Stipes* in cross section with two vascular bundles at base and x-shaped in the upper part. *Sori* elongate along vein, linear, indusiate, indusium elongate along one side of sorus; spore monolet

Key to the genera

- 1a. Rhizome erect to shortly creeping, if long creeping then usually more than 0.6 cm in diameters and densely scaly throughout.....**1. Asplenium**
- 1b. Rhizome long creeping, usually less than 0.6 cm in diameters, with very few scales except near apex.....**2. Hymenasplenium**

1. ASPLENIUM

L., Sp. Pl. 2: 1078. 1753; Tagawa & K. Iwats., Fl. Thailand 3(2): 288. 1985; Y. X. Lin & R. Viane, Fl. China 2—3: 267. 2013.

Rhizome short, erect or ascending, scales clathrate. *Fronde*s simple, pinnate or more compounds, remote or clustered, various in shapes and sizes; veins free or anastomosing, bearing scales or hairs. *Sori* elongate along veins, superficial, protected by elongate indusia attached to the vein.

Key to the species

- 1a. Fronds simple..... **2.**
- 2a. Veins anastomosing, connected near margin, or united into a marginal vein..... **4. A. nidus**
- 2b. Veins free, rarely connected near margin, not united into a marginal vein..... **6. A. scortechinii**
- 1b. Fronds pinnate or more compound..... **3.**
- 3a. Fronds pinnate..... **4.**
- 4a. Midrib of pinna hardly distinct..... **5.**

- 5a. Pinnae not articulated to rachis..... **5. A. normale**
- 5b. Pinnae articulated to rachis..... **6.**
- 6a. Laminae oblong-lanceolate in outline, pinnae overlap with the next one or 1–2 mm apart, acroscopic margin shallowly lobed
..... **7. A. siamense**
- 6b. Laminae elliptic-oblong to oblong-lanceolate in outline, pinnae not overlap, 2–5 mm apart, acroscopic margin subentire to irregularly shallowly lobed..... **8. Asplenium sp.**
- 4b. Midrib of pinna grooved or raised above..... **3. A. crinicaule**
- 3b. Fronds bipinnate or more compound..... **8.**
- 8a. Fronds bipinnate to bipinnate-tripinnatifid..... **1. A. affine**
- 8b. Fronds tripinnate or more compound..... **2. A. confusum**

1. *Asplenium affine* Sw., J. Bot. (Schrader) 1800(2): 56. 1801; Tagawa & K. Iwats., Fl. Thailand 3(2): 288. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 138. 2000.

Figure 5. 5: A-B.

Rhizome short creeping, ascending, densely scaly at apex; scales linear with hair-pointed apex, 1–1.2 by 0.1 cm, dark brown, clathrate, entire, more or less crisped at the upper part. *Fronds* monomorphic, bipinnate to tripinnatifid. *Stipes* dark green to nearly black, minutely scaly or glabrous, about 22 cm long. *Laminae* oblong-subtriangular to broadly-lanceolate, narrowing towards apex, 26–38 by 15–22 cm, pinnae about 15 pairs, the lowest ones largest, stalked, broadly-lanceolate, apex acuminate, broadly cuneate at base, up to 10 by 2–3 cm; pinnules of lower pinnae about 9 pairs, oblong-subquadrangular, apex rounded to acute, base narrowly cuneate, shortly stalked, lobed to 1/4–1/3, or have an acroscopic lobe, 10–15 by about 5 mm; apex of lobes acute to moderately acute, serrate, chartaceous to subcoriaceous; veins distinct on

both surfaces, a few times forked. *Sori* many, 3–5 mm long; indusia pale, stiff and persistent.

Thailand. – NORTHERN: Tak (Ban Musoe), Phitsanulok (Nakhon Thai); NORTH-EASTERN: Loei (Phu Kradueng); SOUTH-EASTERN: Prachin Buri (Ban Ban Hills); PENINSULAR: Phangnga (Koh Ra, Nai Chong).

Distribution. – Madagascar, Mascarene Islands, Seychelles, Sri Lanka, S India, Hainan, Cambodia, Malesia to New Hebrides and Fiji.

Ecology. – Epiphyte on mossy tree-trunks in moist evergreen forests at altitudes about 1,200 m alt.

Specimen examined. – P. Jadprajong 65 (BKF); F. Floto 7698 (BKF).

2. *Asplenium confusum* Tardieu & Ching, Notul. Syst. (Paris) 5: 148, pl. 4, f. 3, pl. 7. 1936; Tagawa & K. Iwats., Fl. Thailand 3(2): 289. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 139. 2000. **Figure 5. 5: C-D.**

Rhizome short, ascending, densely scaly; scales narrow, gradually narrowing towards hair-pointed apex, 7–19 by about 1 mm, entire, dark brown. *Fronde*s monomorphic, tripinnate. *Stipes* 12–39 cm long, dark brown to nearly black, polished, grooved above. *Laminae* elliptic to oblong-subtriangular, apex acuminate, 24–87 by 12–19 cm, primary pinnae 8–22 pairs, rachis glabrous, grooved; lower pinnae 2–4 cm from the next ones, ascending, subtriangular, base cuneate to subtruncate, gradually narrowing towards caudately acuminate apex, stalked, 6–18.5 by 3–8 cm; larger pinnules oblong-subtriangular, apex acute, base cuneate, pinnatifid to pinnate, 1.8–3 by 1.2–2.5 cm; secondary pinnules spatulate, apex rounded and toothed, base cuneate and sessile, up to 2.5 by 1 mm, sometimes lobed to 1/2 way, papyraceous to coriaceous; veins raised on both upper and lower surfaces. *Sori* up to 7 mm long, usually almost to midrib, usually close together, rarely confluent; indusia thin but firm, persistent.

Thailand. – NORTHERN: Chiang Mai (Doi Chiang Dao), Tak (Mae Sot, Huai Krasa), Phitsanulok (Thung Salaeng Luang, Phu Hin Rong Kla); NORTH-EASTERN: Loei (Phu Lueng, Phu Kradueng); EASTERN: Nakhon Rachasima (Sakaerat), Buri Ram (Khao Krap); SOUTH-WESTERN: Phetchaburi, Prachuap Khiri Khan (Huay Yang), Kanchanaburi (Thong Pha Phum); SOUTH-EASTERN: Prachin Buri (Ban Ban Hills), Chon Buri (Si Racha), Chanthaburi (Khao Sabap), Trat (Koh Chang, Koh Kut); PENINSULAR: Chumphon (Ban Krayae), Surat Thani (Koh Tao, Khlong Bakatae, Koh Samui, Ban Don), Phangnga (Pulao Tiban), Nakhon Si Thammarat (Khao Nan).

Distribution. – Indochina.

Ecology. – Epiphyte on mossy tree-trunks in dense evergreen forests at 1,098–1,200 m alt.

Specimen examined. – P. Jadprajong 228 (BKF); T. Boonkerd 133, 134, 147 (BCU); Y. Yuyen 176 (BCU); A. Sathapattayanon 160 (BCU); David J. Middleton 3751 (BKF); H. Takahashi & M. N. Tamura T-63471 (BKF); J. F. Maxwell 00–413 (BKF); M. Tagawa, K. Iwats. & N. Fukuoka T-604, T-1894 (BKF); T. Smitinand 5886 (BKF); T. Smitinand 6765 (BKF); Wanandorn 956 (BKF); C. F. van Beusekom & T. Santisuk 3219 (BKF); E. Hennipman 3684 (BKF).

3. *Asplenium crinicaule* Hance, Ann. Sci. Nat., Bot., Ser. 5, 5: 254. 1866; Tagawa & K. Iwats., Fl. Thailand 3(2): 284. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 109, 139. 2000. **Figure 5. 5: E-F.**

Rhizome short erect, densely scaly; scales very narrow, gradually narrowing from base towards hair pointed apex, 5–7 by about 1 mm, the margin bearing irregular and sparse projections, brown to blackish brown. *Stipes* 4–15 cm long, dull, dark brown to nearly black, bearing narrow scales throughout. *Fronde*s narrowly lanceolate, gradually narrowing towards base and apex, apex acuminate, 20–40 by 4–8 cm; rachis with very narrow hair-like scales; lateral pinnae sessile, 10–30 pairs, narrowly subtriangular to elliptic, falcate or nearly patent, apex acute, acroscopic base with

auricled, basiscopic base narrowly cuneate, the middle largest ones 1.8–5.5 by 0.6–1.5 cm, indistinctly lobed; lobes with a few teeth, each with a single veinlet, softly chartaceous, deep green but brown when dried. *Sori* long, about 0.7 mm long, along the posterior veinlets, crescent-shaped, opening towards posterior, indusium entire.

Thailand. – NORTHERN: Chiang Mai, Chiang Rai, Lamphun (Doi Khun Tan), Lampang; NORTH-EASTERN: Chaiyaphum (Ban Nam Phrom, Phu Khieo), Loei (Phu Kradueng); SOUTH-WESTERN: Kanchanaburi, Phetchaburi, Prachuap Khiri Khan (Huay Yang); CENTRAL: Nakhon Nayok; SOUTH-EASTERN: Chanthaburi, Trat.

Distribution. – India, South China and Indochina.

Ecology. – Lithophyte on rocks crevice or epiphyte on mossy tree-trunks in dense forest or in lower-montane forests at 1,098–1,226 m alt.

Specimen examined. – P. Jadprajong 158, 232 (BKF); D. J. Middleton, R. Namdang, R. Pooma, S. Suddee, S. Suwanachat & K. Williams 2525 (BKF); R. Geesink, T. Hattink & C. Phengklai 7013 (BKF); M. Tagawa, K. Iwats., H. Koyama, N. Fukuoka, A. Nalampoon & A. Chintayungkun T-9247 (BKF); T. Smitinand 11913 (BKF); M. Tagawa, K. Iwats. & N. Fukuoka T-944 (BKF).

4. *Asplenium nidus* L., Sp. Pl. 1079. 1753; Tagawa & K. Iwats., Fl. Thailand 3(2): 266. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 110, 142. 2000.

var. ***nidus***, **Figure 5. 5: G-H.**

Rhizome short, erect or ascending, stout, bearing a rosette of fronds, usually with a mass of roots, scaly; scales brown to darker, clathrate, membranous, up to 2 cm long, 3 mm broad. *Stipes* stramineous to dark, about 2 cm long, scaly at base. *Fronde* simple, coriaceous, up to 100 cm or more long, 12–20 cm broad, broadest at middle, apex gradually attenuate, gradually narrowing towards base, grass-green and paler below; midrib flat on the lower surface, but raised on upper surface; veins 1- or rarely 2- time

forked, the first vein forking near midrib, then running parallel, apex uniting to form submarginal veins inside leaf edges. *Sori* elongate along veins, extending from near midrib, half-way to the margin, usually on every vein; indusia about 0.5 mm broad.

Thailand. – NORTHERN: Chiang Rai (Doi Pacho), Chiang Mai (Doi Chiang Dao, Ban Du, Doi Suthep), Lampang; NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng), Nong Khai (Nong Kai Ploi); SOUTH-WESTERN: Kanchanaburi (Sai Yok, Wangka, Khao Nam Tok); CENTRAL: Saraburi (Muak Lek); SOUTH-EASTERN: Chon Buri (Si Racha), Chanthaburi (Khao Soi Dao), Trat (Huai Raeng); PENINSULAR: Surat Thani (Ko Tao, Ko Phu), Phangnga, Krabi, Nakhon Si Thammarat (Khao Luang).

Distribution. – Throughout the Old World tropics.

Ecology. – Epiphyte on tree-trunks or lithophyte on rocks in dense forests or under heavy crowns of trees in light shade at 350–1,200 m alt.

Specimen examined. – P. Jadprajong 72, 152 (BKF); M. Tagawa, K. Iwats. & N. Fukuoka T-386 (BKF); T. Shimizu, M. Hutoh & D. Chaiglom T-9059 (BKF).

5. *Asplenium normale* D. Don, Prodr. Fl. Nepal. 7. 1825; Tagawa & K. Iwats., Fl. Thailand 3(2): 280. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 111, 112, 143. 2000. **Figure 5. 6: A-B.**

Rhizome short, erect, scaly; scales bicoloured, gradually narrowing from the base towards hair-pointed apex, 1–3 by 0.5–0.7 mm, black at middle, margin brown to darker. *Stipes* very deep castaneous to nearly black, more or less polished, up to 10–15 cm long, grooved. *Laminae* pinnate, lanceolate to narrower, base slightly gradually narrowing upwards, apex caudately acuminate, up to 50 by 4.6 cm; rachis wingless, viviparous; lateral pinnae up to 57 pairs, sessile, patent or slightly reflexed, oblong, apex rounded, lobed to 1/5 way on both margins, basiscopic base narrowly cuneate, acroscopic base auricled and truncate, about 2 by 0.5 cm; midrib rarely viviparous;

veinlets simple or forked, not running to the very top of lobes. *Sori* 2–3 mm long; indusia thin.

Thailand. – NORTHERN: Mae Hong Son, Chiang Mai, Phitsanulok; NORTH-EASTERN; Phetchabun, Loei (Phu Kradueng); SOUTH-WESTERN: Phetchaburi; CENTRAL; Nakhon Nayok; SOUTH-EASTERN: Chanthaburi; PENINSULAR: Krabi, Nakhon Si Thammarat, Songkhla.

Distribution. – Old World tropics throughout, Thailand, Laos, Cambodia, north to Himalaya and Japan.

Ecology. – Epiphyte on mossy tree-trunks in lower-montane forests usually at about 1,183–1,213 m alt.

Specimen examined. – P. Jadprajong 7 (BKF); T. Smitinand 5859 (BKF); T. Shimizu, H. Toyokuni, H. Koyama, T. Yahara & C. Niyomdham T-23113, T-23114, T-23173 (BKF); M. Tagawa, K. Iwats. & N. Fukuoka T-602, T-617 (BKF); E. Hennipman 3657 (BKF).

6. *Asplenium scortechinii* Bedd., J. Bot. 1887: 322; Tagawa & K. Iwats., Fl. Thailand 3(2): 271. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 177. 2000. **Figure 5. 6: C-D.**

Rhizome short, erect or suberect, bearing fronds in a tuft, scaly near apex; scales oblong-lanceolate, gradually narrowing towards acute apex, 5–8 by 1–3 mm, dark brown at central part, paler at margin, sometimes bearing irregular projections at margin, clathrate. *Stipes* indistinct from lamina, winged, stramineous or brown. *Fronde* simple, linear, 16–21 by 1.5–2 cm, broadest at middle portion, narrowing towards caudately acuminate apex, attenuate towards base, margin shallowly serrate at least in upper part or subentire; chartaceous, minutely scaly on midrib; midrib raised abaxially, flat adaxially, 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; indusia entire, about 1 mm broad, firm.

Thailand. – Chiang Rai (Doi Phacho), Chiang Mai (Doi Phahom Pok, Doi Chiang Dao, Doi Suthep, Doi Inthanon), Lamphun (Doi Khun Tan), Tak (Ban Musoe), Phitsanulok (Phu Miang, Phu Hin Rong Kla); NORTH-EASTERN: Phetchabun, Loei (Phu Luang, Wang Saphung, Phu Kradueng), Khon Kaen (Phu Wiang); SOUTH-EASTERN: Chanthaburi; PENINSULAR: Nakhon Si Thammarat, Trang, Pattani, Yala.

Distribution. – Indochina and Peninsular Malaysia.

Ecology. – On mossy tree-trunks or on mossy rocks usually in dense evergreen forests at 1,098–1,237 m alt.

Specimen examined. – P. Jadprajong 195, 237, 285 (BKF); T. Boonkerd 1063 (BCU); T. Boonkerd & R. Pollawatn 413 (BCU); P. Rachata 180 (BCU); W. Rattanathirakul 24 (BCU); T. Smitinand 5883 (BKF); Ch. Charoenphol, K. Larsen & WE. Warncke 4631 (BKF); E. Hennipman 3690 (BKF); T. Shimizu, M. Hutoh & D. Chaiglom T-8970 (BKF).

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7. *Asplenium siamense* Tagawa & K. Iwats., Acta Phytotax. Geobot. 25: 17. 1971; Tagawa & K. Iwats., Fl. Thailand 3(2): 281. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 177. 2000. **Figure 5. 6: E-F.**

Rhizome short, ascending or suberect, bearing some living fronds and many stipes without pinnae, appearing brush-like, densely scaly; scales gradually narrowing from base towards acuminate apex, 2–2.5 mm by 0.25–0.33 mm, nearly black with brown edges, becoming fimbriate or soft multicellular hair in age. *Stipes* very dark purple to dark brown or nearly black, polished, glabrous but scaly at base, up to 5 cm long or less than 1 cm in smaller fronds. *Laminae* simple pinnate with decompound apical portion, oblong-lanceolate in outline, 3–10 cm long, 5–10 mm wide, lower half

of lamina pinnate, nearly parallel at edges; pinnae sessile, pinnae overlap with the next one or 1–2 mm apart, rounded at apex, a little ascending and nearly straight at basiscopic side, subtruncate at inner side, shallowly lobed at acroscopic margin, 0.3–0.7 by 0.2–0.3 cm, fallen ones leaving minute scars on rachis; lobes rounded, with round sinus; veins hardly visible, sometimes forked, not reaching the margin of lobes; rachis bearing branches at middle or above, sometimes the axes forked, each branch sometimes with the appearance of pinnate frond; the apical pinnae adnate at base. *Sori* one to five in each pinnae, 1–1.5 mm long; indusia persistent, covered under sporangia at maturity.

Thailand. – NORTH-EASTERN: Loei (Phu Kradueng).

Distribution. – Endemic to Thailand.

Ecology. – Lithophytic on sandstone near cliffs at about 1,296 - 1,300 m alt.

Specimen examined. – P. Jadprajong 79, 270, 331 (BKF); F. Floto 7905 (BKF).

8. *Asplenium* sp., Figure 5. 6: G-H.

Rhizome short, ascending or erect, bearing both living fronds and stipes without pinnae, densely scaly; scales linear-lanceolate, gradually narrowing from base towards acuminate apex, 1.5–3 by up to 0.3 mm, nearly black at middle and brown margin which becoming fimbriate and hairy. *Stipes* dark brown to nearly black, polished, glabrous but scaly at base, 0.5–4 cm long. *Laminae* simple pinnate with decompose apical portion, 5–10.2 cm long, 0.7–1.8 cm wide, elliptic-oblong to oblong-lanceolate in outline, nearly parallel at edges; pinnae sessile or 0.5 mm stalks, 2–5 mm apart, rounded with minutely dentate at apex, a little ascending and nearly straight at basiscopic edge, subtruncate at inner side, subentire to irregularly shallowly lobed at acroscopic edge, 4–10 by 2–5 mm, fallen ones leaving minute scars on rachis; veins distinct, free, forked, not reaching the margin of lobes; rachis not branched; the apical pinnae adnate at base ending in

indistinct apical pinnae. *Sori* one to five in each lobe, 1–1.8 mm long; indusia persistent, oblong, sometime hook at distal.

Thailand. – NORTH-EASTERN: Loei (Phu Kradueng).

Distribution. – N/A

Ecology. – Lithophytic on sandy rock crevices near the waterfalls in shaded place at 1,296 – 1,300 m alt.

Specimen examined. – P. Jadprajong 38, 258, 280, 332 (BKF).

2. HYMENASPLENIUM

Hayata, Bot. Mag. (Tokyo) 41(492): 712. 1927; Y. X. Lin & R. Viane, Fl. China 2–3: 308. 2013.

Rhizome long creeping, usually up to 0.6 cm in diameter and with clathrate scales. *Fronde*s remote. *Stipe* usually shiny, castaneous to dark purplish or nearly black. *Lamina* usually 1-pinnate, rarely simple; costa usually with 1 or several basal basisopic veins absent.

Hymenasplenium cheilosorum (Kunze ex Mett.) Tagawa, Acta Phytotax. Geobot. 7(2): 84. 1938; Y. X. Lin & R. Viane, Fl. China 2–3: 310. 2013. — *Asplenium cheilosorum* Kunze ex Mett., Abh. Senckenberg. Naturf. Ges. 6: 177. 1859; Tagawa & K. Iwats., Fl. Thailand 3(2): 279. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 139. 2000. **Figure 5.7: A-B.**

Rhizome long creeping, 2–3 mm in diameters, bearing alternate fronds closely, scaly near apex, scales gradually narrowing from base towards long hairy apex, 1–4 by 0.5 mm, clathrate, sometimes the cell-walls thick. *Stipes* 5–9 cm long, dark purplish,

polished but dirty on lower portion. *Lamina* pinnate, narrowly lanceolate in outline, base subtruncate, apex attenuately acuminate, 16–21 by 3.7–4.1 cm; pinnae 19–35 pairs, subquadrangular, dimidiate, up to 2.5 by 0.5–0.8 cm, the lower half very narrow, the midrib close to entire lower margin, apex rounded, acroscopic base truncate, lobed to 1/3–1/4 way on upper margin, apex lobes rounded or forked, about 1 mm broad, lobe usually placed on each apical part of the lower margin, a few lower pairs slightly reduced, shortly stalked, thin, pale green; veins all free, distinct. *Sori* one or two restricted to each lobe, 1–2.5 mm long, 0.5 mm broad; indusia thin, opening outwardly.

Thailand. – NORTHERN: Chiang Rai (Doi Phacho), Chiang Mai (Doi Suthep, Doi Inthanon, Doi Hua Mot), Mae Hong Son (Mae La Noi), Phitsanulok (Phu Miang, Phu Hin Rong Kla); NORTH-EASTERN: Phetchabun, Loei (Phu Kradueng); EASTERN: Chanthaburi (Khao Soi Dao); SOUTH-WESTERN: Prachuap Khiri Khan (Huai Yang); PENINSULAR: Nakhon Si Thammarat (Khao Luang).

Distribution. – Sri Lanka, South India, East Himalaya, South China, Myanmar, Indochina, Peninsular Malaysia, Borneo, Philippines, Taiwan and north to southern edge of Japan.

Ecology. – Lithophyte on moist muddy rocks usually along streams in lower-montane forests at 1,000–1,200 m alt.

Specimen examined. – P. Jadprajong 326 (BKF); E. Hennipman 3663 (BKF); J. F. Maxwell 05–128, 93–111 (BKF).

ATHYRIACEAE

Alston, *Taxon* 5: 25. 1956; Tagawa & K. Iwats., *Fl. Thailand.* 3(3): 436. 1988; Z. R. Wang, Z. R. He & M. Kato, *Fl. China* 2–3: 418. 2013.

Plants terrestrial or lithophyte, small to medium-sized, sometimes large. *Rhizome* creeping, ascending or erect, sometime short trunk, scaly; scales concolorous

or bicolorous, entire or toothed. *Stipe* supplied by 2 vascular strands with xylem seahorse-shaped in cross section and upward united into U-shaped strand, scaly, also hairy or glabrate. *Lamina* simple to 3-pinnate, pinnatifid or with terminal pinna similar to lateral pinnae, apex narrowed; rachis grooved, hairy or glabrous; veins free or anastomosing. *Sori* various, linear, J-shaped, horseshoe-shaped, orbicular-reniform, or orbicular, indusiate or exindusiate; indusia inferior entirely or proximally to receptacle, or lateral, various in shape.

Key to the genera

- 1a. Sori round; indusia round-reniform.....**1. Athyrium**
- 1b. Sori elongate along veins; indusia narrow, usually on both sides of veins.....**2. Diplazium**

1. ATHYRIUM

Roth, Tent. Fl. Germ. 3(1): 31, 58–59. 1800; Tagawa & K. Iwats., Fl. Thailand. 3(3): 445. 1988; Z. R. Wang, Z. R. He & M. Kato, Fl. China 2–3: 449. 2013. — *Anisocampium* C. Presl, Epimel. Bot. 58. 1851; Tagawa & K. Iwats., Fl. Thailand. 3(3): 444. 1988; Z. R. Wang, Z. R. He & M. Kato, Fl. China 2–3: 447. 2013.

Plants terrestrial or lithophyte. Rhizome creeping, ascending or erect, sometime short trunk, scaly; scales concolorous or bicolorous, entire or toothed. Lamina simple to 3-pinnate, pinnatifid or with terminal pinna similar to lateral pinnae, apex narrowed; rachis grooved, hairy or glabrous; veins free or anastomosing. Sori various, linear, J-shaped, horseshoe-shaped, orbicular-reniform, or orbicular, indusiate or exindusiate; indusia inferior entirely or proximally to receptacle, or lateral, various in shape.

Athyrium cumingianum (C. Presl) Ching, Index Filic., Suppl. 3: 40. 1934. — *Anisocampium cumingianum* C. Presl, Abh. Königl. Böhm. Ges. Wiss., ser. 5: 418–419. 1851. **Figure 5. 7: C-D.**

Rhizome short creeping, 3–5 mm diameter, more or less fleshy, scaly throughout; scales linear-subtriangular, 2–3 mm long, 1 mm wide. *Stipes* stramineous with brownish base, sometimes reddish brown, 7–19.5 cm long, scaly on lower portion, hairy. *Laminae* imparipinnate, 12.5–20 by 8–18.5 cm; lateral pinnae 2–4 pairs, sessile or shortly stalked, oblong, apex cuspidate, rounded to narrowly cuneate at base, 4–13 cm long, by 1.1–3.4 cm broad, lobed about 1/5 way to costa; lobes rounded to obtuse at apex with sharp teeth; herbaceous, light green, glabrous or with minutely hairy; terminal pinna oblong, apex acuminate, base round or cordate, cuneate, lobed at margin sometimes deeply in lower portion; veins pinnate, the veinlets uniting to the opposite ones of the next group, the excurrent veinlets continuous. *Sori* round, medial, irregularly scattered; indusia small, thin, pale, round-reniform, margin lacerate, usually persistent.

Thailand. – NORTHERN: Mae Hong Son (Mae La Noi, Khun Yuam), Chiang Mai (Kang Kat, Doi Chiang Dao, Doi Suthep, Doi Makena, Sop Aep), Chiang Rai (Doi Tung), Lamphun (Doi Khun Tan), Lampang (Huai Thak, Mae Mo), Phrae (Mae Ban), Tak (Wang Chao, Lan Sang, Doi Musoe, Khao Phra Wo), Phitsanulok (Thung Salang Luang); NORTH-EASTERN: Loei (Phu Kradueng); SOUTH-WESTERN: Kanchanaburi (Thung Kang Yang); CENTRAL: Saraburi (Sam Lan); SOUTH-EASTERN: Prachin Buri (Ban Ban Hills); PENINSULAR: Phangnga.

Distribution. – Himalaya, South India, Sri Lanka, Laos, and Philippines.

Ecology. – Terrestrial on sandy slopes in mixed forests at low to medium altitudes about 893–900 m usually in open places exposed in the dry season.

Specimen examined. – P. Jadprajong 121, 150 (BKF).

2. DIPLAZIUM

Swartz, J. Bot. (Schrader). 1800(2): 61. 1801; Tagawa & K. Iwats., Fl. Thailand. 3(3): 449. 1988; Z. R. Wang, Z. R. He & M. Kato, Fl. China 2–3: 499. 2013.

Plants almost terrestrial, evergreen, medium-sized to large. *Rhizome* creeping to ascending or erect, brown or nearly black, scaly; scales concolorous or dark brown to black at margin, margin entire, sometimes sparsely toothed,. *Stipe* brown or black and scaly at base, grooved adaxially. *Lamina* simple, pinnate to tripinnate-pinnatifid, mostly broadly ovate, oblong, or deltoid, sometimes broadly lanceolate; veins free or rarely anastomosing. *Sori* elongate along vein, mostly single or less often double on veinlets, diplazoid; indusia membranous or thickly membranous.

Key to the species

- 1a. Fronds pinnate..... **2.**
- 2a. Lateral pinnae often more than 4 cm broad, subentire to crenate
 **2. D.donianum**
- 2b. Lateral pinnae usually less than 3.5 cm broad, crenate to lobed
 **4. D. mettenianum**
- 1b. Fronds bipinnate or more compound..... **3.**
- 3a. Scales concolorous..... **3. D. kappanense**
- 3b. Scales-margin black..... **1. D. dilatatum**

1. Diplazium dilatatum Blume, Enum. Pl. Javae 2: 194. 1828; Tagawa & K. Iwats., Fl. Thailand 3(3): 464. 1988. **Figure 5. 7: E-F.**

Rhizome massive, erect, densely covered with scales at apex; scales linear with long tail at apex, 1–1.5 by 0.1 cm, brown, margin black, toothed. *Stipes* brown, 50–70

cm long, densely scaly at base, black at lower part. *Fronde*s bipinnate, about 100 cm long by 50–70 cm wide, terminal pinna not distinct; pinnae oblong in outline, 20–30 by 10–20 cm, stalks about 1 cm long, apex acuminate; pinnules oblong, 8–12 by 1.5–2.5 cm, sessile or shortly stalked, apex acuminate at, base subtruncate, truncate to cordate; margin subentire to lobed about 1/4 to 1/2 way to costule; veinlets free, simple or once forked, 4–6 pairs. *Sori* elongate along veinlets, usually more than 0.5 cm long, diplazoid; indusia thin.

Thailand. – NORTHERN: Chiang Rai (Doi Pacho, Mae Kok), Chiang Mai (Doi Chiang Dao, Doi Khun Huai Pong, Doi Suthep, Kang Kat, Doi Inthanon), Phitsanulok (Thung Salang Luang, Phu Rom Rot), Tak (Ban Musoe); NORTH-EASTERN: Phetchabun (Phu Maing), Loei (Phu Luang, Phu Kradueng); SOUTH-WESTERN: Kanchanaburi (Khao Ngi Yai), Uthai Thani (Ban Rai); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); PENINSULAR: Surat Thani (Khao Khieo), Nakhon Si Thammarat (Khao Luang, Khao Nan), Phangnga (Khao Pok), Trang (Khao Chong) Satun, Yala (Muang Wing).

Distribution. – India, Myanmar, Southern China, Taiwan, Ryukyu, Southern Japan, Indochina, Malesia throughout (type from Java) to Northern Australia.

Ecology. – Terrestrial on moist humus-rich mountain slopes in dense lower-montane forests at 1,200–1,237 m alt.

Specimen examined. – P. Jadprajong 328, 329, 330 (BKF); C. F. van Bensekom & T. Santisuk 2894 (BKF); H. Thagahashi & MN. Taruma T-63459 (BKF).

2. *Diplazium donianum* (Mett.) Tardieu, *Aspl. Tokin* 58, pl. 5, f. 1–2. 1932; M. Tagawa & K. Iwats., *Fl. Thailand* 3(3): 455. 1988. **Figure 5. 7: G-H.**

Rhizome creeping, about 3–5 mm in diameter, scaly at apex; scales narrowly lanceolate, 3–5 by 0.6–1 mm, dark brown, margin black and toothed. *Stipes* 10–25 cm long, brown, black at the base, grooved adaxially. *Fronde*s imparipinnate, oblong in

outline, 25–40 by 15–30 cm, terminal pinna like the lateral one; lateral pinnae 1–3 pairs, oblong, 14–20 by 3–4.5 cm, stalks 0.5–1 cm long, apex acuminate, base acute or obtuse, margin entire or subentire; costa grooved with minute hairs on adaxial surface; veins free, simple or forked, reaching to margin. *Sori* elongate along veins, longest on acroscopic side of veinlets; indusia thin.

Thailand. – NORTHERN: Chiang Mai (Doi Suthep), Tak (Doi Musoe), Phitsanulok (Thung Salaeng Luang); NORTH-EASTERN: Loei (Phu Kradueng); EASTERN: Nakhon Ratchasima; CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi, Prachin Buri, Trat (Koh Chang); PENINSULAR: Nakhon Si Thammarat (Khao Luang, Khao Nan, Ron Phibun, Khiriwong).

Distribution. – Northern India to Southern China and Taiwan, north to Southern Japan, southwards to Indochina.

Ecology. – Terrestrial on moist mountain slopes in light shade at lower-montane forest at 1,199–1,237 m alt.

Specimen examined. – P. Jadprajong 70 (BKF).

3. *Diplazium kappanense* Hayata, Icon. Pl. Formosan. 8. 143 f. 69-70. 1919. — *Diplazium taiwanense* Tagawa, Acta Phytotax. Geobot. 5: 259. 1936; M. Tagawa & K. Iwats., Fl. Thailand 3(3): 462. 1988. **Figure 5. 8: C-D.**

Rhizome ascending 2–3 cm in diameter, scaly at apex; scales 5–10 by 0.5–0.6 mm, linear with long tail at apex, concolorous, dark brown to nearly black, margin toothed. *Stipes* 30–48 cm long, densely scaly and dark brown at basal part. *Fronde*s bipinnate, subdeltoid, 40–60 cm long, about 50 wide, gradually narrowing upwards; pinnae oblong, 17–26 by 14–22 cm, stalks distinct, 2–3 cm, gradually narrowing towards long acuminate apex; pinnule oblong, up to 8 by 1.6–2 cm, apex long acuminate, base obtuse to subtruncate; margin lobed about 1/3 way to costule, apex

round, margin dentate; veins 5–6 pairs, pinnate, free, forked. *Sori* oblong to elongate along veinlets, 2–5 mm long, medial or submarginal; indusia thin, papyraceous.

Thailand. – NORTH-EASTERN: Loei (Phu Kradueng); CENTRAL: Nakhon Nayok (Khao Yai).

Distribution. – Northern Vietnam and Taiwan (type) to South-Western Japan.

Ecology. – Terrestrial on moist ground along stream banks in light shade at about 1,100–1,200 m alt.

Specimen examined. – P. Jadprajong 191 (BKF).

4. *Diplazium mettenianum* (Miq.) C. Chr., index Filic.: 236. 1906; Tard. & C. Chr., Fl. Indo-Chine. 7(2): 253. 1940; M. Tagawa & K. Iwats., Fl. Thailand 3(3): 460. 1988.

Figure 5. 8: A-B.

Rhizome short creeping, 0.8–1 cm in diameter, scaly throughout; scales narrowly lanceolate, toothed at margin, 6–10 by 0.5–1 mm, concolourous, light brown. *Stipes* stramineous, dark brown to black at lower portion, 20–38 cm long, glabrous. *Fronde*s 1-pinnate, oblong in outline, about 60 by 30–40 cm, terminal pinna not distinct, apex acuminate; lateral pinnae 10–20 by 2–4 cm, stalks 1–2 cm long, lower pinnae the longest, oblong, apex acuminate, base cordate, margin lobed about 1/4 way to costa, oblique, apex round to obtuse, subentire to serrate at margin; upper pinnae rather becoming smaller, base adnate and gradually decurrent; thinly chartaceous, deep green; veins all free, pinnate, 4–5 pairs. *Sori* elongate along veins, about 4–6 mm long, longest at lower veinlets of vein group, diplazoid.

Thailand. – NORTH-EASTERN: Loei (Phu Kradueng).

Distribution. – Northern Vietnam, China, Taiwan to Japan.

Ecology. – On humus-rich slopes in dense forests at about 1,100 m alt.

Specimen examined. – P. Jadprajong 8, 9, 11, 71, 236 (BKF).

BLECHNACEAE

Newman, Hist. Brit. Ferns (ed. 2) 8. 1844; Tagawa & K. Iwats., Fl. Thailand 3(3): 297. 1988; F. G. Wang, F. W. Xing, S. Y. Dong & M. Kato, Fl. China 2–3: 411. 2013.

Plants mostly terrestrial, sometimes like small tree ferns. *Rhizome* mostly erect, or creeping or scandent, scales brown, entire. *Fronde*s monomorphic or dimorphic, mostly long stipitate; stipe scaly at base; lamina pinnate, pinnatifid, or bipinnatifid, glabrous or usually with small scales; pinnae rarely articulate to rachis; veins free or anastomosing with areoles, without included free veinlets. *Sori* elongate or continuous along vascular network or commissure on either side of midrib, indusiate, rarely exindusiate or acrostichoid, indusiate; annulus longitudinal, interrupted. *Spores* monolete.

Key to the genera

- 1a. Tree ferns, stem erect trunklike about 1 meters tall.....**2. Brainea**
 1b. Not like tree ferns, stem erect or ascending.....**1. Blechnum**

1. BLECHNUM

L., Sp. Pl. 2: 1077. 1753; Tagawa & K. Iwats., Fl. Thailand 3(3): 297. 1988; F. G. Wang, F. W. Xing, S. Y. Dong & M. Kato, Fl. China 2–3: 411. 2013.

Plants terrestrial, medium or large sized. *Rhizome* usually erect or ascending, densely scaly; scales basifixed, lanceolate, entire, dark brown to brown, glossy. *Fronde*s clustered, long stipitate. *Stipe* scaly at base, glabrous on the upper part. *Laminae* pinnate, with reduced auricular at lower pinnae, leathery; pinnae linear, margin entire or serrulate; terminal pinna similar to lateral pinnae; veins free, parallel, simple or

forked. *Sori* linear, forming long coenosori adjacent and parallel to costa; indusium attached to commissure, facing with costa; annulus longitudinal, interrupted.

Blechnum orientale L., Sp. Pl. 1077. 1753; Tagawa & K. Iwats., Fl. Thailand 3(3): 298. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 146, 180. 2000; F. G. Wang, F. W. Xing, S. Y. Dong & M. Kato, Fl. China 2–3: 412. 2013. **Figure 5. 8: E-F.**

Rhizome thick, ascending or erect, densely covered with scales; scales linear, gradually narrowing towards apex, 1.5–2 cm or more long by about 2 mm broad, apex acuminate, dark brown with cartilaginous margin. *Fronde*s pinnate, monomorphic. *Stipes* stramineous, sometimes purplish at lower portion or when young, densely scaly at base, bearing small auricles throughout, up to 93 cm long. *Laminae* 1.5–2 m long, up to 64 cm wide. Lateral pinnae many in number, 1–3 cm apart from each other, linear, ascending, gradually narrowing towards long-tailed apex, base round to subtruncate, sessile, adnate in the upper portion, entire, up to 32 by 1.2–1.8 cm, glabrous throughout coriaceous, green; veins distinct on both surfaces, simple or forked usually near costa, up to 0.5 mm apart. *Sori* long-continuous along costa; indusia narrow, usually broken before maturity.

Thailand. – NORTHERN: Chiang Mai (Kong Kat, Doi Suthep, Mae Rim), Chiang Rai (Doi Tung), Nan, Tak (Ban Musoe, Raheng); NORTH-EASTERN: Loei (Phu Ruea, Phu Lueng, Phu Kradueng), Udon Thani (Phon Phisai), Nong Khai; EASTERN: Chaiyaphum (Khao Kong); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi (Laem Sing, Phriu Waterfall, Makham, Khao Sabap), Trat (Ko Kut, Ko Chang); SOUTH-WESTERN: Kanchanaburi (Sai Yok), Phetchaburi; PENINSULAR: Chumphon (Lang Suan, Ban Pak Chan), Ranong (Nok Nang), Krabi (Ko Lanta-yai), Surat Thani (Ban Don), Phangnga (between Thanun and Phangnga), Nakhon Si Thammarat (Khao Luang, Thep Chang), Trang (Khao Chong), Satun, Yala (Betong, Bannang Sata), Narathiwat (Waeng, Sungai Padi).

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

Ecology. – Terrestrial on dry open slopes or in light shade in lower-montane forest at 1,183–1,255 m alt.

Specimen examined. – P. Jadprajong 55, 133, J. F. Maxwell 86–1053 (BKF); M. Tagawa, K. Iwats. & N. Fukuoka T-600, 4678 (BKF); Ch. Charoenphol, Kai Larsen & E. Warncke 5094 (BKF); C. Phengkklai 14816 (BKF); T. Vongthavone 129 (BKF); T. Shimizu, H. Toyokuni, H. Koyama, T. Yahara & T. Santisuk T-18204 (BKF); T. Shimizu, M. Hutoh & D. Chaiglom T-8974 (BKF).

2. BRAINEA

J. Smith, Cat. Ferns Gard. Kew. 5. 1856; Tagawa & K. Iwats., Fl. Thailand 3(3): 302. 1988; F. G. Wang, F. W. Xing, S. Y. Dong & M. Kato, Fl. China 2–3: 414. 2013.

Stem erect, very stout, dictyostelic, woody, apex scaly; scales linear, membranous, acuminate. *Fronde*s clustered in terminal crown, slightly dimorphic. *Stipe* scaly at basal part. *Laminae* pinnate, elliptic-lanceolate in outline, leathery, abaxially with some small scales along costa; pinnae sessile, entire, linear to narrowly oblong; veins free, simple or 1- or 2-forked, except the costal row of subtriangular areoles, fertile pinnae rather shorter, margin sometimes irregularly lobed; rachis grooved adaxially. *Sori* borne on costal veins, abundant, covering whole abaxial surface of pinnae, exindusiate.

Brainea insignis (Hook.) J. Sm., Cat. Ferns Gard. Kew. 5. 1856; Tagawa & K. Iwats., Fl. Thailand 3(3): 302. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 146, 147, 180. 2000; F. G. Wang, F. W. Xing, S. Y. Dong & M. Kato, Fl. China 2–3: 414. 2013. **Figure 5.8: G-H.**

Stem blackish brown, erect, stout, about 50–100 cm tall, 10–30 cm in diameters, woody, scaly at apex; scales linear, rufous, 1–3 cm, membranous, acuminate. *Fronde*s slightly dimorphic, clustered at terminal crown. *Stipe* stramineous, 10–35 cm, scaly at base. *Lamina* simple pinnate, elliptic-lanceolate, slightly narrow downward, up to 1 m or more long, leathery, abaxial sides with small scales along costa and veins; pinnae about 30–55 pairs, opposite or alternate, sessile, linear to narrowly oblong; middle pinnae 10–15 by 0.5–1.5 cm, base asymmetrical, subauriculate, margin serrulate, basal pinnae slightly shorten; veins free, simple or 1 to 2 forked, with costal row of areoles subtriangular; fertile pinnae rather shorter, sometimes irregularly lobed at margin; rachis stramineous, grooved adaxially. *Sori* borne on costal veins, exindusiate, abundant, covering on abaxial surface of pinnae when mature.

Thailand. – NORTHERN: Chiang Mai (Doi Chong, Doi Chieng Dao, Doi Phahom Pok, Doi Suthep, Doi Inthanon, Ban Yang, Pang Bo, Doi Hua Mot), Chiang Rai (Doi Pacho), Lamphun (Doi Khun Tan), Lampang (Doi Luang), Phrae (Mae Sai), Tak (Doi Musoe); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng); SOUTH-WESTERN: Kanchanaburi (Song Tho); SOUTH-EASTERN: Trat (Ko Chang).

Distribution. – Himalayas, South China, Myanmar, Indochina, Peninsular Malaysia and North Sumatra.

Ecology. – Terrestrial on dry slopes near stream or in not so dense forests in at 1,000 - 1,200 m alt.

Specimen examined. – P. Jadprajong 317 (BKF); M. Tagawa, K. Iwats. & N. Fukuoka T-784 (BKF); M. Tagawa, K. Iwats., H. Koyama, N. Fukuoka, A. Nalampoon & A. Chintayungkun T-9245 (BKF).

CIBOTIACEAE

Korall, *Taxon* 55(3): 712. 2006; X. C. Zhang, & H. Nishida, *Fl. China* 2–3: 132. 2013. — Dicsoniaceae, Tagawa & K. Iwats., *Fl. Thailand* 3(1): 109. 1979.

Plants terrestrial. *Rhizomes* massive, ascending or erect, densely covered yellowish brown or golden yellow hairs at apex of rhizomes and persistent stipe bases. *Fronde*s monomorphic or dimorphic, apex forming turf, usually 1–4 meters. *Stipe* hairy at base. *Laminae* 2-pinnate pinnatifid to 3-pinnate pinnatifid, often glaucous abaxially, persistently hairy on rachis, costa, costules, and veins; veins free, simple or forked to pinnate. *Sori* single, marginal at vein ends, indusiate; indusia bivalvate.

CIBOTIUM

Kaulf., Berlin. Jahrb. Pharm. Verbundenen Wiss. 21: 53. 1820; Tagawa & K. Iwats., Fl. Thailand 3(1): 109. 1979; X. C. Zhang, & H. Nishida, Fl. China 2–3: 132. 2013.

Rhizomes massive, ascending or erect, bearing roots. *Rhizome* and base of stipe densely covered with mass, golden yellow, long hairs. *Fronde*s very large, stipe about 1 meter long; veins free forked. *Sori* terminal on veins submarginal, protected by bivalvate indusia.

Cibotium barometz (L.) J. Sm., London J. Bot. 1: 437. 1842; Tagawa & K. Iwats., Fl. Thailand 3(1): 109. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 42, 90. 2000; X. C. Zhang, & H. Nishida, Fl. China 2–3: 132. 2013. **Figure 5. 9: A-B.**

Rhizome massive, erect or ascending, very densely covered with golden yellow hairs. *Fronde*s bipinnatifid. *Stipes* thick, with linear aerophores on each side, sometimes 2 cm in diameters, about 179 cm long or more, densely covered with shining, golden yellow, slender, long hairs at base, 1–2 cm long, the hairs on upper parts not so dense, brown to darker, becoming shorter upwards; *lamina* bipinnate, large, 1.6–2 m in length, about 1.2 m width; pinnae many, the largest ones about 60 cm long, 24 cm wide, with numerous pinnules; pinnules deeply pinnatifid, sessile or very shortly stalked, linear-lanceolate, gradually narrowing towards acuminate apex, broadly cuneate to subtruncate at base, 10–12 cm long, 1.5–2 cm wide; ultimate segments oblong to

subfalcate, apex acute, dentate at margin, glaucous on lower surface, about 0.8 cm long, up to 3 mm broad; costae and costules covered with pale, appressed, wilt hairs below; veins distinct, forked, sparsely hairy below. *Sori* usually 1–5 at base of lower pairs of pinnule segments, parallel to edge of lobes, protected by two indusial; indusia bivalvate, outer indusia round, inner indusia elongate at maturity, oblong.

Thailand. – NORTHERN: Chiang Rai (Doi Tung, Mae Nam Kok, Doi Pacho), Chiang Mai (Doi Phahom Pok, Doi Chiang Dao Doi Hua Mot), Lampang, Phitsanulok (Phu Miang, Thung Salaeng Luang); NORTH-EASTERN: Phetchabun, Loei (Phu Luang, Phu Kradueng); EASTERN: Nakhon Ratchasima (Khao Laem); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao), Trat (Ko Chang); SOUTH-WESTERN: Phetchaburi; PENINSULAR: Ranong, Yala (Gunong Ina.).

Distribution. – Himalayas to South China and Taiwan, south to Laos, Cambodia and West Malaysia, north to the Ryukyus.

Ecology. – Terrestrial on mountain slope near stream in lower-montane forest at 1,199–1,226 m alt.

Specimen examined. – P. Jadprajong 84 (BKF).

CYATHEACEAE

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

Rhizomes massive, erect, almost forming trunk, more or less bearing densely scales. *Stipe* scaly near base. *Fronde*s 1-pinnate to tripinnatifid, large; vein simple or forked. *Sori* on veins, sporangia attached on a small receptacles, with or without indusium, annulus completely oblique.

ALSOPHILA

R. Br., Prodr. 158. 1810; P. Korall, D. S. Conant, J. S. Metzgar, H. Schneider and K. M. Pryer, Amer. J. Bot. 94(5): 873–886. 2007. — *Cyathea* Sm., Mém. Acad. Roy. Sci. (Turin) 5: 416. 1793; Tagawa & K. Iwats., Fl. Thailand 3(1): 101. 1979.

Terrestrial tree ferns. *Stem* erect, tall up to 10 m or more height, covered with large scale at apex and stipe base; scale marginate with apical seta. *Fronde*s large, pinnately compound, bearing scales and hairs; veins usually free. *Sori* round, dorsal on veinlets with distinct receptacles; indusial distinct or wanting; annulus oblique.

Alsophila podophylla Hook., Hooker's J. Bot. Kew Gard. Misc. 9: 334. 1857. — *Cyathea podophylla* (Hook.) Copel., Philipp. J. Sci. 4: 33. 1909; Tagawa & K. Iwats., Fl. Thailand 3(1): 104. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 46, 114. 2000.

Figure 5. 9: E-F.

Rhizome erect, forming trunks, more than 1 meter tall; scales up to 3 cm long, 1–3 mm broad, stiff, shining, narrow, brown to dark brown with scattered black cell on lower portion, marginate with apical seta usually on lower part. *Stipes* 37–56 cm or longer, dark purplish, polished, shortly spiny, scaly near base, pneumathodes in a single row, interrupted. *Fronde*s large, monomorphic, bipinnate; lower pinnae not reduced, 39–56 cm or more long, 15.2–20 cm wide; pinna-rachis hairy on upper surface, minutely scaly on abaxial side; pinnules about 25 in pairs with lobed terminal pinnae, shortly stalked, patent or ascending, more or less falcate, lanceolate, gradually narrowing towards caudately acuminate apex, base broadly cuneate, up to 10 cm long, 1.5–1.8 cm broad, margin subentire or very shallowly serrate at least at distal portion; main rachis castaneous, minutely scaly; costae hairy on both surfaces scaly underneath with dark ferruginous margin; not bullate; papyraceous, green; veins pinnate, veinlets simple, all free or basal veinlets of vein groups forking once and reuniting before margin to form distinct loops. *Sori* naked, close to main veins; receptacles small.

Thailand. – NORTH-EASTERN: Loei (Phu Kradueng); EASTERN: Ubon Ratchathani; CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao), Trat (Ko Chang); PENINSULAR: Surat Thani (Khao Nong), Phangnga (Takua Pa), Nakhon Si Thammarat (Khao Luang).

Distribution. – China (Fujian, Guangdong, Guangxi, Guizhou, Hainan, Taiwan, Yunnan), Japan (Ryukyu Islands), Vietnam, Laos (Hua Phan, Xieng Khouang), Cambodia (Kampot), Thailand.

Ecology. – Terrestrial on slope near stream in lower-montane forest at the altitudes ranging from 1,199–1,237 m.

Specimen examined. – P. Jadprajong 16, 28, 83 (BKF).

DAVALLIACEAE

M. R. Schomb. ex A. B. Frank, *Reis. Br.-Guiana* 3: 883. 1848; Tagawa & K. Iwats., *Fl. Thailand* 3(2): 150. 1985; Tagawa & K. Iwats., *Fl. Thailand* 3(4): 615. 1989; F. W. Xing, F. G. Wang & H. P. Nootboom, *Fl. China* 2–3: 749. 2013.

Plants small to moderate-sized, usually epiphytic or epilithic. *Rhizome* long creeping, densely scally. *Fronde*s remote. *Stipe* articulated at base. *Lamina* simple, pinnate or more compound; veins free, usually forked. *Sori* submarginal or terminal on veinlet, round to oblong; indusia tubular, opening toward margin or inear continuous. *Sporangia* long stalked, annulus longitudinal.

DAVALLIA

Smith, *Mém. Acad. Roy. Sci. (Turin)*. 5: 414. 1793; Tagawa & K. Iwats., *Fl. Thailand* 3(2): 163. 1985; F. W. Xing, F. G. Wang & H. P. Nootboom, *Fl. China* 2–3: 752. 2013.

Rhizome long creeping, with dark, peltate scales. *Fronde*s remote, long stipitate, monomorphic or dimorphic. *Stipe* articulate to short phyllopodia, terete or slightly winged. *Lamina* bipinnate to 4-pinnate-pinnatifid, deltoid or pentagonal, firmly leathery or sometimes thickly herbaceous, glabrous, ultimate segments with crenate or lobed margins. Veins free, usually forked, terminating in lobes or crenations of cartilaginous margin. *Sori* terminal on veins, on small oblique lobes or crenations; indusium elongate toward margin, attached at base or both base and sides, long stalked.

Key to the species

- 1a; indusia semicircular, attached by base only.....**2. D. repens**
- 1b; indusia tubular or cup-shaped, attached by base and sides.....**2.**
- 2a. False veins present.....**1. D. denticulata**
- 2b. False veins absent.....**3. D. trichomanoides**

1. Davallia denticulata (Burm. f.) Mett. ex Kuhn, Filic. Decken.: 27. 1867; Tagawa & K. Iwats., Fl. Thailand 3: 160. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 233. 2000; F. W. Xing, F. G. Wang & H. P. Nootboom, Fl. China 2–3: 753. 2013. **Figure 5. 9: C-D.**

Rhizome long creeping, 2–5 mm in diameters, densely scaly throughout; scales ovate at base, abruptly narrowing to long tailed, the base about 1 mm wide and long, more or less appressed, the tails 3–7 by 0.2 mm, brown to dark brown, toothed at margin. *Stipes* brown, terete, 16–53 cm long, glabrous. *Laminae* subtriangular, quadripinnatifid to quadripinnate, 21–62 cm long by 17–50 cm wide, basal pinna the largest, subtriangular, broadly cuneate at base, stalked, up to 32 cm long by 26–30 cm wide, the upper pinna gradually smaller upwards, pinnules and secondary pinnules stalked or sessile upwards, oblong to oblong-subdeltoid, ultimate segments oblong, oblique, round to moderately acute at apex, cuneate and decurrent at base, lobed at

margin, lobes acute, about 0.5 mm broad, green; veins distinct on the lower surface; false veinlets present but not always clearly. *Sori* small, terminal on very margin of lobes; indusia cup-shaped, about 1 mm long by 0.5 mm in diameters

Thailand. – NORTH-EASTERN: Loei (Phu Kradueng); EASTERN: Nakhon Ratchasima (Khao Lotueng), Ubon Ratchathani; CENTRAL: Nakhon Nayok (Wang Chao); SOUTH-EASTERN: Chon Buri (Si Racha, Nong Kho), Trat (Koh Chang); SOUTH-WESTERN: Kanchanaburi (Sai Yok, Thung Kang Yang Hill, Tha Poh), Prachuap Khiri Khan (Bang Saphan); PENINSULAR: Ranong (Khao Phra Mai), Surat Thani (Ban Don, Khao Lak, Kanchanadit), Phangnga (Takua Thung), Krabi, Nakhon Si Thammarat (Khao Luang), Trang (Khao Chong), Satun, Yala (Bannang Sata), Narathiwat.

Distribution. – Widely distributed in the tropics of the Old World, Madagascar to Polynesia and Australia, north to Laos, Hainan and Guangdong.

Ecology. – Lithophyte on dry rocks in evergreen forests or half-shaded places at 584 to about 1,221 m alt.

Specimen examined. – P. Jadprajong 231, 249 (BKF); O. Ratana 40 (BCU); T. Boonkerd 1179, 1423 (BCU); C. Niyomdham and D. Sriboonma 1599 (BKF); C. Niyomdham, P. Puddjaa & S. Chonkunjana 6348 (BKF); K. Larsen, S. S. Larsen, I. Nielsen & T. Santisuk 30822 (BKF).

2. *Davallia repens* (L. f.) Kuhn, *Filic. Decken.*: 27. 1867 nom. cons., non Desv. — *Humata repens* (L. f.) J. Small ex Diels, *Nat. Pflanzenfam.* 1(4): 209. 1899; Tagawa & K. Iwats., *Fl. Thailand* 3(2): 166. 1985; Boonkerd & Pollawatn, *Pterid. Thailand*: 172, 236. 2000; F. W. Xing, F. G. Wang & H. P. Nootboom, *Fl. China* 2–3: 756. 2013. — *Pachypleuria repens* (L. f.) M. Kato, *J. Fac. Sci. Univ. Tokyo, Sect. 3, Bot.* 13: 573. 1985; Tagawa & K. Iwats., *Fl. Thailand* 3(4): 616. 1989. — *Pachypleuria vestita* (Blume) C. Presl, *Epimel. Bot.*: 261. 1851; Tagawa & K. Iwats., *Fl. Thailand* 3(4): 616. 1989. **Figure 5. 10: A-B.**

Rhizome long creeping, 1.6–2 mm in diameters, glabrous, densely scaly, scales linear-lanceolate, apex long-acuminate, base acuminate, about 0.5 mm by 1.3–1.8 mm, brown with paler at margin. *Stipes* stramineous, terete, up to 10 cm long, sparsely scaly. *Laminae* oblong-subdeltoid or roundly pentagonal, up to 11 cm long, 2.5–5 cm wide, basal pinnae pinnatifid to tripinnatifid; basal pinna the largest, asymmetrically subtriangular to oblong-subdeltoid, upper pinnae linear-subtriangular, gradually smaller upwards, shallowly lobed or entire, sessile or adnate, pinnules oblong, oblique, round at apex, lobed or subentire, coriaceous, glabrous. *Sori* marginal, small; indusia nearly semi-circular, entire, attached at base, free at each sides, about 1 mm broad.

Thailand. – NORTHERN: Mae Hong Son (Doi Pha Dam), Chiang Mai (Doi Chiang Dao, Doi Suthep, Doi Inthanon), Chiang Rai (Doi Tung), Lamphun (Doi Khun Tan), Lampang, Phitsanulok (Phu Miang); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng); 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, Kiriwong), Trang (Khao Chong), Yala (Gonong Ina, Khao Kala Khiri).

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

Ecology. – Epiphyte on mossy tree-trunks or lithophyte on rather dry rocks in half-shaded places in dense forests at 1,098–1,233 m alt.

Specimen examined. – P. Jadprajong 45, 137, 185 (BKF); W. Rattanathirakul and S. Srprathet 14 (BCU); T. Boonkerd 468, 558, 582 (BCU); Y. Yuyen 77 (BCU).

3. *Davallia trichomanoides* Blume, Enum. Pl. Javae 2: 238. 1828; Tagawa & K. Iwats., Fl. Thailand 3(2): 162. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 234. 2000; F. W. Xing, F. G. Wang & H. P. Nootboom, Fl. China 2–3: 754. 2013.

var. **lorrainii** (Hance) Holttum, Revis. Fl. Malaya 2: 361. 1955; Tagawa & K. Iwats., Fl. Thailand 3(2): 163. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 234. 2000.

Figure 5. 10: C-D.

Rhizome long creeping, about 5 mm in diameters, densely scaly; scales narrowing above the base to form long tails at apex, dark, with long paler hairs at margin. *Stipes* stramineous, 7–19 cm long. *Laminae* deltoid or roundly pentagonal, gradually narrowed from base to acute apex, 10–38 cm long and 9–43 cm wide, tripinnate to quadripinnatifid, basal pinnae the largest, 10–15 cm by 5–10 cm, shortly stalked, upper pinnae gradually smaller upwards, pinnules subsessile or shortly stalked, acute at apex, cuneate at base, secondary pinnules sessile, round to moderately acute at apex, cuneate at base, lobed at margin, subcoriaceous, glabrescent, green and paler below; veins pinnate. *Sori* terminal on veinlets; indusia cup-shaped, 1–1.5 mm long by 0.3–0.5 mm in diameters

Thailand. – NORTHERN: Chiang Rai (Doi Tung), Chiang Mai (Doi Su Thep, Ban Chue Kai, Doi Pha Dam, Mae Rim), Lamphun, Lampang (Doi Khun Tan), Tak (Ban Musoe), Phitsanulok (Phu Mieng); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng); EASTERN: Nakhon Ratchasima (Kao Lotueng); CENTRAL: Nakhon Nayok (Kao Yai); SOUTH-EASTERN: Chon Buri (Si Racha), Rayong (Khao Chamao), Chanthaburi (Khao Sabap), Trat (Ko Chang); SOUTH-WESTERN: Kanchanaburi (Khao Ngai Yai); PENINSULAR: Surat Thani (Ban Don), Nakhon Si Thammarat (Khao Luang, Ron Phibun).

Distribution. – Central Myanmar, Indochina and throughout Malesia.

Ecology. – Lithophyte or epiphyte, on mossy rocks or bases of tree-trunks in light shade to dense evergreen forests at 1,183–1,237 m alt.

Specimen examined. – P. Jadprajong 77, 128, 171, 233 (BKF).

DENNSTRETIACEAE

Lotsy, Vortr. Bot. Stammesgesch. 2: 655. 1909; Tagawa & K. Iwats., Fl. Thailand 3(1): 111. 1979; Y. H. Yan, X. P. Qi, W. B. Liao, F. W. Xing, M. Y. Ding, F. G. Wang, X. C. Zhang, Z. H. Wu, S. Serizawa, J. Prado, A. M. Funston, M. G. Gilbert & H. P. Nooteboom, Fl. China 2–3: 147. 2013.

Plants terrestrial, sometimes climbing. *Rhizome* usually long creeping, covered with hairs or multicellular bristles, scales absent. *Fronde*s monomorphic, medium to large-sized. *Stipes* not articulate to rhizome, hairy, rarely glabrous. *Lamina* 1–4-pinnately compound, thinly herbaceous to leathery, hairy or glabrous, without scales; rachis grooved on the upper surface; pinnae opposite or alternate; veins usually free, pinnate or forked, not reaching the margin, but reticulate without included veinlets in *Histiopteris*. *Sori* marginal or intramarginal, linear or orbicular, terminal on veinlet or on vascular commissure joining the apices of veins; indusia linear or bowl-shaped, sometimes double with outer false indusium, formed from the reflexed margin of lamina and inconspicuous inner true indusium; paraphyses present or not.

Key to the genera

- 1a. Sori protected by cup-shaped indusium.....**3. Microlepia**
- 1b. Sori naked or protected by reflexed margin, sometimes also with a linear inner true indusium.....**2.**
- 2a. Rhizome with brown scales; pinnae always opposite with a basal stipulelike pinnules.....**1. Histiopteris**
- 2b. Rhizome hairy, scales absent; pinnae opposite or alternate, all pinnules usually similar.....**3.**
- 3a. Lamina thinly herbaceous, dark green; gemmae usually present on rachis.....**4. Monachosorum**

3b. Lamina papery to leathery, rarely herbaceous, green to pale green; gemmae absent.....**4.**

4a. Sori round or orbicular, terminal on vein.....**2. Hypolepis**

4b. Sori linear along marginal connecting vein.....**5. Pteridium**

1. HISTIOPTERIS

(J. Agardh) J. Sm., Hist. Fil. 294. 1875; Tagawa & K. Iwats., Fl. Thailand 3(1): 126. 1979; Y. H. Yan, X. P. Qi, W. B. Liao, F. W. Xing, M. Y. Ding, F. G. Wang, X. C. Zhang, Z. H. Wu, S. Serizawa, J. Prado, A. M. Funston, M. G. Gilbert & H. P. Nooteboom, Fl. China 2–3: 151. 2013.

Plants terrestrial, climbing. *Rhizome* long creeping, thick, densely covered with thick castaneous-brown scales. *Fronde*s sparse, large, indeterminate. *Stipe* reddish castaneous, shiny, long, glabrous; costae slightly grooved adaxially. *Lamina* 2–3-pinnate, triangular, papery to subleathery, glabrous; pinnae opposite, often sessile; pinnules opposite, with a pair of reduced auricle-like at base; venation reticulate, forming a row of narrow areoles, without included veinlets. *Sori* along margin of lamina, protected by a narrowly linear false indusium, paraphyses present.

Histiopteris incisa (Thunb.) J. Sm., Hist. Fil.: 295. 1875; Tagawa & K. Iwats., Fl. Thailand 3(1): 127. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 38, 86. 2000; Y. H. Yan, X. P. Qi, W. B. Liao, F. W. Xing, M. Y. Ding, F. G. Wang, X. C. Zhang, Z. H. Wu, S. Serizawa, J. Prado, A. M. Funston, M. G. Gilbert & H. P. Nooteboom, Fl. China 2–3: 151. 2013. **Figure 5. 10: E-F.**

Rhizome long creeping, covered with dark hairs. *Stipes* long, 30–84 cm or more in length, about 1 cm in diameters, dark purplish, polished. *Laminae* bipinnate to quadripinnatifid, 1–2 m, climbing with well spaced opposite pinnae and pinnules;

rachis, costae and costules grooved on adaxial side, a pair of reduced stipule-like pinnules usually present at base of each pinnae; pinnae up to 65 cm long, 28 cm wide; pinnules up to 20 by 8 cm; veins anastomosing, rather distinct abaxially. *Sori* linear, submarginal, continuous at edge of lobes, covered by the reflexed margin of lobes.

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

Distribution. – Pantropical.

Ecology. – Terrestrial on rather dry exposed slopes usually at medium altitudes about 1,236 m.

Specimen examined. – P. Jadprajong 20, 53 (BKF); E. Smith 1423 (BKF); M. Tagawa K. Iwats., and N. Fukuoka T-786 (BKF).

2. HYPOLEPIS

Bernh., Neues J. Bot. 1(2): 34. 1805; Tagawa & K. Iwats., Fl. Thailand 3(1): 124. 1979. Boonkerd & Pollawatn, Pterid. Thailand: 38, 86. 2000; Y. H. Yan, X. P. Qi, W. B. Liao, F. W. Xing, M. Y. Ding, F. G. Wang, X. C. Zhang, Z. H. Wu, S. Serizawa, J. Prado, A. M. Funston, M. G. Gilbert & H. P. Nooteboom, Fl. China 2–3: 151. 2013.

Rhizome long creeping, covered with multicellular hairs. *Fronde*s monomorphic. *Stipes* not articulate to rhizome. *Lamina* pinnately compound, both surfaces often with gray multicellular hairs; veins all free, rachis grooved, hairy. *Sori* round, almost marginal, protected by a reflexed tooth or marginal flap, or naked, terminal on veins.

Hypolepis punctata (Thunb.) Mett. ex Kuhn, Fil. Afr.: 120. 1868; Tagawa & K. Iwats., Fl. Thailand 3(1): 124. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 39, 86. 2000.

Figure 5. 10: G-H.

Rhizome long creeping, about 2 mm in diameters, with pale brown short hairs. *Stipe* pale brown or stramineous, with darker at base, 15–75 cm long, 2–4 mm in diameters, smooth or slightly rough, with sparse, brown-tinged, glandular and not glandular hairs, 1–2 mm; rachis chestnut-brown or yellow-brown, hairy same as those on stipe. *Lamina* normally 3-pinnate, ovate to broadly ovate in outline, 30–65 by 20–29 cm, firmly herbaceous or papery, the lower surface with fine, colorless or brown-tinged, with glandular and eglandular hairs, the upper surface with shorter and sparser hairs; pinnae opposite or subopposite, largest at or near the base, narrowly triangular, triangular, or ovate, 9–27 by 3.5–20 cm; pinnules oblong or narrowly triangular, 2–11 by 1–5 cm; ultimate pinnules oblong, apex obtuse. *Sori* circular or ovate, unprotected, without hairs between sporangia.

Thailand. – NORTHERN: Chaing Mai (Doi Chaing Dao, Mae Lui), Phitsanulok (Phu Miang); NORTH-EASTERN: Phetchabun, Loei (Phu Luang, Phu Kradueng);

Distribution. – Pantropical.

Ecology. – Terrestrial on rather dry exposed slopes usually at edges of the forest at altitudes about 1,221 m.

Specimen examined. – P. Jadprajong 64 (BKF).

3. MICROLEPIA

C. Presl, Tent. Pterid. 124–125. 1836; Tagawa & K. Iwats., Fl. Thailand 3(1): 113, 1979; Y. H. Yan, X. P. Qi, W. B. Liao, F. W. Xing, M. Y. Ding, F. G. Wang, X. C. Zhang, Z. H. Wu, S. Serizawa, J. Prado, A. M. Funston, M. G. Gilbert & H. P. Nooteboom, Fl. China 2–3: 158. 2013.

Rhizome creeping, covered with multicellular grayish hairs, without scales. *Fronde*s medium to large in sized. *Stipe* without articulation at base, hairy, adaxially grooved. *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, rarely lanceolate, usually with soft hairs on rachis; veins free, pinnately branching, veinlets not reaching margin. *Sori* orbicular, intramarginal, terminal on one veinlet; indusium fixed at base and both sides, opening toward margin, truncate above, or indusium orbicular-reniform, basifixed.

Key to the species

- 1a. Terminal segment of lamina entire, hastate, like lateral pinnae but symmetrical, distal lateral pinnae distinct, entire with single basal acroscopic blunt tooth..... **1. *M. hookeriana***
- 1b. Terminal segment of lamina pinnatisect to pinnatifid, formed by merging of distal pinnules..... **2.**
- 2a. Fronds with long needlelike hairs and shorter gray hairs..... **3. *M. speluncae***
- 2b. Fronds with only long needlelike hairs, short hairs absent.....**2. *M. marginata***

1. *Microlepia hookeriana* (Wall. ex Hook.) C. Presl, Epimel. Bot.: 95. 1851; Tagawa & K. Iwats., Fl. Thailand 3(1): 113, 1979; Boonkerd & Pollawatn, Pterid. Thailand: 87. 2000; Y. H. Yan, X. P. Qi, W. B. Liao, F. W. Xing, M. Y. Ding, F. G. Wang, X. C. Zhang, Z. H. Wu, S. Serizawa, J. Prado, A. M. Funston, M. G. Gilbert & H. P. Nooteboom, Fl. China 2–3: 159. 2013. **Figure 5. 11: A-B.**

Rhizome long creeping, 2.5–5 mm in diameters, with dense long hairs, red-brown or brown hairs. *Fronde*s remote. *Stipe* erect, brown-straw-colored, 1–5 cm apart, 12–27 cm by 1.5–2.5 mm in diameters, densely gray-brown hairs; rachis and stalks with gray-brown hairs. *Lamina* black-green adaxially, one pinnate, broadly lanceolate to

narrowly oblong in outline, 30–81 by 6–18 cm, base narrowed, apex long caudate; pinnae 24–36 pairs, opposite or alternate, sessile to shortly stalked, lower pinnae smaller, slightly reflexed; middle pinnae linear-lanceolate or falcate, 3–11 by 0.7–1.3 cm, herbaceous, abaxially with grayish hairs on veins, adaxially densely with softly brown hairy on midribs, each vein with sparse long hairs, base rounded-cuneate or asymmetrically hastate, both sides sometime with auricle, acroscopic lobe larger, margin undulate-denticulate, distally serrate, apex acuminate; terminal pinna nearly symmetrical, 6–11 by 0.9–1.5 cm, similar to lateral pinnae, often subhastate. Veins obliquely arising from costa, dichotomously branching, with one veinlet per tooth. *Sori* terminal on veinlet, arranged in the line near margin; indusium as long as wide or slightly wider, glabrous, persistent.

Thailand. – NORTHERN: Chiang Rai, Phitsanulok; NORTH-EASTERN: Loei; EASTERN: Nakhon Ratchasima; CENTRAL: Nakhon Nayok; SOUTH-EASTERN: Chanthaburi; PENINSULAR: Phangnga, Nakhon Si Thammarat.

Distribution. – Himalaya and Upper Myanmar to South China, Northern Vietnam, Taiwan and Ryukyus, southwards to Borneo, Sumatra and Java.

Ecology. – Terrestrial on sandy slope in shaded area or along streams at 1,183–1,200 m alt.

Specimen examined. – P. Jadprajong 26, 68, 164 (BKF).

2. *Microlepia marginata* (Panz.) C. Chr., Index Filic. 4: 212. 1905; Tagawa & K. Iwats., Fl. Thailand 3(1): 114, 1979; Y. H. Yan, X. P. Qi, W. B. Liao, F. W. Xing, M. Y. Ding, F. G. Wang, X. C. Zhang, Z. H. Wu, S. Serizawa, J. Prado, A. M. Funston, M. G. Gilbert & H. P. Nootboom, Fl. China 2–3: 160. 2013.

Rhizome 4–5 mm in diameters, with dense, red-brown hairs. *Fronde* 2–5 cm apart. *Stipe* straw-colored, 43–51 cm, thick and strong, base with red-brown hairs; rachis abaxially with dense, brown-yellow, short, soft hairs. *Lamina* 1- or 2-pinnate,

oblong-ovate in outline, about 55 by 40–50 cm, apex long caudate, papery, glabrous or hairy, costa densely pubescent; pinnae 20–22 pairs, proximally subopposite, 2.5–7 cm apart, distally alternate, obliquely spreading, with stalk 2–7 mm, 11.5–26 cm long, 1.5–3.7 cm wide, pinnatisect to pinnate, narrowly lanceolate in outline, falcate, base asymmetrical, basiscopically shorter, cuneate, distally reduced to form long acuminate pinnatifid terminal segment; lobes obliquely oblong, 1.5–2.3 mm long, 7–10 mm wide, compact, margin serrate; veins 4 or 5 pairs, pinnate, thick and prominent, simple or 2-forked, oblique. *Sori* 2–8 per lobe, orbicular, near margin; indusium wider cup-shaped, truncate above, glabrous or hairy.

Key to the varities

1a. Pinnae glabrous on both surfaces, shortly hairy only on veins; sori fewer per lobe, mostly near sinus..... var. **calvescens**

1b. Pinnae hairy on or between veins..... var. **marginata**

var. **marginata** **Figure 5. 11: C-D.**

Fronde 1-pinnate or bipinnate at base, thickly papery or herbaceous, sparsely hairy on both surfaces; pinnae hairy on or between veins. *Sori* 5–9 per lobe; ndusium hairy.

Thailand. – NORTH-EASTERN: Loei (Phu Kradueng)

Distribution. – China, India, Indonesia, Japan, Nepal, Papua New Guinea, Sri Lanka, Vietnam.

Ecology. – Terrestrial on dry humus-rich slopes in lowermontane forest at 1,202–1,237 m alt.

Specimen examined. – P. Jadprajong 161 (BKF).

var. **calvescens** (Wall. ex Hook.) C. Chr., Index Filic. 4: 425, 427. 1906. — *Microlepia calvescens* (Wall. ex Hook.) C. Presl, Epimel. Bot.: 95. 1851; Tagawa & K. Iwats., Fl. Thailand 3(1): 114, 1979; Boonkerd & Pollawatn, Pterid. Thailand: 39, 40 & 86. 2000; Y. H. Yan, X. P. Qi, W. B. Liao, F. W. Xing, M. Y. Ding, F. G. Wang, X. C. Zhang, Z. H. Wu, S. Serizawa, J. Prado, A. M. Funston, M. G. Gilbert & H. P. Nootboom, Fl. China 2–3: 161. 2013. **Figure 5. 11: E-F.**

Fronde 1-pinnate or bipinnatifid, thickly papery, both surfaces glabrous or almost glabrous; pinnae glabrous on both surfaces, long stalked, shortly hairy only on veins; sori fewer per lobe, mostly near sinus; *Sori* 1–2 per lobe, indusium glabrous or almost glabrous.

Thailand. – NORTHERN: Chiang Mai, Chiang Rai, Lampang, Phitsanulok; NORTH-EASTERN: Phetchabun, Loei; SOUTH-WESTERN: Kanchanaburi; PENINSULAR: Phangnga.

Distribution. – East Himalaya, Upper Myanmar, China (Yunnan & Guangxi), Taiwan, Vietnam and Java.

Ecology. – Terrestrial on rather dry ground but usually humus-rich slopes at 1,183–1,202 m alt.

Specimen examined. – P. Jadprajong 69 (BKF).

3. *Microlepia speluncae* (L.) T. Moore, Index Fil.: 93. 1857; Tagawa & K. Iwats., Fl. Thailand 3(1): 118. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 88. 2000; Y. H. Yan, X. P. Qi, W. B. Liao, F. W. Xing, M. Y. Ding, F. G. Wang, X. C. Zhang, Z. H. Wu, S. Serizawa, J. Prado, A. M. Funston, M. G. Gilbert & H. P. Nootboom, Fl. China 2–3: 166. 2013. **Figure 5.11: G-H.**

Rhizome long creeping, about 0.8 mm diam, brown, *Fronde* not dimorphic, tripinnate. *Stipes* stramineous or brown, pubescent or glabrous, about 40 cm or more

long; lamina large, *Lamina* about 87.5 cm long, up to 62 cm wide; rachis stramineous or brown, grooved on adaxial side, hairy; larger pinnae oblong-subtriangular, broadly cuneate at base, broadest at lower portion, gradually narrowing towards acuminate apex, with 20–26 pinnules, about 31 cm long, up to 12 cm wide; costa grooved on upper surface, hairy, distal pinnae gradually decreasing in size; larger pinnules oblong-subtriangular, gradually narrowing towards apex, cuneate at base, 3–6 cm long, 1–2 cm broad, distinctly stalked; segments oblong to subquadrangular, lobed to pinnatisect, apex round to acute, base unequally cuneate, 1–1.5 cm long, 0.5–0.8 cm wide; ultimate lobes round or spatulate, apex round to acute, margin entire or undulate; papyraceous, green to deep green, hairy on axes or laminar surfaces; veins pinnate, once or twice forked, indistinct on both surfaces. *Sori* near the margin of lobes, small; indusia cup-shaped, hairy.

Thailand. – NORTHERN: Mae Hong Son, Chiang Mai, Chiang Rai, Lampang, Tak; NORTH-EASTERN: Phetchabun, Loei; SOUTH-WESTERN: Kanchanaburi, Phetchaburi; CENTRAL: Nakhon Nayok; SOUTH-EASTERN: Chachoengsao, Chon Buri, Chanthaburi; PENINSULAR: Chumphon, Surat Thani, Phuket, Nakhon Si Thammarat, Trang, Satun, Narathiwat, Yala.

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

Ecology. – Terrestrial on rather dry slopes in open areas, in light shade at about 452 m alt.

Specimen examined. – P. Jadprajong 293 (BKF).

4. MONACHOSORUM

Kunze, Bot. Zeitung (Berlin) 6: 119. 1848; Y. H. Yan, X. P. Qi, W. B. Liao, F. W. Xing, M. Y. Ding, F. G. Wang, X. C. Zhang, Z. H. Wu, S. Serizawa, J. Prado, A. M. Funston, M. G. Gilbert & H. P. Nooteboom, Fl. China 2–3: 147. 2013.

Rhizome shortly creeping or ascending, covered with minute, cylindrical, glandular hairs, scales absent. *Fronde*s 1–4-pinnate-pinnatifid, dark green to black, thinly herbaceous; rachis gemmiferous at tip, or bearing 1–3 axillary buds on upper parts; buds large, consisting of a small rosette of fingerlike trophopods; veins free, ending well behind margin. *Sori* terminal or nearly so, small, orbicular, exindusiate; sporangia mixed with glandular paraphyses. *Spores* trilete, tetrahedral-globose, with prominent angles, irregularly tuberculate.

Monachosorum henryi Christ, Bull. Herb. Boissier. 6: 869. 1898. ; Y. H. Yan, X. P. Qi, W. B. Liao, F. W. Xing, M. Y. Ding, F. G. Wang, X. C. Zhang, Z. H. Wu, S. Serizawa, J. Prado, A. M. Funston, M. G. Gilbert & H. P. Nootboom, Fl. China 2–3: 148. 2013. **Figure 5. 12: A-B.**

Rhizome short, ascending, with minute hairs, bearing fronds radially. *Fronde*s monomorphic. *Stipe* stramineous in upper part, brownish in lower part, 24–42 cm or longer, broadest near base, 3–5 mm in diameters, with minute hairs. *Lamina* 3-pinnate, ovate-subtriangular to oblong-subtriangular, up to 50 cm long, 32–36 cm wide at base, thinly herbaceous, apex acuminate; axes grooved abaxially, decurrent to each other; a large gemmae present, distinct at junction between rachis and costa, rarely gemmae absent; pinnae about 15 pairs or more, oblong-lanceolate to oblong, base truncate with shortly stalked, apex acute to acuminate; pinnules oblong to lanceolate, base truncate and shortly stalked to sessile, apex obtuse to acute; basal pinnule usually anadromous, secondary pinnules oblong, apex moderately acute; veins free. *Sori* 1 per segment, terminal, orbicular, close to margin of lobes, naked.

Thailand. – NORTH-EASTERN: Loei (Phu Kradueng).

Distribution. – Himalayas to Taiwan, South China & Indochina.

Ecology. – Lithophyte on mossy sandy rocks near streams in shady place in dense evergreen forest at 1,207 m alt.

Specimen examined. – P. Jadprajong 283 (BKF).

5. PTERIDIUM

Gled. ex Scop., Fl. Carniol. 169. 1760. Y. H. Yan, X. P. Qi, W. B. Liao, F. W. Xing, M. Y. Ding, F. G. Wang, X. C. Zhang, Z. H. Wu, S. Serizawa, J. Prado, A. M. Funston, M. G. Gilbert & H. P. Nootboom, Fl. China 2–3: 149. 2013.

Rhizome brownish black, thick, about 5 mm in diameters, densely with yellow to castaneous hairs, without scales. *Fronde*s up to 130 cm. *Stipe* with several vascular bundles. *Lamina* large, often ovate or ovate-triangular, subleathery to papery, sparsely hairy, 3- or 4-pinnate-pinnatifid, costae usually clothed with gray-brown hairs, rachises grooved adaxially, glabrous or pubescent, pinnae stalked, subopposite or alternate, basal pair of pinnae the largest; veins 2-forked. *Sori* submarginal, linear, paraphyses not present; indusia two layers, outer layer consisting of reflexed margin of lamina, inner layer thinner, inconspicuous.

Pteridium aquilinum (L.) Kuhn, Bot. Ost-Afrika 3(3): 11. 1879; Tagawa & K. Iwats., Fl. Thailand 3: 125. 1979. **Figure 5. 12: C-D.**

Rhizome long creeping, covered with pale brown hairs. *Fronde*s monomorphic. *Stipes* long, up to more than 1 m long, thick, dark brown to black in lower parts, stramineous upwards, densely covered with pale brown hairs. *Lamina* tripinnate to quadripinnatifid, up to 1.2 m or more in length and up to 1 m width; rachis, costae and costules grooved on upper surface, basal pair of pinnae larger, almost comparable with rest of lamina in size, up to 60 cm long, about 36 cm wide, ultimate leaflets small and narrow, coriaceous, usually covered with pale brown hairs; veins free, forked, raised on lower surface, hairy. *Sori* linear, submarginal, the distal of veins joined by vascular commissure and forming long continuous receptacles; indusia formed in two parts, one

consisting of the thin reflexed edge of the leaflets, the other thin, transparent, attached below the receptacles.

Thailand. – NORTHERN: Chiang Rai (Doi Tung, Doi Phacho), Chiang Mai (Doi Chiang Dao, Pang Ton, Doi Suthep, Doi Phahom Pok, Huai San, Chom Thong), Lamphun (Doi Khun Tan), Phitsanulok (Phu Miang, Thung Salaeng Luang); NORTH-EASTERN: Phetchabun, Loei (Phu Kradueng).

Distribution. – Himalayas to Malesia and Taiwan.

Ecology. – Terrestrial, usually growing in open areas, in edge of forest and in sunny places at 1098–1304 m alt. This is common in pine forest and can produce buds after cut off or fire.

Specimen examined. – P. Jadprajong 52 (BKF).

DRYOPTERIDACEAE

Herter, *Revista Sudamer. Bot.* 9: 15. 1949; Tagawa & K. Iwats., *Fl. Thailand* 3(3): 327. 1988; L. B. Zhang, S. G. Wu, J. Y. Xiang, F. W. Xing, H. He, F. G. Wang, S. G. Lu, S. Y. Dong, D. S. Barrington, K. Iwats., M. J. M. Christenhusz, J. T. Mickel, M. Kato & M. G. Gilbert, *Fl. China* 2–3: 541. 2013.

Plants small to large, evergreen or deciduous, terrestrial, epilithic, or epiphytic. *Rhizomes* erect, ascending, creeping, or sometimes climbing, scaly; scales basally attached or very rarely peltate, usually not clathrate, sometimes clathrate, entire or dentate. *Fronde*s tufted or remote, with segments anadromously or catadromously arranged, or sometimes anadromous at base and catadromous at apex. *Stipe* usually not articulate, sometimes articulate at base, scaly, sulcate adaxially, glabrous or sometimes hairy. *Lamina* monomorphic or dimorphic, simple to 5-pinnate, rarely imparipinnate, usually oblong, deltoid, pentagonal, lanceolate, ovate, or linear, scaly, glandular, hairy, or glabrous; if scaly then scales bullate or flat; glands absent or present; texture thinly

papery, papery, or leathery; rachises sulcate adaxially, with or without proliferous bulbils, rarely proliferous bulbils borne at a terminal of rachis; venation pinnate and free, or anastomosing to form areoles, with or without included veinlets. Fertile fronds similar or weakly to strongly different from sterile fronds. *Sporangia* usually in orbicular sori; sori terminal, subterminal, or dorsal on veins, mostly indusiate or rarely exindusiate; if indusiate then indusial orbicular or reniform, superior, lateral, or rarely inferior, entire or toothed; sometimes nearly covering almost abaxially of the fertile parts. *Spores* monolete.

Key to the genera

- 1a. Frond simple..... **4. Elaphoglossum**
- 1b. Frond pinnate or more compound..... **2.**
- 2a. Fronds weakly to strongly dimorphic..... **2. Bolbitis**
- 2b. Fronds monomorphic..... **3.**
- 3a. Frond lanceolate to ovate, not pentagonal **3. Dryopteris**
- 3b. Frond subdeltoid to pentagonal, with basal basicopic pinnules longer than next pair **1. Arachniodes**

1. ARACHINIODES

Blume, Enum. Pl. Javae. 2: 241. 1828; Tagawa & K. Iwats., Fl. Thailand 3(3): 339. 1988; L. B. Zhang, S. G. Wu, J. Y. Xiang, F. W. Xing, H. He, F. G. Wang, S. G. Lu, S. Y. Dong, D. S. Barrington, K. Iwats., M. J. M. Christenhusz, J. T. Mickel, M. Kato & M. G. Gilbert, Fl. China 2–3: 543. 2013.

Plants terrestrial, medium-sized. *Rhizome* long creeping to short and ascending, or sometime erect, densely scaly. *Fronds* remote or approximate. *Stipe* as long as blade,

base densely scaly, adaxially sulcate. *Lamina* deltoid, ovate, or pentagonal, usually 2–4-pinnate; rachis adaxially sulcate, grooves, scaly to glabrescent; pinnae not articulate to rachis, usually shortly stalked, basal ones often with long basal basispic pinnules; upper portion gradually reduced to acuminate or caudate apex, or with a distinct terminal pinna; basispic pinnules slightly longer than acroscopic ones; ultimate segments sessile, usually oblong to rhomboid, or rarely linear, often with an acroscopic auricle, margin dentate to aristate; veins free, forked, not quite reaching margin of ultimate segment. *Sori* orbicular, in one row between midrib and margin; indusia round-reniform, attached at a narrow sinus, persistent.

Arachniodes cavalerii (Christ) Ohwi, J. Jap. Bot. 37: 36. 1962; Tagawa & K. Iwats., Fl. Thailand 3: 340. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 199. 2000.

Figure 5. 12: E-F.

Rhizome short, ascending, scaly; scales small, lanceolate, dark brown, entire. *Stipes* green to brown-stramineous, about 30 cm or more long, 2–5 mm in diameters, scaly in lower part. *Laminae* subdeltoid to pentagonal, tripinnate, 28–32 by 20 cm at base; rachis grooved above, glabrescent; basal pinna the largest, distinctly stalked with petioles of 0.5–1.5 cm in length, deltoid or oblong-deltoid, subtriangular with large basal pinnules, apex acuminate, 14–19 by 10–12 cm; basal basispic pinnule similar to the second basal pinna; larger pinnule of the large pinna parallelogram-shaped, subsessile or shortly stalked, apex acute, base cuneate, margin crenate, apex of lobes never aristate-mucronate, chartaceous. *Sori* large, dorsal on veinlets, arranged in one row, close to each side of midrib; indusial round-reniform, 1.1–1.8 mm in diameters, completely covering the sori when young, drop off at maturity, irregular at margin .

Thailand. – NORTH-EASTERN: Loei (Phu Kradueng)

Distribution. – South China, North Vietnam and Southern of Japan.

Ecology. – Lithophyte on humus-rich on rocks in shaded place along streams in dense forest at the altitude about 1,163 m alt.

Specimen examined. – P. Jadprajong 281 (BKF).

2. BOLBITIS

Schott, Gen. Fil., pl. 14. 1835; Holttum, Revis. Fl. Malaya 2: 461. 1960; Tagawa & K. Iwats., Fl. Thailand 3(3): 318. 1988.

Plants small to medium-sized. *Rhizome* creeping or shortly erect, usually on rocks, covered with ovate to linear-lanceolate, brown or blackish scales. *Fronde* dimorphic, simple, pinnate, or rarely bipinnate. *Sterile fronds*: stipe with ovate or lanceolate brown scales at base; lamina mostly herbaceous, usually with a bulbil at apex, margin entire or crenate to deeply lobed, with or without teeth or spines, veins free or anastomosing, with or without included veinlets. *Fertile fronds* similar in shape to sterile ones, but usually with narrower lamina and longer stipe. *Sori* acrostichoid, without indusia. *Spores* globose.

Key to the species

- 1a. Veins free.....**1. B. sinensis**
 1b. Veins anastomosing.....**2. B. virens**

1. *Bolbitis sinensis* (Baker) K. Iwats., Acta Phytotax. Geobot. 18: 49. 1959; Tagawa & K. Iwats., Fl. Thailand 3(3): 318. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 184. 2000. **Figure 5. 12: G-H.**

Rhizome short creeping; scales greyish-brown, hardly clathrate, narrowly subtriangular with long acuminate apex, entire, 1–3 by about 1 mm. *Sterile frond*: stipe 13–20 cm long, scaly at base, scales with brown, appressed, membranous, small, broadly oblong scales; lamina narrowly subtriangular, up to 59 cm or more long, 14.5–22 cm broad, the apex attenuately long-tailed, often viviparous at apex; rachis sparsely

scaly, winged in upper portion; lateral pinnae up to 37 or more pairs, with spines at sinus on upper surface, basal pinnae the longest, stalked, middle pinnae patent, lanceolate, shortly stalked, upper ones ascending, oblong, acute or rounded at apex, less lobed, adnate at base to form indistinct apical pinna; lobes oblique, rounded at apex, up to 7 mm broad, close to each other; main veins raised beneath, sparsely minutely scaly, veinlets all free, simple or forked; herbaceous to papyraceous, deep green, dark brown when dried. *Fertile frond* as same height as or lower than the sterile one; stipe 23–27.4 cm long; lamina narrower, 22.2–23 by 5–7 cm; lower lateral pinnae oblong, 0.5–4.5 by 0.1–0.9 cm gradually narrowing from base to apex, subtruncate or rounded at distinctly stalked base, rounded to moderately acute at apex, subentire or very slightly waved at margin, terminal pinna narrowly subtriangular with lobed base; veins all free, simple or pinnate, the apex ending inside the distinct cartilaginous margin; sporangia dispersed on the undersurface, naked.

Thailand. – Chiang Mai (Doi Chiang Dao, Doi Suthep, Doi Chang, Pango, Doi Inthanon), Chiang Rai (Doi Tung, Doi Pacho), Nan, Lamphun (Doi Khun Tan), Lampang, Phitsanulok (Phu Miang); NORTH-EASTERN: Phetchabun, Loei (Phu Luang, Phu Kradueng); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao).

Distribution. – North India, Myanmar, South West China and Vietnam.

Ecology. – Lithophyte on muddy rocks in lower-montane forest at 916–1,098 m alt.

Specimen examined. – P. Jadprajong 187, 215 (BKF).

2. *Bolbitis virens* (Wall. ex Hook. & Grev.) Schott, Gen. Fil., pl. 13. 1834; Holttum, Revis. Fl. Malaya 2: 468. 1960; Tagawa & K. Iwats., Fl. Thailand 3: 314. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 185. 2000. **Figure 5. 13: A-B.**

Rhizome 2–5 cm, 0.8–1.5 cm in diameters, densely scaly; scales brownish, narrowly lanceolate, 4–5.5 by 0.5–1 mm, subclathrate. *Sterile fronds* pinnate, 40–110

cm; stipe 9–28 cm, 2–3 mm in diameters near base; lamina 15–37 by 17–38 cm, widest at or below middle, herbaceous to leathery, terminal segment 6–19.8 cm, subarticulate or joined to rachis, sometime prolonged, bulbil subterminal on terminal segment or pinnae; rachis not winged; pinnae 4–6 pairs, 7–19 by 1.8–3.5 cm, subopposite or alternate, 1–3 cm apart, base symmetrical, sometimes broadly attenuate or cuneate, margin entire or serrate usually at upper portion, apex acuminate, lowermost 2 pinnae 1–3 mm stalked; costa minutely scaly beneath, veins slightly raised on lower surface, reticulate with a few included veinlets in each areole. *Fertile fronds* 45–60 cm; stipe 26–36.5 cm; lamina 19–22 by cm, terminal segment 7–12 cm by 0.4–0.7 mm; pinnae 4–5 pairs, 1–3 cm apart, 4–8 by 0.3–0.5 cm, lowermost 2 pinnae 1–4 mm stalked. *Sporangia* inserted throughout abaxial surface.

Thailand. – NORTHERN: Chiang Mai (Doi Chiang Dao, Doi Suthep), Lamphun (Doi Khun Tan), Phrae (Mae Sai), Tak (Huai Krasa); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng); SOUTH-WESTERN: Kanchanaburi (Khao Yai, Sai Yok), Phetchaburi; SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); PENINSULAR: Surat Thani (Khao Hua Khwai).

Distribution. – China (Yunnan), Bangladesh, Myanmar, Thailand

Ecology. – Lithophyte on muddy rocks near streams in dense lower-montane forest at 1,098–1,103 m alt.

Specimen examined. – P. Jadprajong 192, 220 (BKF).

3. DRYOPTERIS

Adans., *Fam. Pl.* 2: 20. 1763; Tagawa & K. Iwats., *Fl. Thailand* 3(3): 345. 1988; L. B. Zhang, S. G. Wu, J. Y. Xiang, F. W. Xing, H. He, F. G. Wang, S. G. Lu, S. Y. Dong,

D. S. Barrington, K. Iwats., M. J. M. Christenhusz, J. T. Mickel, M. Kato & M. G. Gilbert., Fl. China 2–3: 571. 2013.

Plants terrestrial, rarely on rock. *Rhizomes* short-creeping to erect, no stolons present. *Leaves* monomorphic. *Stipes* about 1/4–2/3 blade length, bases swollen or not. *Lamina* 1–3-pinnate-pinnatifid, deltate-ovate to lanceolate, gradually reduced to pinnatifid apex, herbaceous to leathery; pinnae not articulate to rachis, segment margins entire, crenate, or serrate; proximal pinnae reduced, same size as or larger relative to more distal pinnae, sessile to stalks; costae adaxially grooved; indument linear to ovate scales sometimes with glands, or blades glabrous adaxially. Veins free, forked. *Sori* round, arranged in one row between margin and midrib; indusia round-reniform, attached at sinus.

Key to the species

- 1a. Articulated hairs present on the upper surface of veins and axes of frond
 **2. *D. pseudocaenopteris***
- 1b. No articulated hairs present on axes of frond..... **2.**
- 2a. Sori exindusiate..... **1. *D. polita***
- 2b. Sori indusiate..... **3.**
- 3a. Sori about 0.5 mm in diameter; scale ovate, dull brown..... **3. *D. rheophila***
- 3b. Sori about 1–1.5 mm in diameter; scale lanceolate to ovate-lanceolate,
 brown **4. *D. sparsa***

1. *Dryopteris polita* Rosenst., Repert. Spec. Nov. Regni Veg. 13: 218. 1914; Tagawa & K. Iwats., Fl. Thailand 3(3): 353. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 204. 2000. **Figure 5. 13: C-D.**

Rhizomes short, ascending or suberect; scales linear-lanceolate, light brown, entire, 10–19 by 1–2 mm. *Stipes* stramineous, brown and scaly at base, more sparsely and smaller scaly upwards, up to 20–35 cm. long, grooved on adaxial side, slightly polished. *Laminae* oblong-ovate with acuminate apex, bipinnate, 25.5–32 cm long, 21–26 cm wide; lateral pinnae 5–8 pairs slightly smaller upwards, with stalks up to 1.8 cm long, oblong-subtriangular to narrowly subtriangular with acuminate apex, unequally broadly cuneate at base, or with a slightly enlarged basal basisopic pinnule, 9–12 by 3–5 cm; upper pinnae shortened, with very shortly stalked, sessile or adnate at base, oblong-subdeltoid with acute apex, shallowly lobed to serrate at margin; pinnules oblong, rounded at apex, base round or cuneate, up to 3 cm long, 0.6–1 cm wide, serrate at margin; papyraceous, deep green. *Sori* medial, dorsal on veinlets, exindusiate.

Thailand. – NORTHERN: Chiang Mai (Doi Chiang Dao), Tak (Doi Musoe); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi; PENINSULAR: Ranong (Kapoe), Nakhon Si Thammarat (Khao Luang).

Distribution. – Indochina, West Malaysia, Sumatra, Borneo, Taiwan, and northwards to southern edge of Japan.

Ecology. – Terrestrial on moist ground under opening area in lower-montane forest 1,230–1,251 m alt.

Specimens examined. – P. Jadprajong 49 (BKF); K. Yoda 465 (BKF), E. Hennipman 3093 (BKF), T. Smitinand 5913 (BKF)

2. *Dryopteris pseudocaenopteris* (Kunze) Li Bing Zhang, *Taxon* 61: 1209. 2012. — *Diacalpe aspidioides* Blume, *Enum. Pl. Javae* 2: 241. 1828; Tagawa & K. Iwats., *Fl. Thailand* 3(3): 330. 1988; Boonkerd & Pollawatn, *Pterid. Thailand*: 202. 2000. **Figure 5. 13: E-F.**

Rhizome short, ascending, covered with scales; scales linear-subtriangular, up to 6 by 1–2 mm, entire, glabrous, brown. *Stipes* stramineous to brown, with deep brown on abaxial surface, polished, 20–30 cm long, scaly throughout. *Laminae* tripinnate to quadripinnate, oblong-subdeltoid, as long as stipe; rachis with minutely scaly throughout; pinnae more than 10 pairs, largest at base, 16–20 by 12–15 cm, asymmetrically subtriangular, oblong-subtriangular, apex caudately acute, base broadly cuneate, 10–15 by 4–6 cm; pinnules oblong-subdeltoid, apex acute, unequally broadly caudate at sessile base, 2–4 by 0.8–1.4 cm; segments oblong, oblique, sessile, subentire or pinnate in larger ones, apex rounded, base narrowly cuneate; pinnae papery, green to deep green, veins with sparsely articulated hairs. *Sori* dorsal on veinlets, round; indusia glabrous, about 0.5–1 mm in diameters

Thailand. – NORTHERN: Mae Hong Son, Chiang Mai (Doi Inthanon, Doi Pha Ti Do); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng); SOUTH-WESTERN: Prachuap Khiri Khan; CENTRAL: Nakhon Nayok; SOUTH-EASTERN: Chanthaburi; PENINSULAR: Chumphon, Ranong, Krabi, Nakhon Si Thammarat.

Distribution. – Sri Lanka, North India, South China, Indochina and throughout Malesia.

Ecology. – Terrestrial on humus-rich ground of dense forests at

Specimen examined. – P. Jadprajong 7, 21, 58 (BKF).

3. *Dryopteris rheophila* Mitsuta ex Darnaedi, M. Kato & K. Iwats., J. Jap. Bot. 64(10): 302. 1989; Tagawa & K. Iwats., Fl. Thailand 3(4): 620. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 205. 2000. **Figure 5. 13: G-H.**

Rhizome erect, with large persistent scales, dull brown, ovate, up to 5 by 1–3 mm. *Fronde* monomorphic. *Stipes* 8–14 cm long, stramineous, brown at base; laminae ovate-lanceolate to narrowly deltoid-ovate, bipinnate to tripinnatifid, 11–18 by 9–12 cm; pinnae inserted at angles less than 50° to rachis, subopposite, middle pinnae oblong,

broadest at base and gradually acute towards apex, 3–7 by 2–3 cm; pinnules oblong, base unequally cuneate, apex obtuse, margin shallowly lobed, each lobe with a short sharp tooth; veins pinnate. *Sori* medial on acroscopic veinlets, distributed throughout lamina, about 0.5 mm in diameter.

Thailand. – NORTH-EASTERN: Loei (Phu Kradueng).

Distribution. – Endemic to Thailand.

Ecology. – On sandstone boulders in streamlet in evergreen forest at about 1,098- 1,200 m alt.

Specimen examined. – P. Jadprajong 165, 186 (BKF).

4. *Dryopteris sparsa* (D. Don) Kuntze, Revis. Gen. Pl. 2: 813. 1891; Tagawa & K. Iwats., Fl. Thailand 3(3): 352. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 159, 205. 2000. **Figure 5. 14: A-B.**

Plants 30–50 cm tall. *Rhizome* short, erect or ascending, rhizome and stipe base with many lanceolate, entire, brown scales. *Fronde*s tufted. *Stipe* pale castaneous-brown or dark stramineous, 10–20 cm, scales absent from top of stipe and rachis. *Lamina* ovate-oblong or deltoid-ovate, 17–35 by 10–30 cm, bipinnate to tripinnate, not narrowed to base, apex long acuminate; pinnae 5–9 pairs, opposite or subopposite, shortly stalked, basal pair largest, deltoid-lanceolate, slightly falcate, 8–10 by 1–2 cm, apex caudate-acuminate; pinnules 7–10 pairs, alternate, lanceolate or ovate-lanceolate, base broadly cuneate, basal pair with basispic pinnule longer than others, 1–2.5 cm, 1 cm wide at base; segments oblong, apex obtuse and with several acute teeth. *Sori* on middle of veinlets; indusia orbicular-reniform, entire, about 1–1.5 mm in diameter.

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

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

Distribution. – Bhutan, India, China, Indochina, Myanmar, Nepal, Thailand, Vietnam, Taiwan and north to Japan.

Ecology. – Terrestrial on mountain slopes in dense forests and in light shade by streams at 1,098–1,209 m alt.

Specimen examined. – P. Jadprajong 18, 41 (BKF); Winit 1184 (BKF), E. Hennipman 3669 (BKF), D. J. Middleton, P. Karaket, S. Lindsay, T. Phutthai and S. Suddee 5082, 5156, 5169 (BKF).

3. ELAPHOGLOSSUM

Schott ex J. Sm., J. Bot. (Hooker) 4: 148. 1841; Tagawa & K. Iwats., Fl. Thailand 3(3): 303. 1988.

Plants small to medium-sized, epiphyte or epilithic, rarely terrestrial. *Rhizome* shortly to long creeping, bearing roots at ventral and fronds in dorsal rows, scales linear, ovate-oblong to ovate, pale to brown, margins bearing teeth or hairs. *Fronde* dimorphic, tufted or rarely remote, scaly or glabrous. *Stipes* usually terete. *Sterile lamina* simple, entire, mostly thick and leathery; veins free, simple or forked and parallel almost to margin, sometimes connected by an intramarginal vein at apex. *Fertile lamina* longer or shorter, with longer stipe. *Sporangia* acrostichoid, entirely covering abaxial surface of lamina, exindusiate, not distinctly paraphyses, annulus longitudinal, interrupted.

Key to the species

1a. Lamina surfaces densely covered with stellate scales..... **2. E. stelligerum**

1b. Lamina surfaces subglabrous or covered with scales, without stellate scales..... **2.**

2a. Sterile frond less than 1 cm broad; scales ovate..... **1. E. dumrongii**

2b. Sterile frond more than 1.5 cm broad; scales linear..... **3. E. subellipticum**

1. Elaphoglossum dumrongii Tagawa & K. Iwats., Acta Phytotax. Geobot. 23: 112; 1968; Tagawa & K. Iwats., Fl. Thailand 3(3): 309. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 150, 151, 185. 2000. **Figure 5. 14: C-D.**

Rhizome creeping, 4–5 mm in diameters, densely covered with scales; scales appressed, ovate, hairy at margin, membranous, light brown, 3–5 by 1 mm. *Sterile frond*; stipe stramineous to castaneous, winged on upper part, scales densely at base, sparsely and more patent upwards, 3–7 cm long; lamina linear-lanceolate, apex acute to acuminate, long attenuate at base, 7–22 by 0.6–1.3 cm, frequently involute at margin, midrib raised on both surfaces with very sparsely stellate scales on abaxial side; veins hardly visible on both surfaces, the apex ending inside the cartilaginous margin; coriaceous, pale green in living plants, pale-green to brown when dried, glabrous on upper surface but with small scaly underneath with irregular brown to dark brown appressed scales. *Fertile frond*; stipe 3.7–10 cm long; lamina similar to sterile fronds in shape, 14–35 by 0.4–1 cm. *Sporangia* acrostichoid, exindusiate, lacking paraphyses.

Thailand. – NORTH-EASTERN: Loei (Phu Kradueng).

Distribution. – Endemic to Thailand.

Ecology. – Lithophyte on mossy rocks or moist cliffs by streams in stream-beds in dense evergreen forests at about 1183–1238 m alt.

Specimen examined. – P. Jadprajong 25, 34, 131, 227 (BKF).

2. Elaphoglossum stelligerum (Wall. ex Baker in Hook. & Baker) T. Moore ex Alston & Bonner, Candollea 15: 216. 1956; Tagawa & K. Iwats., Fl. Thailand 3(3):

304. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 186. 2000. — *Elaphoglossum yunnanense* (Baker) C. Chr., Contr. U.S. Natl. Herb. 26: 327, 335. 1931. **Figure 5. 14: E-F.**

Rhizome short creeping, densely scaly throughout; scales light brown, linear, teeth at margin, up to 1 by 0.1 cm. *Fronde* simple. *Sterile fronds* larger than the fertile frond, scales light brown, subentire to teeth at margin; stipe stramineous, 10–21 cm in length, 2–3 mm wide, densely scaly at base, sparsely on the upper part; scales light brown, various, like those on rhizome, hair-like or stellate; lamina linear-lanceolate, sometime falcate, gradually narrowing towards both apex and base, acute at apex, decurrent at base, 26–56 by 1.7–3.5 cm; midrib raised on both surface, stramineous, densely covered with stellate scales; veins simple parallel, a few times forked, the apex ending at margin of frond, hardly visible on both surfaces, often glabrous on upper surface of lamina; papyraceous, green, densely covered with brown long-armed stellate scales on both surfaces. *Fertile frond* smaller than the sterile fronds but longer stipe, stipe 18–36 cm long, stramineous; lamina linear, acute at apex, 20.5–38 by 0.6–1.2 cm, densely covered with stellate scales on upper surface. *Sporangia* acrostichoid, exindusiate, lacking paraphyses.

Thailand. – NORTHERN: Chiang Mai (Doi Phahom Pok, Doi Chiang Dao, Doi Suthep, Doi Inthanon), Phitsanulok; NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng).

Distribution. – North India (type), Southwest. China, Laos (Champasak) and Central Vietnam.

Ecology. – Lithophyte on mossy rocks in stream beds or along the stream, in lower-montane forest at 1199–1238 m.

Specimen examined. – P. Jadprajong 33, 98, 99, 135, 138, 265 (BKF).

3. Elaphoglossum subellipticum Rosenst., Hedwigia 56: 348. 1915; Tagawa & K. Iwats., Fl. Thailand 3(3): 306. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 187. 2000. **Figure 5. 14: G-H.**

Rhizome short, densely scaly throughout; scales brown, shining, linear, up to 1 by 0.1 cm, with irregular projections at margin. *Fronde* simple. *Sterile fronds* two size, smaller and larger than the fertile frond; stipe 9–28 cm long, 2–3 mm wide, stramineous or sometime brown at portion, densely scaly at base, sparsely on the upper part with narrow dark scales; lamina elliptic, gradually narrowing towards both apex and base, acute at apex, decurrent to very narrow wings at base, 10–30 by 2.5–7 cm, midrib raised on lower surface and grooved above, stramineous; veins forked, distinct on both surfaces, the apex ending inside the cartilaginous margin; coriaceous, green, a few scales on lower surface. *Fertile frond* medium in sizes, between the sizes of larger and smaller sterile fronds; stipe about 14 cm long, winged at uppermost part; lamina elliptic-oblong, broadest at middle, acute at apex, gradually narrowing base, up to 15.5–20 by 2–3 cm. *Sporangia* acrostichoid, exindusiate, lacking paraphyses.

Thailand. – NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng).

Distribution. – Taiwan and Sumatra.

Ecology. – Lithophyte on mossy rocks in dense evergreen forests at 1,226–1,236 m alt.

Specimen examined. – P. Jadprajong 61, 141, 132, 266 (BKF).

EQUISETACEAE

Michx. ex DC., Essai Propr. Méd. Pl. 49. 1804; Tagawa & K. Iwats., Fl. Thailand 3(1): 34. 1979; L. B. Zhang, & N. J. Turland, Fl. China 2–3: 67. 2013.

Plants perennial, homosporous, small to large, terrestrial or in shallow streams. *Rhizome* usually creeping, occasionally erect or ascending, blackish brown, branched,

nodes with roots densely covered with trichomes or glabrous. *Aerial stems* monomorphic or dimorphic, annual or perennial, erect, green but often blackish brown on lower part, with nodes, hollow and with longitudinal canals in the center, unbranched or branches, internodes with longitudinal ridges and grooves. *Leaves* reduced, scalelike, whorled, lower part fused to form a collarlike-sheath around base of internode, upper part lobed. *Strobili* conelike, terminal on stem or branches, terete or ellipsoid, sometimes stalked; sporophylls whorled, peltate, hexagonal in surface view, imbricate. *Sporangia* saclike, in whorls on the abaxial of sporophylls. *Spores* subglobose or globose, green.

EQUISETUM

L., Sp. Pl. 2: 1061. 1753; Tagawa & K. Iwats., Fl. Thailand 3(1): 34. 1979; L. B. Zhang, & N. J. Turland, Fl. China 2–3: 67. 2013.

Plant monomorphic. *Stems* with nodes and internodes, with ridges and grooves. *Rhizome* usually creeping, blackish brown, branched, nodes with roots densely covered with trichomes or glabrous. *Aerial stems* usually monomorphic, erect, green but often blackish brown on lower part, with nodes, hollow and with longitudinal canals in the center, unbranched or branches. *Leaves* reduced, scalelike, whorled, lower part fused to form a collarlike-sheath around base of internode, upper part lobed. *Strobili* solitary, terminal on stem or branches, conelike, terete or ellipsoid; sporangiophores whorled, peltate, hexagonal, peltate, bearing sporangia. *Sporangia* saclike, in whorls on the abaxial of sporophylls.

Equisetum ramosissimum Desf., Fl. Atlant. 2: 398–399. 1799; L. B. Zhang, & N. J. Turland, Fl. China 2–3: 70. 2013.

subsp. ***debile*** (Roxb. ex Vaucher) Hauke, Amer. Fern J. 52: 33. 1962; L. B. Zhang, & N. J. Turland, Fl. China 2–3: 70. 2013. — *Equisetum debile* Roxb. ex Vaucher, Mém.

Soc. Phys. Genève 1: 387. 1822; Tagawa & K. Iwats., Fl. Thailand 3(1): 34. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 21, 61. 2000. **Figure 5. 15: G-H.**

Stems with longitudinal ridges and grooves, the nodes bearing whorls leaves, branches and roots; main stems with 7–11 grooves, up to 3 mm in diameter, bearing up to 2 branches at the nodes. Stems and branches sheath similar, 3–5 mm long, with the teeth 1–2 mm in length, green or brown in the upper portion, darker at base, stramineous when dry; teeth pale to brown, caducous. *Cones* solitary at the terminal of stems or branches, 0.5–0.8 cm long, oblong, cuspidate at apex, sessile. *Fronde*s monomorphic, up to 50 cm tall. *Sporangiophores* hexagonal, about 1 mm in diameters, peltate, bearing several sporangia. *Spores* homosporous, assorted with the elaters.

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

Distribution. – India to South China, Indochina and Taiwan, through Malaysia to Polynesia.

Ecology. – Terrestrial on wet sandy soil along streams in open areas or in light shade at 447 m alt.

Specimen examined. – P. Jadprajong 296 (BKF); T. Wongprasert 997-92, T. Smitinand 2760 (BKF), C. F. van Beusekom, C. Phengkhai R. Geesink and B. Wongwan 4071 (BKF).

GLEICHENIACEAE

C. Presl, Reliq. Haenk. 1: 70. 1825; Holtt., Fl. Males. Ser. 2 Pterid. 1: 1. 1959; Takawa & K. Iwats., Fl. Thailand 3(1): 50. 1979.

Rhizomes long creeping, with scales or multicellular hairs. *Fronde* monomorphic, evergreen, erect, or climbing, vernation circinate. *Stipe* distant, not articulate, cylindrical, forked at apex, with dormant bud; apical bud covered with hairs or scales, rachis simple to several times pinnate, with stellate hairs and sometime with ciliate scales when young, these persistent or glabrescent. *Lamina* paperaceous to thinly leathery, frequently glaucous abaxially, pinnules deeply pinnatisect, lobes elliptic or lanceolate, apex obtuse or acute; veins free, forked. *Sori* orbicular, in a single row on both sides of lobe costules, exindusiate, sporangia up to 10, sessile.

Key to the genera

- 1a. veins twice forked or more, scales absent, hairs branching.....**1. Dicranopteris**
 1b. veins simple or once forked, scales and stellate hairs present....**2. Diplopterygium**

1. DICRANOPTERIS

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

Rhizomes long creeping, slender, covered with multicellular hairs. *Fronde* pinnate, rachis often dichotomously branched, each branch usually with a pair of lateral pinnae, dormant apical buds covered with stiff hairs, ultimate pinnae deeply pectinately pinnatifid, lanceolate or broadly lanceolate, most veins 2- or 3-forked. *Sori* orbicular, exindusiate, sporangia 6–18 or more in a sorus.

Key to the species

- 1a. Accessory branches not present at ultimate fork, lower surface with stellate hairs**1. D. linearis var. linearis**
 1b. Accessory branches always present at ultimate fork, lower surface without hairs**2. D. linearis var. tetraphylla**

Dicranopteris linearis (Burm.f.) Underw., Bull. Torrey Bot. Club 34: 249. 1907; Tagawa & K. Iwats., Fl. Thailand 3(1): 55. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 32, 33, 78. 2000.

var. **linearis**, **Figure 5. 15: A-B.**

Rhizome widely creeping, hairy. *Fronde*s not dimorphic. Stipe up to 1 meters tall. Primary rachis-branches usually 2 or 3 forked, the two branches equal or nearly equal at each fork, ultimate branches 15–24 cm long, 4–7 cm wide, accessory branches not present at ultimate fork, ultimate segments linear, entire, round at apex, up to 4 mm broad; texture leathery, lower surface glabrous, slightly glaucous or not; veins more or less prominent on lower surface and hairy. *Sori* exindusiate, one row at each side of costule, 6–8 sporangia.

Thailand. – NORTHERN: Chiang Mai, Chiang Rai, Lamphun, Lampang; NORTH-EASTERN: Loei; SOUTH-WESTERN: Prachuap Khiri Khan; SOUTH-EASTERN: Prachinburi, Chanthaburi, Trat; PENINSULAR: Chumphon, Ranong, Surat Thani, Phuket, Nakhon Si Thammarat, Trang, Yala.

Distribution. – Tropical and subtropical regions in the Old World, north to Central Japan.

Ecology. – Terrestrial in clearings usually at edge of forest in open or half-shaded places at 1,000–1,300 m alt.

Specimen examined. – P. Jadprajong 175, 261 (BKF); A. Sathaoattayanon 20 (BCU); P. Ratchata 55 (BCU); T. Boonkerd 1171 (BCU); Y. Yuyen 185 (BCU); C. Phengkklai *et al.* 6751, 12986, 13758 (BKF)

var. **tetraphylla** (Rosenst.) Nakai, Bull. Natl. Sci. Mus., Tokyo 29: 67. 1950; Tagawa & K. Iwats., Fl. Thailand 3(1): 56. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 79. 2000. **Figure 5. 15: C-D.**

Similar to *Dicranopteris linearis* var. *linearis* but differ in accessory branches always present at bases of ultimate forks, ultimate branches commonly 2 or 3 times as long as broad, 16–25 cm long by 5–7 cm wide, accessory branches 6–13 cm long by 3–4 cm wide.

Thailand. – NORTH-EASTERN: Loei (Phu Kradueng).

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

Ecology. – Terrestrial on rather dry open area or dry slope in slightly shaded at edge of forest at 1100–1200 m alt.

Specimen examined. – P. Jadprajong 262 (BKF).

2. DIPLOPTERYGIUM

(Diels) Nakai, Bull. Natl. Sci. Mus., Tokyo. 29: 47. 1950. — *Gleichenia* sect. *Diplopterygium* Diels, Nat. Pflanzenfam. 1(4): 353, f. 188A. 1900.

Rhizome long creeping, branched, covered with scales; scales lanceolate, brown, margin entire or ciliate. *Stipe and rachis* with lanceolate scales and stellate hairs, these glabrescent or persistent, apical bud with dense brown scales, *Lamina* 2(or 3)-pinnatifid, ultimate pinnules many, deeply pectinately pinnatifid to costa, lanceolate in outline, sessile or shortly stalked at base, acuminate at apex; veins once forked, spreading to lobe margins. *Sori* in single lines on either side of costule.

Diplopterygium blotianum (C. Chr.) Nakai, Bull. Natl. Sci. Mus., Tokyo. 29: 49. 1950. — *Gleichenia blotiana* C. Chr., Bull. Mus. Natl. Hist. Nat., Ser. 2, 6: 103. 1934; Tagawa & K. Iwats., Fl. Thailand 3(1): 52. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 80. 2000. **Figure 5. 15: E-F.**

Plants about 2 meters or more tall. *Rhizome* long creeping, covered with scales, brown, lanceolate, margin entire or ciliate. *Fronde* bipinnate; pinna rachises stramineous, about 3 mm wide, pinnae bipinnatifid, up to 120 or more long by 17–26 cm; pinnules many, alternate, deeply pinnatifid, lanceolate to narrowly lanceolate, 12–25 by 2–3 cm, acuminate at apex, attenuate at base and with 2–3 mm of stipe, lobes linear-lanceolate to broadly lanceolate, emarginate at apex; thick paperaceous, glabrous on adaxial, costae, costules, and veins abaxially with sparse brown stellate hairs, costae flat adaxially; veins prominent on both surfaces. *Sori* brown, with 4 or 5 sporangia.

Thailand. – NORTH-EASTERN: Loei (Phu Kradueng); PENINSULAR: Nakhon Si Thammarat (Khao Nan).

Distribution. – China, Central Taiwan, Cambodia, Laos, Vietnam to Peninsular Malaysia.

Ecology. – Terrestrial on moist ground along streams with light shaded in dense evergreen forest at 1,199 m alt.

Specimen examined. – P. Jadprajong 142, 263 (BKF); P. Nopsiriwong 72 (BCU); S. Boonsin 7, 9, 17 (BCU); M. Tagawa, K. Iwats. & N. Fukuoka 584 (BKF)

จุฬาลงกรณ์มหาวิทยาลัย
CHULALONGKORN UNIVERSITY

HYMENOPHYLLACEAE

Mart., Consp. Regn. Veg. 3. 1835; Holtt., Revis. Fl. Malaya 2: 72. 1954; Tagawa & K. Iwats., Fl. Thailand 3(1): 68. 1979; J. X. Liu, Q. Y. Zhang, A. Ebihara & K. Iwats., Fl. China 2–3: 93. 2013.

Plants epiphytic, petrophilous, or terrestrial, small to medium-sized. *Rhizome* sometimes short and erect, but usually slender and long creeping, often covered with hairs when young, simple or sometimes irregularly branching. *Lamina* simple to pinnately decompose, or flabellate, digitate, dichotomous, or even irregularly divided, segments with a single veinlet. *Sori* terminal on veins, solitary, at apex of ultimate

segments, or marginal on simple to pinnatifid fronds; involucre cup-shaped to deeply 2-cleft nearly to base; receptacles terminating a vein, short, capitate or clavate, or long and projecting; sporangia shortly stalked to sessile, maturing basipetally; annulus oblique, not interrupted; dehiscence irregular; spores globose-trilete, tetrahedral,

Key to the genera

1a. Rhizomes covered with sparse light-colored hairs or subglabrous; involucre usually bivalvate.....**1. Hymenophyllum**

1b. Rhizomes covered with reddish to dark-colored hairs; involucre usually not bivalvate.....**2. Vandemboschia**

1. HYMENOPHYLLUM

Sm., Mém. Acad. Roy. Sci. (Turin) 5. 418, t. 9(8). 1793; Tagawa & K. Iwats., Fl. Thailand 3(1): 74. 1979; J. X. Liu, Q. Y. Zhang, A. Ebihara & K. Iwats., Fl. China 2–3: 93. 2013.

Plants small, epiphyte or lithophyte. *Rhizome* long creeping, or short and erect, slender, filiform. *Fronds* small to medium-sized. *Lamina* pinnately decompose, margin entire or toothed; rachis and lamina covered with brown hairs to glabrous. Involucre bivalvate, deeply cleft nearly halfway to the base, or tubular with bivalvate mouth, apex entire or serrate; receptacles included or projecting.

Key to the species

1a. Lamina hairy or with scales..... **1. H. exsertum**

1b. Lamina glabrous..... **2. H. polyanthos**

1. *Hymenophyllum exsertum* Wall. ex Hook., Sp. Fil. 1: 109. 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., Fl. Thailand 3(1): 73. 1979; J. X. Liu, Q. Y. Zhang, A. Ebihara & K. Iwats., Fl. China 2–3: 102. 2013. **Figure 5. 16: A-B.**

Rhizome wiry, brown, with sparse light brownish short hairs or subglabrous. *Stipes* remote, 1–2 cm apart, brown, filiform, 1–4 cm long, sparsely hairy or subglabrous, not or sometimes winged on the upper part. *Lamina* bipinnate to tripinnatifid, oblong or ovate, round to acute at apex, 3–8 by 1.5–3 cm, membranous and not transparent; pinnae sessile, spreading, ovate to oblong or triangular-ovate, 0.3–1.8 by 0.5–1.5 cm, apex obtuse, base decurrent; rachis winged throughout or narrowly winged at apex, hairy; ultimate segments simple or forked, narrow, linear-oblong, 1–2 by 0.8–1 mm, margin entire or serrate, undulate apex round to obtuse; veins dichotomous, slightly raised, dark brown, short hairs on each surface. *Sori* on upper parts of frond; involucre circular to oval, 1–1.5 mm, often with teeth at apex; receptacles slender, included.

Thailand. – PENINSULAR: Krabi (Phanom Bencha), Ranong (Khao Phota Chongdong), Surat Thani (Khao Nong), Phangnga (Khao Katha Khwam, Khao Bangto), Nakhon Si Thammarat (Khao Luang), Trang (Khao Sung), Yala (Khao Kalakhiri).

Distribution. – China, Bhutan, Cambodia, India, Laos, Malaysia, Thailand, Vietnam.

Ecology. – Epiphyte on mossy tree trunks in dense tropical evergreen forest,

Specimen examined. – P. Jadprajong 15, 226 (BKF).

2. *Hymenophyllum polyanthos* (Sw.) Sw., J. Bot. (Schrader) 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., Fl. Thailand 3(1): 70. 1979; J. X. Liu, Q. Y. Zhang, A. Ebihara & K. Iwats., Fl. China 2–3: 103. 2013. **Figure 5. 16: C-D.**

Rhizome slender, less than 0.2 mm diameter with hairy rootlets. *Stipes* 1–3 cm long, wingless except the uppermost part, sparsely hairy in the younger parts, the rootlets densely with brown hairs, about 1 mm long. *Fronde*s very variable in size and form, 1- or 2-pinnate to tripinnatifid, lanceolate, oblong-lanceolate, oblong or subdeltoid, 3–8 by 1.5–4 cm, apex acute, acuminate or obtuse, base cuneate, cordate, or rounded, light green, membranous; rachis with very narrowly wings throughout, entire, flat; pinnae up to 10 pairs, the largest one in the middle of the frond, both upward and downward smaller in size, the larger ones oblong-subdeltoid or oblong lanceolate, sometime falcate; ultimate segments linear or narrowly lanceolate, apex round to obtuse, margin entire and flat, about 1 mm broad; veins dichotomous, obvious. *Sori* scattered on the upper portion of fronds; involucre about 1 mm long, usually longer than the wide, subdeltoid or rarely reniform, deeply divided; lips round or moderately acute, entire or slightly toothed; receptacles clavate, included.

Thailand. – NORTHERN: Chiang Mai (Doi Phahom Pok, Doi Chiang Dao, Doi Suthep, Doi Inthanon); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng, Phu Tong); CENTRAL: Nakhon Nayok (Khao Khieo); SOUTH-EASTERN: Chanthaburi (Khao Sabap), Trat (Khao Kuap); SOUTH-WESTERN: Kanchanaburi (Khao Ri Ya); PENINSULAR: Chumphon (Langsuan, Pang Wa), Surat Thani (Khao Nong, Ban Don), Nakhon Si Thammarat (Khao Luang).

Distribution. – Tropics or subtropics throughout the world, north to central Japan.

Ecology. – Epiphytic on tree trunks or on mossy rocks in light or deep shade, common at medium or higher altitudes

Specimen examined. – P. Jadprajong 56, 155, 184 (BKF).

2. VANDENBOSCHIA

Copel., Philipp. J. Sci. 67: 51. 1938. — *Trichomanes* L., Sp. Pl.: 1907. 1753; Tagawa & K. Iwats., Fl. Thailand 3(1): 82. 1979; J. X. Liu, Q. Y. Zhang, A. Ebihara & K. Iwats., Fl. China 2–3: 107. 2013.

Rhizome stout, long creeping, usually with brown multicellular hairs. *Lamina* pinnately compound, entire, not thickened at margin. *Sori* terminal on veinlets; involucre projecting from fronds, tubular to cup-shaped, entire at mouth; receptacles projecting, filiform.

Vandenboschia striata (D. Don) Ebihara, Fl. China 2–3: 109. 2013. — *Trichomanes birmanicum* Bedd., Suppl. Ferns S. Ind. 3, pl. 349. 1876; Tagawa & K. Iwats., Fl. Thailand 3(1): 84. 1979; J. X. Liu, Q. Y. Zhang, A. Ebihara & K. Iwats., Fl. China 2–3: 109. 2013. — *Crepidomanes birmanicum* (Bedd.) K. Iwats., J. Fac. Sci. Univ. Tokyo, Sect. 3, Bot. 13(5): 530. 1985; Tagawa & K. Iwats., Fl. Thailand 3(4): 613. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 69. 2000. **Figure 5. 16: E-F.**

Plants 7–16 cm tall. *Rhizome* deep smoke-colored, about 1 mm in diameters, densely covered with dark brown multicellular hairs. *Stipes* light brown, 1–3 cm apart, 4–9 cm by 1–2.5 mm, glabrous, broadly winged near base. *Fron*d tripinnate to quadripinnatifid. *Lamina* ovate to broadly lanceolate, 4–10 by 2–3.5 cm, membranous; pinnae oblong-ovate, 8–11 pairs, alternate, sessile, spreading, 0.8–2.5 by 0.3–1.5 cm, base unequally cuneate, apex obtuse; pinnules sessile, alternate, cuneate to obovate, 3–6 by 2.5–5 mm, base decurrent, apex obtuse, rachis and costae broadly winged throughout, glabrous; ultimate segments simple or forked, narrowly linear, 2–3 by 0.5–1 mm, apex rounded, margin entire. *Veins* dichotomous, dark green-brown, raised on each surface. *Sori* on upper parts of frond, apical on short acroscopic segments; involucre tubular, 1–1.5 mm, truncate; receptacles projecting, brown, filiform, about 2–3 mm, straight.

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

Distribution. – Myanmar, Laos, South China, North Indochina and Japan.

Ecology. – On wet muddy rocks near streams, slopes near streams,

Specimen examined. – P. Jadprajong 288 (BKF).

HYPODERMATIACEAE

Ching, Acta Phytotax. Sin. 13(1): 96. 1975; G. M. Zhang, F. W. Xing, F. G. Wang, K. Iwats. & H. P. Nootboom, Fl. China 2–3: 535. 2013.

Plants medium-sized. *Rhizomes* shortly creeping, ascending, or long creeping, stout, densely covered with scales and hairs or only scales; scales ovate-lanceolate or rarely linear-lanceolate. *Fronde*s approximate, subclustered, or remote. *Stipe* stramineous, base swollen and concealed in scales, or articulate to rhizome, glabrous. *Lamina* deltoid or ovate-oblong to pentagonal-ovate, 3-pinnate to finely 4-pinnate-pinnatifid, herbaceous or papery, both surfaces, rachises, and costules frequently covered with acicular and/or glandular hairs, rarely glabrous. Veins free, pinnate, branches simple or forked. *Sori* orbicular; indusia large, reniform, covered with acicular or glandular hairs, rarely glabrous.

HYPODEMATIUM

Kunze, Flora 16: 690. 1833; Tagawa & K. Iwats., Fl. Thailand 3(3): 436. 1988; G. M. Zhang, F. W. Xing, F. G. Wang, K. Iwats. & H. P. Nootboom, Fl. China 2–3: 535. 2013.

Plants mostly on rocks or walls, small to medium-sized or. *Rhizomes* short creeping or ascending, densely covered with scales; scales large, persistent, light brown, ovate-lanceolate or rarely linear-lanceolate, margin entire or seldom denticulate, apex acuminate. *Fronde*s approximate or subclustered. *Stipe* stramineous, base swollen and concealed in scales, upper portion usually glabrous, pubescent, or glandular. *Lamina* ovate-oblong to pentagonal-ovate, truncate at base, 3-pinnate to finely 4-pinnate-pinnatifid, basal pinnae largest, upper ones gradually reduced, herbaceous or papery, both surfaces, rachises, and costules frequently covered with hairs, rarely glabrous. Veins free, pinnate, ending at margin. *Sori* orbicular at middle of veinlets; indusia large, persistent, reniform or horseshoe-shaped, membranous.

Hypodematium glanduloso-pilosum (Tagawa) Ohwi, Bull. Nat. Sci. Mus. Tokyo 3: 98. 1956; Tagawa & K. Iwats., Fl. Thailand 3(3): 438. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 198. 2000; G. M. Zhang, F. W. Xing, F. G. Wang, K. Iwats. & H. P. Nootboom, Fl. China 2–3: 538. 2013. **Figure 5. 16: G-H.**

Rhizome short creeping, with close fronds, densely scaly, scales oblong-lanceolate, about 1.0–1.5 cm long, concolorous, brown, entire. *Stipes* 10–18 cm long. *Lamina* 14–25 by 10–20 cm, basal pinnae quadripinnatifid, rachis grooved, grooves open at junction of costa, pinnae subtriangular, gradually becoming smaller in upper ones, ultimate segments oblique, acute to moderately acute at apex; hairs with two kinds, sparsely glandular hairs and setose-hairs about 0.3–0.5 mm long; veins all free, pinnate, reaching the margin of lobes. *Sori* dorsal on veinlets, sometimes close to costules; indusia round-reniform or horseshoe-shaped.

Thailand. – NORTH-EASTERN: Loei (Phu Kradueng); SOUTH-WESTERN: Prachuap Khiri Khan (Sam Roi Yot); PENINSULAR: Ranong.

Distribution. – Japan, Korea and China

Ecology. – Terrestrial in open area at sandstones crevice in deciduous or mixed deciduous forests at about 400 m alt.

Specimen examined. – P. Jadprajong 108, 206, 299 (BKF).

LINDSAEACEAE

C. Presl ex M. R. Schomb., Reis. Br.-Guiana 3: 883, 1048. 1848; Tagawa & K. Iwats., Fl. Thailand 3(2): 129. 1985; S. Y. Dong, S. J. Lin, M. J. M. Christenhusz & J. Barcelona, Fl. China 2–3: 139. 2013.

Rhizomes creeping, sometimes scandent, protostelic or solenostelic, covered with narrow scales and/or hairs. *Fronde*s approximate or distant. *Stipe* not articulate to rhizome, with a single vascular bundle. *Lamina* 1–4-pinnate, rarely simple, herbaceous, papery, or thinly leathery, glabrous or with scattered very minute hairs, pinnae or pinnules symmetrical or dimidiate; veins free or anastomosing without included veinlets. *Sori* marginal or submarginal, linear or oblong; indusia adnate at base, laterally free or adnate, opening toward margin.

Key to the genera

- 1a. Frond 3-pinnate or more; veins 2–3 in each ultimate lobe, hardly distinct.....**2. Odontosoria**
- 1b. Frond pinnate to bipinnate; veins free or anastomosing.....**2.**
- 2a. Spores trilete, lamina 1- or 2-pinnate or pinnatifid.....**1. Lindsaea**
- 2b. Spores monolete, lamina once pinnate..... **3. Osmolindsaea**

1. LINDSAEA

Dryand. ex Sm., Mém. Acad. Roy. Sci. (Turin). 5: 413. 1793, S. Y. Dong, S. J. Lin, M. J. M. Christenhusz & J. Barcelona, Fl. China 2–3: 142. 2013.

Plants terrestrial, lithophyte or epiphyte. *Rhizomes* creeping, covered with scales or acicular hairs or both. *Fronde*s approximate or distant; stipe short, stramineous or castaneous, glabrous; lamina 1- or 2-pinnate or pinnatifid, gradually narrowed toward apex, rarely with a terminal pinna, herbaceous to papery; rachis widely sulcate, abaxially keeled; ultimate pinnules or segments usually dimidiate or flabellate; veins free or anastomosing in a few species. *Sori* marginal or submarginal, linear, terminal on 2 to many uniting veins, or rarely orbicular and terminal on a single vein; annulus consisting of 9–17 thickened cells; indusia linear or oblong, usually attached only at base. *Spores* trilete.

Key to the species

- 1a. Veins anastomosing; lamina 1-pinnate, terminal pinna similar to lateral ones
.....2. **L. ensifolia**
- 1b. Veins free; lamina 2- or 3-pinnate, pinnatifid and gradually reduced toward apex
.....2.
- 2a. lamina ovate, ovate-lanceolate or deltoid-ovate.....1. **L. chienii**
- 2b. lamina deltoid-lanceolate.....3. **L. javanensis**

1. *Lindsaea chienii* Ching, *Sinensia* 1: 4. 1929; Tagawa & K. Iwats., *Fl. Thailand* 3(2): 133. 1985; Boonkerd & Pollawatn, *Pterid. Thailand*: 91. 2000; S. Y. Dong, S. J. Lin, M. J. M. Christenhusz & J. Barcelona, *Fl. China* 2–3: 146. 2013. **Figure 5. 17: A-B.**

Rhizome creeping, about 2 mm in diameters; scales linear, about 2 mm long, 2 or 3 cells, broad at base, brown, more or less bright. *Stipes* castaneous to nearly black, quadrangular in cross section, up to 25 cm long. *Laminae* bipinnate, or rarely pinnate in small sterile fronds, subtriangular, 8–16 by 3–11.5 cm; lateral pinnae 1–5 pairs of pinnate pinnae, 9–15 pairs when including the simple pinnae, basal ones largest, shortly

stalked, linear, up to 10 by 2.5 cm; terminal pinnae large, up to 12 by 3 cm; pinnules of lateral pinnae oblong, inner and lower edges straight, or more or less dimidiate, meeting in cuneate base, outer and upper edges entire or lobed in larger ones, forming round apex, up to 1.5 cm by 4 mm, those of terminal pinnae oblong to subquadrangular, lower edges dimidiate curving, inner edge close or imbricate to rachis, upper edge more or less lobed, up to 1.8 by 0.8 cm, subcoriaceous; veins free except those united by sori, distinct on both surfaces. *Sori* marginal along outer and upper edges of pinnules, continuous in smaller ones, but usually interrupted.

Thailand. – NORTHERN: Chiang Mai (Doi Suthep); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng); PENINSULAR: Nakhon Si Thammarat (Khao Luang).

Distribution. – South China, Vietnam, Taiwan, northwards to South Japan.

Ecology. – Terrestrial on slope near streams in evergreen forest at 1,237 m alt.

Specimen examined. – P. Jadprajong 47 (BKF).

2. *Lindsaea ensifolia* Sw., J. Bot. (Schrader) 1800(2): 77. 1801; Tagawa & K. Iwats., Fl. Thailand 3(2): 131. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 92. 2000; S. Y. Dong, S. J. Lin, M. J. M. Christenhusz & J. Barcelona, Fl. China 2–3: 143. 2013. **Figure 5. 17: E-F.**

Rhizome creeping, 2–4 mm in diameters, bearing fronds close together or 1–2 cm apart, scaly at least apical part; scales linear, 1.5–2 mm by 0.3 mm, brown, slightly shining. *Stipes* stramineous or castaneous-brown at least at base, 20–34 cm long. *Laminae* simply pinnate ovate to oblong-lanceolate in outline, lateral pinnae 2–5 pairs, linear-lanceolate, caudately acuminate at apex, cuneate, round or subtruncate at base, very shortly stalked, entire at margin, 14–17 cm long, 0.8–1.5 cm broad, terminal pinnae like the lateral ones; veins anastomosing, forming areoles with 2–4 rows at each side of costa, distinct beneath. *Sori* continuous along margin; indusia firm, nearly reaching margin.

Thailand. – NORTHERN: Chiang Mai (Doi Chiang Dao, Doi Suthep, Buak Ha), Phitsanulok (Thung Salaeng Luang); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng), Nong Khai (Phon Phisai); EASTERN: Ubon Ratchathani; SOUTH-WESTERN: Kanchanaburi (Khao Ngi Yai), Phetchaburi; CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Rayong (Khao Chamao), Chanthaburi (Khao Sabap, Makham, Phriu), Trat (Ko Chang, Ko Kut, Tha San falls, Ban Saphan Hin); PENINSULAR: Ranong (Ko Chong Lat), Surat Thani (Ko Tao, Ban Don), Phangnga, Phuket (Ko Boi Noi), Krabi, Nakhon Si Thammarat (Tha Samet), Trang (Tahbum), Satun, Yala (Ban Malao, Ban Chana).

Distribution. – Old World tropics from West Africa to Australia and Polynesia, north to the Ryukyus.

Ecology. – Terrestrial on rather dry slopes or on sandy soil, usually in open areas or in light shade, at low to medium altitudes, about 1,100–1,200 m.

Specimen examined. – P. Jadprajong 324 (BKF); C. F. van Beusekom, C. Phengkhilai, R. Gesink & B. Wongwan 4607 (BKF); T. Shimizu, H. Toyokuni, H. Koyama, T. Yahara & C. Niyomdham T-23218 (BKF).

3. *Lindsaea javanensis* Blume, Enum. Pl. Javae: 219. 1828; Tagawa & K. Iwats., Fl. Thailand 3(2): 134. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 92. 2000; S. Y. Dong, S. J. Lin, M. J. M. Christenhusz & J. Barcelona, Fl. China 2–3: 143. 2013. **Figure 5. 17: C-D.**

Rhizomes shortly creeping, sparsely scaly; scales appressed or slightly spreading, lanceolate, castaneous, long uniseriate at apex. *Fronde*s approximate. *Stipe* castaneous, 13–28 cm, quadrangular. *Lamina* deltoid-lanceolate, pinnatifid, 15–18 by 12–16 cm, herbaceous to papery, 1-pinnate at apex and 2-pinnate at base, gradually reduced toward apex; pinnae 4–12 pairs, alternate, larger pinnae on middle and lower part lanceolate, upper smaller pinnae rhombic, narrowly triangular or oblong, unequal at base, basiscopically concave, apex acuminate, 1–3 basal pinnae 1-pinnate

with pinnules rhombic; veins free, usually twice forked, immersed but evident. *Sori* submarginal, terminal on 2 to many veins; indusia linear, continuous or interrupted.

Thailand. – NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng); CENTRAL: Nakhon Nayok (Khao Yai); PENINSULAR: Nakhon Si Thammarat (Khao Luang), Trang, Yala.

Distribution. – India (Assam), Myanmar, Indochina and West Malesia, north to the Ryukyus and southern edge of Japan.

Ecology. – Terrestrial on mountain slopes at altitudes 1,200–1,237 m alt.

Specimen examined. – P. Jadprajong 2, 162, 163 (BKF).

2. ODONTOSORIA

Fée, Mém. Foug. 5: 325. 1852; S. Y. Dong, S. J. Lin, M. J. M. Christenhusz & J. Barcelona, Fl. China 2–3: 139. 2013.

Rhizomes shortly creeping, covered with dark brown hairs or subulate scales. *Fronde*s approximate. *Stipe* stramineous or darker, glabrous. *Lamina* 3- or 4-pinnate, pinnatifid and gradually narrowing toward apex, ultimate segments usually cuneate or linear; veins free, simple or once or twice forked on ultimate pinnules, papery to slightly leathery. *Sori* usually submarginal, ovate, terminal on a single vein, or on two or three veins; indusia ovate or cup-shaped, adnate at base and part of lateral or adnate entirely at lateral.

Odontosoria chinensis (L.) J. Sm., Bot. Voy. Herald 10: 430. 1857. — *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; S. Y. Dong, S. J. Lin, M. J. M. Christenhusz & J. Barcelona, Fl. China 2–3: 139. 2013.

var. **chinensis**, **Figure 5. 17: G-H.**

Rhizome short-creeping, densely scaly; scales dark brown, 1–2 mm long. *Fronde*s close together. *Stipes* stramineous, brown in the lower part, scaly at base, grooved on abaxial side of the upper part, 8–17 cm long. *Laminae* oblong to narrower, 14–37 by 7–18 cm, apex acuminate, finely divided to quadripinnate; pinnae alternate, subtriangular, apex acuminate, base cuneate, stalked, gradually becoming smaller upwards, third segments cuneate, lobed; veins hardly distinct, usually two or three in each ultimate lobe. *Sori* terminal on veinlet, or merging the apical portion of 2–3 veinlets, close to apex of lobes; indusia attached at base and the basal part of both sides, almost as long as laminae, toothed.

Thailand. – NORTHERN: Chiang Mai (Doi Chiang Dao, Mae Tuen, Bo Luang, Doi Inthanon), Nan, Phitsanulok (Phu Miang); NORTH-EASTERN: Phetchabun, Loei (Phu Luang, Phu Kradueng); 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.

Ecology. – Lithophyte along stream in light shade at 1,098–1,237 m alt.

Specimen examined. – P. Jadprajong 29, 183, 253 (BKF).

3. OSMOLINDSAEA

(K.U. Kramer) Lehtonen & Christenh., Bot. J. Linn. Soc. 163: 335. 2010; S. Y. Dong, S. J. Lin, M. J. M. Christenhusz & J. Barcelona, Fl. China 2–3: 140. 2013.

Rhizomes shortly to long creeping, densely scaly; scales appressed or spreading, reddish brown, nearly acicular. *Fronde*s approximate or distant, 0.5–1 cm apart. *Stipe* stramineous or castaneous to black, adaxially sulcate, glabrous. *Lamina* one pinnate,

lanceolate, gradually narrowed toward apex, herbaceous; pinnae subsessile, dimidiate, rhomboid or cuneate, upper margin shallowly lobed-incised or entire, apex obtuse-acute; veins free, obvious, not reaching margin. *Sori* marginal, terminal on several veinlet ends; indusia oblong, continuous or interrupted by incisions, attached at base. *Spores* monoete.

Osmolindsaea odorata (Roxb.) Lehtonen & Christenh., Bot. J. Linn. Soc. 163(4): 335. 2010. — *Lindsaea odorata* Roxb., Calcutta J. Nat. Hist. 4: 511. 1844; Kramer, Fl. Males., Ser. II, Pterid. 1: 228. 1971; Tagawa & K. Iwats., Fl. Thailand 3(2): 141. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 43, 94. 2000. **Figure 5. 18: A-B.**

Rhizome short creeping, 1.0–1.2 mm in diameters; scales dense, hair-like, up to 3 mm long, dark brown to castaneous. Fronds monomorphic. *Stipes* 2–5 mm apart, up to 8 cm long, dark brown, terete. *Laminae* simple pinnate, stramineous, linear or linear-lanceolate, up to 13 by 1.7 cm, gradually narrowing towards both ends; pinnae up to 20 pairs, more or less ascending, stalked, except on the upper part; middle ones the largest, about 8 mm apart, oblong, round at apex, cuneate at base, up to 8 by 4 mm, lower edge roundly curved and entire, inner edge straight or curved, upper edge lobed to 1/3, upper ones gradually upwards, shortly stalked or sessile, more ascending; lobes rounded, 1–2 mm broad, up to 2 mm in depth, thin; veins raised on both surfaces, free except when united by sori. *Sori* up to 1.5 mm long, interrupted by sinus of lobes; indusia firm, reaching the margin or lobes, the margin more or less irregular.

Thailand. – NORTH-EASTERN: Loei (Phu Kradueng); PENINSULAR: Trang.

Distribution. – Tropics of the Old World, Madagascar and Sri Lanka to Australia, north to S Japan.

Ecology. – Lithophyte on sandy rocks in the stream-beds in dense evergreen forests at 1,185–1,257 m alt. on Phu Kradueng.

Specimen examined. – P. Jadprajong 24 (BKF).

LYGODIACEAE

M. Roem., Handb. Allg. Bot. 3: 520. 1840; X. C. Zhang & J. G. Hanks, Fl. China 2–3: 118. 2013.

Rhizome wide-creeping. *Fronde*s distinctly spaced. *Sterile leaflets* simple, palmate, or lobed near the base only; venation of sterile leaflets free. *Primary rachis* branches 4–10 mm long below the pair of secondary branches. *Secondary rachis* branches, pinnate, with a few leaflets, or dichotomous.

LYGODIUM

Sw., J. Bot. (Schrader) 1800(2): 7, 106; Tagawa & K. Iwats., Fl. Thailand 3(1): 59. 1979; X. C. Zhang & J. G. Hanks, Fl. China 2–3: 118. 2013.

Morphological characters and distribution are the same as those of the family.

Key to the species

- 1a. Secondary branches bipinnate. Leaflets not articulate at the base
 **1. *L. japonicum***
- 1b. Secondary branches simply pinnate. Leaflets articulate at the base
 **2. *L. microphyllum***

1. *Lygodium japonicum* (Thunb.) Sw., J. Bot. (Schrader) 1800(2): 106. 1801; Tagawa & K. Iwats., Fl. Thailand 3(1): 61. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 82. 2000. — *Ophiglossum japonicum* Thunb., Fl. Jap. 328. 1784; X. C. Zhang & J. G. Hanks, Fl. China 2–3: 120. 2013. **Figure 5. 18: C-D.**

Rhizome creeping, densely covered with blackish brown hairs. *Fronde*s climbing. *Stipes* slender, 17–33 cm, stramineous, pubescent near base, sparsely hairy upwards,

very narrowly winged except only at base; hairs at base of stipes brown, rachis similar to the upper part of stipes, rather densely hairy on the upper side. *Pinnae* numerous, usually up to 10 cm apart or to 15 cm at the lower portion; primary rachis-branches distinct, about 3 mm long, dense with light brown hair at apex, secondary rachis-branches up to 15 cm long, densely hairy on the upper and very sparsely on the lower sides, winged throughout; the two main branches of large fronds bipinnate, deltoid to suborbicular in outline; tertiary leaflets of lower rachis-branches palmate with 5–7 lobes, not articulate at the base, the middle lobe longer than other, tertiary leaflets of higher portion trilobed, lobes biserrate at margin, obtuse to acute at apex, obliquely subtruncate or more or less auricled at base; stalks of leaflets 1–5 mm long, with distinct wings; midrib hairy; veins on both surfaces hairy with long pale brown hairs, venation of sterile leaflets free. *Sporangia* borne on tertiary leaflets at margin of protruding lobes, fertile parts smaller than the sterile parts that without sporangia, 2–6 mm long, about 1 mm broad; indusia hairy.

Thailand. – NORTHERN: Chiang Mai (Ban Klang, Fang, Doi Chiang Dao, Doi Noi, Doi Makena, Ping Khong, Doi Suthep, Mae Klang, Doi Phracha), Tak (Doi Ka); NORTH-EASTERN: Loei (Phu Kradueng); SOUTH-WESTERN: Kanchanaburi (Sai Yok, Hindat, Ban Kao), Phetchaburi, Prachuap Khiri Khan.

Distribution. – Sri Lanka, Himalaya to China north to Chekiang, Korea, Japan, Indochina, throughout Malesia east to New Guinea; also naturalized in the United States.

Ecology. – Terrestrial on mountain slopes in deciduous forest at 709–1,155 m alt.

Specimen examined. – P. Jadprajong 88, 112, 201 (BKF).

2. *Lygodium microphyllum* (Cav.) R. Br., Prodr. Fl. Nov. Holland. 162. 1810; Tagawa & K. Iwats., Fl. Thailand 3(1): 60. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 34, 83. 2000; X. C. Zhang & J. G. Hanks, Fl. China 2–3: 120. 2013. **Figure 5. 18: E-F.**

Rhizome widely creeping, 2–3 mm in diameter, densely covered with blackish brown hairs. *Fronde*s climbing to several metres. *Stipes* about 8 cm long, stramineous or green, brown to dark brown when dry, glabrescent, narrowly winged in the upper part; rachis similar to the upper part of stipes, stramineous, glabrous, with narrowly winged throughout. *Pinnae* numerous, 6–8 cm apart; primary rachis-branches distinct, 3–4 mm, densely covered with brown hairs at the apex; secondary rachis-branches up to 8 cm long, glabrescent, narrowly winged; leaflets simple pinnate, several in pairs on secondary rachis-branches, with distinct stalk 1–3 mm, subdeltoid to oblong-subdeltoid, acute at apex, subtruncate or broadly cuneate or more or less auricled at base, entire at margin, glabrescent, up to 4 cm long by 1 cm broad, venation of sterile leaflets free. *Sporangia* bearing lobes narrow, margin of lobes protruding, 3–5 mm long by 1 mm broad; indusia glabrous, serrate at margin.

Thailand. – NORTHERN: Chiang Mai (Tat Noi, Doi Suthep), Lampang (Mae Tam, Ban Du); NORTH-EASTERN: Loei (Phu Kradueng); SOUTH-WESTERN: Kanchanaburi, Prachuap Khiri Khan; CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi (Makham, Khao Sabap), Trat (Ban Saphan Hin, Ko Chang); PENINSULAR: Surat Thani (Ban Don, Ko Samui, Khun Thale), Trang, Songkhla (Hat Yai), Yala (Bunnang Sata), Narathiwat.

Distribution. – Tropics of the Old World, from Africa to Indo-China, Melanesia and Australia, north to the Ryukyus and south to New South Wales.

Ecology. – Terrestrial on sandy soil in dry open grass land in lower-montane coniferous forest at 1,200–1,236 m alt.

Specimen examined. – P. Jadprajong 23 (BKF); O. Ratana 11 (BCU); T. Boonkerd 681, 683 (BCU); Hennipman 3647 (BKF); K. Iwats., N. Fukuoka and M. Hutoh 14167 (BKF).

MARATTIACEAE

Kaulf., Enum. Filic. 31. 1824; Tagawa & K. Iwats., Fl. Thailand 3(1): 41. 1979; Z. R. He, & M. J. M. Christenhusz, Fl. China 2–3: 82. 2013.

Plants terrestrial, usually restricted to high humidity areas, such as by stream, or spring in shady forest. *Rhizomes* fleshy, stipe green fleshy. *Fronde*s 1–2 pinnate or palmate, circinate, stalks with swollen base, stipulate; vein free, forked. *Sporangia* grouped into sori, or fused laterally into synangia, marginal or submarginal.

ANGIOPTERIS

Hoffm., Commentat. Soc. Regiae Sci. Gott. 12: 29. 1796; Tagawa & K. Iwats., Fl. Thailand 3(1): 41. 1979; Z. R. He, & M. J. M. Christenhusz, Fl. China 2–3: 83. 2013.

Rhizomes erect or ascending, massive fleshy. *Stipe* green, fleshy, swollen at base. *Laminae* bipinnate; pinnae alternate or subopposite swollen at base; veins free, simple or forked; scales peltate but generally basifixed due to asymmetry. *Sori* borne on veins, marginal or submarginal; sporangia fused at base into receptacles, arranged into 2 opposite rows, opening through a vertical slit of each valve.

Angiopteris evecta (Forst.) Hoffm., Commentat. Soc. Regiae Sci. Gott. 12: 29. 1796; Tagawa & K. Iwats., Fl. Thailand 3(1): 41. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 22, 64. 2000; Z. R. He, & M. J. M. Christenhusz, Fl. China 2–3: 86. 2013.

Figure 5. 18: G-H.

Rhizome short, massive, bearing large fronds in a tuft. *Fronde*s 2–2.5 meters. *Stipes* smooth, about 1.2 meters, fleshy, green, swollen at base (stipules). *Laminae* bipinnate, 1.83–2 meters long, up to 1.5 meters broad; pinnae swollen at base, about 67 cm, with 13–25 pairs of spreading pinnules; pinnules 6–20 by 1.2–3.2 cm, bases rounded to truncate, swollen at base, serrate to crenulate at margins, acuminate at apex,

glabrous on the adaxial sides, abaxial side with sparsely long-arm stellate scales. Veins very distinct, free, forked, false veins extending nearly to costule. *Sori* with two close rows of sporangia, sporangia fused only at base, marginal to 1 mm from margin, with 10–19 sporangia, 1–2 mm.

Thailand. – Common species throughout Thailand.

Distribution. – From India and China through Southeast Asia and Malesia to the islands of the Pacific.

Ecology. – Terrestrial along stream in lower-montane forest, usually in shade at about 1,220 m alt.

Specimen examined. – P. Jadprajong 286 (BKF); A. Sathapattayanon 152 (BCU); T. Boonkerd 447 (BCU); J.F. Maxwell 94–693 (BKF); T. Shimizu, H. Toyokuni, H. Koyama, T. Yahara and C. Niyomdham 26680 (BKF).

NEPHOLEPIDACEAE

Pic. Serm., *Webbia*. 29: 8. 1975; F. W. Xing, F. G. Wang & P. H. Hovenkamp, *Fl. China* 2–3: 727. 2013.

Rhizome long creeping, or short and erect, sometimes bearing stolons or tubers, scales peltate. *Fronde*s distant or tufted, pinnate. *Lamina* lanceolate to elliptic-lanceolate, glabrous or sometimes finely hairy; veins free forked, ending in submarginal hydathodes. *Sori* orbicular, terminal on a veinlet, indusium orbicular-reniform. *Spores* monolete.

NEPHOLEPIS

Schott, Gen. Fil. t. 3. 1834; F. W. Xing, F. G. Wang & P. H. Hovenkamp, Fl. China 2–3: 727. 2013.

Rhizome erect, short, producing long wiry stolons and sometimes tubers giving rise to new plants. *Stipe* tufted. *Lamina* pinnate, pinnae sessile, articulate to rachis, lanceolate or falcate, base usually asymmetrical, often auriculate on upper side, margin crenate. *Sori* orbicular, terminal on a veinlet; indusia orbicular-reniform, often with a narrow sinus.

Key to the species

- 1a. Pinnae more than 5 cm long..... **1. N. biserrata**
- 1b. Pinnae up to 3 cm long..... **2.**
- 2a. indusia broad, lunulate or crescent-shaped..... **2. N. cordifolia**
- 2b. indusia reniform to broadly reniform..... **3. N. undulata**

1. *Nephrolepis biserrata* (Sw.) Schott, Gen. Fil. t 3. 1834; Tagawa & K. Iwats., Fl. Thailand 3(2): 175. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 237. 2000; F. W. Xing, F. G. Wang & P. H. Hovenkamp, Fl. China 2–3: 728. 2013. **Figure 5. 19: A-B.**

Rhizome ascending or suberect, many wiry roots and stolons, scales gradually narrowing from base towards tailed apex, 2–5 mm or more long by about 1 mm broad, thin, brown, with hairy or irregular margin. *Stipes* stramineous, 20–37cm or more long, densely scaly with narrower scales. *Laminae* large, pinnate, more than 60 by 20–30 cm, lanceolate, narrowing towards both ends; lateral pinnae up to 45 or more pairs; middle ones larger, patent or slightly falcate linear-lanceolate, apex acuminate to caudate, base cuneate, sessile, posterior part of margin serrate, 13–22 by 1.5–2 cm, thin but stiff; veins forked near costa, sometimes branches, minutely scaly on costa and on laminar surface.

Sori round, arrange in one row at 1/3 way from margin to costa; indusia reniform, round, 1–1.5 mm in diameters.

Thailand. – NORTHERN: Chiang Mai (Doi Suthep, Ban Du), Chiang Rai; NORTH-EASTERN: Loei (Phu Kradueng); EASTERN: Ubon Ratchathani; CENTRAL: Bangkok; SOUTH-EASTERN: Chon Buri (Sri Racha), Trat (Ko Chang, Ban Saphan Hin, Khlong Yai); PENINSULAR: Surat Thani (Khao Tao), Phangnga (Takua Thung), Nakhon Si Thammarat (Khao Luang), Trang (Khao Chong), Satun, Songkhla (Rattaphum), Yala (Bunnang Sata), Narathiwat (Waeng).

Distribution. – Pantropical.

Ecology. – Lithophyte on rock near by streams in half shade lower-montane forest at 1,000–1,098 m alt.

Specimen examined. – P. Jadprajong 200 (BKF).

2. *Nephrolepis cordifolia* (L.) C. Presl, Tent. Pterid.: 79. 1836; Tagawa & K. Iwats., Fl. Thailand 3(2): 172. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 173, 237. 2000; F. W. Xing, F. G. Wang & P. H. Hovenkamp, Fl. China 2–3: 727. 2013. **Figure 5. 19: C-D.**

Rhizome short, ascending to suberect, numerous wiry roots and stolons, densely scaly; scales acuminate at base and long-tailed at apex, narrowly lanceolate, 3–6 mm by about 1 mm broad, pale brown. *Stipes* terete, stramineous or brown, 7–9.5 cm long, scaly with narrow scales. *Laminae* pinnate, linear-lanceolate, apex moderately acute, gradually narrowing towards base, 28–74 cm or more long by 5–6 cm wide; rachis grooved on upper surface, scaly above; lateral pinnae up to 42 pairs; middle ones larger, patent, acute to moderately acute at apex, base truncate, auricled at anterior base, sessile, 1–3 cm by 0.7 cm, serrate at margin, papyraceous; veins distinct on lower surface, forked near costa. *Sori* in one row at middle to submarginal between costa and margin; indusia broad, lunulate or crescent-shaped, brown, glabrous, 1–2 mm broad.

Thailand. – NORTHERN: Mae Hong Son, Chiang Mai (Doi Chiang Dao, Doi Suthep), Phitsanulok (Phu Miang, Thung Salaeng Luang); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao).

Distribution. – Pantropical, north to Japan and south to New Zealand.

Ecology. – Lithophyte on muddy rocks near stream, on mountain slopes, in light shade at 1,200–1,236 m alt.

Specimen examined. – P. Jadprajong 48, 157 (BKF).

3. *Nephrolepis undulata* (Afzel.) J. Sm., Bot. Mag. 72: 35. 1845. — *Nephrolepis delicatula* (Decne.) Pic. Serm., Webbia 23: 181. 1968; Tagawa & K. Iwats., Fl. Thailand 3(2): 174. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 174, 238. 2000; F. W. Xing, F. G. Wang & P. H. Hovenkamp, Fl. China 2–3: 728. 2013. **Figure 5. 19: E-F.**

Rhizome short, erect, 1–2 mm in diameters, scaly, with a few fronds, bearing wiry slender roots, and stolons, sometimes with tubers, scales about 2.5 by 0.5 mm, pale brown. *Stipes* stramineous to brown, up to 10 cm or more long, scaly. *Laminae* linear-lanceolate, up to 45 by 6 cm, pinnate, rachis green, grooved on upper surface, minutely scaly above, lateral pinnae up to 50 or more pairs, larger at middle, gradually narrowing from base to acute apex, apical portion patent or falcate, dimidiate at base, auricle distinct and enclose the rachis at anterior base, up to 3 by 1 cm, margin crenate, herbaceous; veins forked, glabrous. *Sori* submarginal; indusia broadly reniform, up to 1.2 mm broad.

Thailand. – NORTHERN: Mae Hong Son (Doi Phadam), Chiang Mai (Doi Chiang Dao, Doi Suthep, Sop Aep), Lamphun (Doi Khun Tan), Phrae (Mae Ban), Tak; NORTH-EASTERN: Loei (Phu Kradueng); EASTERN: Ubon Ratchathani; SOUTH-WESTERN: Kanchanaburi (Sai Yok).

Distribution. – Tropics and subtropics worldwide.

Ecology. – Lithophyte, on muddy rocks or in muddy rocks crevices in forest at 1,191–1,233 m alt.

Specimen examined. – P. Jadprajong 174 (BKF).

OLEANDRACEAE

Ching ex Pic. Serm., *Webbia* 20(2): 745. 1965; P. H. Hovenkamp & Boon-Chuan Ho, *PhytoKeys* 11: 1–37. 2012; X. C. Zhang, & P. H. Hovenkamp, *Fl. China* 2–3: 747. 2013.

Plant terrestrial, lithophyte or epiphyte, almost creeping. *Rhizome* long, creeping, erect, or scandent; scales dark to blackish brown, spreading or appressed. *Fronde*s distant or clustered; stipe articulate to raised phyllopodia; lamina simple, entire, lanceolate to linear-lanceolate, herbaceous, papery, or leathery, margin cartilaginous, glabrous or pubescent; costa prominent, raised adaxially, often with small scales on abaxial surface; veins simple or forked, free. *Sori* in a single often irregular row on either side of costa; indusia reniform or orbicular-reniform. *Spores* monoletic.

OLEANDRA

Cav., *Anales Hist. Nat.* 2: 115. 1799; P. H. Hovenkamp & Boon-Chuan Ho, *PhytoKeys* 11: 8. 2012; X. C. Zhang, & P. H. Hovenkamp, *Fl. China* 2–3: 747. 2013.

Rhizome scaly, scales dark to blackish brown, thick, spreading or appressed, peltate at base, margin often long ciliate, roots scattered. *Fronde*s scattered, stipitate. *Stipe* with stipe-like phyllopodia, dehiscing at an articulation point. *Lamina* simple, margin entire to hairy; veins distinct, rather raised on both sides, once to twice fork near the costa, costa more or less with scales, lamina and veins often with hairs. *Sori* in one,

often irregular row on each side of the costa, with a more or less reniform, glabrous or hairy indusium.

Key to the species

- 1a. Phyllopodia very short, up to 1.5 (–2.5) cm long.....**2.**
- 2a. Rhizome white waxy in older part, scales appressed; stipes stramineous, without dark coloration.....**2. O. musifolia**
- 2b. Rhizome not white waxy in older part, scales squarrose; stipes usually with dark coloration.....**4. Oleandra sp.**
- 1b. Phyllopodia usually more than 2.5 cm long.....**3.**
- 3a. Rhizome not white waxy in older part, scales appressed to spreading; root often with unbranched parts; midrib without or with few pale to dark scales.....**1. O. cumingii**
- 3b. Rhizome sometimes white waxy in older part, scales spreading; root branching with root hairs; midrib without scales.....**3. O. undulata**

1. *Oleandra cumingii* J. Sm., J. Bot. (Hooker) 4: 413. 1842. C. Presl, Epimel. Bot. 41. 1851; P. H. Hovenkamp & B. C. Ho, PhytoKeys 11: 12. 2012. **Figure 5. 19: G-H.**

Rhizome creeping, 3–8 mm thick, sometimes white waxy in the older parts, a few branched, not forming extensive stands, with or without scattered sclerified strands in cross section, roots scattered often with unbranched aerial parts; phyllopodia scattered to tufted, 1.5–10 cm long; scales appressed to spreading, peltate, persistently covering the rhizome, 3–6 by about 1 mm, dark center and lighter at margin, margin ciliate usually when young. *Fronde* monomorphic. *Stipe* 2–6 cm long. without dark colouration, glabrous or hairy, 1–2 mm long, *Lamina* 10–52 by 2–4 cm, apex acute to long-acuminate, base narrowly cuneate to truncate, both surfaces and margin with

acicular hairs about 1 mm long, sparsely on upper surface, densely on lower surface, costa without dark colouration, lower surface without or with few, pale to dark scales, texture thin chartaceous. *Sori* close to or far from the costa about 3 mm, indusium distinct, 1–1.5 mm wide, densely hairy. Sporangial stalk with glands below the sporangium.

Thailand. – NORTH-EASTERN: Loei (Phu Kradueng).

Distribution. – China (Yunnan, Guangdong, Guangxi, Guizhou), Laos, Thailand, Malaysia, Peninsular Malaysia, Indonesia, Flores, Timor Leste, Philippines.

Ecology. – Lithophyte on rocks in light shade areas, at 1,174–1,233 m alt.

Specimen examined. – P. Jadprajong 102, 134, 177, 180 (BKF); W. Rattanathirakul 218 (BCU).

2. *Oleandra musifolia* (Blume) C. Presl, Epimel. Bot. 42. 1851; Tagawa & K. Iwats., Fl. Thailand 3(2): 181. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 175, 239. 2000; P. H. Hovenkamp & B. C. Ho, PhytoKeys 11: 8. 2012. **Figure 5. 20: A-B.**

Rhizome long creeping, about 5 mm in diameters, with white waxy in the older parts, often supported above surface by unbranched root, densely scaly throughout, scales appressed, peltate, round to moderately acute at base, gradually narrowing towards the tailed at apex, 3–6 by about 1 mm, dark at center and lighter brown at acumen and margin, margin ciliate with sessile glands especially when young. *Fronde*s monomorphic, arranged in scattered tufts. *Stipes* usually short, up to 2 cm long, including phyllopodia about 0.5 cm. rarely 1 cm long, often hidden by the scales, without dark coloration, bearing scales and hairs. *Laminae* linear-lanceolate, apex acute to acuminate, gradually narrowing towards cuneate to truncate base, up to 60 by 3.9 cm, margin entire to hairy, both surfaces often with glandular hairs; midrib raised below, without dark coloration, with inconspicuous long brown scales, 1–3 mm long on lower surface; veins all free, once or twice forked, glabrous to sparsely hairy both

sides of lamina, glabrous to densely hairy at margin. *Sori* regular row near midrib or sometimes scattered about 2–5 mm from midrib; indusia distinct, 0.8–2 mm broad, glabrous, glandular or hairy. Sporangial stalks with glands below the sporangium.

Thailand. – NORTHERN: Chiang Mai (Doi Chiang Dao, Doi Inthanon), Lamphun (Doi Khun Tan), Phrae (Mae Sai), Tak (Ban Musoe), Phitsanulok; NORTH-EASTERN: Phetchabun, Loei (Phu Luang, Phu Kradueng); SOUTH-WESTERN: Kanchanaburi (Khriti); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); PENINSULAR: Ranong (Khao Phota Chongdong), Phangnga (Khao Phra Mai).

Distribution. – South China, South India, Sri Lanka, Thailand, Indonesia (Java, Lesser, Sunda Islands, Sulawesi), Philippines (Luzon), Australia (Queensland).

Ecology. – Lithophyte on crevices of rocks in sunny places in light shade area at 1,100–1,304 m alt.

Specimen examined. – P. Jadprajong 125, 138, 197 (BKF); W. Rattanathirakul 218 (BCU); A. Sathapattayanon 60 (BCU); T. boonkerd 1244 (BCU).

3. *Oleandra undulata* (Willd.) Ching, Lingnan Sci. J. 12: 565. 1933; Tagawa & K. Iwats., Fl. Thailand 3(2): 180. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 239. 2000; P. H. Hovenkamp & B. C. Ho, PhytoKeys 11: 25. 2012. **Figure 5. 20: C-D.**

Rhizome creeping, little branching, not covered with white waxy, 3–5 mm thick, in cross-section with many sclerified strands; phyllopodia scattered, close together or distant, 2.5–6.5 cm long, roots scattered, without distinct unbranched parts. *Scales* persistently covering the rhizome, peltate, slightly spreading, 4–5 by 1–1.3 mm, margin sparsely ciliate, apex short, wide, brown. *Fronde*s monomorphic. *Stipe* 12.5–21.5 cm long, without dark coloration, articulation at 1/4–1/2 from the base. *Lamina* 18.5–25 by 3.6–4.2 cm, widest at middle, base truncate or cuneate to gradually narrowed, apex acute to acuminate, texture herbaceous, glabrous or sparsely on upper surface, lower

surface more densely set with hairs, 0.5–1 mm long; costa on lower surface without dark coloration, without scales. *Sori* close to costa, 1–2 mm wide, sterile zone between costa and soral zone, indusium firm, 1.5–2 mm wide, hairy. Sporangial stalk without glands below the sporangium.

Thailand. – NORTHERN: Chiang Mai (Fang, Doi Chiang Dao, Doi Suthep, Doi Hua Mot, Ping Klong, Doi Saket, Mae Klang), Chiang Rai (Doi Pha Cho), Lampang (Ngao), Phrae; NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng, Phu Tong); EASTERN: Chaiyaphum, Ubon Ratchathani (Phu Chong Nayoi); SOUTH-WESTERN: Kanchanaburi (Hat Phalom, Sai Yok); SOUTH-EASTERN: Chanthaburi (Laem Sing, Khao Sabap), Trat (Khao Kuap); PENINSULAR: Ranong (Ko Phayam), Phangnga (Khao Phra Mai), Krabi (Ko Pu), Nakhon Si Thammarat (Thung Song).

Distribution. – Myanmar, Laos, Thailand, China (Yunnan).

Ecology. – In open or deciduous forests, often disturbed; terrestrial or epilithic, Rhizome subterraneous, on rocks or in crevices, mostly on granite.

Note. — *Oleandra undulata* can be difficult to distinguish from *O. cumingii*. In addition to the differences listed under that species, subterraneous growth of the rhizome may be characteristic for *O. undulata*, but field observations are lacking for many specimens.

Specimen examined. – P. Jadprajong 292 (BKF); T. Boonkerd & R. Pollawatn 220 (BCU); R. Chaveerach 19 (BCU); T. Boonkerd 1363 (BCU).

4. *Oleandra* sp., Figure 5. 20: E-F.

Rhizome long creeping, up to 2.5 mm thick, not white waxy in the older part, the leafless parts alternating with less dense clusters of short phyllopodia; phyllopodia scattered, usually less than 0.5 (–2.5) cm high, of which usually up to 2–3 fronds at the same time, branches often in opposite pairs; in cross-section with sclerified strands, root

branching with root hair over the entire length; scales squarrose, persistently covering the rhizome, peltate, 0.88–1.1 by 5–5.75 mm, ovate with long tail at the apex, light brown and dark brown at the attachment, margin with short glandular hairs. *Fronde* monomorphic, pendulous, more or less clustered. *Stipe* light brown with dark coloration on abaxial side often distinctly bicolorous, up to 4.6 cm long, densely covered with long multicellular hairs on the surface. *Lamina* greenish brown when dry, linear to linear-lanceolate, 0.8–2.5 by 3.2–17 cm, base rounded to cuneate, apex acute, texture thin-papyraceous, both surface densely covered with multicellular hairs; margin slightly wavy, with long multicellular hairs and some glandular hairs; costa hairy with multicellular hairs and glandular hairs same as both surfaces but rare thin pale scales, 0.5–1.5 mm long. *Sori* close to costa, indusium thin, reniform to orbicular reniform, light brown, hairy, about 1–1.5 mm, sporangial stalk with clavate glands below the sporangium. *Spore* monolet, exospore echinate, perispore echinate and ridge, fragileness, about 5–5.5 μm long 3.25–4 μm wide.

Thailand. – NORTH-EASTERN: Loei (Phu Kradueng).

Distribution. – N/A

Ecology. – Lithophyte on mossy rocks near cliff faces or boulders in lower-montane forest at 1,304 m alt.

Specimen examined. – P. Jadprajong 268, 291 (BCU);

Discussion. – The *Oleandra* sp. is similar to *O. wallichii* in size of leaves and leaves hairy on both surfaces. But the different characters of two species are margin of Rhizome scales with glandular hairs, phyllopodia can be up to 2.5 cm long, costa with rare thin scales and perispore fragileness found in *Oleandra* sp., while in *O. wallichii* showed Rhizome scales with ciliate margin, phyllopodia less than 0.5 cm long, costa covered with abundant scales and perispore solid.

OPHIOGLOSSACEAE

Martinov, Tekhno-Bot. Slovar. 438. 1820. Tagawa & K. Iwats., Fl. Thailand 3(1): 35. 1979; W. Shinohara, N. Nakato, Y. Y. Kakugawa, T. Oka, J. K. Kim, N. Murakami, H. Noda, & N. Sahashi, Syst. Bot. 38(3): 564–570. 2013; Q. Liu, and N. Sahashi, Fl. China 2–3: 77. 2013.

Plants terrestrial, lithophyte or epiphyte, fleshy. *Rhizome* erect, glabrous or hairy; roots without root hairs, fleshy. *Laminae* simple or pinnate, not circinate vernation, stipe base wide, sterile frond usually branching into fertile segment; veins anastomosing. *Sporophores* one per frond, spikelike, simple or compound. *Spores* trilete, eusporangiate.

Key to the genera

- 1a. Terrestrial; trophophyll entire, ovate to oblong; sporophyll with long stalk**2. Ophioglossum**
- 1b. Epiphyte; trophophyll usually forked, strap-shaped; sporophyll with short or indistinct stalk**1. Ophioderma**

1. OPHIODERMA

(Blume) Endl., Gen. Pl. 66. 1836. — *Ophioglossum* subg. *Ophioderma* (Blume) R. T. Clausen, Mem. Torrey Bot. Club 19(2): 114. 1938.

Plants epiphytic. *Rhizome* horizontal, fleshy, with long hairs. *Phyllomophore* short to not distinct from sterile lamina. *Trophophyll* (sterile lamina) large, ribbon-shaped, pendulous. *Sporophyll* arising from near base or middle part of sterile lamina.

Ophioderma pendula (L.) C. Presl, Suppl. Tent. Pterid. 56. 1845. — *Ophioglossum pendulum* L., Sp. Pl. (ed. 2) 2: 1518. 1763; Tagawa & K. Iwats., Fl. Thailand 3(1): 37. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 24, 66. 2000; Q. Liu, and N. Sahashi, Fl. China 2–3: 78. 2013. **Figure 5. 20: G-H.**

Rhizome horizontal, about 1 cm long, fleshy. *Phyllomophore* short, not distinct from sterile lamina, about 6 cm long. *Trophophyll* usually forked, long, strap-shaped, sometimes bifurcate, 30–80 cm long including the stipes, round to acute at apex, entire, about 1 cm broad; venation distinct, reticulate forming narrow areoles usually without included veinlets, costae not differentiated. *Sporophyll* arising from middle part of the sterile fronds, simple, stalks about 2 cm long; spikes 4 cm long. *Sporangia* about 1 mm in diameter.

Thailand. – NORTHERN: Chiang Rai, Phitsanulok (Nakhon Thai); NORTH EASTERN: Loei (Dan Sai, Hup Bon, Phu Kradueng); SOUTH-WESTERN: Prachuap Khiri Khan; PENINSULAR: Nakhon Si Thammarat (Khao Luang), Trang, Yala (Khao Kalakhiri).

Distribution. – Palaeotropical.

Ecology. – Epiphyte on tree-trunks in mixed deciduous forest at 280–451 m alt., usually live with *Platycterium wallichii* Hook.

Specimen examined. – P. Jadprajong 298 (BKF).

2. OPHIOGLOSSUM

L., Sp. Pl. 2: 1062. 1753. Tagawa & K. Iwats., Fl. Thailand 3(1): 35. 1979; W. Shinohara, N. Nakato, Y. Y. Kakugawa, T. Oka, J. K. Kim, N. Murakami, H. Noda, & N. Sahashi, Syst. Bot. 38(3): 564–570. 2013; Q. Liu, and N. Sahashi, Fl. China 2–3: 77. 2013.

Plants terrestrial or epiphyte, small, fleshy, erect or pendulous. *Rhizome* erect, rarely creeping, short. *Fronde*s solitary, sometime two or more; trophophyll (sterile lamina) usually simple, ovate or ribbon-shaped, margin entire or undulate; midrib not distinct; veins reticulate; sporophyll borne on base, near base, or on the middle part of sterile lamina, with long stalk. *Sporangia* embedded in two rows along margin of spike.

Ophioglossum petiolatum Hook., Exot. Fl. 1: 56. 1823; Tagawa & K. Iwats., Fl. Thailand 3(1): 37. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 25, 66. 2000; Q. Liu, and N. Sahashi, Fl. China 2–3: 78. 2013. **Figure 5. 21: A-B.**

Rhizome cylindrical, short, bearing many roots, 2–3 mm in diameters. *Fronde*s 7–13 cm long, one or two fronds on a rhizome; *Trophophyll* (sterile lamina) ovate to oblong, 2.5–3 cm long, 1.5–2 cm broad; costae not differentiated; veins reticulate, areoles visible, many, free included veinlets often present, simple or branched; texture softly herbaceous, rather fleshy. *Sporophyll* simple, stalks, 2–10 cm long; spikes 1.5–3 cm long. *Sporangia* about 0.5 mm in diameters. *Spores* dark.

Thailand. – NORTHERN: Mae Hong Son, Chiang Mai (Doi Phahom Pok, Doi Chiang Dao, Doi Suthep), Chiang Rai (Doi Tung), Lampang (Ngao), Kamphaeng Phet; NORTH-EASTERN: Loei (Phu Kradueng); SOUTH-WESTERN: Kanchanaburi (Hin Dat); CENTRAL: Bangkok; SOUTH-EASTERN: Chanthaburi (Khao Soi Dao, Pong Namron); PENINSULAR: Surat Thani (Ban Don).

Distribution. – Pantropical.

Ecology. – Terrestrial on open sandy soil in light shade area at 1,202 m alt.

Specimen examined. – P. Jadprajong 167 (BKF); J. F. Maxwell 86-316, 86-1005 (BKF); T. Smitinand 6123 (BKF).

OSMUNDACEAE

Martinov, Tekhno-Bot. Slovar. 445. 1820; Tagawa & K. Iwats., Fl. Thailand 3(1): 44. 1979; X. C. Zhang, K. Iwats. & Y. Kadokawa, Fl. China 2–3: 90. 2013.

Rhizome erect, ascending, short creeping or sometimes treelike trunk. *Fronde*s simple to bipinnate, dimorphic as a whole or as to the pinnae, fertile portions lacking green laminae. *Stipe* spirally arranged, tufted, with lateral winged at bases; lateral pinnae and pinnule often articulate at base; veins free, forked. *Sporangia* not assembled in sori, or entirely covering fertile segments, sporangia large, annulus lateral opening by an apical slit; spores trilete.

OSMUNDA

L., Sp. Pl. 2: 1063. 1753; Tagawa & K. Iwats., Fl. Thailand 3(1): 44. 1979; X. C. Zhang, K. Iwats. & Y. Kadokawa, Fl. China 2–3: 91. 2013.

Rhizome erect to ascending, woody, without scales. *Fronde*s dimorphic or commonly hemidimorphic with dimorphic pinnae. *Stipes* arising as a crown at apex of rhizome, hairy when young, stipe base swollen, lateral stipules flaplike; lamina 1-pinnate, fertile portions reduced, lacking lamina present, pinnae articulate to rachis. *Sporangia* large, naked, annulus small.

Osmunda angustifolia Ching, Acta Phytotax. Sin. 8: 160. 1959; Tagawa & K. Iwats., Fl. Thailand 3(1): 45. 1979; Boonkerd & Pollawatn, Pterid. Thailand: 31, 77. 2000; X. C. Zhang, K. Iwats. & Y. Kadokawa, Fl. China 2–3: 91. 2013. **Figure 5. 21: C-D.**

Rhizome erect. *Fronde*s dimorphic, turf at apex of rhizome, 49–53 cm long. *Stipes* stramineous, 13–15 cm long. Laminae simple pinnate, with distinct apical pinna, acute at apex, a few basal pairs of lamina slightly shortened; lateral pinnae linear, gradually narrowing towards acute apex and shortly stalked based, margin slightly waved, up to

15 cm. long, 0.8–1 cm broad, the sinus about 0.8–1 mm in depth; veins dichotomously branching; texture papyraceous to softly coriaceous, fresh green in color; a few fertile pinnae at middle of lamina, contracted, brown after shedding the spores.

Thailand. – NORTHERN: Phitsanulok (Phu Miang); NORTH-EASTERN: Phetchabun, Loei (Phu Luang, Phu Kradueng); SOUTH-EASTERN: Trat (Ko Chang)

Distribution. – Laos, Hainan, Hongkong, China and Taiwan

Ecology. – Terrestrial on sandy banks along streams in dense forest or in half shaded areas at medium altitude, 1,183–1,237 m alt.

Specimen examined. – P. Jadprajong 10, 82 (BKF)

POLYPODIACEAE

J. Presl & C. Presl, *Delic. Prag.* 159. 1822; Tagawa & K. Iwats., *Fl. Thailand* 3(4): 486. 1989; X. C. Zhang, S. G. Lu, Y. X. Lin, X. P. Qi, S. Moore, F. W. Xing, F. G. Wang, P. H. Hovenkamp, M. G. Gilbert, H. P. Nootboom, B. S. Parris, C. Haufler, M. Kato & A. R. Smith, *Fl. China* 2–3: 758. 2013.

Plants mostly epiphyte and epilithic, a few terrestrial. *Rhizomes* shortly to long creeping, dictyostelic, bearing scales. *Fronds* monomorphic or dimorphic. *Stipes* cleanly abscising near their bases or not, leaving short phyllopodia. *Laminae* mostly simple to pinnatifid or 1-pinnate; veins often anastomosing or reticulate, sometimes with included veinlets, or veins free; indument various, of scales, hairs, or glands. *Sori* abaxial (rarely marginal), orbicular to oblong or elliptic, occasionally elongate, or sporangia acrostichoid, sometimes deeply embedded, sori exindusiate, sometimes covered by caducous scales (soral paraphyses) when young; sporangia with 1–3-rowed, usually long stalks, frequently with paraphyses on sporangia or on receptacle.

Key to the genera

- 1a. Fronds with stellate hairs at least when young..... **2.**
- 2a. Fronds strongly dimorphic, basal fronds with basal part tightly adpressed to substrate**10. Platycerium**
- 2b. Fronds monomorphic or weakly dimorphic, base not adpressed to substrate..... **11. Pyrrosia**
- 1b. Fronds glabrous, unbranched hairs, glandular hairs, and/or forked hairs, or with scales..... **3.**
- 3a. Nest-leaves or widened frond bases present..... **4.**
- 4a. Fronds usually strongly dimorphic with short brown sessile nest-leaves..... **2. Drynaria**
- 4b. Fronds monomorphic, fronds with broad humus-collecting base..... **1. Aglaomorpha**
- 3b. Nest-leaves or widened lamina bases not present..... **5.**
- 5a. Fronds pinnate..... **3. Goniophlebium**
- 5b. Fronds simple or pinnately lobed..... **6.**
- 6a. Sporangia acrostichoid or covering upper part of lamina surface..... **7.**
- 7a. Frond not bearing peltate scales..... **5. Leptochilus**
- 7b. Frond bearing peltate scales on surface or sori..... **4. Lepisorus**
- 6b. Sporangia in discrete sori or coenosori..... **8.**
- 8a. Sori elongate to linear..... **6. Loxogramme**

- 8b. Sori orbicular to elliptic..... **9.**
- 9a. Paraphyses absent **10.**
- 10a. Rhizome slender; scales ovate-lanceolate to ovate
..... **13. Selliguela**
- 10b. Rhizome thick, fleshy; scales peltate or pseudopeltate
..... **7. Microsorium**
- 9b. Paraphyses present..... **11.**
- 11a. Midrib raised on both surfaces; scales strongly
clathrate..... **9. Paragramma**
- 11b. Midrib and lateral veins obscure; scales not strongly
clathrate..... **12.**
- 12a. Lamina mostly lanceolate or narrowly lanceolate to
linear, up to 3.5 cm. broad..... **4. Lepisorus**
- 12b. Lamina narrowly elliptic to narrowly oblong-lanceolate,
usually more than 5 cm. broad..... **8. Neolepisorus**

1. AGLAOMORPHA

Schott, Gen. Fil. 4: 19. 1836; Tagawa & K. Iwats., Fl. Thailand 3(4): 551. 1989; X. C. Zhang, S. G. Lu, Y. X. Lin, X. P. Qi, S. Moore, F. W. Xing, F. G. Wang, P. H. Hovenkamp, M. G. Gilbert, H. P. Nootboom, B. S. Parris, C. Haufler, M. Kato & A. R. Smith, Fl. China 2–3: 764. 2013.

Plants epiphyte or lithophyte, rarely terrestrial. *Rhizome* thick, short to long creeping; rhizome scales appressed or spreading, pseudopeltate or rarely peltate, margin toothed or ciliate. *Fronde*s monomorphic, not articulate, sessile with dilated base, each

frond bases forming individual nests, rachises not persistent. *Lamina* deeply pinnatifid or subpinnate; pinnae gradually smaller toward frond apex, entire, apical pinna present. Venation highly complex, with main areoles delimited by veins and connecting veins, filled with many small areoles containing free veinlets, each veinlet terminating in a hydathode. *Sori* small, in rows along connecting veins or veinlets, or distinctly enlarged to form soral patches, in one row between midrib and margin.

Aglaomorpha coronans (Wall. ex Mett.) Copel., Univ. Calif. Publ. Bot. 16(2): 117. 1929; Tagawa & K. Iwats., Fl. Thailand 3(4): 551. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 245, 262. 2000. **Figure 5. 21: E-F.**

Rhizome creeping, thick, 2–3 cm in diameters, densely scaly throughout; scales pseudopeltate, linear, brown, 1–1.5 cm long, 0.5–1 mm broad, toothed at margin. *Fronde*s sessile, 60–112 by 25–48 cm, lobed almost to rachis, lobes continuing with wings, less 0.5–1 cm broad, base of laminae broadly rounded to cordate, subentire or shallowly lobed, brown, similar to the nest leaves of *Drynaria*; lobes of the upper part of laminae ascending, usually more than twelve pairs, linear-subtriangular, apex attenuately acuminate, margin entire, 15–22 by 2–5 cm, every lobe falling at the abscission along rachis; veins raised on both surfaces, reticulate, main areoles quadrangular, smaller areoles with free included veinlets; coriaceous, green, glabrous. *Sori* usually present on all pinnae, several rows between midrib and margin between, one in each main areole, more or less elongate, slightly sunken.

Thailand. – NORTHERN: Chiang Mai (Doi Hua Mot, Doi Suthep, Huai Tong, Doi Inthanon), Chiang Rai (Doi Tung), Lampang (Mae Tia), Phrae (Mae Sai), Tak (Huai Krasa, Doi Musoe), Phitsanulok (Thung Salaeng Luang); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng); EASTERN: Chaiyaphum; SOUTH-WESTERN: Kanchanaburi (Song Tho); SOUTH-EASTERN: Prachin Buri (Khao Yai), Chanthaburi (Khao Soi Dao); PENINSULAR: Surat Thani (Ban Don), Nakhon Si Thammarat (Khao Luang), Trang (Khao Chong), Phangnga (Khao Phota Luang Kaeo).

Distribution. – Himalayas to South China, Indochina, Taiwan and northwards to the Ryukyus.

Ecology. – Lithophyte on rather dry or mossy rocks or epiphyte on tree-trunks in open places or in dense forests at 1,103–1,258 m alt.

Specimen examined. – P. Jadprajong 63, 172 (BKF).

2. DRYNARIA

(Bory) J. Sm., J. Bot. (Hooker) 4: 60. 1841; Copel., Gen. Fil.: 203. 1947; Tagawa & K. Iwats., Fl. Thailand 3(4): 545. 1989.

Rhizome creeping, with scales appressed or spreading, basifixed or peltate, toothed at margin. *Fronde*s usually dimorphic, with basal (nest-leaves) and foliage frond, rarely monomorphic (basal frond absent). *Basal fronds* sessile, orbicular to ovate-elliptic, entire to lobed. *Foliage fronds* pinnatifid, rarely pinnate, stalked, hairs sometimes present, spreading throughout lamina, costae, costules, and main veins prominent abaxially, cross veins and minor venation obvious, anastomosing with irregular free included veinlets, cartilaginous at margins. *Sori* small, round or elongate, exindusiate, borne in rows along veins or connecting veins.

Key to the species

1. Foliage fronds pinnate; pinnae articulate to rachis.....**2. D. rigidula**
 1. Foliage fronds pinnatifid; pinnae not articulate to rachis.....**1. D. bonii**

1. Drynaria bonii Christ, Notul. Syst. (Paris) 1(6): 186. 1910; Tagawa & K. Iwats., Fl. Thailand 3(4): 545. 1989; P. H. Hovenkamp, M. T. M. Bosman, E. Hennipman & M.

C. Roos, Fl. Malesiana, Ser. 2, Pterid. 3: 36. 1998; Boonkerd & Pollawatn, Pterid. Thailand: 249, 268. 2000. **Figure 5. 21: G-H.**

Rhizome creeping, tightly fixed on substrates, sometimes flat, about 2 cm wide, 3–5 mm thick, scaly; scales peltate, ovate with long tails, round at base, up to 4 mm long include tails of 2.0–2.5 mm long, 1.0–1.5 mm broad, margin sharply toothed to fimbriate, bi-coloured with central portion dark brown and brown at margin. *Nest-leaves*: many, imbricate, covering almost entirely the rhizome, ovate or nearly circular in outline, deeply cordate at base, subentire, 5.5 by 2.5–6.0 cm. *Foliage-leaves*: stipes stramineous, 5–12 cm long, with narrowly winged close to base of stipes, scaly at base. *Laminae* pinnatifid nearly to rachis, 14–39 cm by 8–24 cm, lobes more or less ascending, oblong-lanceolate, apex moderately acute to caudately acuminate, 4.0–13.5 cm by 2.0–4.5 cm, subentire, more or less narrowed down to the base; veins anastomosing with areoles between main veins, distinct on both surfaces, light green, glabrous. *Sori* round, in 2–4 irregular rows between main veins.

Thailand. – NORTHERN: Mae Hong Son, Chiang Mai, Chiang Rai, Lampang, Phrae, Tak, Phitsanulok; NORTH-EASTERN: Loei (Phu Kradueng), Nong Khai; EASTERN: Chaiyaphum, Nakhon Ratchasima; SOUTH-WESTERN: Uthai Thani, Kanchanaburi, Prachuap Khiri Khan; CENTRAL: Sing Buri, Saraburi; SOUTH-EASTERN: Prachin Buri, Chon Buri.

Distribution. – China (Guizhou) and Indochina. Laos (Champasak)

Ecology. – Epiphyte on tree-trunks in medium shade or in dense deciduous forests at low to medium altitudes, about 350 m, fairly common.

Specimen examined. – P. Jadprajong 247, 248 (BKF).

2. *Drynaria rigidula* (Sw.) Bedd., Ferns Brit. India: pl. 314. 1869; Tagawa & K. Iwats., Fl. Thailand 3(4): 550. 1989; P. H. Hovenkamp, M. T. M. Bosman, E. Hennipman &

M. C. Roos, Fl. Malesiana, Ser. 2, Pterid. 3: 42. 1998; Boonkerd & Pollawatn, Pterid. Thailand: 250, 270. 2000. **Figure 5. 22: A-B.**

Rhizome short creeping, densely scaly throughout, 5–11 mm in diameters; scales peltate, rounded at base and gradually narrowing at apex, pale brown with darker at base, 5–8 mm long by 0.5–0.7 mm, margin sparsely hairy with pale long hairs. *Nest-leaves* sessile, narrowly oblong-subdeltoid, round at base, acute at apex, 10–16 by 5.5–8.5 cm, lobed 1/2–4/5 way towards midribs, lobes subtriangular, round at apex, entire, up to 3 by 2 cm. *Foliage-leaves*: stipes pale castaneous to purple, more or less dense with pale downy hairs, up to 40 cm long, usually bearing unevolved pinnae. *Laminae* pinnate, oblong-lanceolate, 10–87 by 6–22 cm; rachis pale purple, downy-hairy; lateral pinnae about 10–25 pairs, linear-lanceolate, 5–14 by 0.5–2 cm, sessile, subentire or serrate at margin, apex caudately acuminate, unequally cuneate at base; costa pale stramineous, jointed to rachis; veins raised on both surfaces, anastomosing, with 2–5 areoles between main veins. *Sori* round, one between main veins, raised on upper surface, close to costa, single row along each side of costa.

Thailand. – NORTHERN: Chiang Mai, Chiang Rai, Tak, Phitsanulok; NORTH-EASTERN: Loei (Phu Kradueng); SOUTH-WESTERN: Kanchanaburi; CENTRAL: Nakhon Nayok; SOUTH-EASTERN: Chanthaburi; PENINSULAR: Surat Thani, Krabi, Yala

Distribution. – Indochina, Laos, Cambodia, Myanmar, Malesia, Polynesia and tropical Australia.

Ecology. – Lithophyte on muddy crevices of rocks and epiphyte on tree-trunks in light to medium shade in some open areas, in mixed forest to lower-montane coniferous forest 1,198–1,238 m alt., rather common throughout the country.

Specimen examined. – P. Jadprajongs 92, 101, 103 (BKF).

3. GONIOPHLEBIUM

(Blume) C. Presl, Tent. Pterid. 185. 1836. — *Polypodium* L., Sp. Pl. 2: 1082. 1753; Tagawa & K. Iwats., Fl. Thailand 3(4): 568. 1989.

Rhizome long creeping, densely scaly; scales brown to dark brown, pseudopeltate, lanceolate, apex narrowly acuminate, broad at base, clathrate. *Fronde* monomorphic. *Stipe* long, glabrous straw-colored. *Lamina* imparipinnate, oblong in outline; lateral pinnae 5–40 pairs, articulate, lanceolate or linear-lanceolate, herbaceous, glabrous or pubescent, margins tooth; veins anastomosing, outer veinlets free, areoles 2–3 rows on each side of costa, a simple included veinlet distinct in each areole. *Sori* round, borne on simple included veinlets in costal areoles, sunken on abaxial surface and raised on adaxial surface.

Goniophlebium subauriculatum (Blume) C. Presl, Tent. Pterid. 186. 1836. — *Polypodium subauriculatum* Blume, Enum. Pl. Javae: 133. 1828; Tagawa & K. Iwats., Fl. Thailand 3(4): 573. 1989. *Polypodium beddomei* Baker, Syn. Fil. ed. 2: 344. 1874. Tagawa & K. Iwats., Fl. Thailand 3(4): 572. 1989. **Figure 5. 22: C-D.**

Rhizome long creeping, 3–5 mm in diameters, glaucous, densely scaly throughout; scales linear, 1–5 by 1 mm, toothed at margin, clathrate, brown. *Stipes* 3–25 cm long, stramineous or brown, densely scaly at base, glabrous or minutely scaly upwards. *Laminae* imparipinnate, lanceolate, 7–110 by 4.5–25 cm, widest at the base, rachis brown, minutely scaly throughout, lateral pinnae 9–65 pairs, a basal pairs usually little shorter than the next above, deflexed or patent, subopposite, sessile, linear, subtruncate, auricled at base, gradually narrowing from base to long attenuate apex, serrate at margin, patent or slightly ascending, straight or a little falcate, 2.5–20 by 0.8–1.5 cm, upper pinnae becoming smaller; terminal pinna up to 10 cm long, irregularly lobed at basal portion; veins anastomosing to form areoles 1–3 rows 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

along costa, more than 1.5 mm in diameters, distinctly immersed and raised on the upper surface.

Thailand. – NORTHERN: Chiang Rai (Doi Pacho, Mae Lao, Pong Pa Phon), Chiang Mai (Doi Suthep, Doi Inthanon, Doi Chianf Dao, Fang), Mae Hong Son (Doi Pha Dam), Lampang (Doi Luang), Tak (Mae Sot), Phitsanulok (Phu Miang, Thung Salaeng Luang); NORTH-EASTERN: Phetchabun, Loei (Phu Luang, Phu Kradueng); SOUTH-EASTERN: Prachin Buri (Kao Yai), Chanthaburi (Kao Soi Dao); SOUTH-WESTERN: Kanchanaburi (Sai Yok, Kao Nam Tok)

Distribution. – NORTH-EASTERN; India, South-Western China, Myanmar, Tenasserim, Laos, Vietnam, throughout Malesia to Australia (Queensland).

Ecology. – Epiphyte on mossy tree-trunks or on mossy rocks in evergreen forests at medium to high altitudes, 1,000–1,300 m alt.

Specimen examined. – P. Jadprajong 100, 104, 126, 130 (BKF).

4. LEPISORUS

(J. Sm.) Ching, Bull. Fan Mem. Inst. Biol. 4: 47. 1933; Tagawa & K. Iwats., Fl. Thailand 3(4): 507. 1989. — *Belvisia*, Mirb., Hist. Nat. Vég. 5: 473. 1802; Tagawa & K. Iwats., Fl. Thailand 3(4): 519. 1989.

Plants epiphyte or lithophyte, rarely terrestrial. *Rhizomes* creeping, terete or slightly flattened, densely scaly when young; scales very dark brown, opaque or clathrate, ovate, orbicular, or broadly lanceolate, entire to serrate at margin. *Fronde*s simple. *Stipe* usually short, sparsely scaly at base, smooth on the upper part, mostly straw-colored to dark brown. *Lamina* mostly lanceolate or narrowly lanceolate to linear, margin entire or undulate, revolute when dried, leathery or papery, both surfaces glabrous or sparsely scaly on abaxial; midrib and lateral veins obscure, veinlets reticulate, areoles with included veinlets. *Sori* large, orbicular or elliptic, sometimes

confluent into linear coenosori, in one row on each side of midrib, on narrow apical part of fronds, superficial or sometimes deeply immersed, covered with paraphyses when young; paraphyses peltate, sometimes stellate or scalelike, often brown at center and paler at margin.

Key to the species

- 1a. Sori orbicular or elliptic..... **2.**
- 2a. Scales concolorous, brown, clathrate..... **3. L. nudus**
- 2b. Scales bi-coloured, dark central portion and paler at margin..... **1. L. bicolor**
- 1b. Sori linear in one row on each side of midrib, almost on narrow apical part of fronds..... **3.**
- 3a. Rhizome scales concolorous, clathrate, toothed at margin..... **2. L. henryi**
- 3b. Rhizome scales bi-coloured, with dark central portion and pale at margin, without toothed at margin..... **4. L. spicata**

1. *Lepisorus bicolor* (Takeda) Ching, Bull. Fan Mem. Inst. Biol. 4: 66. 1933; Tagawa & K. Iwats., Fl. Thailand 3(4): 510. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 273. 2000. **Figure 5. 22: E-F.**

Rhizome creeping, bearing sparsely fronds, glaucous on the surface, densely scaly; scales ovate with long attenuate apex, bicoloured, central portion dark brown, paler at margin, 2–3 by 1 mm, minutely toothed at margin. *Fronds* not dimorphic. *Stipes* indistinct, stramineous, winged on the lower portion, scaly at base. *Laminae* linear-lanceolate, gradually narrowing towards both base and apex, 11–18 by 1.9–2.3 cm; midrib raised on both surfaces, stramineous, papyraceous; veins forming areoles with included veinlets. *Sori* medial or a bit close to midrib, round or oblong, brown, 1–2 mm in diameters.

Thailand. – NORTHERN: Chiang Mai; NORTH-EASTERN: Loei (Phu Kradueng); SOUTH-EASTERN: Chanthaburi.

Distribution. – Himalayas and South-West China.

Ecology. – Lithophyte on humus rich on rocks in open area at 1258 m alt.

Specimen examined. – P. Jadprajong 301 (BKF).

2. *Lepisorus henryi* (Hieron. ex C. Chr.) L. Wang, Bot. J. Linn. Soc. 162: 35. 2010. — *Belvisia henryi* (Hieron. ex C. Chr.) Raymond, Mém. Jard. Bot. Montréal 55: 32. 1962; Tagawa & K. Iwats., Fl. Thailand 3(4): 520. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 263. 2000. **Figure 5. 22: G-H.**

Rhizome short creeping, about 5 mm in diameters, densely scaly; scales narrowly subtriangular, gradually narrowing from towards apex, long-attenuate and tailed at apex, broadest at basal portion, about 1.5–2.3 by about 1 mm, concolorously brown, clathrate, toothed at margin. *Stipes* short, castaneous, narrowly winged, scaly at base. *Laminae* narrowly oblong, rather narrowing at apex, bearing linear fertile portion, narrowly cuneate at base, the sterile portion 13–24 cm long, 1.5–3 cm broad, hardly revolute at margin; papyraceous to thin chartaceous, veins hardly distinct, anastomosing; fertile portion linear, not constricted at base, up to 11 by 0.2–0.3 cm broad. *Sporangia* covered the whole under surface except on midribs and margin.

Thailand. – NORTHERN: Chiang Rai (Mae Talop), Chiang Mai (Doi Suthep, Doi Inthanon), Mae Hong Son (Khun Kong San), Phitsanulok (Phu Miang), Tak (Huai Krasa, Ban Musoe); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng, Phu Tong); EASTERN: Nakhon Ratchasima (Khao Yai); SOUTH-WESTERN: Kanchanaburi; CENTRAL: Nakhon Nayok; PENINSULAR: Surat Thani, Nakhon Si Thammarat, Trang, Yala.

Distribution. – Himalayas to South-West China and North Vietnam.

Ecology. – Epiphyte on tree-trunks or lithophyte on mossy rocks in lower-montane forest at 1,174–1,199 m alt.

Specimen examined. – P. Jadprajong 244, 260 (BKF)

3. *Lepisorus nudus* (Hooker) Ching, Bull. Fan Mem. Inst. Biol. 4: 83. 1933; Tagawa & K. Iwats., Fl. Thailand 3(4): 512. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 274. 2000. **Figure 5.23: A-B.**

Rhizome long creeping, about 1.5 mm in diameters, green on surface, bearing remote fronds, scaly throughout; scales ovate-oblong with gradually narrowing attenuate apex, 1–3 by about 1 mm, clathrate, concolorous, light brown, margin entire. *Fronds* monomorphic. *Stipes* 4–7 cm long, castaneous or dark, winged on the upper part and scaly at base. *Laminae* linear or linear-lanceolate, usually broadest at middle portion, gradually narrowing towards both attenuate ends, up to 34.5 by 2–3.4 cm, entire at margin; coriaceous, with few and sparsely scaly beneath. *Sori* medial, round or oblong, 2–4 mm long, 1–3 mm broad, more or less raised, hollowing on upper surface.

Thailand. – NORTHERN: Chiang Mai, Chiang Rai, Tak; NORTH-EASTERN: Loei; SOUTH-EASTERN: Chanthaburi.

Distribution. – Sri Lanka, South India, Himalayas, Upper Myanmar to South-West China (Yunnan).

Ecology. – Lithophyte on humus rich on rocks in open area at 1,258 m alt.

Specimen examined. – P. Jadprajong 241 (BKF).

4. *Lepisorus spicatus* (L. f.) L. Wang, Bot. J. Linn. Soc. 162(1): 35. 2010. — *Belvisia spicata* (L. f.) Mirb., Hist. Nat. Vég. 4: 65. 1803. — *Belvisia revoluta* (Blume) Copel.,

Gen. Fil.: 192. 1947; Tagawa & K. Iwats., Fl. Thailand 3: 521. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 245, 246, 264. 2000. **Figure 5. 23: C-D.**

Rhizome short creeping, 2–5 mm in diameters, densely scaly; scales oblong-subtriangular, gradually narrowing from base towards apex, round at base, attenuate at apex, about 1–2 by about 1 mm, entire, middle portion dark with thick internal walls, paler and thinner at margin. *Stipes* 0.5–2 cm long, not distinct from the midribs of laminae, upper portion with narrowly winged, scaly at base, stramineous to pale castaneous. *Laminae* linear-lanceolate, broadest at middle portion, attenuate towards both ends, 5–15 cm long in sterile portion, 1–2.5 cm broad, margin more or less revolute; softly chartaceous; veins hardly distinct, copiously anastomosing. *Sporangia* wholly covered under surface except on the midribs and margin, linear, 1–9 by 0.3–0.5 cm broad.

Thailand. – NORTHERN: Tak (Mae Sot, Ban Musoe); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng); EASTERN: Nakhon Ratchasima; SOUTH-WESTERN: Kanchanaburi; CENTRAL: Nakhon Nayok; PENINSULAR: Surat Thani, Nakhon Si Thammarat (Khao Luang), Trang (Khao Chong), Yala.

Distribution. – Tropics of Asia, from Sri Lanka to Tahiti.

Ecology. – Epiphyte on mossy tree-trunks in light shade in lower-montane forest at 1,237–1,239 m alt.

Specimen examined. – P. Jadprajong 36, 96, 129, 160, 238, 259 (BKF).

5. LEPTOCHILUS

Kaulfuss, Enum. Filic. 147. 1824; Tagawa & K. Iwats., Fl. Thailand 3(4): 542. 1989.

Plants epilithic, terrestrial, or epiphytic, small to medium-sized. *Rhizome* long creeping; scales peltate, ovate-lanceolate, dark brown, clathrate, entire or toothed at margin, acuminate at apex. *Fronde*s remote, articulate, usually dimorphic. *Lamina*

simple, entire, palmately lobed, digitate, pinnatifid, or pinnate with pinnae adnate to rachis, herbaceous to thinly chartaceous; veins anastomosing, secondary veins prominent, usually 1 or 2, or more rows of areoles between adjacent secondary veins, with excurrent or recurrent free veins; fertile fronds similar to sterile ones or much contracted with lamina absent. *Sori* usually between adjacent secondary veins, orbicular or elongate to linear, or sporangia acrostichoid.

Leptochilus decurrens Blume, Enum. Pl. Javae: 206. 1828; Tagawa & K. Iwats., Fl. Thailand 3(4): 542. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 276. 2000. **Figure 5. 23: E-F.**

Rhizome long-creeping, 3–4 mm in diameters, dorsiventrally flattened, bearing fronds 1–1.5 cm apart, roots dense, scaly throughout; scales narrowly ovate or subtriangular, broadest below the middle, gradually narrowing from base towards acuminate apex, clathrate, up to 2.5 by 1 mm, margin denticulate, concolorous brown. *Fronds* dimorphic. *Sterile fronds*; stipe about 5 cm long, winged at least on the upper part, sparsely scaly at the lower part, stramineous; lamina oblong-lanceolate or narrowly ovate, 21–32 by 3–7 cm, acute to acuminate at apex, margin entire to a little undulate, cuneate at base and decurrent to form wings of stipes; veins anastomosing, distinct on both surfaces, main lateral veins distinct, the other veins forming many areoles with included free veinlets; dark green. *Fertile fronds*: stipe present, 14–33 cm long, stramineous, winged indistinct; lamina linear, 8.5–22 cm long, up to 0.4 cm broad. *Sori* acrostichoid, wholly covered by sporangia except on the midrib.

Thailand. — NORTHERN: Mae Hong Son, Chiang Mai, Chiang Rai, Lamphun, Lampang, Phrae; NORTH-EASTERN: Phetchabun, Loei (Phu Luang, Phu Kradueng); SOUTH-WESTERN: Uthai Thani, Kanchanaburi; SOUTH-EASTERN: Chanthaburi; PENINSULAR: Nakhon Si Thammarat.

Distribution. — Sri Lanka, India, Bhutan, Nepal, Myanmar, South China and Taiwan, Vietnam, Laos, throughout Malaysia, New Guinea, Philippines, Indonesia.

Ecology. – Lithophyte on humid rocks in lower-montane forests at 1,098–1,258 m alt.

Specimen examined. – P. Jadprajong 85, 194 (BKF).

7. LOXOGRAMME

(Blume) C. Presl, Tent. Pterid. 214–215, pl. 9, f. 8. 1836; Tagawa & K. Iwats., Fl. Thailand 3(4): 575. 1989; ; X. C. Zhang, S. G. Lu, Y. X. Lin, X. P. Qi, S. Moore, F. W. Xing, F. G. Wang, P. H. Hovenkamp, M. G. Gilbert, H. P. Nootboom, B. S. Parris, C. Haufler, M. Kato & A. R. Smith, Fl. China 2–3: 761. 2013.

Rhizome short to long creeping, usually slender, sometimes branching; scales clathrate, red-brown to blackish, entire, basifixed. *Fronde* monomorphic to dimorphic, not articulation. *Lamina* simple, linear, elliptic or oblanceolate, margin entire, thinly to thickly papery, margin not cartilaginous, revolute or involute when dry, surface almost glabrous sometime with glandular hairs; veins regularly anastomosing, with or without free included veinlets. *Sori* exindusiate, elongate, oblique to costa, discrete.

Key to the species

- 1a. Base of stipe glossy purplish dark brown or black..... **1. L. duclouxii**
 1b. Base of stipe greenish yellow or paler..... **2. L. salicifolia**

1. Loxogramme duclouxii Christ, Bull. Acad. Int. Geogr. Bot. 16: 140. 1907; Tagawa & K. Iwats., Fl. Thailand 3(4): 578. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 278. 2000; X. C. Zhang, S. G. Lu, Y. X. Lin, X. P. Qi, S. Moore, F. W. Xing, F. G. Wang, P. H. Hovenkamp, M. G. Gilbert, H. P. Nootboom, B. S. Parris, C. Haufler, M. Kato & A. R. Smith, Fl. China 2–3: 764. 2013. **Figure 5. 23: G-H.**

Rhizome long-creeping, about 2 mm in diameters, dark brown, densely covered with scales; scales thin, dark or fuscous-brown, clathrate, oblong-ovate to narrower, margin entire, 4–6 by 1 mm. *Fronde*s monomorphic, remote. *Stipes* short with castaneous base, 2–3 mm in diameters. *Laminae* oblanceolate, broadest at middle to a quarter way from apex, acute to acuminate at apex, up to 44 by 2.6–4.2 cm, often involute at margin, gradually attenuate towards base, decurrent to narrow wings of indistinct stipes; midrib raised on adaxial, flattened beneath, pale green; veins indistinct; coriaceous, thick and fleshy, deep green on upper surface, pale green beneath, glabrous. *Sori* restricted to the upper half of the laminae, close together, deeply overlapping with the next ones, oblique, superficial, 1–3 cm by about 1 mm, close to costa than to the margin of laminae.

Thailand. – NORTHERN: Chiang Mai (Doi Chiang Dao), Phitsanulok (Phu Miang); NORTH-EASTERN: Loei (Phu Luang, Phu Paek, Phu Kradueng), Phetchabun.

Distribution. – Tibet, North-East India, South-West China, Korea, South Japan to Taiwan.

Ecology. – Lithophyte on moist mossy rocks in evergreen forest at 1212 m alt.

Specimen examined. – P. Jadprajong 145 (BKF).

2. *Loxogramme salicifolia* (Makino) Makino, Bot. Mag. (Tokyo). 19: 138. 1905; X. C. Zhang, S. G. Lu, Y. X. Lin, X. P. Qi, S. Moore, F. W. Xing, F. G. Wang, P. H. Hovenkamp, M. G. Gilbert, H. P. Nooteboom, B. S. Parris, C. Haufler, M. Kato & A. R. Smith, Fl. China 2–3: 463. 2013. **Figure 5. 24: A-B.**

Rhizome long-creeping, slender, 2–2.5 mm in diameters, densely scaly; scales brown, ovate-lanceolate, margin entire, apex acuminate. *Fronde*s distant, not or hardly dimorphic, up to 35 cm. *Stipe* greenish yellow to paler (not purplish), 2–5 cm, or subsessile. *Lamina* narrowly oblanceolate to linear, 10–32 by 1–2.5 cm, stipe with long

narrowly winged upwards, attenuated downwards, acuminate at apex, margin entire, involute when dry; costa raised abaxially, flat adaxially; veins indistinct, coriaceous. *Sori* on upper half portion of lamina, up to 15 or more pairs, 1–2 cm, very oblique to costa, arranged midway between the costa and the frond margin, slightly sunken into lamina, paraphyses absent..

Thailand. – NORTH-EASTERN: Loei (Phu Kradueng).

Distribution. – China, Taiwan, Korea, Vietnam, Japan, the Ryukyus.

Ecology. – Lithophyte on mossy rocks in lower-montane forest at 1132–1174 m alt.

Specimen examined. – P. Jadprajong 124, 274, 275 (BKF).

8. MICROSORUM

Link, Hort. Berol. 2: 110. 1833; Tagawa & K. Iwats., Fl. Thailand 3(4): 523. 1989; X. C. Zhang, S. G. Lu, Y. X. Lin, X. P. Qi, S. Moore, F. W. Xing, F. G. Wang, P. H. Hovenkamp, M. G. Gilbert, H. P. Nootboom, B. S. Parris, C. Haufler, M. Kato & A. R. Smith, Fl. China 2–3: 830. 2013.

Plants medium-sized, mainly epiphyte or lithophyte, rarely terrestrial. *Rhizome* thick, fleshy, white waxy or not, creeping, with peltate or pseudopeltate clathrate or subclathrate scales. *Fronde*s dimorphic or not, simple or pinnatifid; lamina leathery or herbaceous, veinlets anastomosing, free included veinlets forked, ending in hydathode. *Sori* scattered and sometimes forming 2–8 irregular rows between veins, often some connate, elongate on veinlets, without scalelike paraphyses.

Key to the species

- 1a. Fronds normally pinnate or forked, sometimes simple; rhizome often dorsiventrally flattened, closely attached to rocky substrate..... **2.**

- 2a. Fronds normally pinnate, occasionally trilobate or simple; stipe and costa abaxially not scaly **1. M. insigne**
- 2b. Fronds normally trilobate or simple; stipe and costa abaxially scaly **3. M. pteropus**
- 1b. Fronds simple, entire, lanceolate; rhizome usually cylindrical, often more loosely attached and epiphytic..... **3.**
- 3a. Lateral veins obscure..... **2. M. membranaceum**
- 3b. Lateral veins prominent, raised prominently, almost from main veins to margin **4. M. punctatum**

1. *Microsorium insigne* (Blume) Copel., Univ. Calif. Publ. Bot. 16: 112. 1929; Boonkerd et al., Thai Forest Bull. (Bot.) 32: 9. 2004. — *Microsorium dilatatum* (Bedd.) Sledge, Bull. Brit. Mus. (Nat. Hist.), Bot. 2: 143. 1960; Tagawa & K. Iwats., Fl. Thailand 3: 530. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 279. 2000. **Figure 5. 24: C-D.**

Rhizome creeping, thick, 2–6 mm diameter, dark brown to blackish, bearing closely spaced fronds, scaly; scales oblong-subtriangular, apex long-acuminate, base round, brown to dark brown, 2–5 by 0.5–2.5 mm, margin entire to dentate, finely to strongly clathrate, round to oblong-ovate on older rhizome. *Stipes* 15–35 cm long, winged distinct nearly to the base, scaly at base. *Laminae* simple to pinnatifid with a few lobes, 37 by about 20 cm, the lower lateral lobes adnate, oblong to oblong-lanceolate, apex caudate, entire, up to 16 by 3.5 cm, the upper lobes gradually becoming smaller, terminal lobes oblong, gradually narrowing towards apex, margin undulate; rachis and midrib raised, main lateral veins distinct but the other visible, copiously anastomosing; light green, papyraceous. *Sori* round, irregularly scattered on the abaxial side, smaller, about 1.6 mm diameter.

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

Distribution. – Himalayas to Indochina, Taiwan, Japan and throughout Western Malesia.

Ecology. – Lithophyte on muddy rocks near streams in deep shade area at about 1,200 m alt.

Specimen examined. – P. Jadprajong 282 (BKF); K. Iwats. & N. Fukuoka T-7172 (BKF); M. Tagawa, K. Iwats. & N. Fukuoka T-1301 (BKF).

2. *Microsorium membranaceum* (D. Don) Ching, Bull. Fan Mem. Inst. Biol. 4: 309. 1933; Tagawa & K. Iwats., Fl. Thailand 3(4): 526. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 280. 2000. **Figure 5. 24: E-F.**

Rhizome creeping, 5–10 mm., bearing closely spaced fronds, usually near apical portion, scaly; scales oblong-subtriangular, gradually narrowing towards apex, up to 1 by 0.2–0.3 cm, clathrate, bi-coloured with the central portion dark greyish-brown, brown at margin, and margin more or less fringed. *Stipes* 7–12 cm long, winged nearly at the base, stramineous or greenish. *Laminae* narrowly oblong, gradually narrowing towards acuminate apex, roundly narrowing and then attenuate to base, margin subentire to slightly wavy, up to 75 by 10–15 cm; midrib raised beneath, lateral veins prominent, areoles visible to hardly visible, many in number and irregularly arranged; thinly herbaceous. *Sori* round, 1–1.5 mm diameter, at joint of veins, irregularly scattered usually in 2–4 rows between main lateral veins.

Thailand. – NORTHERN: Mae Hong Son (Mae Sariang), Chiang Mai (Doi Pha Hom Pok, Doi Chiang Dao, Doi Suthep, Doi Inthanon), Chiang Rai (Doi Tung),

Lamphun (Doi Khun Tan), Lampang (Mae Ngao), Tak (Khao Phra Wo); NORTH-EASTERN: Loei (Phu Kradueng).

Distribution. – Sri Lanka, Himalayas to South China, Taiwan, Northern Vietnam, Laos.

Ecology. – Epiphyte on mossy tree trunks near streams in dense forests, at altitudes about 452 m.

Specimen examined. – P. Jadprajong 246 (BKF).

3. *Microsorium pteropus* (Blume) Copel., Univ. Calif. Publ; Bot. 16: 112. 1929; Tagawa & K. Iwats., Fl. Thailand 3(4): 529. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 280. 2000. **Figure 5. 24: G-H.**

Rhizome long creeping, 1–5 mm diameter, bearing rather closely spaced fronds, densely scaly; scales oblong-lanceolate, gradually narrowing towards apex, base round, 1–4 by 0.4–1.2 mm, brown, distinctly clathrate, margin entire. *Stipes* stramineous, winged on upper part, up to 17 cm long. *Laminae* simple to trifoliate, narrowing towards attenuate base, decurrent downwards as wings of stipes, narrowing towards attenuately long acuminate apex, entire, up to 45 by 1–25 cm, trifoliate laminae usually with various in size and form of the lateral lobes, usually narrower, terminal lobes like simple laminae; midrib raised on both surfaces, more or less minutely scaly, lateral main veins distinct abaxially, anastomosing with main areoles along both sides of midrib, many smaller areoles in irregular arrangement; papyraceous to herbaceous, dark green in colour. *Sori* round, oblong to elongate, many, irregularly scattered on abaxial side of laminae.

Thailand. – NORTHERN: Chiang Rai Mae Lao), Chiang Mai (Doi Chiang On Luang); NORTH-EASTERN: Loei (Phu Luang); EASTERN: Buri Ram (Bu Khanun), Chaiyaphum; CENTRAL: Nakhon Nayok (Khao Yai, Saraburi (Muak Lek); SOUTH-EASTERN: Chanthaburi (Pong Nam Ron); SOUTH-WESTERN: Ratchaburi Kanchanaburi (Khao Ri Yai), Prachuap Khiri Khan (Huai Yang); PENINSULAR: Chumphon (Ban Tha Ngo), Ranong (Mueang Laen), Surat Thani (Ko Samui, Ban Don),

Nakhon Si Thammarat (Khao Luang, Thap Chang, Khiriwong, Trang (Khao Chong), Satun (Bukit Racha Wang), Yala (Bannang Sata).

Distribution. – India to Malesia, Laos, north to Southern China and the Ryukyus.

Ecology. – Lithophyte on wet rocks in stream-beds, usually in spraying water, at 1,000–1,100 m alt.

Specimen examined. – P. Jadprajong 287 (BKF).

4. *Microsorium punctatum* (L.) Copel., Univ. Calif. Publ. Bot. 16: 111. 1929; Tagawa & K. Iwats., Fl. Thailand 3(4): 528. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 255, 280. 2000. **Figure 5. 25: A-B.**

Rhizome creeping, 3–5 mm diameter, dark or glaucous on the surface, bearing closely spaced fronds, scaly; scales narrowly oblong-subtriangular, gradually narrowing from ovate basal portion to long-attenuate apex, clathrate, concolorous, dark greyish-brown, margin toothed, 1–7 by 0.5–2 mm. *Stipes* not distinct or up to 10 cm long, scaly at base, stramineous to greenish. *Laminae* narrowly oblong to lanceolate, apex acute or moderately acute without a pointed apex, narrowing towards attenuate base, decurrent downwards to form wings of stipes sometimes nearly to the base, about 30–120 cm by 4–10 cm; midrib raised on both surfaces, other veins obscure, anastomosing to form areoles; subcoriaceous, the margin of laminae sometimes revolute. *Sori* round, small, many, scattered on the whole under surface of laminae.

Thailand. – NORTHERN: Chiang Rai (Mae Kok), Chiang Mai (Fang, Doi Chiang Dao, Tin Tok, Mae Rim, Doi Inthanon), Lampang (Mae Ngao), Tak (Lan Sang, Doi Musoe), Phitsanulok (Phu Miang, Salaeng Haeng, Thung Salaeng Luang); NORTH EASTERN: Phetchabun, Loei (Phu Luang, Phu Kradueng); EASTERN: Chaiyaphum (Phu Khieo); SOUTH-EASTERN: Prachin Buri (Khao Yai), Chon Buri (Si Racha, Hup Bon), Nakhon Ratchasima (Pak Thong Chai, Pak Chong Chanthaburi (Takhamao Falls, Makham, Khao Kluea), Trat (Ban Saphan Hin, Ko Chang, Ko Kut); SOUTH-WESTERN: Kanchanaburi (Khao Ri Yai, Wangka, Sai Yok, Prachuap Khiri Khan

(Bang Saphan); PENINSULAR: Ranong (Kra Buri, Khlong Nakha), Surat Thani (Ban Don), Phangnga (Khlong Nang Yon), Phuket, Nakhon Si Thammarat (Khao Luang, Thung Song), Trang (Khao Chong, Yala (Khao Khalakhiri, Bannang Sata).

Distribution. – Throughout the tropics of the Old World, Laos (Khammouane, Luang Phrabang), Cambodia (Kampot, Koh Kong), Western Africa to Tahiti.

Ecology. – Lithophyte on mossy rocks usually in dry open places with in light shade at 575-584 m alt.

Specimen examined. – P. Jadprajong 250, 302 (BKF).

9. NEOLEPISORUS

Ching, Bull. Fan Mem. Inst. Biol., Bot. 10(1): 11–12. 1940; L. WANG, Z. Q. WU, Q. P. XIANG, J. HEINRICH, H. SCHNEIDER & X. C. ZHANG, Bot. J. Linn. Soc. 162, 28–38. 2010; X. C. Zhang, S. G. Lu, Y. X. Lin, X. P. Qi, S. Moore, F. W. Xing, F. G. Wang, P. H. Hovenkamp, M. G. Gilbert, H. P. Nooteboom, B. S. Parris, C. Haufler, M. Kato & A. R. Smith, Fl. China 2–3: 806. 2013.

Plants terrestrial or lithophyte, small to medium-sized. *Rhizome* long creeping; scales pseudopeltate to peltate, ovate to lanceolate, margin entire or denticulate. *Fronde* distant, monomorphic. *Stipe* long, scaly. *Lamina* usually simple, entire, sometimes lobed or hastate, herbaceous or papery, scaly; veins anastomosing, areoles regular or irregular, free included veinlets simple or forked. *Sori* in 1–2 rows on each side of midrib, or in 1 row between two lateral veins, oblong or orbicular, sometimes linear or slightly irregular; paraphyses peltate, clathrate or simple uniseriate hairs with glandular apical cells.

Neolepisorus zippelii (Blume) L. Wang, Bot. J. Linn. Soc. 162: 36. 2010; X. C. Zhang, S. G. Lu, Y. X. Lin, X. P. Qi, S. Moore, F. W. Xing, F. G. Wang, P. H. Hovenkamp, M. G. Gilbert, H. P. Nooteboom, B. S. Parris, C. Haufler, M. Kato & A. R. Smith, Fl.

China 2–3: 807. 2013. — *Microsorium zippelii* (Blume) Ching, Bull. Fan Mem. Inst. Biol. 4: 308. 1933; Holttum, Revis. Fl. Malaya ed. 1, 2: 176. 1960; Tagawa & K. Iwats., Fl. Thailand 3(4): 525. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 281. 2000.

Figure 5. 25: C-D.

Rhizome shortly creeping, thick, 3–5 mm in diameter, not white waxy; scales narrowly oblong-subtriangular, 2–5 by 1–2 mm, pseudopeltate, margin denticulate to dentate, apex acute, clathrate or subclathrate, central region glabrous. *Fronde*s not or slightly dimorphic. *Stipe* 1–8 cm, 0.8–3.2 mm in diameter, winged on the upper part. *Lamina* simple, narrowly elliptic to narrowly oblong-lanceolate, 33–65 by 5.3–7.5 cm, apex caudately acuminate, broadest at middle portion, gradually narrowing towards long-attenuate base, margin entire and flat; midrib and main lateral veins raised on both surfaces, veins anastomosing, more or less distinct, smaller areoles in 3 rows between adjacent main veins, with branched included veinlets; papyraceous. *Sori* round, arranged in two rows between main veins, usually at junction of veinlets, about 2 mm diameter

Thailand. – NORTHERN: Chiang Mai (Doi Chiang Dao), Chiang Rai (Mae Len); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng); SOUTH-WESTERN: Phetchaburi.

Distribution. – Himalayas and throughout Malesia, Philippines, Indonesia, northeast to South China and Indochina.

Ecology. – Lithophyte in muddy crevices of rocks by streams in lower-montane forests at about 1,098 m alt.

Specimen examined. – P. Jadprajong 188 (BKF).

10. PARAGRAMMA

T. Moore, Index Filic.: 32. 1857; L. Wang, Z. Q. Wu, Q. P. Xiang, J. Heinrichs, H. Schneider & X. C. Zhang, Bot. J. Linn. Soc. 162: 28–38. 2010.

Rhizome short creeping, bearing close fronds, glaucous on surface; scales strongly clathrate, oblong-ovate with attenuate apex, sharply toothed at margin. *Stipes* stramineous, indistinct or 1–5 cm long, base scaly, winged nearly to the base. *Laminae* linear, gradually narrowing towards both ends, midrib raised on both surfaces, veins hardly distinct; coriaceous, *Sori* round to oblong, arranged in a single row, more or less immersed in the cavities, and densely covered with scale-like paraphyses when young.

Paragramma longifolia (Blume) T. Moore, Index Fil.: 32. 1857. — *Lepisorus longifolius* (Blume) Holttum, Revis. Fl. Malaya 2: 151. 1960; Tagawa & K. Iwats., Fl. Thailand 3(4): 508. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 274. 2000. **Figure 5. 25: E-F.**

Rhizome short creeping, 3–4.5 mm diameter, bearing closely spaced fronds, glaucous on surface, scaly; scales oblong-ovate with attenuate apex, 2–3 mm long by 0.5–1 mm broad, light brown, more or less clathrate, sharply toothed at margin. *Stipes* stramineous, indistinct or 1–5 cm long, scaly at base, winged nearly to base. *Laminae* linear, 21–48 cm long, 1.5–3.4 cm broad, broadest usually at about 1/4 way from base, gradually narrowing towards both ends, attenuate towards apex, round or pointed at the very apex, attenuate towards base; midrib raised on both surfaces, veins hardly distinct on both surfaces, copiously anastomosing with included free veinlets; coriaceous. *Sori* usually oblong, occasionally round, 3–6 by 2 mm, arranged in a single row, about 1–2 mm from the margin, more or less immersed in cavities and densely covered with scale-like paraphyses when young. *Spores* monolete.

Thailand. – NORTHERN: Chiang Mai (Doi Chiang Dao); PENINSULAR Chumphon (Tha San), Ranong (Kapoe), Phangnga, Nakhon Si Thammarat (Khao

Luang, Thung Song), Satun (Adang, Klong Ton), Narathiwat (Sungai Padi), Yala (Betong).

Distribution. – North-Eastern India, Myanmar, Western Malesia to the Philippines and Java.

Ecology. – Epiphyte on tree-trunks or on rocks in dense evergreen forests or along streams in light shade at about 1,239 m alt.

Spicimen examined. – P. Jadprajong 97 (BKF).

11. PLATYCERIUM

Desv., Mém. Soc. Linn. Paris 6: 213. 1827; Tagawa & K. Iwats., Fl. Thailand 3(4): 487. 1989.

Plants epiphyte or sometimes lithophyte. *Rhizome* thick, shortly creeping, covered by roots and fronds; scales basifixed to peltate, often with a thickened dark central portion, margin ciliate, concolorous or pale brown, large. *Fronde*s extremely dimorphic; lamina fleshy and leathery, covered with stellate hairs; main veins conspicuous, dichotomously branched, usually on each lobe or branch, minor veins often anastomosing with free included veinlets. Basal fronds persistent, base strongly appressed to substrate, entire or forked; fertile fronds in pairs, simple to dichotomously forked, erect to pendulous. *Sori* forming large soral patches, stellate paraphyses many. Spores monoete.

Platycerium wallichii Hook., Gard. Chron. 765: 1858; Tagawa & K. Iwats., Fl. Thailand 3(4): 488. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 258, 283. 2000.

Figure 5. 25: G-H.

Rhizome short creeping, about 1 cm in diameters, densely covered with scales; scales linear, 1.2 by 0.2 cm, dark brown at center, paler with ciliate margin. *Fronde* strongly dimorphic with nest leaves and fertile fronds. *Nest leaves* erect, 58 cm or more in length, as wide as long, dichotomously lobed, the deepest sinus more than 20 cm, lobes round or moderately acute at apex, longer than wide; main veins dichotomous and secondary veins forming network, distinct on both surfaces, smaller ones more anastomosing and hardly visible; very thick and fleshy near base, thinner and green at upper portion. *Normal leaves* up to 50 cm or longer, pendulous, repeatedly dichotomously branching, broadly cuneate at base; ultimate lobes narrow, up to 15 cm by 3 cm, entire; main veins distinct, dichotomous, smaller ones hardly visible, anastomosing with included veinlets; thick but not leathery, densely covered with stellate hair. *Sporangia* on the lower surface at base of the two first sinuses, to form soral patches, mixed with many stellate hairs.

Thailand. – NORTHERN: Chiang Rai (Mae Suai), Chiang Mai (Fang, Ping Klong, Doi Suthep), Mae Hong Son (Ban Mae Pang), Lampang (Huai Thak), Nakhon Sawan (Pang Ma Kham Pom, Takhli); NORTH-EASTERN: Loei (Phu Luang, Pha Nok Khao, Phu Kradueng), Nong Khai; SOUTH-WESTERN: Kanchanaburi; CENTRAL: Saraburi; SOUTH-EASTERN: Chon Buri; PENINSULAR: Ranong, Satun.

Distribution. – East India, Myanmar (Tenasserim) and Yunnan to Malaysia (Langkawi; Kedah).

Ecology. – Epiphyte on tree-trunks sometimes on sandy rocks usually in deciduous forests at low to medium altitudes, 300–750 m alt.

Specimen examined. – P. Jadprajong 205 (BKF).

12. PYRROSIA

Mirb., *Hist. Nat. Vég.* 3: 471. 1803; X. C. Zhang, S. G. Lu, Y. X. Lin, X. P. Qi, S. Moore, F. W. Xing, F. G. Wang, P. H. Hovenkamp, M. G. Gilbert, H. P. Nootboom, B. S. Parris, *Fl. China* 2–3: 786. 2013.

Plants small to medium-sized. *Rhizomes* shortly to long creeping, densely scaly. *Fronde*s monomorphic or dimorphic, remote or clustered, covered with stellate hairs. *Lamina* simple; main veins distinct; lateral veins obliquely spreading, distinct or obscure; veinlets distinct or obscure and joined into different types of areoles, these with included veinlets, mostly ending with an adaxial hydathode. *Sori* orbicular, borne at ends of included veinlets, in one to several rows on each side of main veins, exindusiate, sometimes with stellate paraphyses.

Key to the species

- 1a. Fronds dimorphic with longer fertile fronds..... **1. P. adnascens**
- 1b. Fronds monomorphic or subdimorphic..... **2.**
- 2a. Laminae linear-lanceolate to narrower, up to 2 cm broad..... **4. P. porosa**
- 2b. Laminae lanceolate to oblong-lanceolate, up to 3 cm or longer..... **3.**
- 3a. Rhizome short-creeping, bearing fronds close together..... **2. P. stigmosa**
- 3b. Rhizome long-creeping, bearing distant fronds
 **3. P. lingua var. heteractis**

1. *Pyrrrosia adnascens* (Sw.) Ching, *Bull. Chin. Bot. Soc.* 1: 45. 1935; Tagawa & K. Iwats., *Fl. Thailand* 3(4): 496. 1989; Boonkerd & Pollawatn, *Pterid. Thailand*: 286. 2000. **Figure 5. 26: A-B.**

Rhizome long-creeping, 1–2 mm in diameter, densely scaly throughout; scales oblong-subdeltoid, apex attenuate, round at base, 1–3 by 0.5 mm, dark brown in middle and paler at margin, margin hairy, appressed. *Fronde*s dimorphic. *Sterile fronds*: stipes dark brown or paler upwards, about 1 cm long, scaly at base, with stellate hairs. *Laminae* lanceolate, apex round, gradually narrowing to the base, usually 6–15 by 1.5–2 cm; midrib grooved above, raised beneath, pale green, veins completely hidden, anastomosing; thick and fleshy, adaxially surface stellate-hairy or glabrous, abaxially surface densely with appressed stellate hairs with brown center, *Fertile fronds* longer, stipes 1–3.5 cm in length, up to 20 by about 1 cm, apex acute. *Sporangia* covering the whole lower surface of apical half, narrowing in soriferous portion. *Sori* naked, covered with dense stellate hairs when young, curved back in dried condition.

Thailand. – NORTHERN: Chiang Rai (Chiang Khong, Mae Suai), Chiang Mai (Fang, Mae Rim, Doi Chiang Dao, Doi Saket, Doi Suthep, Mae Klang, Sop Aep), Lampang (Khao Tham Pha Thai), Phitsanulok (Thung Salaeng Luang), Tak (Ban Musoe, Huai Krasa, Lan Sang); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng, Pha Nam Thop), Khon Kaen (Pha Nok Khao), Nong Khai (Ban Kun Ka, Mukdahan); EASTERN: Nakhon Ratchasima (Khao Lotueng), Chaiyaphum (Tat Ton Phu Khieo), Buri Ram (Chan Thuek); CENTRAL: Saraburi (Muak Lek), Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chon Buri (Si Racha, Ko Sichang), Chanthaburi (Makham, Khlung, Laem Sing, Khao Sabap), Trat (Ban Saphan Hin, Ko Chang, Ko Rang Yai); SOUTH-WESTERN: Kanchanaburi (Erawan), Prachuap Khiri Khan (Huai Yang, Bang Saphan); PENINSULAR: Ranong (Khao Sai Daeng), Surat Thani (Ko Tao, Ko Kut, Ban Don), Phangnga Takua Thung, Ko Kho Khao, Thung Maphrao, Ko Similan), Phuket (Ko Phu), Nakhon Si Thammarat (Okhriwong, Chawang, Khao Luang), Trang (Khao Chong, Phatthalung, Narathiwat (Bacho Falls), Yala (Bannang Sata).

Distribution. – Widely known in the tropics of Asia, Nepal, India to South China, Indochina, Thailand, Vietnam, Cambodia, Taiwan and the Ryukyus, Malasia throughout to Polynesia.

Ecology. – Epiphytic on dry tree-trunks or lithophyte on rocks in open places or in light shade at 450–800 m alt.

Specimen examined. – P. Jadprajong 91, 204, 210, 277 (BKF).

2. *Pyrrosia lingua* (Thunb.) Farw., Amer. Midl. Naturalist 12(8): 302. 1931.

var. *heteractis* (Mett. ex Kun) Hovencamp, Blumea 30(1): 208. 1984; Boonkerd & Pollawatn, Pterid. Thailand: 286. 2000. — *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., 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. **Figure 5. 26: C-D.**

Rhizome long creeping, 2–3 mm diameter, scaly throughout; scales narrowly subtriangular, lanceolate or oblong-lanceolate, appressed or patent, apex attenuate, up to 5 by 1–1.5 mm, bicoloured, dark at basal and middle portion, brown at margin, apex margin with long downy hairs. *Fronde* simple. *Stipes* up to 30 cm long, densely hairy throughout with greyish-brown hairs and dark stellate hairs, scaly at base. *Laminae* oblong-lanceolate, ovate or elliptic, apex round to acuminate, rounded to decurrent at base, margin often involute, 5–19 by 3–7 cm, coriaceous, fertile fronds not different or a little taller; midrib and main veins distinct, raised abaxially, other veins hardly visible, anastomosing; coriaceous, upper surface with scattered hydathodes, stellate hairy or glabrous, lower surface densely covered with grey-brown hairs on the lower layer and needle-like arms. *Sori* round, not confluent, scattered on all the abaxial surface, or in upper part of it, embedded in stellate hairs.

Thailand. – NORTHERN: Chiang Rai (Doi Tung), Chiang Mai (Doi Phahom Pok, Doi Chiang Dao, Doi Inthanon, Doi Suthep, Pha Mon), Tak, Phitsanulok (Phu Miang, Thung Salaeng Luang); NORTH EASTERN: Loei (Phu Luang, Phu Kradueng, Phu Paek); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi

(Khao Soi Dao), Trat (Khao Kuap); SOUTH-WESTERN: Kanchanaburi (Si Sawat), Phetchaburi, Prachuap Khiri Khan; PENINSULAR: Nakhon Si Thammarat (Khao Luang, Khao Phra Mi), Ranong, Phangnga (Khao Phota Luang Kaeo), Trang (Khao Chong).

Distribution. – Northern India, Nepal, Bhutan, Southern China, Myanmar, Cambodia, Laos, Vietnam.

Ecology. – Lithophyte on rocks or epiphyte on tree trunks in exposed places or in light shade, rather dense forests at 1,150-1,236 m alt.

Specimen examined. – P. Jadprajong 60, 62, 67, 179 (BKF).

3. *Pyrrosia porosa* (C. Presl) Hovenkamp, *Blumea* 30: 208. 1984; Hovenkamp, *Fl. Malesiana*, Ser. 2, Pterid. 3: 168. 1998. — *Pyrrosia mollis* auct. non (Kunze) Ching: Tagawa & K. Iwats., *Fl. Thailand* 3(4): 501. 1989; Boonkerd & Pollawatn, *Pterid. Thailand*: 287. 2000. **Figure 5. 26: E-F.**

Rhizome creeping, 1–2.5 mm diameter, densely scaly throughout; scales oblong-lanceolate, gradually narrowing towards tailed apex, margin hairy, thin 2–5 by 0.5–2 mm, dark brown to darker in middle portion, paler at margin. *Fronde*s simple. *Stipes* indistinct, winged almost to the base. *Laminae* oblanceolate, apex acute to acuminate, base attenuate, 10–25 by 1–2 cm; midrib raised on abaxial side, not raised on upper part of adaxial surface, veins anastomosing, hardly distinct; thickly fleshy, upper surface green, with downy stellate hairs or glabrous, hydathodes scattered, lower surface densely covered with soft wavy rays and long stiff brown rays. *Sori* scattered on the abaxial surface of the upper half of fronds, almost covering the whole under surface, covered with stellate hairs.

Thailand. – NORTHERN: Chiang Mai (Doi Phahom Pok, Doi Chiang Dao, Khun Kong San, Doi Hua Mot, Doi Suthep, Doi Inthanon, Pang Bo), Chiang Rai (Phu

Langka), Lampang (Mae Mo, Mae Ta); NORTH-EASTERN: Loei (Phu Kradueng); SOUTH-EASTERN: Trat (Ko Chang).

Distribution. – Sri Lanka, Himalayas to South-Western China, Upper Burma and Indochina.

Ecology. – Epiphyte on mossy tree trunks usually in evergreen forests at 1,212–1,228 m alt.

Specimen examined. – P. Jadprajong 105, 106, 151, 176 203, 254 (BKF).

4. *Pyrrosia stigmosa* (Sw.) Ching, Bull. Chin. Bot. Soc. 1: 67. 1935; Tagawa & K. Iwats., Fl. Thailand 3(4): 504. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 260, 288. 2000. **Figure 5. 26: G-H.**

Rhizome short creeping, 2–3 mm in diameter, scaly; scales ovate with long tails, 0.5–1 mm broad, more or less bicoloured, basal portion dark brown to nearly black, marginal portion and long-tails brown to dark brown. *Fronde*s simple, thick, the sterile and the fertile fronds not different. *Stipes* about 1–2 cm long, stramineous or brown, scaly at base, hairy throughout. *Laminae* lanceolate, apex acuminate, base cuneate, decurrent downwards, 20–28 cm long, 2.9–5.2 cm broad; midrib and main veins raised abaxially, the other veins invisible, anastomosing; upper surface deep green, with scattered hydathodes, covered with stellate hairs or glabrous, lower surface densely covered with stellate hairs. *Sori* round, about 0.8 mm diam., usually covering the whole undersurface of fronds except for the lower portion.

Thailand. – NORTHERN: Chiang Rai (Phu Langka), Chiang Mai (Fang Doi Chiang Dao), Mae Hong Son, Lampang (Mae Mo, Mae Long Ngao, Tham Pha Thai), Tak (Khao Phra Wo, Lan Sang, Huai Krasa, Rahaeng), Phitsanulok (Thung Salaeng Luang); NORTH EASTERN: Loei (Phu Luang, Phu Kradueng), Nakhon Phanom (Mukdahan); CENTRAL: Saraburi (Muak Lek, Khao Khao), Nakhon Nayok (Nang Rong); SOUTH-EASTERN: Prachin Buri (Ban Hills), Chanthaburi (Takhamao Falls);

SOUTH-WESTERN: Kanchanaburi (Huai Ban Kao, Linthin, Sa Yok, Prachuap Khiri Khan (Huai Yang); PENINSULAR: Chumphon (Tha Ko), Surat Thani (Khao Hua Khwai, Khao Na Daeng), Phangnga (Thap Put), Yala (Bannang Sata).

Distribution. – Burma, Indochina and southwards to Malesia.

Ecology. – Lithophyte on moist rocks usually in light shade in dense forest at about 1,110 m alt.

Specimen examined. – P. Jadprajong 276 (BKF).

13. SELLIGUEA

Bory, Dict. Class. Hist. Nat. 6: 587. 1824; Tagawa & K. Iwats., Fl. Thailand 3(4): 562. 1989. — *Crypsinus* Presl., Epimel. Bot.: 123. 1849; Tagawa & K. Iwats., Fl. Thailand 3(4): 553. 1989.

Rhizome slender, densely scaly; scales reddish brown to dark brown, ovate-lanceolate or lanceolate, margin entire, toothed, or ciliate. *Fronds* monomorphic or dimorphic, fertile fronds usually longer and narrower, remote, articulate torrhizome. *Stipe* usually glabrous, scaly at base. *Lamina* simple, hastately 3-lobed, pinnately divided, or sometimes pinnatisect, glabrous or pubescent. Lobes usually lanceolate, distinctly cartilaginous at margin, entire, notched, or serrate, apex acuminate or obtuse. Lateral veins distinct; veinlets anastomosing, forming areoles with included free veinlets. *Sori* orbicular, in one row on each side of costa, superficial, rarely sunken on abaxial side and raised on adaxial side.

Key to the species

1a. All fronds simple, linear, lanceolate, or ovate..... **2. *S. rhynchophylla***

1b. At least some fronds deeply lobed, hastately divided, palmately parted, pinnately parted, or pinnatisect..... **2.**

- 2a. Fronds hairly throughout..... **3. S. trisecta**
- 2b. Fronds glabrous..... **1. S. oxyloba**

1. Selligaea 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., Fl. Thailand 3: 559. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 248, 267. 2000.

Figure 5. 27: A-B.

Rhizome long creeping, 3–4 mm in diameters, densely scaly throughout; scales peltate, gradually narrowing from base to long-tailed apex, 2–5 by 1 mm, brown with paler in narrow tails, toothed at margin. *Stipes* stramineous or brown, short phyllopodia, scaly, glabrous upwards, 3.5–14 cm long. *Laminae* lobed, 1–3 pairs of lateral lobes and a terminal one, up to 21 by up to 17.5 cm; rachis brown on lower surface, paler on upper surface, winged 7–15 mm in breadth; lateral lobes usually longest at base, linear to oblong-subdeltoid, round to acute at apex, up to 11 by 1–2 cm, entire, terminal lobes longer, up to 13 by 2.2 cm; midrib raised on both surfaces, main veins distinct, ascending, the other veins obscure, reticulate to form areoles with included veinlets; papyraceous, green on upper surface and paler beneath, glabrous. *Sori* one in a single row, between adjacent main veins, along both sides of midrib, medial or subcostular, round, 2–3 mm in diameters

Thailand. – NORTHERN: Chiang Mai, Chiang Rai, Lamphun, Phitsanulok; NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng); SOUTH-WESTERN: Ratchaburi; SOUTH-EASTERN: Prachin Buri.

Distribution. – North India, Nepal, Upper Myanmar, South-West China (Yunnan & Szechuan) and Indochina.

Ecology. – Lithophyte on rocks in light shade area and dry places near cliff faces or boundary at 1304 m alt.

Specimen examined. – P. Jadprajong 269 (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., Fl. Thailand 3: 556. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 268. 2000. **Figure 5, 27: C-D.**

Rhizome long creeping, 1–1.5 mm in diameters, densely scaly throughout; scales ovate-lanceolate or ovate with long-tails at apex, 2–4 by 0.5–1 mm, margin entire to sparsely toothed, membranous, brown. *Fronde* simple, two forms or moderately dimorphic. *Sterile fronds* smaller with short stipe of up to 3 cm long, ovate-oblong, moderately acute at both ends, about 4 by 1.5 cm. *Fertile fronds* larger than the sterile ones, stipes 5–13 cm in length, scaly at base, glabrescent upwards; laminae linear-lanceolate to lanceolate, cuneate at base, broadest at about 1/4 way from base, narrowing at upper than 1/4 from base, acute at apex, 8–18 by 1.5–2.3 cm, the soriferous portion less than 1 cm in breadth; coriaceous, green, glabrous; cartilagenous margin thick, brown or black. *Sori* one between adjacent main veins, a single row at each side of midrib, not or slightly contracted; sori round, 1–2 mm diam, separate.

Thailand. – NORTHERN: Chiang Mai, Phitsanulok; NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng); SOUTH-WESTERN: Kanchanaburi; SOUTH-EASTERN: Chanthaburi.

Distribution. – Cambodia, North India, Myanmar, South-West China, Indonesia, Laos, Myanmar, Nepal, Philippines, Thailand, Vietnam

Ecology. – Lithophyte on rocks or crevice of rocks in light shade at 1233 m alt.

Specimen examined. — P. Jadprajong 136, 156 (BKF).

3. *Selliguea trisecta* (Baker) Fraser-Jenk., Taxon. Revis. Indian Subcontinental Pteridophytes 45. 2008. — *Crypsinus hirsutus* Tagawa & K. Iwats., Acta Phytotax. Geobot. 24: 176. 1970; Tagawa & K. Iwats., Fl. Thailand 3(4): 560. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 267. 2000. **Figure 5. 27: E-F.**

Rhizome long creeping, about 3 mm in diameters, glaucous, densely scaly throughout; scales subulate, about 3 by 0.5–0.8 mm, dark brown, paler and ciliate at margin; phyllopodia about 0.5 cm long. *Stipes* stramineous, 5–9 cm long, densely hairy throughout. *Laminae* almostly hastate, up to 16 by 15.5 cm; lateral lobes ascending, narrowly elliptic, slightly falcate, long-acuminate apex, 6–9 cm long by 1.5–2 cm broad; apical lobes gradually narrowing towards long-acuminate apex, little constricted at base, up to 16 long by 1.7–2.4 cm broad; midrib flat above, raised below, densely hairy; main veins distinct on both surfaces, about 5 mm between the next ones; veins usually visible or hardly, forming many larger areoles and included smaller areoles with free veinlets inside, the end of free veinlets often thickened, papyraceous, quite densely hairy on both surfaces and margin, sometimes only sparsely hairy above and glabrous below, subentire or undulate at margin, with cartilaginous membrane at margin; small unicellular hairs present. *Sori* round, 1–2 mm in diameters, formally one between main veins, closer to midrib than margin.

Thailand. – NORTHERN: Chiang Mai, Chiang Rai, Tak, Phitsanulok; NORTH-EASTERN: Loei.

Distribution. – Endemic to Thailand.

Ecology. – Lithophyte on rocks in moist and light shade area or dry places at about 1200 m alt.

Specimen examined. – P. Jadprajong 233 (BKF).

PSILOTACEAE

J. W. Griff. & Henfr., Microgr. Dict. 540. 1855; Tagawa & K. Iwats., Fl. Thailand 3(1): 5. 1979.

Plants small to medium in sized, mostly epiphyte. *Rhizomes* long creeping, usually dichotomously branched. *Stems* erect or rather pendulous, glabrous, branches ridged or complanate. *Leaves* reduced, sessile, dimorphic, trophophylls scalelike, sporophylls deeply bifid. *Sporangia* 3-lobed, attached at bases of sporophylls. *Spores* monolete.

PSILOTUM

Swartz, J. Bot. (Schrader). 1800(2): 8, 109. 1801; Tagawa & K. Iwats., Fl. Thailand 3(1): 5. 1979.

Rhizomes long creeping, usually dichotomously branched. *Stems* erect or rather pendulous, glabrous, repeatedly dichotomously branched; branches green, ridged or complanate. *Leaves* reduced, vein not present, sessile, dimorphic; trophophylls scalelike, subulate-triangular; sporophylls deeply bifid. *Sporangia* 3-lobed, isosporous, attached at bases of sporophylls.

Psilotum nudum* (L.) P. Beauv, Prodr. Aethéogam. 112. 1805; Tagawa & K. Iwats., Fl. Thailand 3(1): 5. 1979. — *Lycopodium nudum* L., Sp. Pl. 2: 1100. 1753. **Figure 5. 27: G-H.*

Rhizomes creeping, terete, with dense rhizoids, brown. *Aerial stems* erect to rather pendulous, green, with a lot of white stomata, glabrous, 22–28 cm long, 1.2–3 mm wide, unbranched at the basal part, dichotomously branched on the upper part repeatedly, triangle or 3-ridged. *Trophophylls* subulate-triangular, scalelike, 2 mm long, 1 mm in widest part, herbaceous; sporophylls bifid, lobes narrowly subulate, about 1

mm. *Sporangia* yellow to yellowish brown, obtriangular-globose, isosporous, 1–2 mm in diameters, 3-lobed.

Thailand. – NORTHERN: Chiang Rai, Chiang Mai (Mae Rim, Doi Inthanon, Om Koi), Tak (Lan Sang); NORTH-EASTERN: Loei (Wang Saphung, Phu Kradueng), Khon Kaen (Phu Wieng); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chon Buri (Sri Racha), Chanthaburi (Pong Nam Ron, Soi Dao); SOUTH-WESTERN: Kanchanaburi (Ban Kaeng Liang), Prachuap Khiri Khan (Huai Yang); PENINSULAR: Chumphon (Ko Wieng, Bang Son), Ranong, Surat Thani (Ko Phangan), Nakhon Si Thammarat (Kao Luang), Phatthalung.

Distribution. – Tropics and subtropics throughout the world, north to Jeju Island (South Korea).

Ecology. – Epiphyte on tree-trunks, sometime terrestrial, in light shade at altitudes ranging from 280 to 1,271 m.

Specimen examined. – P. jadprajong 80, 245 (BKF); K. Sridith 16 (BCU); P. Nopsiriwong 55, 207 (BCU); T. Boonkerd 1320 (BCU); Y. Yuyen 8 (BCU); A.F.G. Kerr 6443 (BKF); G. Murata, C. Phengklai, S. Mitsuta, T. Yahara, H. Nagamasu and N. Nantasan 50985 (BKF); D.J. Middleton, S. Suddee and C. Hemrat 1292 (BKF).

PTERIDACEAE

E. D. M. Kirchn., Schul-Bot. 109. 1831; Tagawa & K. Iwats., Fl. Thailand 3(2): 231. 1985; G. M. Zhang, W. B. Liao, M. Y. Ding, Y. X. Lin, Z. H. Wu, X. C. Zhang, S. Y. Dong, J. Prado, M. G. Gilbert, G. Yatskievych, T. A. Ranker, E. A. Hooper, E. R. Alverson, J. S. Metzgar, A. M. Funston, S. Masuyama & M. Kato, Fl. China 2–3: 169. 2013.

Plants mostly terrestrial or epilithic, some epiphytic, small to large in size. *Rhizomes* erect, ascending, or creeping, usually scaly; scales brown or black, sometimes

clathrate, lanceolate to cordate, sometimes peltate. *Fronde*s monomorphic to dimorphic, clustered to scattered. *Stipe* terete or adaxially grooved, glabrous, hairy, or scaly. *Lamina* simple or 1–4-pinnate, or 1–3-palmate or dichotomously branched; ultimate pinnules often stalked, sometimes articulate; veins free or anastomosing, simple or forked. *Sori* confluent along veins or marginal commissures, sometimes immersed in grooves, sometime discrete on vein tips or on recurved membranous marginal lobe or false indusium, true indusium absent.

Key to the genera

- 1a. Sporangia along veins or over most of abaxial surface of lamina..... **2.**
- 2a. Fronds obovate to oblanceolate, widest above middle; sori multiseriate along veins, in grooves along veins on abaxial surface of lamina..... **3. Antrophyum**
- 2b. Fronds filiform to linear or ribbonlike; sori biseriate or uniseriate, in marginal or submarginal grooves, rarely superficial..... **5. Haplopteris**
- 1b. Sporangia in discrete sori, usually near lamina margin..... **3.**
- 3a. Pinnules obviously stalked, often articulate; stipe and rachis slender, glossy black or reddish brown..... **1. Adiantum**
- 3b. Pinnules sessile or obscurely stalked, never articulate; stipe and rachis often not dark and glossy..... **4.**
- 4a. Lamina pentagonal in outline..... **4. Calciphlopteris**
- 4b. Lamina lanceolate, oblong-lanceolate, or oblong-triangular to deltoid-lanceolate or deltoid-ovate in outline..... **5.**
- 5a. Sporangia continuous along most of length of pinnae margin; pinnae entire or pectinately divided into segments..... **6. Pteris**

- 5b. Sporangia in discrete sori at veins tips at least when young; pinnae pinnatifid..... **2. Aleuritopteris**

1. ADIANTUM

L., Sp. Pl. 2: 1094. 1753; Tagawa & K. Iwats., Fl. Thailand 3(2): 206. 1985.

Rhizome creeping to erect, scaly with small scales. *Stipe* not jointed to rachis. *Fronde* simple to pinnately, usually with dimidiate or flabellate leaflets; soft to papery, glabrous or hairy, rarely glaucous beneath; veins free or rarely anastomosing. *Sori* along veins, on inner face of reflexed marginal flaps (false-indusia); spores tetrahedral.

Key to the species

- 1a. Fronds 1–3-palmate or dichotomously branched..... **3. A. hispidulum**
- 1b. Fronds 1-pinnate or more compound..... **2.**
- 2a. Pinnae almost sessile..... **1. A. caudatum**
- 2b. Pinnae with distinct stalk..... **3.**
- 3a. Pinnae fan-shape; sori semicircular to oblong, 1–3 mm..... **2. A. erylliae**
- 3b. Pinnae crescent-shape; sori elongate, usually 0.4–1.5 cm.. **4. A. philippense**

1. Adiantum caudatum L., Mant. Pl.: 308. 1771; Tagawa & K. Iwats., Fl. Thailand 3: 207. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 117. 2000. **Figure 5. 28: A-B.**

Rhizome erect, covered with scales; scales linear, 4–5 mm long, 0.5 mm wide, bicoloured, black at middle and pale brown at margin, margin entire or minutely tooth.

Stipes up to 10 cm long, castaneous to dark brown, polished, densely hairy with long multicellular uniseriate brown hairs, scaly at base. *Laminae* one pinnate, lanceolate to linear-lanceolate, 10–36 by 2.2–4 cm; rachis densely hairy on upper surface, apex usually prolonged, rooting at tip to form new plantlet; lateral pinnae 32–50 pairs, alternate or subopposite, 0.5–2 by 0.3–0.8 cm, the lower ones smaller and reflexed, largest pinnae sessile, suboblong, round at apex, lower margin almost straight and entire, nearly parallel to the upper margin, inner edge straight, to form narrowly cuneate base with lower margin, upper and outer margins deeply lobed into more than half width of pinna, forming many narrow lobes and sinus; lobes truncate or slightly toothed at apex, margin entire; papyraceous, lower surface with short and long hairs, upper surface with stiff hairs; veins visible on both surfaces, many forked. *Sori* on apices of lobes; false indusia dark brown, narrow, orbicular or oblong, hairy.

Thailand. – NORTHERN: Mae Hong Son, Chiang Mai (Doi Chiang Dao), Chiang Rai, Lampang, Phrae, Tak, Phitsanulok (Tung Salaen Luang); NORTH-EASTERN: Loei (Phu Kradueng), Nong Khai; EASTERN: Chaiyaphum (Nam Phrom), Nakhon Ratchasima; SOUTH-WESTERN: Kanchanaburi (Erawan waterfall), Prachuap Khiri Khan; CENTRAL: Phra Nakhon Si Ayutthaya, Saraburi; SOUTH-EASTERN: Chon Buri, Chanthaburi; PENINSULAR: Chumphon, Surat Thani, Phangnga, Nakhon Si Thammarat, Phatthalung, Trang, Satun, Songkhla, Pattani, Yala.

Distribution. – Tropics of the Old World in general (Bhutan, Cambodia, India, Indonesia, Laos, Malaysia, Myanmar, Nepal, Philippines, Thailand, Vietnam), from Africa to Polynesia.

Ecology. – Terrestrial on rather dry slopes or sandt soil usually in deciduous dipterocarp forests at altitudes from 452–709 m.

Specimens examined. – P. Jadprajong 87, 111, 295 (BKF).

2. *Adiantum erylliae* C. Chr. & Tardieu, Notul. Syst. (Paris) 6; 172, f. 1 & 2. 1938; Tardieu & C. Chr., Fl. Indo-Chine 7(2): 184. 1940; Tagawa & K. Iwats., Fl. Thailand 3: 213, 1985; Boonkerd & Pollawatn, Pterid. Thailand: 117. 2000. **Figure 5. 28: C-D.**

Rhizome short erect, rather densely covered with scales; scales linear, 1–3 mm long, 1 mm wide, indistinctly bicoloured with black center somewhat paler at margin, entire or with irregular tooth at margin. *Stipes* shiny, brown to nearly black, 6–9 cm long, glabrous except for scaly basal part, scales concolorous dark brown. *Laminae* simply pinnate, 3–5 pairs of pinnae, lanceolate to linear-lanceolate, gradually narrowing upwards, 5–14 by 2–4 cm; rachis glabrous, often greatly prolonged and rooting at tip; lateral pinnae distinctly stalked, 1.5–3 mm long; leaflets flabellate, 1–1.9 by 0.6–2 cm, basal edge entire, base cuneate to obtuse, distal margin round or truncate, subentire or with shallow sinuses; thin, glabrous; veins repeatedly forked. *Sori* semicircular to oblong, up to 6 per pinna; false indusia 1–3 mm.

Thailand. – NORTHERN: Chiang Mai, Lampang, Tak (Raheng); NORTH-EASTERN: Loei (Phu Kradueng), Phetchabun, Khon Kaen; EASTERN: Chiayaphum; SOUTH-WESTERN: Kanchanaburi; PENINSULAR: Surat Thani, Phangnga, Krabi.

Distribution. – Vietnam, Laos (Champasak) and Cambodia.

Ecology. – Terrestrial on dry slopes in light shade in deciduous forest at altitudes from 351–476 m.

Specimens examined. — P. Jadprajong 208 (BKF).

3. *Adiantum hispidulum* Sw., J. Bot. (Schrader). 1800 (2): 82. 1801; Boonkerd & Pollawatn, Songklanakarin J. Sci. Technol. 35 (5): 513. 2013. **Figure 5. 28: E.**

Rhizome short, erect, covered with lanceolate, concolorous brown scales; scales about 2 by 0.35 mm, entire. *Fronde* erect, tufted. *Stipe* castaneous, polished, about 17 cm long, clothed towards the base with brown scales, covered with short stiff

multicellular hairs. *Lamina* ovate to deltate, 15.0–17.5 by 5–12 cm, 2- to 3-pinnate. Middle pinnae largest, linear-oblong, ca. 15 cm long; costa densely covered with multicellular hispid hairs, lateral pinnules up to 22 pairs, alternate, with short stalks; middle pinnules nearly equal in size, mostly rhombic, ca. 0.9 by 0.6 cm, becoming gradually smaller toward both ends, thin, firm, dark green, bases cuneate, inner and lower margins straight and entire, upper margins with narrow shallow sinuses, outer margins serrate to incised; veins free, forked, visible on both sides, hairy on both surfaces, hairs multicellular, stiff, patent; lateral pinnae similar to the middle one. *Sori* at 2–3 vein tips, near margin, 4–9 for each leaflets; indusia flaps oblong, bearing brown hairs.

Thailand. – NORTH-EASTERN: Loei (Phu Kradueng).

Distribution. – East Guangdong, East Taiwan, Southeast Yunnan, India, Indonesia (Java), Malaysia, Philippines, Thailand, Vietnam Bhutan, Cambodia, Laos, Myanmar, Nepal; tropical and subtropical regions: Africa, Asia, Pacific islands.

Ecology. – On steep forested slopes, on rocks near the waterfall at altitudes 1,000–1,200 m.

Specimens examined. – P. Nopsiriwong 14 (BCU).

4. *Adiantum philippense* L., Sp. Pl. 2: 1094. 1753; Tagawa & K. Iwats., Fl. Thailand 3: 211. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 99,118. 2000. **Figure 5. 28: G-H.**

Rhizome suberect, apex covered with scales; scales linear, a little wider at base, entire, about 3 mm long, bicoloured. *Stipes* castaneous to black, glabrous or sparsely scaly at basal portion, 1–13 cm long; scales on stipe like those on rhizome except in being concolorous brown. *Laminae* linear-lanceolate to oblong, pinnate, 5- 22 by 2–8 cm; rachis perfectly glabrous, sometimes prolonged and rooting at tip; lateral pinnae large at base, slightly reduced in size upwards, distinctly stalked; stalks 0.1–2 cm long;

leaflets crescent, semicircular or sometimes nearly orbicular in shaped, 0.6–3.5 by 0.5–1.7 cm, apical pinnae slightly flabellate; softly herbaceous, thin, glabrous on both surfaces, outer edge of leaflets subentire, crisped or lobed to about 1/4 of width of leaflets, sinus narrow, lobes round to subquadrangular, apex round to truncate, subentire or toothed; veins free, forked, a little raised,. *Sori* at margin of leaflets, reflexed soral flaps, elongate usually 0.4–1.5 cm or continuous along margin.

Thailand. – NORTHERN: Mae Hong Son, Chiang Mai (Doi Suthep-Doi Pui), Chiang Rai, Lamphun, Lampang, Tak, Phitsanulok; NORTH-EASTERN: Phetchabun, Loei (Phu Kradueng); SOUTH-WESTERN: Kanchanaburi; CENTRAL: Nakhon Nayok, Bangkok; SOUTH-EASTERN: Prachin Buri, Chon Buri, Chanthaburi; PENINSULAR: Krabi (Klong Chilat), Nakhon Si Thammarat.

Distribution. – Throughout the tropics of the Old World.

Ecology. – Terrestrial on rather dry slopes, on humus-rich floor or on muddy crevices of rocks in light shade at low to medium altitudes, 613–1,013 m alt.

Specimens examined. – P. Jadprajong 114, 115, 146, 211, 222, 239 (BKF).

2. ALEURITOPTERIS

Fée, Mem. Foug., Gen. Filic. 5: 153–154. 1852. — *Cheilanthes* Swartz, Syn. Fil.: 5, 126. 1806; Tagawa & K. Iwats., Fl. Thailand 3(2): 200. 1985.

Rhizome suberect to ascending, scaly. *Scales* ovate-lanceolate, brown, semihyaline, with a sparsely serrate margin. *Fronde* monomorphic to dimorphic. *Stipe* not articulation, axes grooved on upper surface, grooves decurrent. *Lamina* pinnately divided; veins free. *Sori* at the end of veinlets, often continuous at the margin of lobes and protected by reflexed margin of lobes.

Aleuritopteris anceps (Blanf.) Panigrahi, Bull. Bot. Surv. India 2(3–4): 321. 1961. — *Cheilanthes pseudofarinosa* (Ching & S. K. Wu) K. Iwats., Fl. Thailand 3(4): 618. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 121. 2000. **Figure 5. 29: A-B.**

Rhizome short, scaly at apex; scales linear-lanceolate, bicolorous, dark at center with light brown at margin, up to 3 mm long, not more than 0.5 mm wide. Fronds monomorphic, usually clustered. Stipes castaneous to dark brown, 1.5–3.5 cm long, scaly at base. *Lamina* ovate to subdeltoid, bipinnatifid; pinnae up to 1.4 cm by 0.4–0.6 cm, lowermost pinnae with basiscopic lobe, basiscopic lobe enlarged and deeply lobed, up to 6 by 3 mm; lower surface of lamina densely covered with white farina, no scales on costae or costules; vein free, dark brown; *Sori* at the end of veinlets, often continuous at the margin of lobes, protected by reflexed margin of lobes, interrupted, fimbriate, light brown.

Thailand. – NORTHERN: Chiang Mai (Doi Suthep); NORTH-EASTERN: Loei (Phu Kradueng); SOUTH-EASTERN: Chanthaburi.

Distribution. – Nepal, India, China (type from Yunnan) and the Philippines.

Ecology. – Lithophyte on rocks in light shade in lower-montane forests at the altitudes about 1,250 m.

Specimens examined. – P. Jadprajong 292 (BKF).

3. ANTROPHYUM

Kaulf., Enum. Filic. 197, 282. 1824; Tagawa & K. Iwats., Fl. Thailand 3(2): 221. 1985.

Plants epiphyte or lithophyte. *Rhizome* erect or creeping, densely covered with clathrate, iridescent scales, and roots with numerous root hairs. *Fronds* simple. *Lamina* fleshy or leathery, shrunken when dry, usually broadly lanceolate or oblanceolate, sometimes linear, spatulate, obovate, or suborbicular, mostly gradually narrowed

towards stipelike base; costa usually present in basal part; lateral veins abundantly reticulate, without free included veinlets. *Sori* forming coenosori, soral lines superficial or immersed, on lateral veins, simple or branched; paraphyses abundant. *Spores* trilete.

Key to the species

- 1a. Lamina oblong-lanceolate to broadly oblanceolate; paraphyses filiform or filamentous.....**1. A. callifolium**
- 1b. Lamina oblanceolate, spatulate, or elliptic; paraphyses club-shaped
.....**2. A. parvulum**

1. *Antrophyum callifolium* Blume, Enum. Pl. Javae.: 111. 1828; Tagawa & K. Iwats., Fl. Thailand 3(2): 221. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 133. 2000.

Figure 5. 29: C-D.

Rhizome short creeping, bearing fronds in a tuft, scaly; scales linear-lanceolate, 1–3 by 0.5–1 mm, dark brown, toothed at margin. *Stipes* short, indistinctly uniting with the basal part of frond, scaly. *Lamina* usually oblong-lanceolate to broadly oblanceolate, gradually narrowing towards acuminate apex, gradually narrowing towards the base, 10–19 by 2–5 cm, leathery; costa distinct only in the lowest portion of fronds; veins more or less distinct, evenly anastomosing without included veinlets. *Sori* linear, anastomosing along veins, usually on the whole undersurface except for the lowest middle portion; paraphyses filamentous, long, numerous.

Thailand. – NORTHERN: Chiang Mai (Doi Suthep, Chiang Mai, Mae Taeng, Lamoo), Tak (Huay Krasa); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng, Khao Huay Khae), Nong Khai; SOUTH-WESTERN: Kanchanaburi (Khao Sakan, Song Tho), Phetchaburi; CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao, Khao Sabap), Trat (Koh Chang); PENINSULAR: Chumphon (Tha Ngo, Lanngsuan, Tako, Sapli), Ranong, Surat Thani (Ko Tao, Ban Don, Ko Phangan), Nakhon Si Thammarat (KiriWong, Khao Luang, Thung Song),

Phangnga (Thap Put), Phuket, Trang (Khao Chong), Satun, Yala (Bunnang Sata), Narathiwat.

Distribution. – Cambodia, India, Indonesia, Laos, Malaysia, Philippines, Sri Lanka, Thailand, Vietnam, Australia.

Ecology. – Lithophyte on muddy rocks by the stream in shady place at altitudes 1,000–1,191 m.

Specimen examined. – P. Jadprajong 193 (BKF).

2. *Antrophyum parvulum* Blume, Enum. Pl. Javae 2: 110. 1828; Tagawa & K. Iwats., Fl. Thailand 3(2): 220. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 133. 2000.

Figure 5. 29: E-F.

Rhizome short creeping, bearing a mass of roots and several fronds, densely scaly; scales lanceolate or very narrowly subtriangular, brown to greyish-brown, clathrate, irregularly toothed at margin, 2–5 by up to 1 mm. *Stipes* 1–2 cm long, sparsely scaly, green. *Lamina* oblanceolate, broadest above middle, rounded to acuminate at apex, gradually narrowing downwards to narrowly cuneate base, decurrent to stipe forming very narrow wings, up to 12 cm long, 0.8–1.3 cm broad, leathery, green; costa distinct only the lowest part of fronds; veins reticulate without included veinlets. *Sori* linear or reticulate along the veins; paraphyses club-shaped.

Thailand. – NORTHERN: Chiang Mai (Doi Chiang Dao), Lamphun (Doi Khun Tan); NORTH-EASTERN: Loei (Phu Kradueng); PENINSULAR: Nakhon Si Thammarat, Phatthalung, Trang (Khao Chong), Yala (Bunnang Sata).

Distribution. – India, Hainan, Taiwan, Indonesia, Malaysia, Philippines, Thailand, Vietnam.

Ecology. – Epiphyte on mossy tree trunks in shady area, near the water-channel below the cliff at 1,200–1,258 m alt.

Specimen examined. – P. Jadprajong 240 (BKF).

4. CALCIPHILOPTERIS

Yesilyurt & H. Schneid., *Phytotaxa*. 7: 53. 2010. — *Doryopteris* J. Sm., *J. Bot.* 3: 404. 1841; Tagawa & K. Iwats., *Fl. Thailand* 3(2): 196. 1985.

Plants terrestrial or on rocks. *Rhizomes* creeping, scales lanceolate to narrowly ovate, clathrate, mostly bicolorous, with a dark brown at center and lighter at margin. Fronds dimorphic. *Stipe* longer than lamina, shiny, dark brown to black, rounded to slightly grooved on upper surface. *Lamina* pinnatifid to bipinnatifid, pedately lobed, or trilobate, pentagonal to broadly cordate, or ovate in outline, margins entire with white cartilaginous, papery to leathery, glabrous on both surfaces or rarely sparsely hairy or scaly at base; veins blackish abaxially, veins anastomosing. *Sori* continuous along commissural vein, margin of false indusium entire to slightly erose; false indusia formed by reflexed lamina margins.

Calciphilopteris ludens (Wall. ex Hook.) Yesilyurt & H. Schneid. *Phytotaxa* 7: 56. 2010. — *Doryopteris ludens* (Wall. ex Hook.) J. Sm., *Hist. Fil.*: 289. 1875; Tagawa & K. Iwats., *Fl. Thailand* 3(2): 197. 1985; Boonkerd & Pollawatn, *Pterid. Thailand*: 101, 123. 2000. **Figure 5. 29: G-H.**

Rhizome long creeping, 2–3 mm in diameters, covered with scales; scales linear-subulate, 1–3 mm long, bicolored, entire, glabrous. *Fron*d dimorphic. *Stipes* 24–42 cm, nearly black, polished, long scaly at base, sparsely hairy upwards. *Sterile lamina* smaller and less lobed, 10–20 cm long and wide, pinnatifid with usually 5 lobes, apical lobe the largest, lobes oblong-subdeltoid to triangular, apex acute, entire or slightly waved; veins distinct, reticulate without included veinlets; papyraceous, glabrous. *Fertile lamina* subdeltoid in outline, up to 20 cm long and wide, deeply pinnatisect, the lowest pair of lobes the largest; lobes linear or linear subtriangular, apex caudately

acuminate, entire, 1–2 cm broad, up to 10 cm long; main veins distinct, black. *Sori* continuous along margin, sometime very short interrupted at lobes of fronds, covered by thin reflexed margin.

Thailand. – NORTHERN: Mae Hong Son (Doi Tan Ma Keng), Chiang Mai (Pong Nam Khao), Chiang Rai (Doi Tham Tu Pu), Lampang (Mae Somali), Phrae (Ban Pak Tawan), Tak (Lan sang), Nakhon Sawan (Mae Wong); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng); EASTERN: Nakhon Ratchasima (Pak Thong Chai); SOUTH-WESTERN: Kanchanaburi (Khao Nam Tok, Sai Yok, Thung Kang Yang Hills, Koeng Chada), Ratchaburi, Phetchaburi, Prachuap Khiri Khan (Sam Roi Yot, Thap Sakae, Bang Saphan); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chon Buri (Si Racha), Chanthaburi (Khao Soi Dao, Pong Nam Ron); PENINSULAR: Chumphon (Ko Wiang, Thap Li, Tha Ko), Surat Thani, Phangnga, Krabi, Nakhon Si Thammarat (Thung Song), Trang, Satun, Yala (Bannang Sata).

Distribution. – North India, South China, Indochina and throughout Malesia.

Ecology. – Terrestrial near the stream in medium shade at about 452 m alt.

Specimen examined. – P. Jadprajong 297 (BKF).

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5. HAPLOPTERIS

C. Presl, Tent. Pterid. 141. 1836. G. M. Zhang, W. B. Liao, M. Y. Ding, Y. X. Lin, Z. H. Wu, X. C. Zhang, S. Y. Dong, J. Prado, M. G. Gilbert, G. Yatskievych, T. A. Ranker, E. A. Hooper, E. R. Alverson, J. S. Metzgar, A. M. Funston, S. Masuyama & M. Kato, Fl. China 2–3: 252. 2013.

Plant epiphyte or lithophyte, grasslike plants. *Fronde*s simple, linear, entire, glabrous; veins consisting of a costa and oblique unbranched veins, free except for a submarginal fertile connecting vein. *Sori* in one elongate marginal or submarginal

groove on each side of lamina, immersed, rarely superficial; paraphyses long with a dark obconic head.

Key to the species

- 1a. Sori intramarginal, superficial **1. *H. amboinensis***
- 1b. Sori at marginal, submarginal, immersed in groove..... **2.**
- 2a. Frond up to 13 cm long, not more than 2 mm broad..... **4. *H. sikkimensis***
- 2b. Frond more than 20 cm long..... **3.**
- 3a. Sori at marginal grooves, immersed in two-lipped, open outwards
 **2. *H. elongata***
- 3b. Sori submarginal, immersed in groove between costa and margins of
 lamina **3. *H. ensiformis***

1. *Haplopteris amboinensis* (Fée) X. C. Zhang, Ann. Bot. Fenn. 40: 460. 2003. — *Vittaria amboinensis* Fée, Mém. Foug. 3: 14, pl. 1, f. 1. 1852; Tagawa & K. Iwats., Fl. Thailand 3(2): 226. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 135. 2000. **Figure 5. 30: A-B.**

Rhizome short creeping, 3–3.5 mm diam., bearing a mass of roots, densely scaly throughout; scales narrow, apex subulate, 5–10 by 1.5 mm, dark brown to blackish, clathrate, margin minutely toothed. *Stipes* indistinct or distinct, up to 15 cm, deep castaneous on lower part, very narrowly winged almost to the base. *Laminae* linear-lanceolate, apex acuminate to caudate, gradually narrowing downwards into wings of stipe, 45–70 cm long including stipe, 1.5–2.5 cm broad, margin flat or slightly recurved, coriaceous or thicker; costa distinctly raised on abaxially surface, distinct on adaxially surface, veins hidden. *Sori* superficial, submarginal, almost throughout the margin of frond except for the apex and lowermost part.

Thailand. – NORTHERN: Chiang Mai, Tak, Phitsanulok (Phu Hin Rong Kla); NORTH-EASTERN: Loei (Phu Kradueng); EASTERN: Nakhon Ratchasima; SOUTH-EASTERN: Chanthaburi; PENINSULAR: Krabi, Trang.

Distribution. – India, Burma, Laos, Vietnam, Malaysia, Indonesia.

Specimens examined. – P. Jadprajong 54, 127, 257, 290 (BKF).

2. *Haplopteris elongata* (Sw.) E. H. Crane, Syst. Bot. 22(3): 514. 1998. — *Vittaria elongata* Sw., Syn. Fil.: 109, 302. 1806; Tagawa & K. Iwats., Fl. Thailand 3(2): 223. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 135. 2000. **Figure 5. 30: C-D.**

Rhizome short creeping, 3–5 mm diameter, bearing closely spaced fronds to 1 cm apart, very densely scaly throughout; scales linear with long-tailed apex, base cordate, up to 1.5 cm long, about 1 mm broad, greyish-brown to dark, clathrate, minutely toothed at margin. *Stipes* usually short or indistinct, green to darker. *Laminae* linear, gradually narrowing towards both base and apex, variable in size, 0.5–2.5 cm broad, 25–60 cm or longer, coriaceous to leathery; costa usually distinct adaxially on the lower part of frond; veins more or less visible, anastomosing to form a row of elongate oblique areoles at each side of midrib. *Sori* immersed in marginal two-lipped groove, usually along the margin of frond.

Thailand. – NORTHERN: Chiang Rai, Chiang Mai (Doi Chiang Dao), Tak, Phitsanulok (Thung Salaeng Luang); NORTH-EASTERN: Loei (Phu Kradueng, Phu Suan Sai), Nong Khai; EASTERN: Nakhon Ratchasima (Pak Thong Chai); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Trat (Ko Chang); SOUTH-WESTERN: Kanchanaburi (Wang Ka); PENINSULAR: Surat Thani (Ban Don, Ko Tao, Khun Thale, Ko Samui), Nakhon Si Thammarat (Khao Luang, Thung Song), Satun (Ko Tarutao), Narathiwat (Waeng), Yala (Khao Kalakhiri, Ban Chana, Bla Ha).

Distribution. – Tropics of the Old World generally, north to Sikkim, Hainan and southern edge of Japan.

Ecology. – Pendulous on mossy rocks in light shade at 1,183-1,226 m alt.

Specimens examined. – P. Jadprajong 3, 66, 159, 173 (BKF).

3. Haplopteris ensiformis (Sw.) E. H. Crane, Syst. Bot. 22(3): 514. 1998. — *Vittaria ensiformis* Sw., Ges. Naturf. Freunde Berlin Neue Schriften 2: 134, t. 7, f. 1. 1799; Tagawa & K. Iwats., Fl. Thailand 3(2): 223. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 135. 2000. **Figure 5. 30: E-F.**

Rhizome short-creeping, slender, 0.8–1.3 mm diam., densely covered with a mass of roots, scaly throughout; scales linear, gradually narrowing from base towards tailed apex, 5–7 by 0.5–0.6 mm, dark brown to nearly black, clathrate, minutely toothed at margin. *Stipe* usually indistinct, narrowly winged throughout. *Fronde* linear, up to 40 by 2–6 mm, leathery; costa indistinct below or hardly visible on the lower portion, other veins indistinct, the margin sometimes inrolled, *Sori* immersed in deep grooves almost at margin, usually elongate along both margin of fronds.

Thailand. – NORTH-EASTERN: Loei (Phu Kradueng); SOUTH-EASTERN: Chanthaburi (Makham), Trat (Huai Raeng, Ko Chang); CENTRAL: Bangkok; PENINSULAR: Krabi (Ko Pu), Surat Thani (Ko Tao, Ban Don), Phangnga (Khao Suang), Nakhon Si Thammarat (Khao Luang), Trang (Khao Chong, Khao Khao), Phuket, Satun (Khuan Kalong, Boriphath Falls), Pattani (Khok Pho, Ban Sai Khao).

Distribution. – Tropics of the Old World

Ecology. – Epiphyte on tree trunks or lithophyte on rocks usually in dense evergreen forests at 1,191-1,221 m alt.

Specimens examined. – P. Jadprajong 14, 93, 140, 181 (BKF).

4. *Haplopteris sikkimensis* (Kuhn) E. H. Crane, Syst. Bot. 22(3): 514. 1998. — *Vittaria angustifolia* Blume, Enum. Pl. Javae.: 199. 1828; Tagawa & K. Iwats., Fl. Thailand 3(2): 225. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 106, 107, 135. 2000. — *Vittaria sikkimensis* Kuhn, Linnaea 36: 66. 1869; Tagawa & K. Iwats., Fl. Thailand 3(2): 224. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 108, 136. 2000.

Figure 5. 30: G-H.

Rhizome short creeping, 1–1.5 mm diameter, densely scaly throughout; scales narrow, gradually narrowing from base towards hair-pointed apex, up to 5 by 0.5–0.8 mm, margin minutely toothed, brown to greyish-brown, clathrate. *Stipes* short or indistinct, green or darker at the base. *Laminae* linear, often slightly broader in upper part, 3.5–10 cm long, 0.3–2 mm wide, usually curved, apex acute, gradually narrowing downwards and merging into very narrow wings of stipe, leathery; costa visible on upper surface or indistinct, the margin flat, veins anastomosing to form narrow areoles. *Sori* immersed in deep groove almost at the margin of fronds, occupying most of frond length or limited to the upper half.

Thailand. – NORTHERN: Chiang Mai (Doi Suthep, Doi Inthanon), Phitsanulok (Phu Miang); NORTH-EASTERN: Phetchabun, Loei (Phu Luang, Phu Kradueng); SOUTH-EASTERN: Chanthaburi; PENINSULAR: Nakhon Si Thammarat, Krabi, Trang, Yala.

Distribution. –India, China, Vietnam, and throughout Malesia east to New Caledonia.

Ecology. Lithophyte on moist muddy or mossy rocks in montane forest at 1,200–1,236 m alt.

Specimens examined. – P. Jadprajong 13, 42, 57 (BKF).

6. PTERIS

L., Sp. Pl. 2: 1073. 1753; Tagawa & K. Iwats., Fl. Thailand 3(2): 231. 1985.

Rhizome erect or ascending, scaly; scales brown, narrowly lanceolate or linear, membranous, firm. *Fronde*s clustered. *Stipe* grooved adaxially. *Laminae* 1- to 2-pinnate, or sometimes 3-forked, pinnae entire or pectinately divided into segments, sometimes asymmetrical; basal pinnae often with basiscopic pinnule near base; apical pinnae similar to lateral ones; costa deeply grooved above; veins free, 1- or 2-forked, or sometime with regular rows of narrow areoles along costa; herbaceous, papery or sometimes subleathery, glabrous or rarely pubescent. *Sori* linear along margin, except at basal sinus and apex, indusial formed by reflex margin of lobes.

Key to the species

- 1a. Frond simple to trifoliolate or tripartite..... 2.
- 2a. Veins free except as united in sorol commissure..... 4. **P. longipes**
- 2b. Veins anastomosing, forming costal areoles..... 6. **P. wallichiana**
- 1b. Frond pinnate or pinnately decompound..... 3
- 3a. Pinnae all simple, not branch, entire or serrate at apical margin.. 5. **P. venusta**
- 3b. Pinnae deeply lobed, or lowest pinnae with one or a few branches..... 4.
- 4a. Frond distinctly dimorphic..... 3. **P. ensiformis**
- 4b. Frond not or hardly dimorphic..... 5.
- 5a. Veins anastomosing to form regular costal areoles...1. **P. biaurita**
- 5b. Veins free except as united in sorol commissure
..... 2. **P. cretica var. leata**

1. *Pteris biaurita* L., Sp. Pl.: 1076. 1753; Tagawa & K. Iwats., Fl. Thailand 3(2): 237. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 106, 127. 2000. **Figure 5. 31: A-B.**

Rhizome short, erect, bearing a few fronds in a tuft, densely scaly at apex; scales 1–5 by about 0.5 mm, nearly black margined by pale brown edges with toothed margin. *Stipes* 19–35 cm long, dark brown and scaly at apex. *Laminae* deeply bipinnatifid, 35–64 cm or more in length, about 24–30 cm wide; pinnae opposite or subopposite, straight, ascending, linear-lanceolate, gradually narrowing towards acuminate apex, base broadly cuneate, 12–20 by 4–5 cm, deeply lobed to 5/6 way from margin, basal pinnae bearing a long basispic pinnule; ultimate segments oblong, falcate, apex rounded or moderately acute, with rounded sinus, 5–7 mm broad, green, glabrous; basal veinlets uniting with those of opposite groups forming arches close to costa, bearing a little branches at posterior side, other veinlets free, forked. *Sori* marginal, continuous along segments, except the apex and bottom of sinus; indusia thin, pale.

Thailand. – NORTHERN: Chiang Mai, Chiang Rai, Lamphun, Tak; NORTH-EASTERN: Phetchabun, Loei (Phu Kradueng); EASTERN: Chaiyaphum; SOUTH-WESTERN: Kanchanaburi; CENTRAL: Nakhon Nayok; SOUTH-EASTERN: Chon Buri, Chanthaburi (Phlio, Khlong Khruue Wai, Khao Soi Dao), Trat; PENINSULAR: Surat Thani, Phangnga, Nakhon Si Thammarat, Trang, Yala.

Distribution. – Pantropical.

Ecology. – Terrestrial on mountain slopes in light shade or in lower montane forests at about 1,209 m alt.

Specimens examined. – P. Jadprajong 219, 273 (BKF).

2. *Pteris cretica* L., Mant. Pl.: 130. 1767; Tagawa & K. Iwats., Fl. Thailand 3(2): 255. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 127. 2000.

var. **leata** (Wall. ex Ettingsh.) C. Chr. & Tardieu, Notul. Syst. (Paris) 6(3): 137. 1937.

Figure 5. 31: C-D.

Rhizome ascending or short creeping, bearing closely spaced fronds, scaly; scales brown, 1–5 mm long, entire. *Stipes* often brown, sparsely hairy at base, surface scabrous with puberulous upwards, 10–45 cm long, usually longer in fertile frond. *Laminae* more or less dimorphic, imparipinnate, ovate-oblong in outline, 20–34 by 15–28 cm; terminal pinna 3-lobed, base decurrent to winged downwards, nearly to the next pair; lateral pinnae 2–3 pairs, apex long-acuminate, base narrowly cuneate, decurrent, margin serrate, distinctly undulate at margins, sessile or shortly stalked, 12–16 cm long, 2–2.5 cm wide and 1.5 cm in fertile ones, papyraceous to subcoriaceous, light green; veins all free, forked, ascending. *Sori* along the margin of pinnae; indusia firm, brown.

Thailand. – NORTH-EASTERN: Loei (Phu Kradueng).

Distribution. – Tropics and subtropics throughout the World.

Ecology. – Terrestrial on mountain slopes in light shade at about 1,098 m alt.

Specimens examined. – P. Jadprajong 168 (BKF).

3. Pteris ensiformis Burm. f., Fl. Indica 230. 1768; Tagawa & K. Iwats., Fl. Thailand 3(2): 234. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 128. 2000. **Figure 5. 31: E-F.**

Rhizome short creeping, bearing rather close fronds, densely scaly; scales lanceolate with a long tail apex, 2–4 by 0.5 mm, brown, entire. *Fronde* distinctly dimorphic. *Sterile frond*: stipe stramineous, brown and scaly at base, 3–15 cm long, grooved on abaxial surface; lamina oblong, apex acute, tripinnatifid, 7–15 by 4–7 cm; pinnae 2–5 pairs, opposite, with a large apical segments; pinnules simple to trifoliate, ultimate segments oblong to oblong-lanceolate, apex moderately acute, margin minutely serrate, 1.5–5 by 0.5–1 cm; veins all free, forked, ascending. *Fertile frond*;

taller, stipe 5–45 cm long; lamina bipinnate, up to 30 by 5–20 cm; pinnae simple to trifoliolate, ultimate segments linear, 3–15 by 0.5–1 cm, apex caudately acuminate, base broadly cuneate to subtruncate, non-soriferous margin serrate. *Sori* linear, submarginal, continuous almost from base to apex; indusial pale green.

Thailand. – NORTHERN: Chiang Mai, Lampang, Tak; NORTH-EASTERN: Loei (Phu Kradueng), Khon Kaen, Nakhon Phanom; EASTERN: Chaiyaphum; SOUTH-WESTERN: Uthai Thani, Kanchanaburi, Prachuap Khiri Khan; SOUTH-EASTERN: Chon Buri, Rayong, Chanthaburi (Khao Soi Dao), Trat; PENINSULAR: Chumphon, Surat Thani, Phangnga, Nakhon Si Thammarat, Krabi, Phatthalung, Trang, Satun, Pattani, Yala.

Distribution. – Tropics of Old World, Sri Lanka to Australia and Polynesia throughout Malesia, north to India, Southern China, Indochina and the Ryukyus.

Ecology. – Terrestrial on mountain slopes or on ground in dry evergreen forests at 750–1,013 m alt.

Specimens examined. – P. Jadprajong 89, 149, 214 (BKF).

4. *Pteris longipes* D. Don, Prodr. Fl. Nepal.: 15. 1825; Tagawa & K. Iwats., Fl. Thailand 3(2): 235. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 129. 2000. **Figure 5. 31: G-H.**

Rhizome erect, bearing a few fronds in a tuft, scaly; scales about 5 by 1 mm, concolorous, brown to darker, entire. *Stipes* up to 15–30 cm long, stramineous throughout, glabrescent upwards. *Laminae* tripartite, middle branch longer, 25–55 cm by up to 20 cm, deeply bipinnatisect, lateral branches smaller, 10–25 by 10–12 cm; pinnae linear-lanceolate, apex caudately acuminate, base broadly cuneate, sessile, deeply pinnatisect nearly to costa, 4–10 cm long; fertile pinnae about 1.5 cm wide, sterile pinnae sometimes more than 2 cm; ultimate segments oblong, oblique, apex round to acute, serrate near apex, papyraceous, green, upper surface with glandular hair;

veins all free, forked, distinct on both surfaces. *Sori* along margin from base nearly to apex of segment; indusia brown, rather firm, about 1 mm broad.

Thailand. – NORTHERN: Chiang Mai (Doi Suthep-Doi Pui), Chiang Rai, Phrae, Tak; NORTH-EASTERN: Loei (Phu Kradueng); EASTERN: Chaiyaphum (Nam Phrom); SOUTH-WESTERN: Kanchanaburi (Khao Laem); SOUTH-EASTERN: Chanthaburi.

Distribution. – Northern India, South China, Vietnam, Laos and Taiwan, southwards to the Philippines.

Ecology. – Terrestrial on mountain slopes usually in dense forest in dry evergreen or lower montane forests at 709-1,000 m alt.

Specimens examined. – P. Jadprajong 86 (BKF).

5. *Pteris venusta* Kunze, Bot. Zeitung (Berlin) 6: 195. 1848; Tagawa & K. Iwats., Fl. Thailand 3(2): 256. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 132. 2000. **Figure 5. 32: A-B.**

Rhizome short, creeping or ascending, 0.5–1 cm diameter, bearing close fronds, densely scaly at apex; scales linear, up to 0.5 cm long, dark brown to nearly black at middle with paler margin, entire. *Stipes* dark brown with scaly at base, stramineous to castaneous above, puberulous or glabrescent, 30– 65 cm long. *Lamina* oblong, imparipinnate, 35–60 by 20–30 cm; rachis stramineous or castaneous, winged in upper part; lateral pinnae 3–5 pairs, not branching, sessile or shortly stalked, falcate, base cuneate, apex caudate with long tail, margin subentire or minutely serrate at apical part, 20–30 cm or more long, 3–4 cm broad, terminal pinnae like the lateral pinnae but straight, chartaceous, veins close, visible on both surfaces. *Sori* continuous along the margin of pinnae, except for the base and towards apex; indusia thin but firm, pale brown.

Thailand. – NORTHERN: Chiang Mai, Chiang Rai, Lamphun, Lampang, Tak, Phitsanulok; NORTH-EASTERN: Loei (Phu Kradueng, Phu Suan Sai), Khon Kaen; EASTERN: Nakhon Ratchasima; SOUTH-WESTERN: Kanchanaburi; SOUTH-EASTERN: Prachin Buri, Chon Buri, Chanthaburi (Khao Soi Dao).

Distribution. – Northern India, Laos, Cambodia to Malaysia.

Ecology. – Terrestrial on rather dry mountain-slopes at about 892 m alt.

Specimens examined. – P. Jadprajong 252 (BKF).

6. *Pteris wallichiana* J. Agardh, Recens. Spec. Pter.: 69. 1839; Tagawa & K. Iwats., Fl. Thailand 3(2): 236. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 133. 2000.

Figure 5. 32: C-D.

Rhizome thick, short, erect, densely scaly at apex; scales oblong-subtriangular, about 1 cm long, 3–5 mm broad at base, concolorous, brown, entire. *Stipes* thick, about 80–150 cm long, castaneous, dark brown and scaly at basal part, puberulous or glabrous. *Laminae* tripartite, middle branch deeply bipinnatisect, about 100 by 25–30 cm, lateral branches as long as middle branch, bearing large secondary bipinnatifid branch on the lower side, secondary branch sometimes bearing bipinnatifid branch; lateral pinnae about 20 pairs in middle branch, 15–17 in lateral branch, linear-lanceolate, apex caudately acuminate, base broadly cuneate at sessile, 20–25 by 4–5 cm, deeply lobed nearly to costa, leaving wings 1.5–2 mm broad; ultimate segments narrowly oblong, apex acute, margin serrate, herbaceous or thicker, glabrous; veins anastomosing, forming narrow costal areoles, other veins free, forked, visible on both surfaces. *Sori* continuous along margin from base to half-way or apical part of segments; indusia rather thick, pale green to paler, entire.

Thailand. – NORTHERN: Mae Hong Son, Chiang Mai, Chiang Rai, Phrae, Phitsanulok; NORTH-EASTERN: Phetchabun, Loei (Phu Kradueng); SOUTH-EASTERN: Chanthaburi.

Distribution. – Northern India, Southern China, Laos, Southern Japan to Taiwan, south to Java, Sulawesi, and a variety in Samoa.

Ecology. – Terrestrial in stream-bed or near by the water way in light shade or half-shaded places at about 1,221-1,258 m alt.

Specimens examined. – P. Jadprajong 81 (BKF).

TECTARIACEAE

Panigrahi, J. Orissa Bot. Soc. 8: 41. 1986; F. W. Xing, Y. H. Yan, S. Y. Dong, F. G. Wang, M. J. M. Christenhusz & P. H. Hovenkamp, Fl. China 2–3: 730. 2013.

Plants terrestrial. *Rhizome* erect or ascending to creeping, stout or slender, scaly at apex; scales brown, linear or lanceolate, margins entire, finely toothed, or ciliate. *Stipe* stramineous, brown, or black, scaly usually at base or sometimes throughout. *Fronde*s monomorphic to strongly dimorphic, simple or pinnate to 4 times pinnate-pinnatifid, often triangular or pentagonal, usually decompose toward apex; rachises and costae usually covered with multicellular hairs; veins free or anastomosing, with included veinlets, simple or forked. *Sori* terminal on included free veins, dorsal on veins or at intersection of connected veins, usually orbicular, sometimes elongate, anastomosing in lines, in some species throughout abaxial surface of lamina when mature, indusiate or exindusiate.

TECTARIA

Cav., Anales Hist. Nat. 1(2): 115. 1799; Tagawa & K. Iwats., Fl. Thailand 3(3): 364. 1988; F. W. Xing, Y. H. Yan, S. Y. Dong, F. G. Wang, M. J. M. Christenhusz & P. H. Hovenkamp, Fl. China 2–3: 733. 2013.

Plant small to large, terrestrial or lithophyte. *Rhizome* erect, ascending or creeping, apex densely scaly; scales basifixed, concolorous or bicolored, stramineous to nearly black, margin entire to hairy. *Fronde*s monomorphic or dimorphic. *Stipes* stramineous to nearly black, covered with a little short hairs throughout, usually scaly at base, sometimes scaly throughout. *Lamina* simple to pinnately compound, ovate-subdeltoid or elliptic-oblong in outline, margin entire, pinnatifid to deeply lobed, basal pinnae often having the longest basiscopic lobes; veins free to anastomosing, forming areoles, veinlets simple, forked or branched. *Sori* usually round, sometimes elongate, located on terminal veins or veinlets, indusiate or exindusiate; indusia if present round-reniform, persistent or caducous. *Spores* ellipsoid, ovoid or subspheroidal.

Key to the species

- 1a. Fronds distinctly dimorphic..... 2.
- 2a. Sori acrostichoid..... 6. **T. zeilanica**
- 2b. Sori not acrostichoid..... 3. **T. impressa**
- 1b. Fronds not or hardly dimorphic..... 3.
- 3a. Basal pinna lobed with short basal posterior lobes or pinnules
.....4. **T. sagenioides**
- 3b. Basal pinna not lobed, if lobed the basal posterior lobes or pinnules
longest.....4.
- 4a. Vein all free or anastomosing to form costal areoles only..... 1. **T. fuscipes**
- 4b. Vein copiously anastomosing to form areoles outside the costal and
costular one 5.
- 5a. Apical pinnae similar to the next below..... 2. **T. herpetocaulos**
- 5b. Apical pinnae not similar to the next below..... 5. **T. simonsii**

1. *Tectaria fuscipes* (Wall. ex Bedd.) C. Chr., Contr. U.S. Natl. Herb. 26: 290. 1931; Tagawa & K. Iwats., Fl. Thailand 3(3): 365. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 213. 2000; F.W. Xing, Y.H. Yan, S.Y. Dong, F.G. Wang, Christenh. & Hovenkamp, Fl. China 2–3: 737. 2013. **Figure 5.32: E-F.**

Rhizome short, erect to ascending, scales basifixed, dark brown at center and paler at margin, lanceolate, 4–6 by about 1.5 mm. *Fronde* monomorphic to slightly dimorphic. *Sterile frond*: stipe 11.5–36 cm long, scaly at base, pubescent throughout, stramineous to darker; lamina bipinnatifid, oblong to oblong-lanceolate, apex acuminate, broadest at base, up to 45 by 20–25 cm, basal pinnae asymmetrically oblong-subdeltoid, up to 15 by 12 cm, apex caudate-acuminate, lobed to 4/5 way towards costa, bearing large basal basisopic pinnules, middle lateral pinnae lanceolate, broadest at base, up to 12 by 2–4 cm, upper pinnae adnate at base and decurrent toward apical portion, lobes oblong-subdeltoid, apex round, entire, 0.5–0.8 cm broad, herbaceous, deep green, hairy on upper surface, costa pubescent, costal areoles present. *Fertile frond*: taller, stipe up to 50 cm long; lamina narrower, middle pinnae 1–3 cm wide, lobed to 4/5 way towards costa; veins all free. *Sori* terminal on free vein, round, arranged in two rows between main veins, about 1 mm diameters; indusia small, round-reniform, persistent.

Thailand. – NORTHERN: Chiang Mai (Chiang Dao, Doi Suthep-Pui, Hang Dong), Chiang Rai (Doi Chong, Doi Luang, Doi Tung, Lam Nam Kok, Mae Sai, Namtok Khun Khon), Nan (Doi Pha Chang, Doi Phu Kha, Tham Sakoen, Thung Chang), Lampang (Ngao), Phrae (Rong Kwang), Tak (Doi Musoe), Phitsanulok (Thung Salaeng Luang); NORTH-EASTERN: Phetchabun (Nam Nao), Loei (Nong Hin, Phu Luang, Phu Kradueng); EASTERN: Chaiyaphum (Phu Khiao), Nakhon Ratchasima (Khao Yai); SOUTH-EASTERN: Prachin Buri (Khao Yai), Chonburi (Ban Bueng), Chantaburi (Khao Sra Bhap, Khao Soi Dao); SOUTH-WESTERN: Kanchanaburi (Dong Yai, Sai Yok, Thong Pha Phum, Wang Ka).

Distribution. – Nepal, India, Bangladesh, Myanmar, Cambodia, Vietnam, China, Malesia.

Ecology. – Terrestrial in half shade and moist places on mountain slopes in lower-montane forest at 1,103–1,174 m alt.

Specimens examined. — P. Jadprajong 43, 202 (BKF); A. Sathapattayanon 632, 674, 709 (BCU).

2. *Tectaria herpetocaulos* Holttum, Dansk Bot. Ark. 23: 241. 1965; Fl. Thailand 3(3): 379. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 213. 2000. **Figure 5. 32: G-H.**

Rhizome long creeping, 0.6-1 cm in diameter, densely scaly; scales basifixed, dark brown at middle with paler margin, about 5 by 1–1.5 mm, lanceolate, apex acuminate, margin subentire. *Fronde*s monomorphic to slightly dimorphic, fertile fronds longer and narrower than sterile fronds. *Stipes* stramineous to brown, grooved on adaxial side, 40–68 cm long, covered with short hairs, scaly at base. *Laminae* oblong-ovate, consisting of 1–4 pairs of pinnae and pinna-like apex, 30–45 by 25–51 cm; apex to 20 by 10 cm, entire or rarely crenate, base cuneate, apex abruptly acuminate; upper pinnae sessile, up to 20 by 5–7 cm with asymmetric base rounded on the basiscopic side; basal pinnae 12–30 by 7–15 cm, stalked, opposite or subopposite, asymmetric with a single basiscopic lobe, 15–20 by 4–6 cm, sometime the largest fronds have two pairs of pinnae with basal lobes, or lobe absent; veins fully anastomosing forming irregular areoles with free included veinlets, veinlets free, simple or forked; both surface of costae and main veins bearing short hairs. *Sori* round, mostly not on free veins in areoles, rather small, in a single row on each side of main veins but with additional ones irregularly between the rows; indusia round-reniform, thin, usually glabrous or with few short hairs, brown.

Thailand. – NORTHERN: Mae Hong Son, Chiang Mai (Doi Chiang Dao, Doi Pha Hom Pok, Doi Suthep, Mae Ho), Chiang Rai (Doi Tung, Mae Chan, Mae Suai, Namtok Khun Kon), Phayao, Nan, Lamphun (Doi Khun Tan), Lampang, Phrae, Tak (Doi Musoe), Sukhothai, Phitsanulok, Kamphaeng Phet; NORTH-EASTERN: Phetchabun (Nam Nao), Loei (Phu Luang, Phu Kradueng, Phu Ruea), Sakon Nakhon

(Phu Phan); EASTERN: Chaiyaphum (Nam Phrom, Phu Khiao), Nakhon Ratchasima (Khao Yai); CENTRAL: Saraburi, Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Prachin Buri, Chonburi, Chantaburi (Khao Soi Dao, Namtok Phliu); SOUTH-WESTERN: Kanchanaburi (Sangkhla Buri, Song Tho, Tham Nam, Thung Kang Yang), Ratchaburi, Phetchaburi (Kaeng Krachan), Prachuap Khiri Khan (Hua Hin, Huai Yang, Kui Buri); PENINSULAR: Chumphon (Bang Son, Phato), Surat Thani (Ko Tao), Nakhon Si Thammarat (Khao Luang, Khao Nan), Phuket (Ton Sai), Yala (Betong).

Distribution. – India, China, Myanmar, Cambodia, Vietnam, Peninsular Malesia, Borneo.

Ecology. – Terrestrial on light shaded mountain slopes in lower-montane forest or dry evergreen forest at 1,149–1,221 m alt.

Specimens examined. – P. Jadprajong 189 (BKF); A. Sathapattayanon 697 (BCU); Boonnag 632 (BCU); H. B. G. Garrett 222 (BCU); T. Boonkerd 1527 (BCU).

3. *Tectaria impressa* (Fée) Holttum, Kew Bull. 43: 483. 1988; Tagawa & K. Iwats., Fl. Thailand 3(4): 621. 1989; Boonkerd & Pollawatn, Pterid. Thailand: 162, 163, 218. 2000. — *Tectaria variolosa* (Wall. ex Hook.) C. Chr., Contr. U.S. Natl. Herb. 26: 289. 1931; Tagawa & K. Iwats., Fl. Thailand 3(3): 368. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 163. 2000. **Figure 5. 33: A-B.**

Rhizome short, creeping or suberect; scales linear-lanceolate, basifixed, margin hairy, bicoloured, dark brown at middle with paler at margin, up to 7 by 0.8 mm. *Fronde*s dimorphic, fertile and sterile fronds similar in shape, fertile fronds rather smaller and narrower. *Stipes* pale brown to dark brown, 20–35 cm in sterile and 22–43 cm in fertile fronds, densely pubescent on adaxial surface. *Laminae* ovate-subdeltoid or pentagonal in outline, 30–46 by 22–30 cm, bipinnate to tripinnatifid at base; lateral pinnae 2–4 pairs, the basal pinna much the largest, stalked, asymmetrically subtriangular, acute at apex, with one or two basal basisopic pinnules; upper pinnae shortly stalked, deeply lobed or with sessile basal basisopic pinnule; apical pinna subdeltoid, cuneate and a

little decurrent at base, deeply lobed to pinnatifid; herbaceous, green, glabrous on laminar surface; rachis with dense articulated hairs above, glabrous beneath; veins anastomosing, forming areoles with and without included veinlets. *Sori* round, terminal on free included veinlets in areoles, arranged in a single row at each side of midrib, more or less raised on upper surface; indusia round-reniform, about 1 mm diameter, persistent, glabrous.

Thailand. – NORTHERN: Mae Hong, Chiang Mai (Doi Chiang Dao, Doi Inthanon, Doi Pha Hom Pok, Doi Saket, Doi Suthep), Chiang Rai (Mae Kok), Phayao, Nan, Lamphun, Lampang (Mae Ngao), Phrae, Uttaradit, Tak (Ban Musoe), Sukhothai, Phitsanulok (Phu Hin Rong Kla, Thung Salaeng Luang), Kamphaeng Phet; NORTH-EASTERN: Phetchabun, Loei (Phu Kradueng, Phu Luang), Nong Bua Lam Phu, Sakon Nakhon (Phu Phan), Khon Kaen (Phu Pha Man), Nakhon Sawan; EASTERN: Chaiyaphum, Ubon Ratchathani, Nakhon Ratchasima (Khao Yai); CENTRAL: Nakhon Nayok, Saraburi; SOUTH-EASTERN: Sa Kaeo, Prachin Buri (Khao Yai), Chonburi, Rayong, Chantaburi (Khao Soi Dao, Namtok Phliu), Trat (Ko Chang, Ko Kut, Ko Mak); SOUTH-WESTERN: Uthai Thani, Kanchanaburi (Wangka), Phetchaburi, Prachuap Khiri Khan; PENINSULAR: Ranong, Surat Thani, Phangnga, Krabi, Satun.

Distribution. – Nepal, India, Bangladesh, China, Myanmar, Laos, Cambodia, Vietnam, Peninsular Malaysia, Sumatra.

Ecology. – Terrestrial in shady areas on mountain slopes in dry evergreen forest or mixed deciduous forest at 893–916 m alt.

Specimens examined. – P. Jadprajong 212, 213 (BKF); Y. Yuyen 28 (BCU); T. Boonkerd 110, 1377 (BCU).

4. *Tectaria sagenioides* (Mett.) Christenh., Phytotaxa 10: 58. 2010. — *Heterogonium sagenioides* (Mett.) Holttum, Sarawak Mus. J. 5: 161. 1941; Tagawa & K. Iwats., Fl. Thailand 3(3): 362. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 207. 2000. **Figure 5. 33: C-D.**

Rhizome short, erect, densely scaly at apex; scales basifixed, ovate-lanceolate, bicolored, dark brown at middle portion with paler margin, 2–4 by 1–1.5 mm, margin hairy. *Fronde*s monomorphic to subdimorphic. *Stipes* deep castaneous to deep brown, rarely greenish, grooved, 16–35 cm long, covered with short hairs throughout, scaly at base. *Lamina* bipinnatifid, oblong-lanceolate, apex acuminate, 13–15 by 10 cm; pinnae subsessile or sessile, lanceolate, apex caudate, base truncate, deeply lobed nearly to costa; basal pinnae 5–10 by 3–5 cm, shortly stalked, elliptic-oblong, apex acuminate, base round to subtruncate, margin lobed to 1–2 mm from costa, apex acute, entire to serrate, with basal basiscopic lobe reduced, much shorter than acroscopic ones; lateral pinnae oblong-lanceolate, apex acuminate, base round to subtruncate, alternate to subopposite, shortly stalked to sessile, 5–12 by 1.5–3 cm, margin lobes, apex acute, lobes margin entire to slightly crenate; terminal pinna ovate, apex acuminate, base cuneate; herbaceous to papyraceous, pubescent on both surface; veins all free, forked, about 6 pairs in each lobe, elongate to margin. *Sori* round, terminal on acroscopic branches of veinlets, arranged in two rows between main veins; indusia round-reniform.

Thailand. – NORTHERN: Chiang Rai, Phitsanulok (Thung Salaeng Luang); NORTH-EASTERN: Phetchabun (Khao Ko), Loei (Phu Kradueng); EASTERN: Chaiyaphum (Phu Khiao), Nakhon Ratchasima (Khao Yai); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Rayong (Khao Chamao-Khao Wong, Khao Yai Da), Chantaburi (Khao Khitchakut, Khao Sabap, Khao Soi Dao, Makham), Trat (Bo Rai, Ko Chang); SOUTH-WESTERN: Kanchanaburi (Sai Yok, Thong Pha Phum), Phetchaburi (Kaeng Krachan), Prachuap Khiri Khan (Huai Yang); PENINSULAR: Ranong (Kapoe, Khlong Nakha, Laem Son, Thungraya Nasak), Surat Thani (Bandon, Khao Sok), Phangnga (Khao Kata Lawan, Khao Phra Mi), Phuket (Khao Kluay), Nakhon Si Thammarat (Khao Luang, Khao Nan), Trang (Khao Chong, Phu Pha Mek), Yala (Than To), Narathiwat.

Distribution. – India, China, Myanmar, Laos, Vietnam, Peninsular Malaysia, Sumatra, Java, Borneo, Sulawesi, Philippines.

Ecology. – Terrestrial on moist mountain slopes in deep shaded places in dense evergreen forest at 1,237 m alt.

Specimens examined. — P. Jadprajong 27, 50 (BKF).

5. *Tectaria simonsii* (Baker) Ching, *Sinensia* 2(2): 32, pl. 13. 1931; *Fl. Thailand* 3(3): 374. 1988; Boonkerd & Pollawatn, *Pterid. Thailand*: 217. 2000. **Figure 5. 33: E-F.**

Rhizome creeping, ascending, or erect, short, thick, apex and stipe bases densely scaly; scales linear-lanceolate, dark brown, 6-10 mm, entire, apex long acuminate. *Fronde*s clustered. *Stipe* dark brown or dark purple, 36–60 cm long, minutely pubescent throughout. *Lamina* bipinnate to tripinnatifid, subpentagonal or triangular-ovate, 30–45 by 20–30 cm, papery, both surfaces glabrous; lateral pinnae 2–4 pairs, basal pinnae 10–20 cm long and wide, stalked, with a few free pinnules like the upper pinnae, stalked or sessile, oblanceolate, caudate at apex, rounded at base, with one or two lateral lobes, 15–23 by 5 cm, subentire, apical pinna subdeltoid-lanceolate, broadest at base, lobed at basal part; deep-green; costa of lower pinnae nearly black, pubescent; veins paler, distinctly raised beneath, anastomosing, forming areoles with simple or forked included veinlets. *Sori* orbicular, small, at apex or at junction of veinlets, in irregular rows between adjacent main veins, indusia small.

Thailand. – NORTHERN: Chiang Rai (Lam Nam Kok, Mae Lao, Phan), Lampang, Phitsanulok (Thung Salaeng Luang); NORTH-EASTERN: Phetchabun (Khao Ko), Loei (Nong Hin, Phu Hin Rong Kla, Phu Kradueng); EASTERN: Chaiyaphum (Phu Khiao); SOUTH-EASTERN: Chonburi (Si Racha); SOUTH-WESTERN: Uthai Thani (Ban Rai); PENINSULAR: Chumphon (Bang Son).

Distribution. – India, China, Japan, Laos, Vietnam, Malesia, Java, Borneo.

Ecology. – Terrestrial in moist and shady places on mountain slopes in dense evergreen forest near stream at about 1,098 m alt.

Specimens examined. – P. Jadprajong 190 (BKF).

6. *Tectaria zeilanica* (Houtt.) Sledge, Kew Bull. 27: 422. 1972. — *Quercifilix zeilanica* (Houtt.) Copel., Philipp. J. Sci. 37: 409. 1928; Tagawa & K. Iwats., Fl. Thailand 3(3): 383. 1988; Boonkerd & Pollawatn, Pterid. Thailand: 210. 2000. **Figure 5. 33: G-H.**

Rhizome short, creeping or ascending, bearing a few sterile fronds in a rosette and usually an erect fertile frond; scales 1–5 by 0.3–1 mm, membranous, dark brown, toothed at margin. *Frond* dimorphic. *Sterile frond*: usually in rosette, not erect; stipe stramineous, 4–6 cm long, densely scaly at base, densely hairy throughout; lamina pinnatifid to trifoliate, 5–10 by 5 cm; lateral pinnae asymmetrically oblong-subdeltoid to nearly circular, apex rounded, base broadly cuneate to cordate, sessile, 2.5–3.5 by 1.5–2 cm, margin subentire or slightly undulate, sometimes bearing auricles at basiscopic base; terminal pinnae oblong, apex rounded, base cuneate to broadly, margin lobed to 1/3 way towards costa, lobes rounded-subdeltoid, entire; herbaceous, green, undersurface and margin hairy; veins anastomosing forming copious areoles, hairy beneath. *Fertile frond* erect; stipe slender, very sparsely scaly or glabrescent; lamina trifoliate, lateral pinnae sometimes with short basiscopic lobes. *Sori* covering the whole under surface of pinnae except for edges.

Thailand. – NORTHERN: Lampang (Mae Long), Phitsanulok (Thung Salaeng Luang); NORTH-EASTERN: Phetchabun (Nam Nao), Loei (Phu Kradueng, Phu Luang, Phu Suan Sai); CENTRAL: Lop Buri (Wang Kan Lueang), Saraburi (Muak Lek); SOUTH-EASTERN: Chantaburi (Khao Soi Dao); SOUTH-WESTERN: Prachuap Khiri Khan.

Distribution. – Mauritius, S India, Sri Lanka (type), China (Yunnan, Guizhou, Guangxi, Hainan, Guangdong, Hong Kong, Fujian, Taiwan), Laos, Vietnam, Malesia (Peninsular Malaysia, Borneo, Philippines), Polynesia.

Ecology. – Terrestrial moist and shady places near stream banks in mixed deciduous forest at 452 m alt.

Specimens examined. – P. Jadprajong 336 (BKF).

THELYPTERIDACEAE

Ching ex Pic. Serm., *Webbia* 24: 709. 1970; Tagawa & K. Iwats., *Fl. Thailand* 3(3): 393. 1988; Y. X. Lin, Z. Y. Li, K. Iwats. & A. R. Smith, *Fl. China* 2–3: 319. 2013.

Plants terrestrial or on rocks. *Rhizomes* erect, ascending, or long creeping, branched or not, scaly, scales basifixed, lanceolate or narrowly ovate, brown. *Fronde*s monomorphic, remote or clustered. *Stipes* slender, stramineous, not articulate, distally with grayish-white unicellular acicular hairs. *Laminae* 1–2-pinnate (–3-pinnatifid), oblong-lanceolate or oblanceolate, sometimes ovate or ovate-triangular, both sides with grayish-white unicellular or acicular hairs, rarely glabrous; veins free or anastomosing, often with an excurrent veinlets running to the sinus between lobes. *Sori* orbicular to shortly linear, not marginal; exindusiate or indusia orbicular-reniform.

Key to the genera

- 1a. Veins free..... **3. Metathelypteris**
- 1b. Veins partly or entirely reticulate..... **2.**
- 2a. All veinlets joining into square or rectangular areoles..... **2. Pronephrium**
- 2b. Veinlets joining into triangular areoles and producing an excurrent veinlet; excurrent veinlet running to a sinus..... **1. Cyclosorus**

1. CYCLOSORUS

Link. *Hort. Berol.* 2: 128. 1833; Y. X. Lin, Z. Y. Li, K. Iwats. & A. R. Smith, *Fl. China* 2–3: 372. 2013.

Plants terrestrial. *Rhizomes* creeping to erect, scaly, sometimes hairy. *Fronde*s distant to clustered. *Laminae* pinnate to pinnate-pinnatifid, usually oblong-lanceolate, middle pinnae usually linear-lanceolate, subentire to deeply lobed, apical pinnae

usually more lobed, proximal pinnae sometimes shortened, segments usually entire; veinlets usually simple or rarely forked, proximal one or more pairs of closely segments anastomosing with an excurrent veinlet and from uniting point reaching the sinus membrane, other veinlets running to sinus membrane or margin above the sinus. *Sori* orbicular, usually at middle of veinlets; indusia orbicular-reniform, persistent.

Key to the species

- 1a. Swamp ferns; costae with ovate scales abaxially..... **2. C. interruptus**
- 1b. Terrestrial plants; costae without scales or rarely with lanceolate scales abaxially
..... **2.**
- 2a. At least one of the second basal veinlets uniting with excurrent veinlets below
callous sinus..... **4. C. subelatus**
- 2b. Basal pair of veinlets distinctly anastomosing, the second basal pairs reaching the
callous sinus **3.**
- 3a. Proximal veinlets on each segment sterile; sori confined to segments
..... **5. C. terminans**
- 3b. Proximal veinlets on each segment usually fertile; sori not confined to
segments..... **4.**
- 4a. Pinnae with long clavate glands, glands dense on lamina underneath
..... **1. C. clarkei**
- 4b. Pinnae with sessile glands, orange to reddish orange, glands confined to
axes **3. C. parasiticus**

1. *Cyclosorus clarkei* (Bedd.) Ching, Bull. Fan. Mem. Inst. Biol. Bot. 8: 178. 1938. — *Cyclosorus cylindrothrix* (Rosenst.) Ching, Bull. Fan Mem. Inst. Biol. 8: 199. 1938; Boonkerd & Pollawatn, Pterid. Thailand: 223. 2000. — *Thelypteris cylindrothrix* (Rosenst.) K. Iwats., Fl. E. Himalaya 1: 482–483. 1966; Tagawa & K. Iwats., Fl. Thailand 3(3): 423. 1988. **Figure 5. 34: A-B.**

Rhizome long creeping, 3–5 mm in diameters; scales narrow, brown, hairy, up to 0.7 by about 0.1 cm. *Fronde*s monomorphic. *Stipes* stramineous to brown, hairy, 20–45 cm long, scaly at base, aerophores absent. *Laminae* oblong-lanceolate, acute at apex, 19–37 by 10–24 cm; basal pairs of pinnae deflexed, not shortened or not butterfly-shaped auricles, middle pinnae patent, sessile, more or less falcate, caudately-acuminate at apex, truncate at base, deeply lobed near the costa, up to 12 by 0.8–1.6 cm, rachis and costa hairy throughout, segments oblong, oblique, acute to rounded at apex, entire, up to 0.6 by 0.2 cm; veins pinnate, veinlets simple, basal pairs of veinlets anastomosing, uniting to form excurrent veinlets towards callous-sinus, hairy as well as glandular; texture papyraceous, densely hairy with unicellular hairs, pale green; glandular densely on under surface, sessile glands, orange to red, round to clavate. *Sori* not confine to segment; indusia small, persistent, shortly hairy, sporangia glabrous.

Thailand. – NORTHERN: Chiang Mai, Chiang Rai, Lamphun, Lampang, Tak; NORTH-EASTERN: Loei.

Distribution. – East Himalaya and South West China.

Ecology. – Terrestrial on dry ground in dry evergreen or mixed deciduous forests at medium elevation, 952 m alt.

Specimen examined. – P. Jadprajong 119 (BKF).

2. *Cyclosorus interruptus* (Willd.) H. Itô, Bot. Mag. Tokyo 51(608): 714. 1937; Boonkerd & Pollawatn, Pterid. Thailand: 223. 2000. — *Thelypteris interrupta* (Willd.)

K. Iwats., J. Jap. Bot. 38: 314. 1963; Tagawa & K. Iwats., Fl. Thailand 3(3): 400. 1988.

Figure 5. 34: C-D.

Rhizomes long creeping, with ovate-lanceolate scales. *Fronde*s distant, not dimorphic. *Stipes* up to 73 cm, stramineous, darker or black at bases. *Laminae* up to 45 by 22 cm, bases not narrowed, caudate at apex, texture subcoriaceous, lateral pinnae linear-lanceolate, 3.5–11 by 0.5–1 cm, shortly stalked, bases rounded-truncate, lobed 1/4–1/2 toward costae, acuminate at apex, segments triangular, pointed at apex; veins anastomosing, basal pair of veinlets anastomosing, the second basal pair running to sinus membrane, adaxial surface subglabrous, abaxial surface with acicular hairs and orange sessile spherical glands along veins, costae with several membranous broadly ovate scales, aerophore absent at base of costae. *Sori* orbicular, confined to segments, or proximal 1–3 pairs of veinlets sterile; indusia sparsely hairy. Sporangia stalks bearing spherical reddish orange glands.

Thailand. – NORTHERN: Chiang Mai (Mae Klang), Phayao, Lampang (Mae Toi); NORTH-EASTERN: Loei (PhuKradueng); SOUTH-WESTERN: Kanchanaburi, Phetchaburi, Prachuap Khiri Khan (Sam Roi Yot); CENTRAL: Bangkok; PENINSULAR: Surat Thani (Ban Don), Phuket (Ko Yao Yai, Khun Talao Lake), Krabi (Khao Phanom), Nakhon Si Thammarat (Thung Song), Phatthalung, Songkhla, Yala (Bunnang Sata).

Distribution. – Throughout tropical and subtropical regions of the world.

Ecology. – Terrestrial, swamp ferns, on grassy banks or in open swamp along streams at about 280 m alt.

Specimen examined. – P. Jadprajong 148 (BKF).

3. *Cyclosorus parasiticus* (L.) Farw., Amer. Midl. Naturalist 12(8): 259. 1931. — *Christella parasitica* (L.) H. Lév., Fl. Kouy-Tchéou: 475. 1915; Holttum, Fl. Males., Ser. II, Pterid. 1: 559. 1982; Boonkerd & Pollawatn, Pterid. Thailand: 221. 2000. —

Thelypteris parasitica (L.) Fosberg, Occas. Pap. Bernice Pauahi Bishop Mus. 23: 30. 1962; Tagawa & K. Iwats., Fl. Thailand 3(3): 424. 1988. **Figure 5. 34: E-F.**

Rhizome short to long creeping, 5–8 mm in diameter; scales narrow, with a few hairs at margin, up to 1 by 0.1 cm, pale to dark brown. *Stipes* 16–28 cm long, stramineous, scaly at base, hairy throughout. *Laminae* oblong-lanceolate, apex acute to caudate-acuminate, 36–57 by 18–30 cm; up to 15 pairs of free pinnae, basal pinnae deflexed, lower pinnae patent, linear-lanceolate, sessile at acroscopic base, 6.7–10 by 1.2–2.2 cm, lobed 1/2–1/3 towards costa; segments oblong, oblique, apex rounded, entire; thinly papyraceous, yellow-green to green, both surfaces with thin acicular hairs throughout, abaxially with sessile glands, rod-shaped, orange to reddish orange; proximal pairs of veins anastomosing, the other veinlets reaching to margin of lobes. *Sori* orbicular, medial; indusia persistent, hairy.

Thailand. – NORTHERN: Chiang Mai, Chiang Rai, Lampang, Tak, Phitsanulok; NORTH-EASTERN: Loei (Phu Kradueng); EASTERN: Chaiyaphum (Nam Phrom); SOUTH-WESTERN: Phetchaburi; SOUTH-EASTERN: Chon Buri, Chanthaburi, Trat; PENINSULAR: Surat Thani (Ban Don, Ban Huai Thai), Phangnga, Nakhon Si Thammarat (Khiriwong), Trang, Satun.

Distribution. – Tropics and subtropics in Asia, north to South Japan and south to New Zealand.

Ecology. – Terrestrial on dry slopes along path in open areas at low to medium altitudes, 893–900 m.

Specimen examined. – P. Jadprajong 218 (BKF).

4. Cyclosorus subelatus (Baker) Ching, Bull. Fan Mem. Inst. Biol. 8: 224. 1938. — *Thelypteris subelata* (Baker) K. Iwats., J. Jap. Bot. 38: 315. 1963; Tagawa & K. Iwats., Fl. Thailand 3(3): 429. 1988. — *Christella subelata* (Baker) Holttum, Kew Bull. 31: 331. 1976; Boonkerd & Pollawatn, Pterid. Thailand: 222. 2000. **Figure 5. 34: G-H.**

Rhizome creeping, about 5 mm in diameters, scales narrow, 2–5 by about 1 mm, dark brown hirsute. *Fronde*s monomorphic. *Stipes* 10–27 cm long, hairy throughout, bearing small lower pinnae on upper portion. *Laminae* 36–71 by 14–25 cm, oblong, acuminate at apex, with long terminal pinna, lower lateral pinnae reduced to small auricles, middle pinnae sessile, linear-lanceolate, gradually narrowing towards acuminate apex, round to acute at base, 12.5–17 by 1.8–2.2 cm, lobed more than 1/3 way to costa, segments oblong, oblique, rounded at apex, papyraceous, dark to greyish-green, paler below, subglabrous, costa hairy, two or three pairs of lower veinlets truly anastomosing below callous sinus. *Sori* medial; indusia round reniform, persistent, sporangia glabrous.

Thailand. – NORTHERN: Mae Hong Son (Ban Mae Pong), Chiang Mai (Doi Phahom Pok, Doi Chiang Dao, Fang, Kang Kat, Doi Suthep, Ban Yang), Chiang Rai (Doi Tung, Mae Sai, Mae Kok, Doi Phacho, Ban Doi Hang), Lamphun, Lampang, Phrae (Mae Sai), Tak (Doi Musoe, Mae Sot), Phitsanulok (Phu Miang); NORTH-EASTERN: Loei (Phu Kradueng), Nong Khai; SOUTH-WESTERN: Kanchanaburi (Sai Yok); SOUTH-EASTERN: Chon Buri (Si Racha), Chanthaburi (Khao Soi Dao, Ta Khamao Falls).

Distribution. – SW China and Upper Myanmar.

Ecology. —Terrestrial on mountain slopes in deep shade open places at medium altitudes, 900–915 m alt. and found in the northern part of Thailand.

Specimen examined. – P. Jadprajong 120, 216 (BKF).

5. *Cyclosorus terminans* (J. Sm. ex Hook.) K. H. Shing, Fl. Reipubl. Popularis Sin. 4(1): 220. 1999. — *Amphineuron terminans* (J. Sm. ex Hook.) Holttum, Amer. Fern J. 63: 82. 1973; Boonkerd & Pollawatn, Pterid. Thailand: 219. 2000. — *Thelypteris terminans* (J. Sm.) Tagawa & K. Iwats., Acta Phytotax. Geobot. 26: 169. 1975; Tagawa & K. Iwats., Fl. Thailand 3(3): 432. 1988. **Figure 5. 35: A-B.**

Rhizome long creeping, 0.8–1 cm in diameters; scales narrow, brown, about 1 cm long, hairy. *Stipes* 47–70 cm long, pubescent, stramineous with dark scaly base. *Laminae* ovate to oblong-lanceolate, acute at apex, 53–72 by 38–46 cm, lateral pinnae up to 30 pairs, basal pinnae not or slightly reduced and deflexed, lower ones linear, gradually narrowing towards long-acuminate apex, cuneate at base with shortly stalked, 19–23 by 1–1.5 cm, lobed to half-way towards costa; segments oblong, oblique, round to acute at apex, entire, texture thick papyraceous, green; veins pinnate, veinlets simple, basal pairs uniting with the next group below sinus, the second basal pair running to callous membrane, minutely hairy on both sides of veinlets, lamina between veins with minutely hairy or glabrous, sessile spherical yellow glands on veinlets and lamina near apex of lobes. *Sori* confined to segments, lower 1–3 veinlets not soriferous; indusia persistent, hairy, sometimes with yellow spherical glands, sporangia glabrous.

Thailand. – Common throughout Thailand.

Distribution. – Tropics of Asia to Australia (Queensland).

Ecology. – Terrestrial, on rather dry slopes in dry evergreen forests or lower-montane forest, not in swamp, at low or medium altitudes 750–900 m alt.

Specimen examined. – P. Jadprajong 217 (BKF).

2. METATHELYPTERIS

(H. Itô) Ching, Acta Phytotax. Sin. 8: 305. 1963; Y. X. Lin, Z. Y. Li, K. Iwats. & A. R. Smith, Fl. China 2–3: 334. 2013.

Plants terrestrial. *Rhizomes* usually short, decumbent, ascending or erect, covered with brown scales, glaucous short hairs or subglabrous. *Fronde*s approximate or clustered. *Stipes* brown to dark brown at bases, apex stramineous, glabrous or sparsely hairy. *Laminae* oblong, lanceolate, pinnate-pinnatifid, rarely tripinnate, apex acuminate and pinnatifid, texture herbaceous or thinly papyraceous, usually green when

dry, both surfaces with grayish white unicellular hairs, dense along rachises and costae, pinnae usually no glands abaxially, costae rounded and raised adaxially, not grooved; veins pinnate, simple or forked, not reaching margins. *Sori* small, orbicular, attached above the middle of veinlets; indusia orbicular-reniform, attached at a sinus, membranous, persistent. Spores bilateral.

Metathelypteris flaccida (Blume) Ching, Acta Phytotax. Sin. 8(4): 306. 1963; Boonkerd & Pollawatn, Pterid. Thailand: 224. 2000. — *Thelypteris flaccida* (Blume) Ching, Bull. Fan Mem. Inst. Biol. 6: 336. 1936; Tagawa & K. Iwats., Fl. Thailand 3(3): 399. 1988. **Figure 5. 35: C-D.**

Rhizome short, erect, scales narrow, 3–5 by about 1 mm, thin and usually crisped, brown, hairy on lower surface and margin. *Fronde* pinnate-bipinnatifid, monomorphic. *Stipes* stramineous, 8–10 cm long, scaly at base, hairy throughout. *Laminae* oblong-lanceolate, about 22 by 15.5 cm, pinnae falcate, with grayish white multicellular hairs on both surfaces, basal one or two smaller, sessile, larger ones at middle, lanceolate, acuminate at apex, up to 8 by 1.5 cm, costa hairy throughout, winged, pinnules patent, narrowly oblong, rounded at apex, decurrent at base, deeply lobed nearly to costule, up to 1 by 0.4 cm; lobes oblong to subdeltoid, acute at apex, serrate at margin, thin papyraceous, green; veins pinnate, veinlets usually forked, not reaching the very margin of lobes, hairs simple, unicellular on laminar surface. *Sori* medial, dorsal on veinlets, indusial small, brown, hairy.

Thailand. – NORTHERN: Phitsanulok (Phu Miang); NORTH-EASTERN: Loei (Phu Kradueng), Phetchabun.

Distribution. – Sri Lanka, India, Southwest China (Yunnan and Guizhou), North Vietnam, and Java.

Ecology. – Terrestrial on half-shaded, humus-rich along streams at the altitudes about 1,233 m alt.

Specimen examined. – P. Jadprajong 289 (BKF).

3. PRONEPHRIUM

C. Presl, Epimel. Bot. 258. 1851; Y. X. Lin, Z. Y. Li, K. Iwats. & A. R. Smith, Fl. China 2–3: 389. 2013.

Rhizome long creeping, or short and decumbent, with sparsely brown scales. *Fronde*s remote or approximate. *Stipes* glabrous except at bases. *Laminae* usually 1-imparipinnate, sometimes simple; pinnae large, usually 3–15 pairs, terminal pinna free, similar shape as the lateral ones, proximal pair not or little shortened, lanceolate, subsessile or shortly stalked, margins entire to serrate; venation meniscioid, i.e., veinlets joining into oblique square areoles between veinlets, an excurrent veinlet come from joining point of every pair of veinlets, continuous or interrupted, with hydathodes at apices. *Sori* orbicular, in two lines between veinlets, one per veinlet, exindusiate or indusiate, hairy or glabrous; sporangia glabrous or with acicular hairs.

Pronephrium triphyllum (Sw.) Holttum, Blumea. 20(1): 122. 1972; Boonkerd & Pollawatn, Pterid. Thailand: 167, 168, 228. 2000; Y. X. Lin, Z. Y. Li, K. Iwats. & A. R. Smith, Fl. China 2–3: 391. 2013. — *Thelypteris triphylla* (Sw.) K. Iwats., Mem. Coll. Sci. Univ. Kyoto B. 31: 190. 1965; Tagawa & K. Iwats., Fl. Thailand 3(3): 414. 1988.

Figure 5. 35: E-F.

Rhizome long creeping, 2–3 mm in diameters; scales narrow, up to 5 mm long, brown, hairy. *Stipes* stramineous, up to 25 cm long, hairy, dark scaly at base, remote. *Fronde*s pinnate, long triangular in outline. *Laminae* with 1 opposite pair of lateral pinnae; terminal pinna larger, oblong-lanceolate, caudate-acuminate at apex, rounded to cuneate at base, up to 15 by 4.5 cm, subentire or irregularly undulate; lateral pinnae one pair, opposite, caudate at apex, cuneate to round at base, sometime falcate, 1.3–3

by 0.5–1.5 cm; venation meniscioid, hairy; texture herbaceous to papyraceous, deep green. *Sori* elongate along united veinlets, crescent-shape, naked; sporangia setiferous.

Thailand. – NORTHERN: Chiang Rai, Phitsanulok (Nakorn Thai); NORTH-EASTERN: Loei (Phu Kradueng), Nong Khai; CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chon Buri (Si Racha), Chanthaburi (Kao Sabap), Trat (Ko Chang, Huai Raeng); PENINSULAR: Ranong (Kapoe, Muang Laen), Phangnga (Tha Nun), Nakhon Si Thammarat (Khao Luang), Narathiwat (Waeng).

Distribution. – Tropics of Asia to Australia and north to southern of Japan.

Ecology. – Terrestrial on sandy soil or dry banks along the streams in shade at medium altitudes, about 1,213 m alt.

Specimen examined. – P. Jadprajong 39 (BKF).

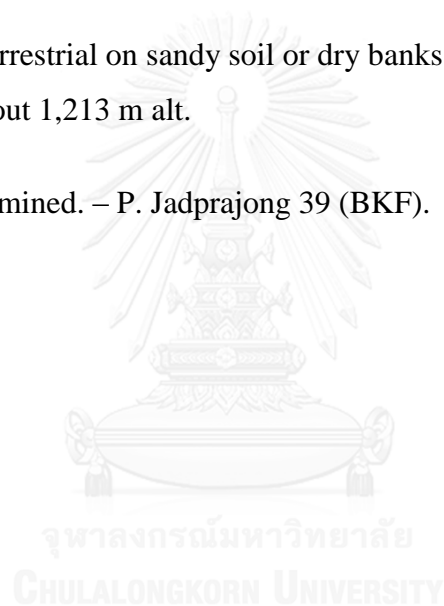


Table 5. 2 List of citation abbreviations

Abbreviation	Publication Title
Abh. Königl. Böhm. Ges. Wiss.	Abhandlungen der Königlichen Böhmisches Gesellschaft der Wissenschaften
Abh. Senckenberg. Naturf. Ges.	Abhandlungen herausgegeben von der Senckenbergischen Naturforschenden Gesellschaft
Acta Phytotax. Geobot.	Acta Phytotaxonomica et Geobotanica
Acta Phytotax. Sin.	Acta Phytotaxonomica Sinica
Amer. Fern J.	American Fern Journal
Amer. J. Bot.	American Journal of Botany
Amer. Midl. Naturalist	American Midland Naturalist
Anales Hist. Nat.	Anales de Historia Natural
Anleit. Stud. Bot.	Anleitung zum Studien der Wissenschaftlichen Botanik
Ann. Bot. Fenn.	Annales Botanici Fennici
Ann. Sci. Nat.	Annales des Sciences Naturelles
Ann. Sci. Nat., Bot.	Annales des Sciences Naturelles; Botanique
Asplen. Tonkin	Les Aspleniacees du Tonkin
Atti Soc. Ital. Sci. Nat.	Atti della Societa Italiana di Scienze Naturali e del Museo Civico di Storia Naturali (in Milano; di Milano)
Berlin. Jahrb. Pharm. Verbundenen Wiss.	Berlinisches Jahrbuch fur die Pharmacie und fur die Damit Verbundenen Wissenschaften
Blumea	Blumea
Bol. Soc. Brot.	Boletim da Sociedade Broteriana
Bot. J. Linn. Soc.	Botanical Journal of the Linnean Society
Bot. Mag.	Botanical Magazine; or, Flower-Garden Displayed ... London
Bot. Mag. (Tokyo)	Botanical Magazine, Tokyo

Abbreviation	Publication Title
Bot. Misc.	Botanical Miscellany
Bot. Ost-Afrika	Botanik von Ost-Afrika
Bot. Tidsskr.	Botanisk Tidsskrift
Bot. Voy. Herald	Botany of the Voyage of H.M.S. Herald, under the Command of Captian Henry Kellett, R.N., C.B., during the years 1845-1851. London
Bot. Zeitung (Berlin)	Botanische Zeitung (Berlin)
Bull. Acad. Int. Geogr. Bot.	Bulletin de l'Académie Internationale de Géographie Botanique
Bull. Acad. Roy. Sci. Bruxelles	Bulletin de l'Academie Royale des Sciences et Belles-lettres de Bruxelles
Bull. Brit. Mus. (Nat. Hist.), Bot.	Bulletin of the British Museum (Natural History), Botany
Bull. Chin. Bot. Soc.	Bulletin of the Chinese Botanical Society
Bull. Fan Mem. Inst. Biol.	Bulletin of the Fan Memorial Institute of Biology.
Bull. Fan Mem. Inst. Biol., Bot.	Bulletin of the Fan Memorial Institute of Biology: Botany
Bull. Herb. Boissier	Bulletin de l'Herbier Boissier
Bull. Mus. Natl. Hist. Nat.	Bulletin du Muséum National d'Histoire Naturelle. Paris
Bull. Natl. Sci. Mus., Tokyo	Bulletin of the National Science Museum [Tokyo, Japan]
Bull. Torrey Bot. Club	Bulletin of the Torrey Botanical Club. New York
Calcutta J. Nat. Hist.	Calcutta Journal of Natural History, and Miscellany of the Arts and Sciences in India.
Candollea	Candollea
Cat. Ferns Gard. Kew	Catalogue of the Ferns in the Royal Gardens of Kew

Abbreviation	Publication Title
Commentat. Soc. Regiae Sci. Gott.	Commentationes Societatis Regiae Scientiarum Gottingensis
Consp. Regn. Veg.	Conspectus regni vegetabilis : secundum characteres morphologicos praesertim carpicos in classes ordines et familias digesti, adjectis exemplis nominibusque plantarum usui medico technico et oeconomico inservientium = Uebersicht der Classen, Ordnungen und Familien des Gewächsreiches nach morphologischen Grundsätzen, unter besonderer Rücksicht auf den Fruchtbau, mit Angabe von Beispielen und von den in der Medicin, Technik und Oekonomie besonderswichtigen Pflanzen
Contr. U.S. Natl. Herb.	Contributions from the United States National Herbarium. Smithsonian Institution
Dansk Bot. Ark.	Dansk Botanisk Arkiv
Delic. Prag.	Deliciae pragenses, historiam naturalem spectantes.
Dict. Class. Hist. Nat.	Dictionnaire classique d'histoire naturelle
Enum. Filic.	Enumeratio Filicum quas im Itinere Circa Terram Legit Cl. Adalbertus de Chamisso Adiectis in Omnia Harum Plantarum Genera Permultasque Species non Satis Cognitas vel Novas Animadversionibus... Cum Tabulis Aeneis Duabis. Lipsiae [Leipzig]
Enum. Pl. Javae	Enumeratio Plantarum Javae
Epimel. Bot.	Epimeliae Botanicae
Essai Propr. Méd. Pl.	Essai sur les propriétés médicales des plantes, comparées avec leurs formes extérieures et leur classification naturelle

Abbreviation	Publication Title
Exot. Fl.	Exotic Flora
Fam. Pl.	Familles des Plantes
Ferns Brit. India	Ferns of British India
Filic. Afr.	Filices africanæ : revisio critica omnium hucusque cognitorum cormophytorum Africae indigenorum additamentis Braunianis novisque africanis speciebus ex reliquiis Mettenianis adaucta : accedunt filices Deckenianæ et Petersianæ
Filic. Decken.	Filices Deckenianæ
Fl. Atlant.	Flora Atlantica
Fl. Carniol.	Flora Carniolica
Fl. China	Flora of China
Fl. E. Himalaya	Flora of Eastern Himalaya
Fl. Indica	Flora Indica: cui accedit series zoophytorum Indicorum, nec non prodromus floræ Capensis.
Fl. Indo-Chine	Flore Générale de l'Indo-Chine
Fl. Ins. Austr.	Florulæ Insularum Australium Prodromus
Fl. Jap.	Flora of Japan
Fl. Kouy-Tchéou	Flore du Kouy-Tchéou
Fl. Males.	Flora Malesiana Bulletin
Fl. Malesiana, Ser. 2, Pterid.	Flora Malesiana, Series II, Pteridophyta
Fl. Reipubl. Popularis Sin.	Flora Reipublicæ Popularis Sinicæ
Fl. Taiwan	Flora of Taiwan
Fl. Thailand	Flora of Thailand
Flora	Flora
Forschungsr. Gazelle	Die Forschungsreise S. M. S. "Gazelle" in den Jahren 1874 bis 1876 : unter Kommando des Kapitän See Freiherrn von Schleinitz

Abbreviation	Publication Title
Gard. Chron.	The Gardeners' Chronicle & Agricultural Gazette
Gen. Fil.	Genera Filicum
Gen. Pl.	Genera Plantarum (Endlicher)
Ges. Naturf. Freunde Berlin Neue Schriften	Der Gesellschaft Naturforschender Freunde zu Berlin, neue Schriften
Handb. Allg. Bot.	Handbuch der Allgemeinen Botanik: zum Selbststudium auf der Grundlage des des natürlichen Systems.
Hedwigia	Hedwigia
Hist. Brit. Ferns	A History of British Ferns
Hist. Fil.	Historia Filicum
Hist. Nat. Vég.	Histoire Naturelle des Végétaux, Classés par Familles
Hooker's J. Bot. Kew Gard.	Hooker's Journal of Botany and Kew Garden
Misc.	Miscellany
Hort. Berol.	Hortus Regius Botanicus Berolinensis
Icon. Pl. Formosan.	Icones plantarum formosandarum nec non et contributiones ad floram formosanam.
Index Filic.	Index Filicum
J. Bot.	Journal of Botany, British and Foreign
J. Bot. (Hooker)	Journal of Botany, being a second series of the Botanical Miscellany
J. Bot. (Schrader)	Journal fuer die Botanik (Schrader)
J. Fac. Sci. Univ. Tokyo, Sect. 3, Bot.	Journal of the Faculty of Science: University of Tokyo, Section 3, Botany
J. Jap. Bot.	Journal of Japanese Botany
J. Orissa Bot. Soc.	Journal of Orissa Botanical Society
J. Wash. Acad. Sci.	Journal of the Washington Academy of Sciences.
Kew Bull.	Kew Bulletin

Abbreviation	Publication Title
Lingnan Sci. J.	Lingnan Science Journal
Linnaea	Linnaea
London J. Bot.	London Journal of Botany
Mant. Pl.	Mantissa Plantarum
Mém. Acad. Roy. Sci. (Turin)	Mémoires de l'Académie Royale des Sciences (Turin)
Mém. Acad. Roy. Sci. Belgique	Mémoires de l'Académie Royales des Sciences, Lettres et Beaux Arts de Belgique
Mém. Foug.	Mémoires sur les Familles des Fougères
Mem. Foug., Gen. Filic.	Memoires sur les Familles des Fougères, Gen. Filic.
Mém. Jard. Bot. Montréal	Mémoires du Jardin Botanique de Montréal
Mém. Soc. Linn. Paris	Mémoires de la Société Linnéenne de Paris
Mém. Soc. Phys. Genève	Mémoires de la Société de Physique et d'Histoire Naturelle de Genève
Mem. Torrey Bot. Club	Memoirs of the Torrey Botanical Club
Microgr. Dict.	The micrographic dictionary; a guide to the examination and investigation of the structure and nature of microscopic objects. By J. W. Griffith, M. D., F. L. S. &c ... and Arthur Henfrey, F. R. S., F. L. S. &c ... Illustrated by forty-one plates and eight hundred and sixteen woodcuts.
Nat. Pflanzenfam.	Die Natürlichen Pflanzenfamilien
Neues J. Bot.	Neues Journal für die Botanik
Notul. Syst. (Paris)	Notulae Systematicae. Herbier du Museum de Paris
Occas. Pap. Bernice Pauahi Bishop Mus.	Occasional Papers of the Bernice Pauahi Bishop Museum of Polynesian Ethology and Natural History

Abbreviation	Publication Title
Phan. Pterid. Jap. Icon.	Phanerogamae et Pteridophytæ Japonicæ Iconibus Illustrata
Philipp. J. Sci.	Philippine Journal of Science
PhytoKeys	PhytoKeys
Preslia	Preslia
Prodr.	Prodromus Floræ Novæ Hollandiæ
Prodr. Aethéogam.	Prodrome des Cinquième et Sixième Familles de l'Aéthéogamie
Prodr. Fl. Nepal.	Prodromus Floræ Nepalensis
Prodr. Fl. Nov. Holland.	Prodromus Floræ Novæ Hollandiæ et Insulæ van-Diemen
Pterid. Thailand	Pteridophytes in Thailand
Quart. J. Chin. Forest.	Quarterly Journal of Chinese Forestry
Recens. Spec. Pter.	Recensio Specierum Generis Pteridis
Reis. Br.-Guiana	Reisen in Britisch-Guiana
Reliq. Haenk.	Reliquiæ Haenkeanæ
Repert. Spec. Nov. Regni Veg.	Repertorium Specierum Novarum Regni Vegetabilis
Revis. Fl. Malaya	Revised Flora of Malaya
Revis. Gen. Pl.	Revisio Generum Plantarum
Revista Sudamer.	Revista Sudamericana de Botánica
Sarawak Mus. J.	Sarawak Museum Journal
Schul-Bot.	Schul-Botanik, oder, Kurze Naturgeschichte der Pflanzen überhaupt
Sinensia	Sinensia
Songklanakarin J. Sci. Technol.	Songklanakarin Journal of Science and Technology
Sp. Fil.	Species Filicum
Sp. Pl.	Species Plantarum

Abbreviation	Publication Title
Suppl. Ferns Brit. Ind.	A Supplement to the Handbook of the Ferns of British India
Suppl. Ferns S. Ind.	Supplement to the Ferns of Southern India and British India
Suppl. Tent. Pterid.	Supplementum Tentaminis Pteridographiae, Continens Genera et Species Ordinum Dictorum Marattiaceae, Ophioglossaceae, Osmundaceae, Schizaeaceae et Lygodiaceae, Pragae [Praha]
Syn. Fil.	Synopsis filicum; or, A synopsis of all known ferns, including the Osmundaceae, Schizaeaceae, Marattiaceae, and Ophioglossaceae (chiefly derived from the Kew herbarium) Accompanied by figures representing the essential characters of each genus.
Syst. Bot.	Systematic Botany
Syst. Veg.	Systema Vegetabilium
Taxon	Taxon
Taxon. Revis. Indian Subcontinental Pteridophytes	Taxonomic revision of three hundred Indian subcontinental pteridophytes with a revised census-list : a new picture of fern-taxonomy and nomenclature in the Indian subcontinent
Tekhno-Bot. Slovar.	Tekhno-Botanicheskĩ Slovar': na latinskom i rossĩskom iazykakh. Sanktpeterburgie
Tent. Fl. Germ.	Tentamen Florae Germanicae
Tent. Pterid.	Tentamen Pteridographiae
Thai Forest Bull. (Bot.)	Thai Forest Bulletin (Botany)
Univ. Calif. Publ. Bot.	University of California Publications in Botany
Votr. Bot. Stammesgesch.	Vorträge über Botanische Stammesgeschichte

Abbreviation	Publication Title
Voy. Bonite, Bot.	Voyage autour du monde :exécuté pendant les années 1836 et 1837 sur la corvette la Bonite
Webbia	Webbia
Wesen Farrenkr.	Das Wesen der Farrenkräuter



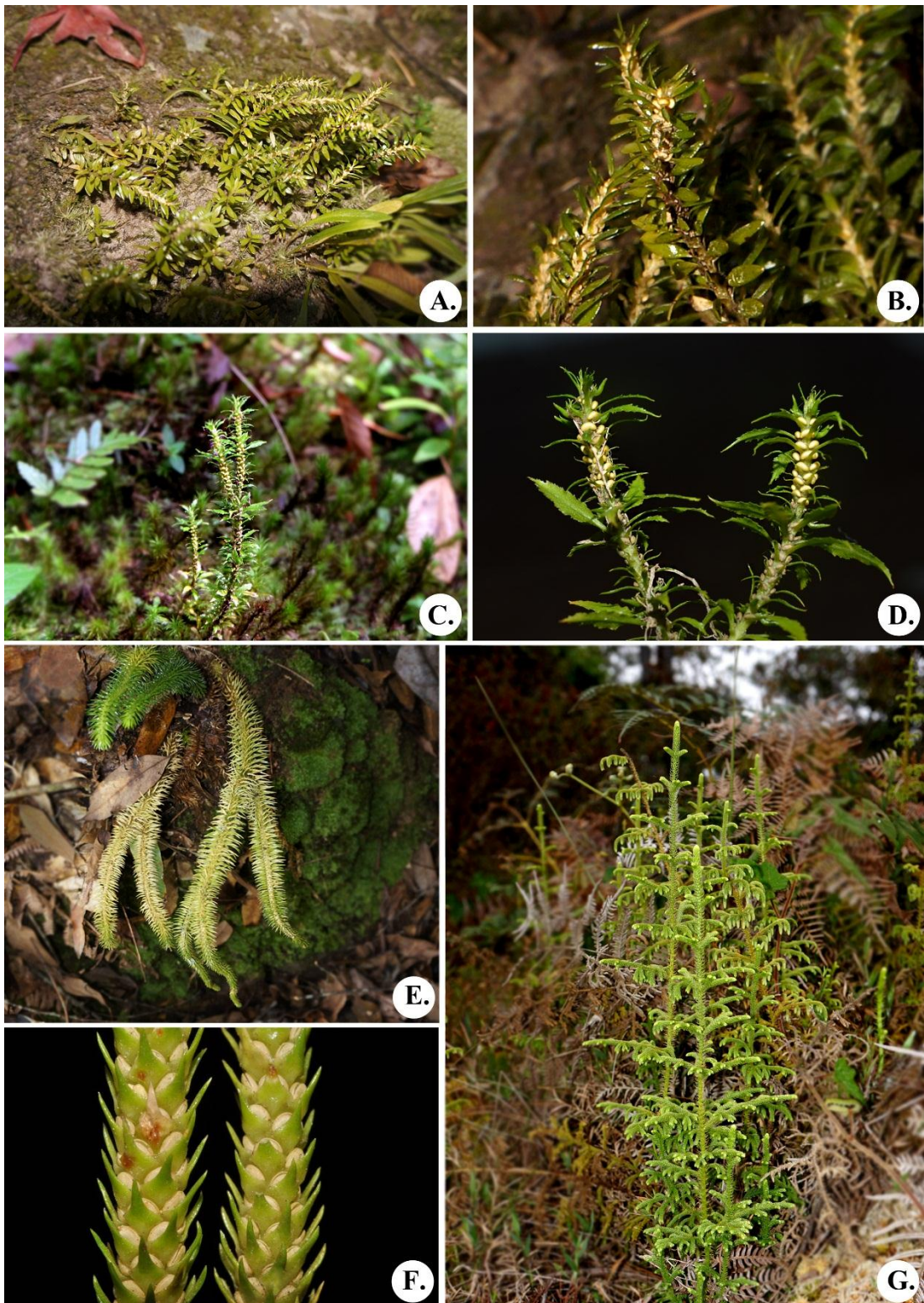


Figure 5. 1 A-B: *Phlegmariurus hamiltonii*, A: habitat, B: yellowish sporangia; C-D: *Huperzia serrata*, C: habitat, D: leaves margin serrate and yellowish sporangia; E-F: *Phlegmariurus squarrosus*, E: habitat, F: part of strobili showing sporangia; G: *Palhinhaea cernua*, showing habitat and pendulous strobili.

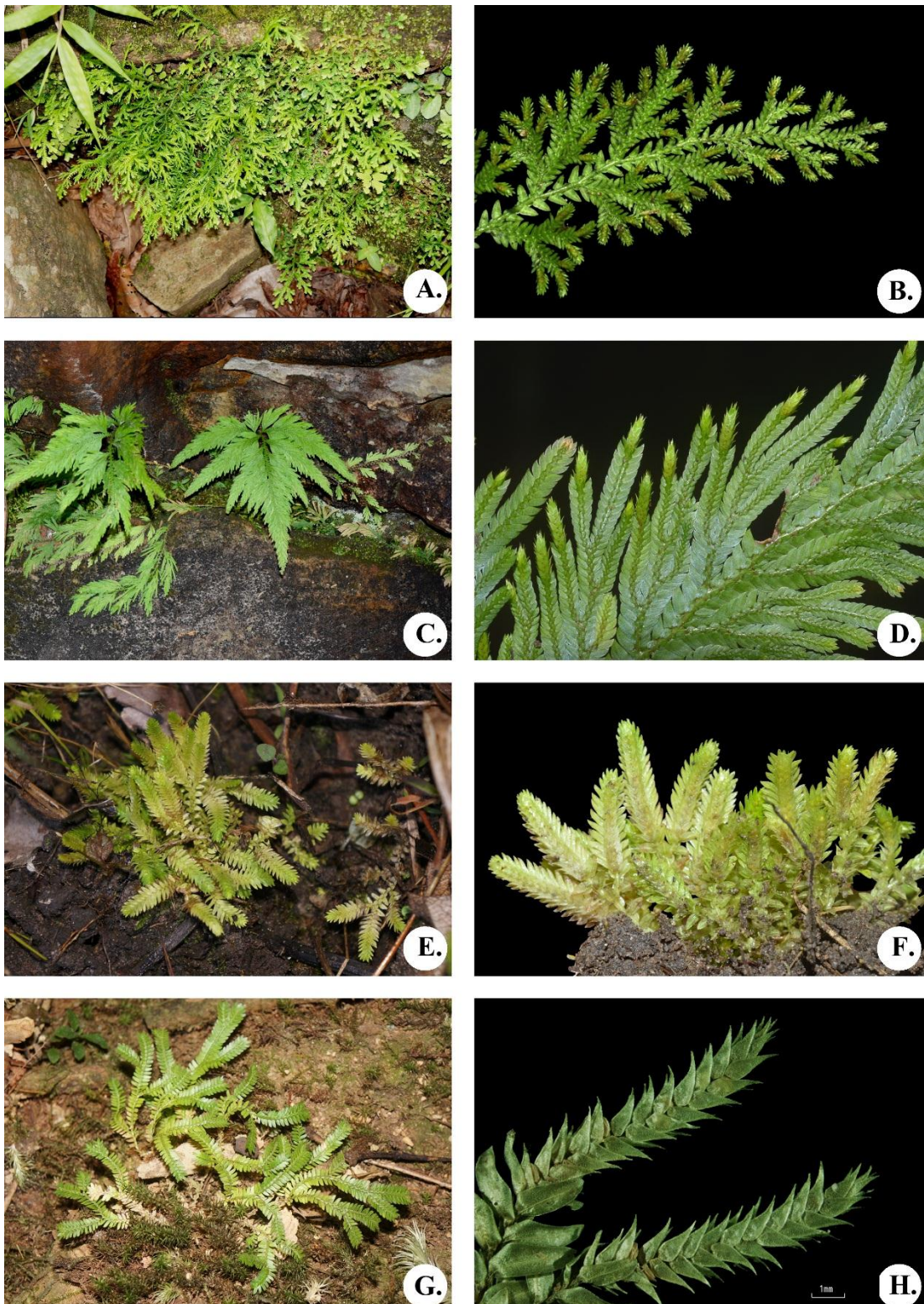


Figure 5. 2 A-B: *Selaginella amblyphylla*, A: habitat, B: dimorphic sporophylls; C-D: *S. biformis*, C: habitat, D: uniform sporophylls; E-F: *S. ciliaris*, E: habitat, F: dimorphic sporophylls; G-H: *S. intermedia*, G: habitat, H: parts of sporophylls and ventral leaves.

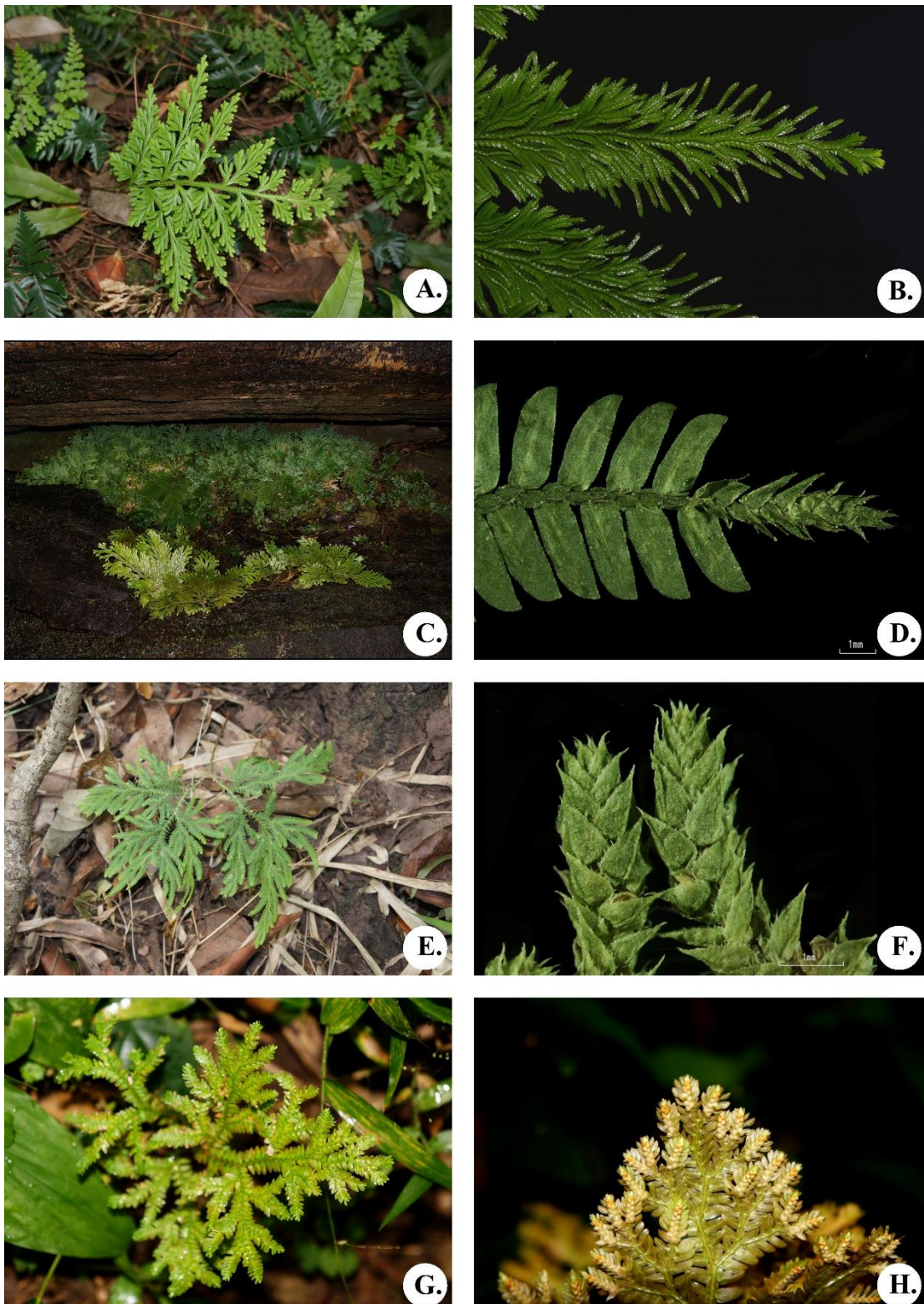


Figure 5.3 A-B: *Selaginella involvens*, A: habitat, B: uniform sporophylls; C-D: *S. monospora*, C: habitat, D: dimorphic sporophylls; E-F: *S. ostenfeldii*, E: habitat, F: close-up of the uniform sporophylls; G-H: *S. pennata*, G: habitat, H: dimorphic sporophylls.

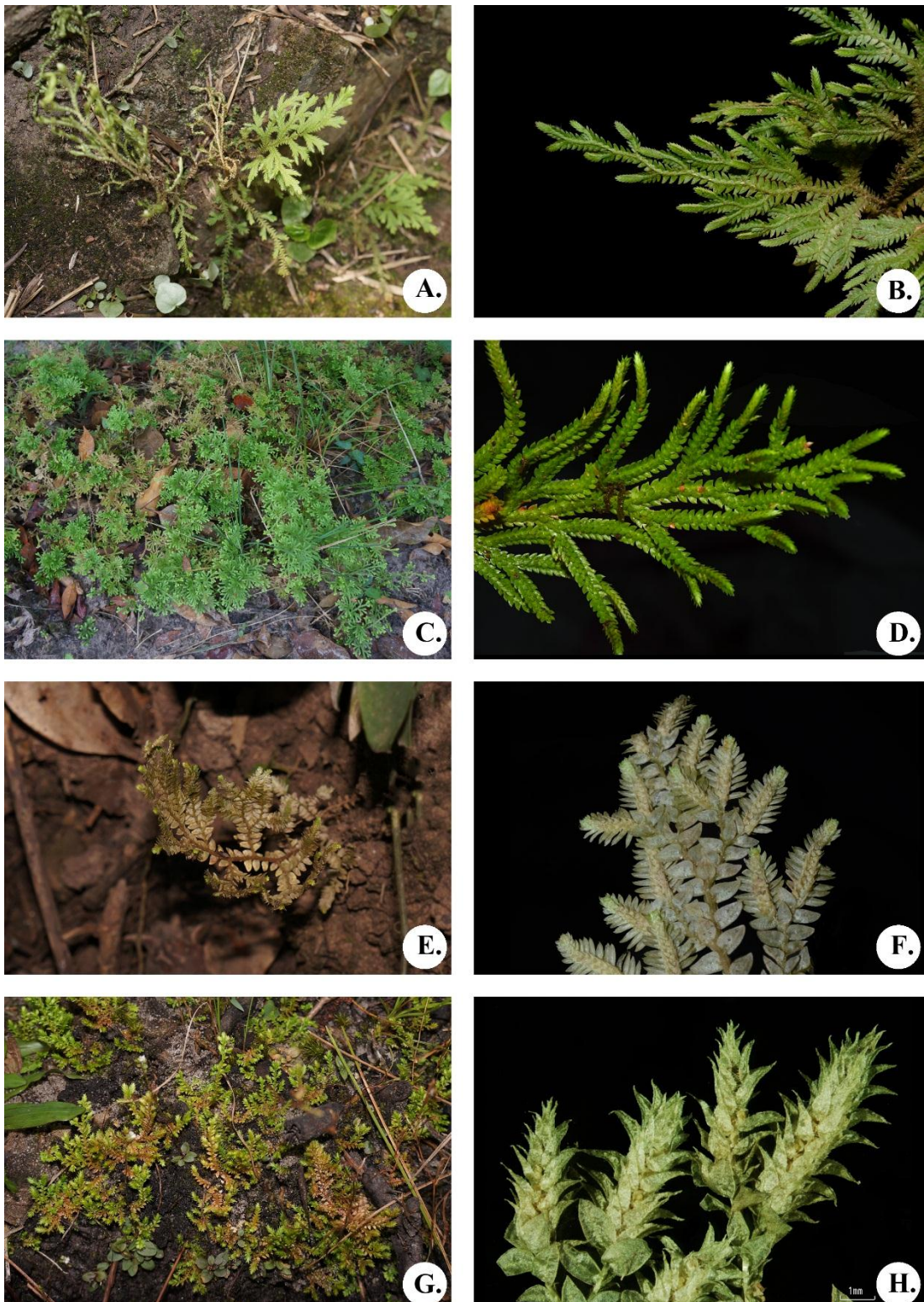


Figure 5.4 A-B: *Selaginella repanda*, A: habitat, B: part of stem showing sporophylls; C-D: *S. siamensis*, C: habitat, D: part of stem showing sporophylls; E-F: *S. tenuifolia*, E: habitat, F: close-up of dimorphic sporophylls; G-H: *Selaginella* sp., G: habitat, H: close-up of dimorphic sporophylls.

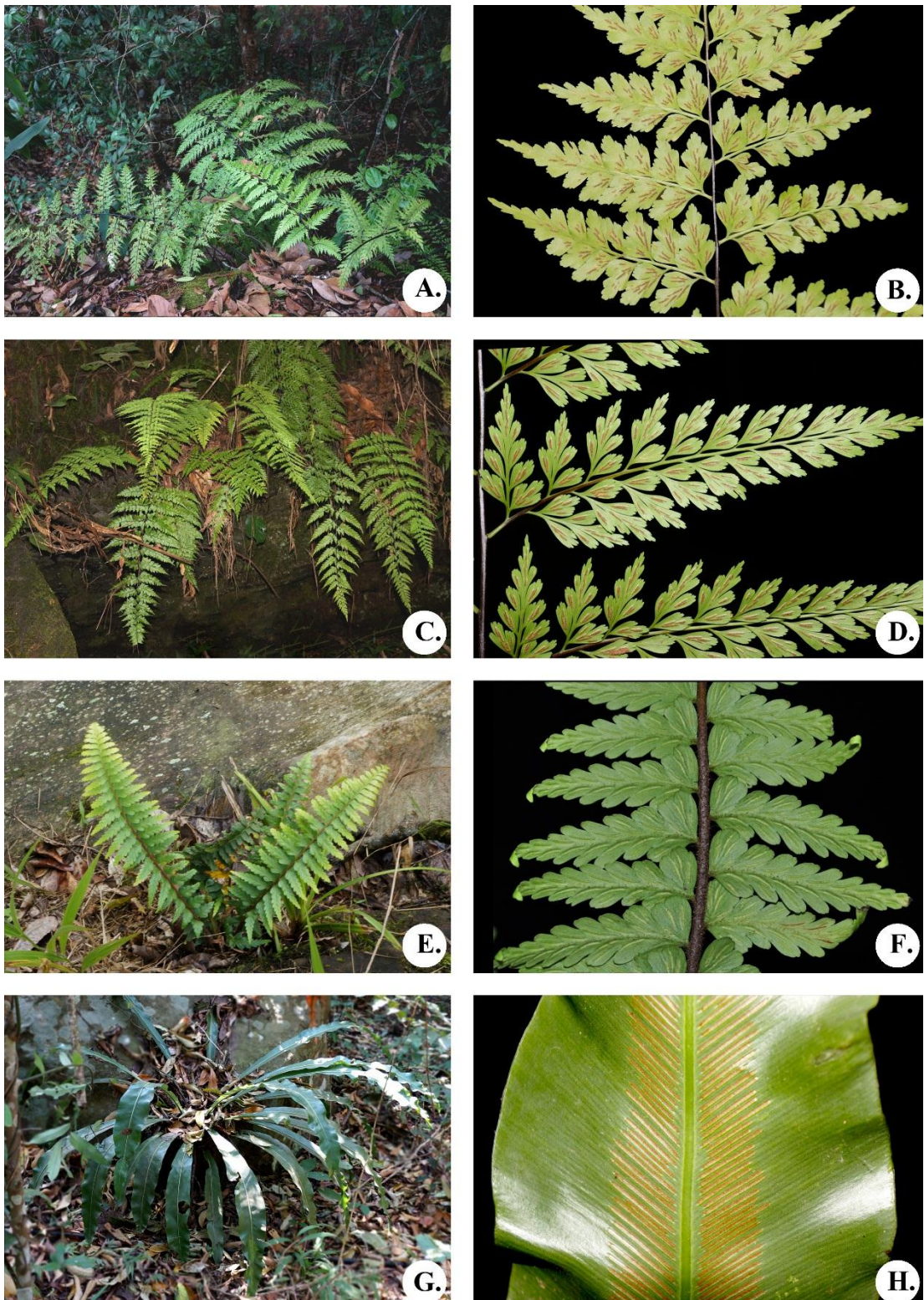


Figure 5.5 A-B: *Asplenium affine*, A: habitat, B: part of lamina showing sori; C-D: *A. confusum*, C: habitat, D: abaxial surface of lamina and sori; E-F: *A. crinicaule*, E: habitat, F: abaxial surface of lamina and sori; G-H: *A. nidus*, G: habitat, H: elongate sori.

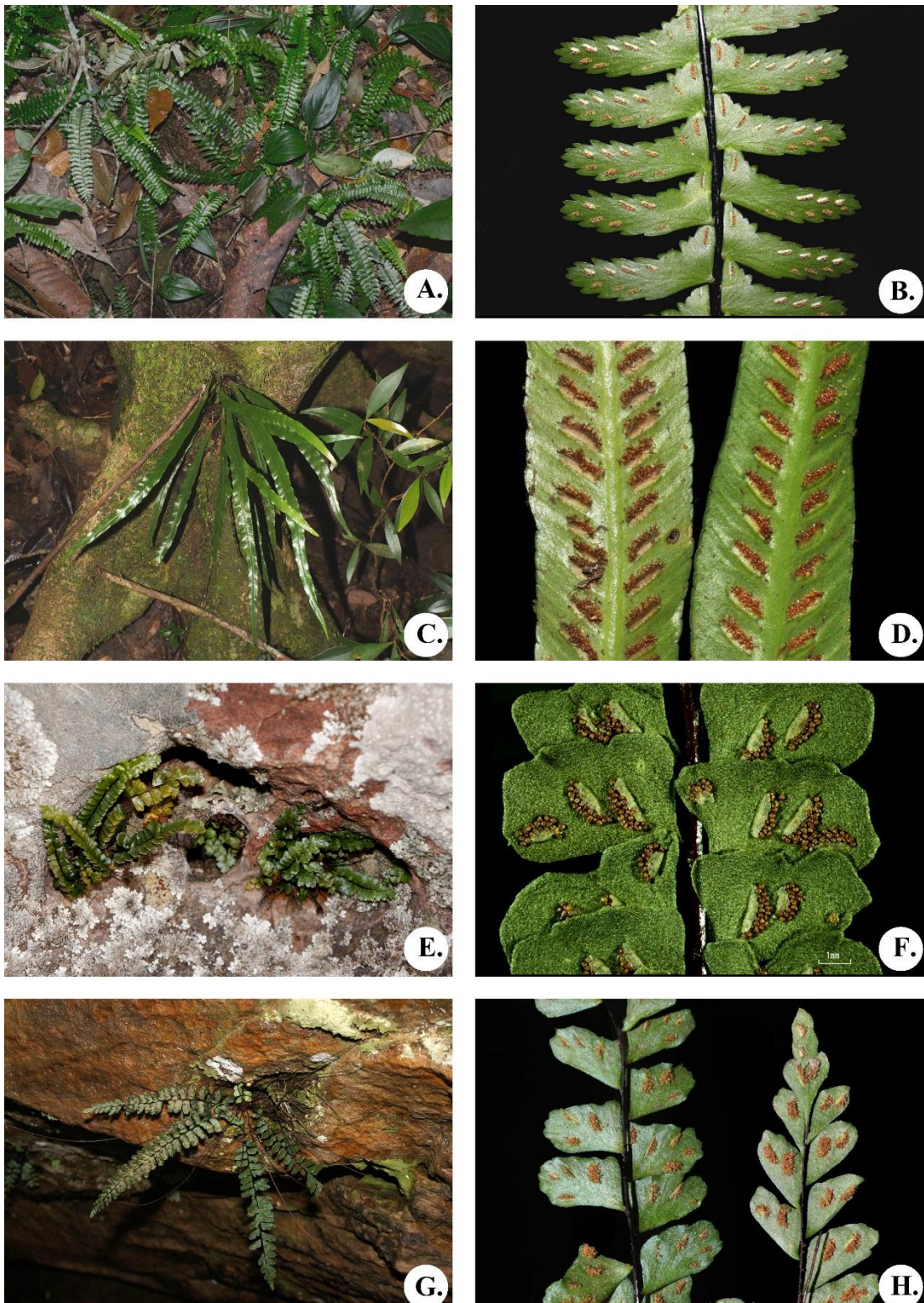


Figure 5. 6 A-B: *Asplenium normale*, A: habitat, B: part of frond showing acroscopic lobes and sori; C-D: *A. scortechinii*, C: habitat, D: close-up of sori on lower surface of fronds; E-F: *A. siamense*, E: habitat, F: lower surface of frond and close-up sori; G-H: *Asplenium* sp., G: habitat, H: part of lower surface of frond and sori.

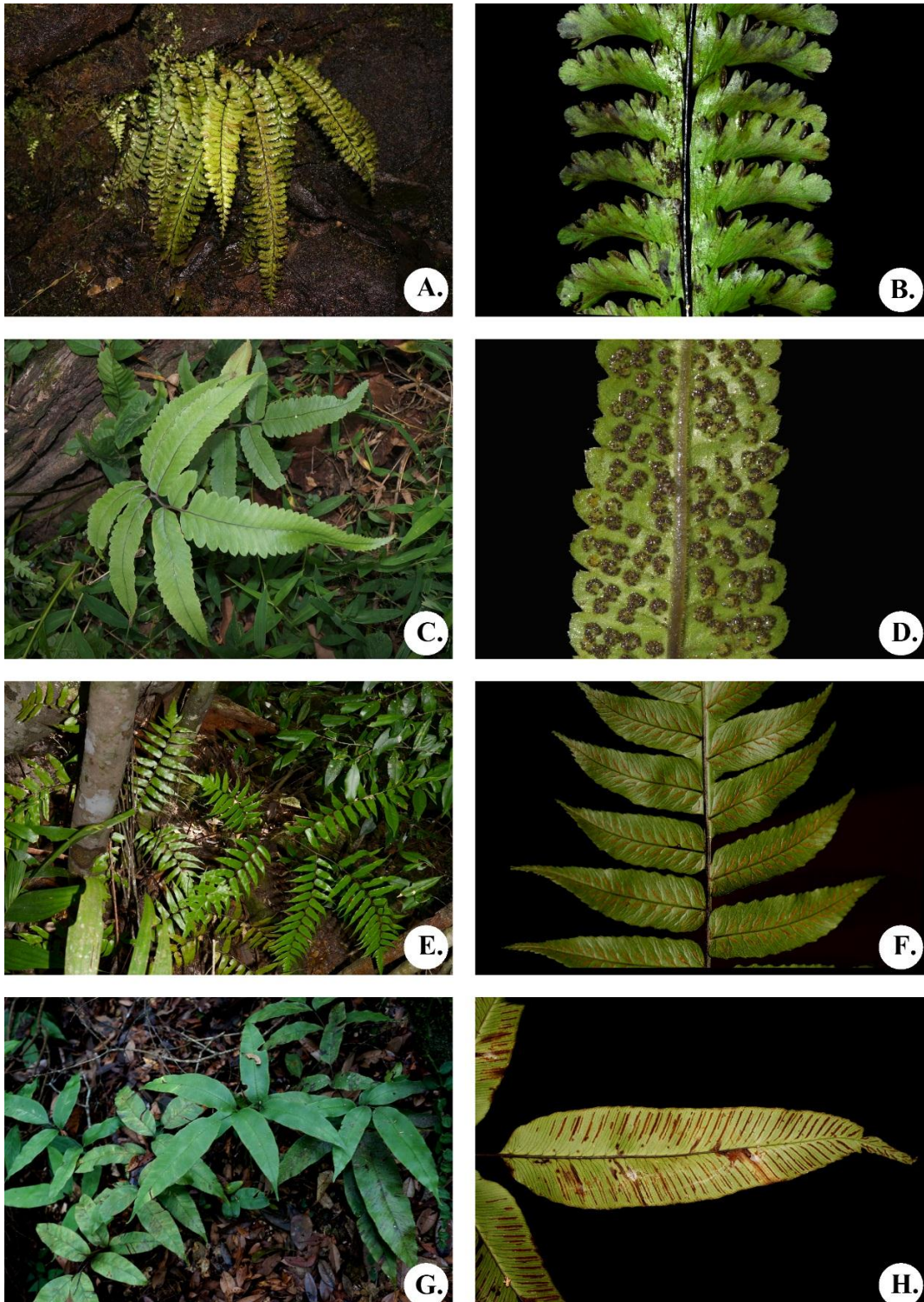


Figure 5. 7 A-B: *Hymenasplenium cheilosorum*, A: habitat, B: close-up of abaxial surface showing sori; C-D: *Athyrium cumingianum*, C: habitat, D: lower surface of frond showing sori; E-F: *Diplazium dilatatum*, E: habitat, F: part of lamina showing sori along veins; G-H: *D. donianum*, G: habitat, H: elongate sori along both sides of veins.



Figure 5. 8 A-B: *Diplazium mettenianum*, A: habitat, B: elongate sori; C-D: *D. kappanense*, C: habitat, D: oblong to elongate sori; E-F: *Blechnum orientale*, E: habitat, F: sori along costa; G-H: *Brainea insignis*, G: habitat, H: close-up of lamina on lower surface.



Figure 5. 9 A-B: *Cibotium barometz*, A: habitat, B: sori at margin of sinus; C-D: *Davallia denticulata*, C: habitat, D: part of lamina showing sori; E-F: *Alsophila podophylla*, E: close-up sori, F: habitat.

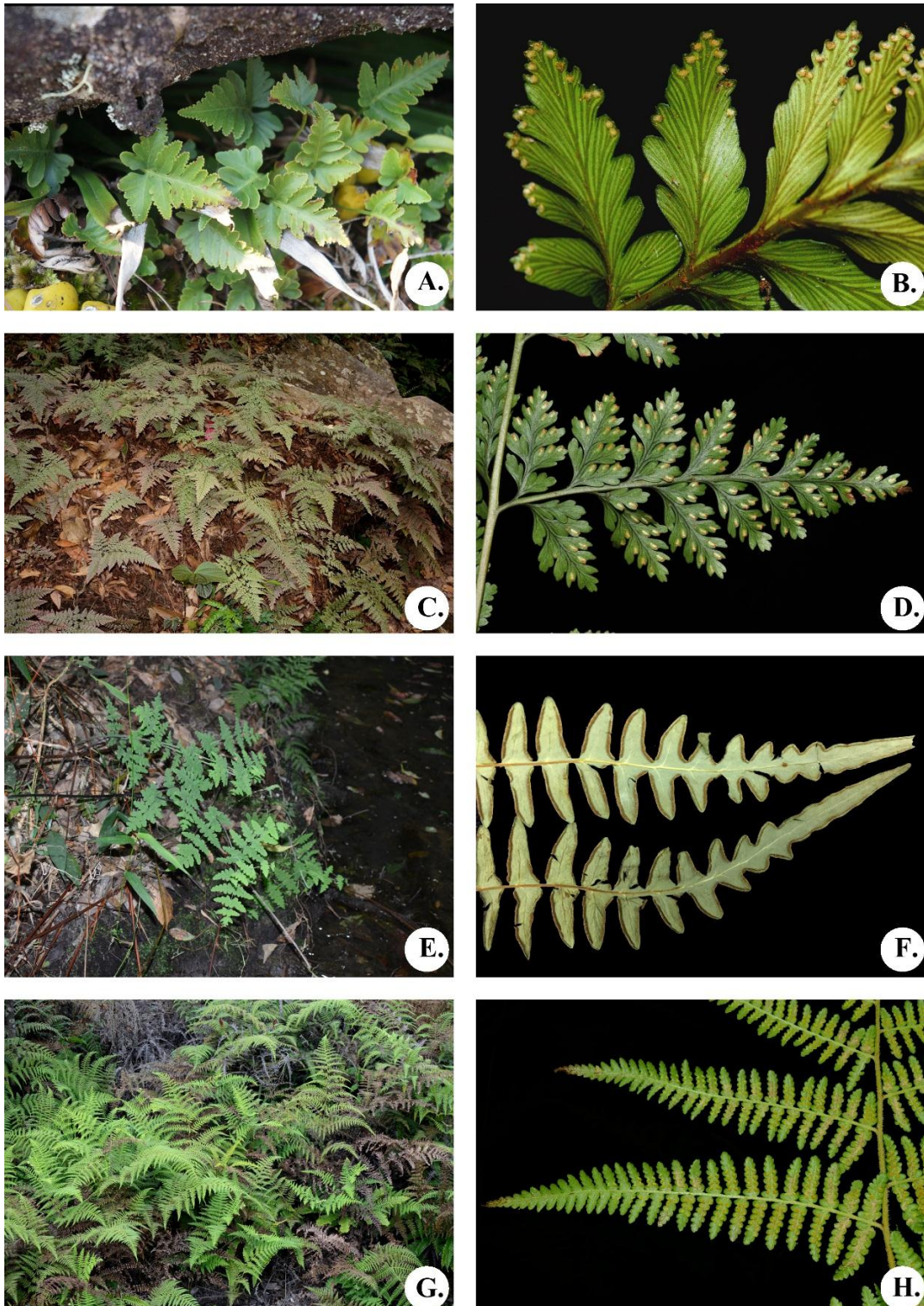


Figure 5.10 A-B: *Davallia repens*, A: habitat, B: distinct venation and sori; C-D: *D. trichomanoides* var. *lorrainii*, C: habitat, D: sori with tubular indusium; E-F: *Histiopteris incisa*, E: habitat, F: sori along margin; G-H: *Hypolepis punctata*, G: habitat, H: part of lamina and sori.

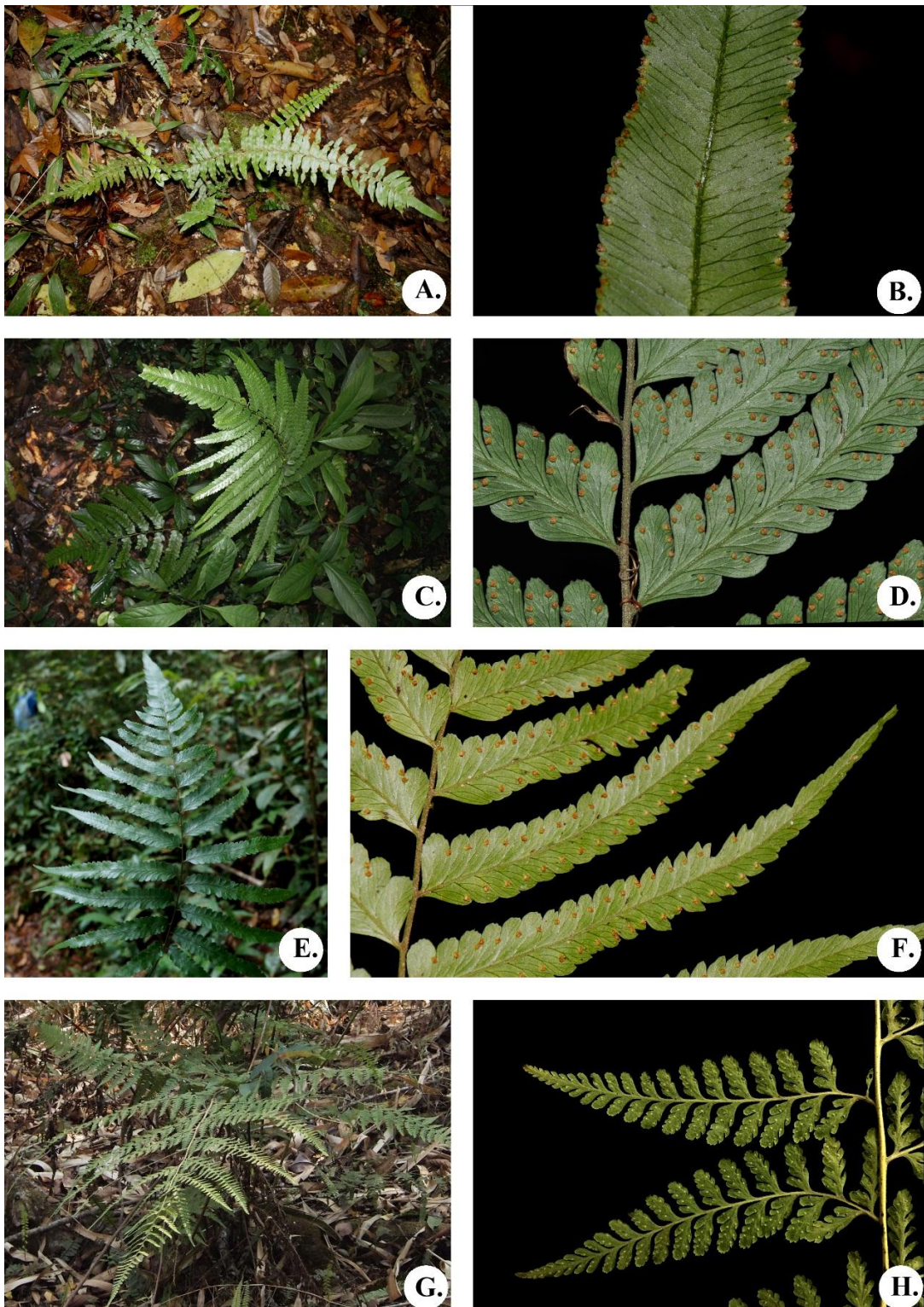


Figure 5. 11 A-B: *Microlepia hookeriana*, A: habitat, B: close-up sori; C-D: *M. marginata* var. *marginata*, C: habitat, D: part of lamina and cup-shaped sori; E-F: *M. marginata* var. *calvescens*, E. habitat, F: lower surface of lamina and cup-shaped sori; G-H: *M. speluncae*, G: habitat, H: part of lamina with sori

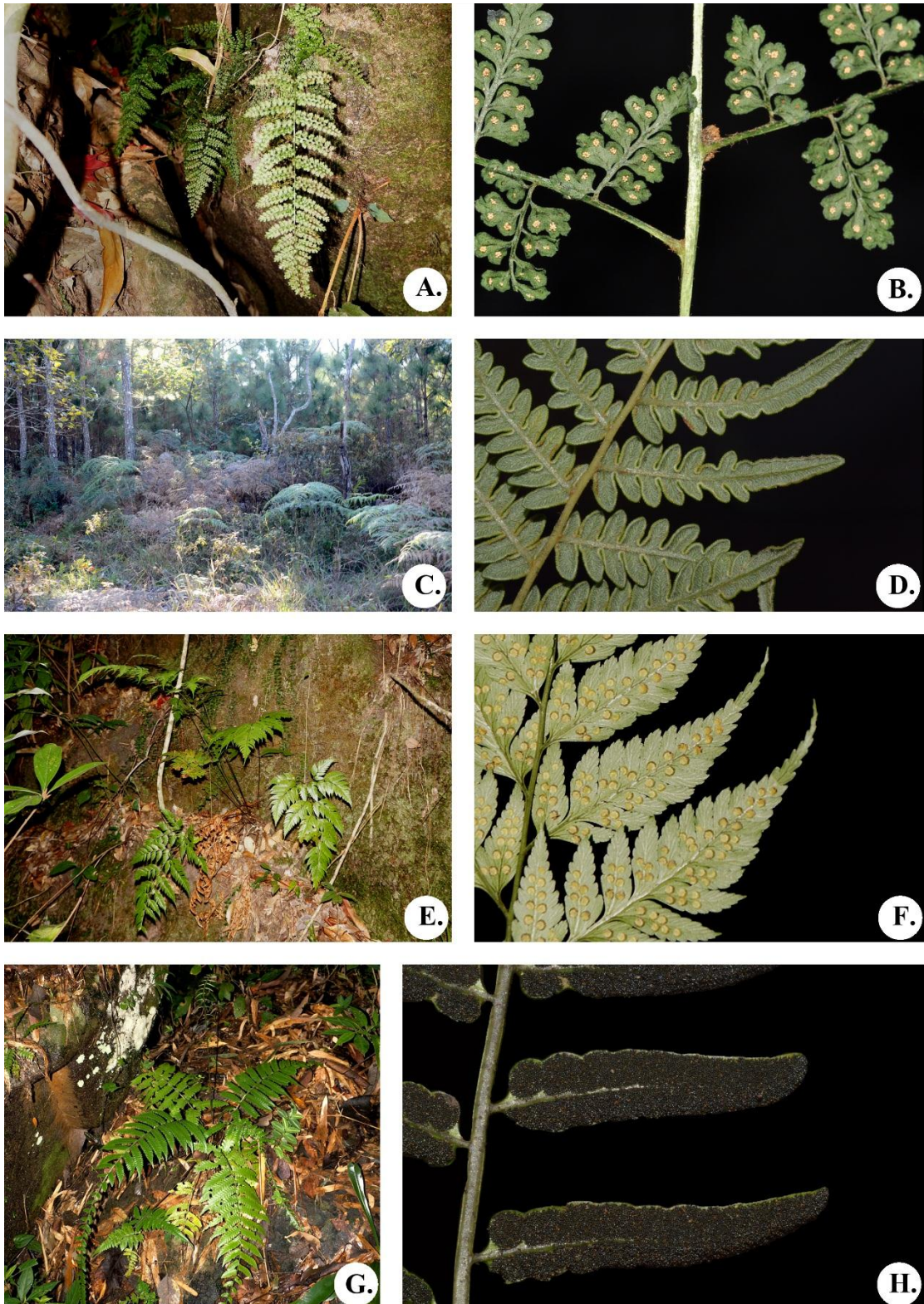


Figure 5.12 A-B: *Monachosorum henryi*, A: habitat, B: sori and bulbil on the axe; C-D: *Pteridium aquilinum*, C: habitat, D: sori; E-F: *Arachniodes cavalerii*, E: habitat, D: round sori; G-H: *Bolbitis sinensis*, G: habitat showing dimorphic leaves, H: sori cover the lower surface of pinnae.

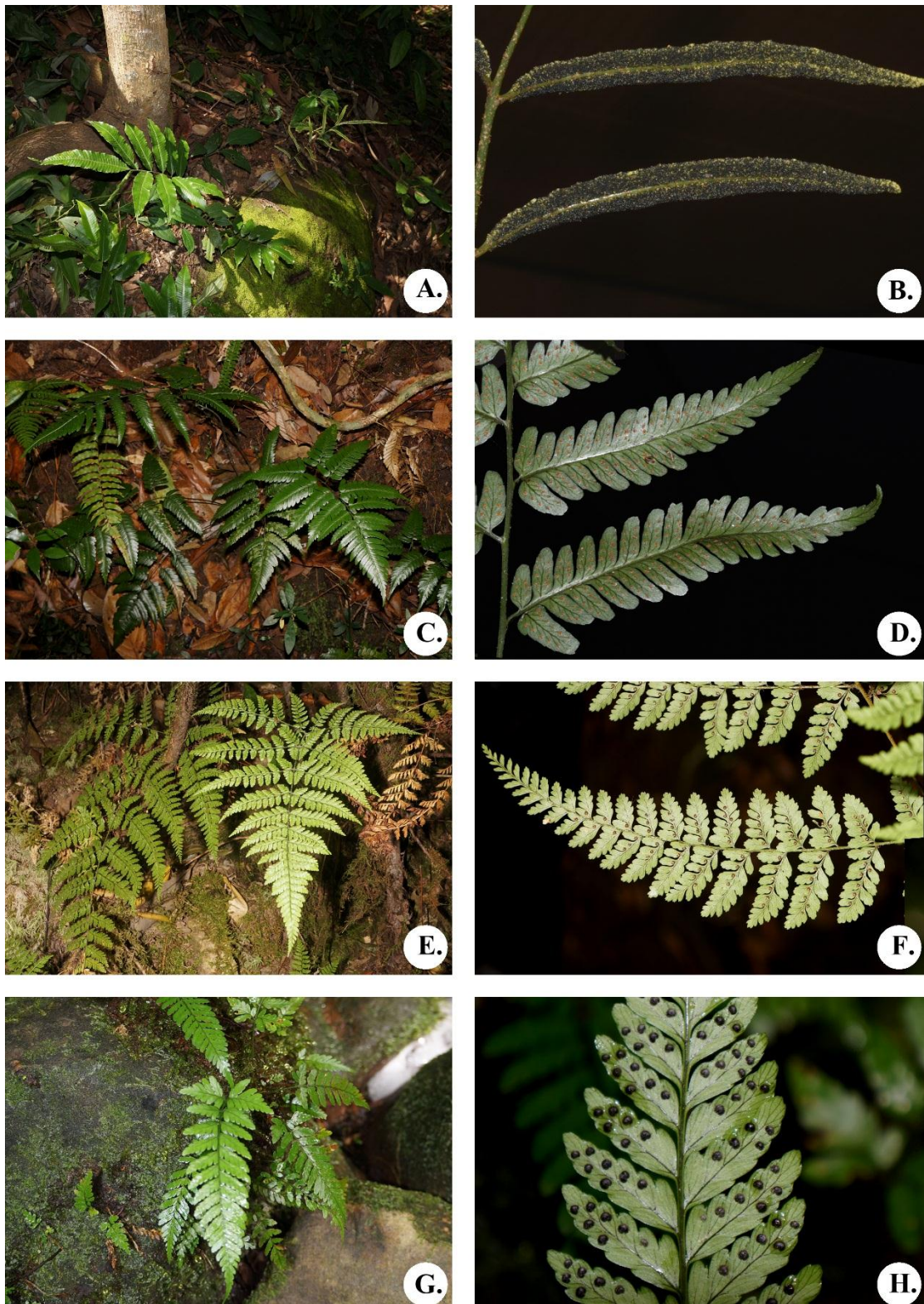


Figure 5.13 A-B: *Bolbitis virens*, A: habitat showing dimorphic leaves, B: sori on the lower surface of pinnae; C-D: *Dryopteris polita*, C: habitat, D: pinnae and sori; E-F: *D. pseudocaenopteris*, E: habitat, F: globose sori; G-H: *D. rheophila*, G: habitat, H: close-up sori.

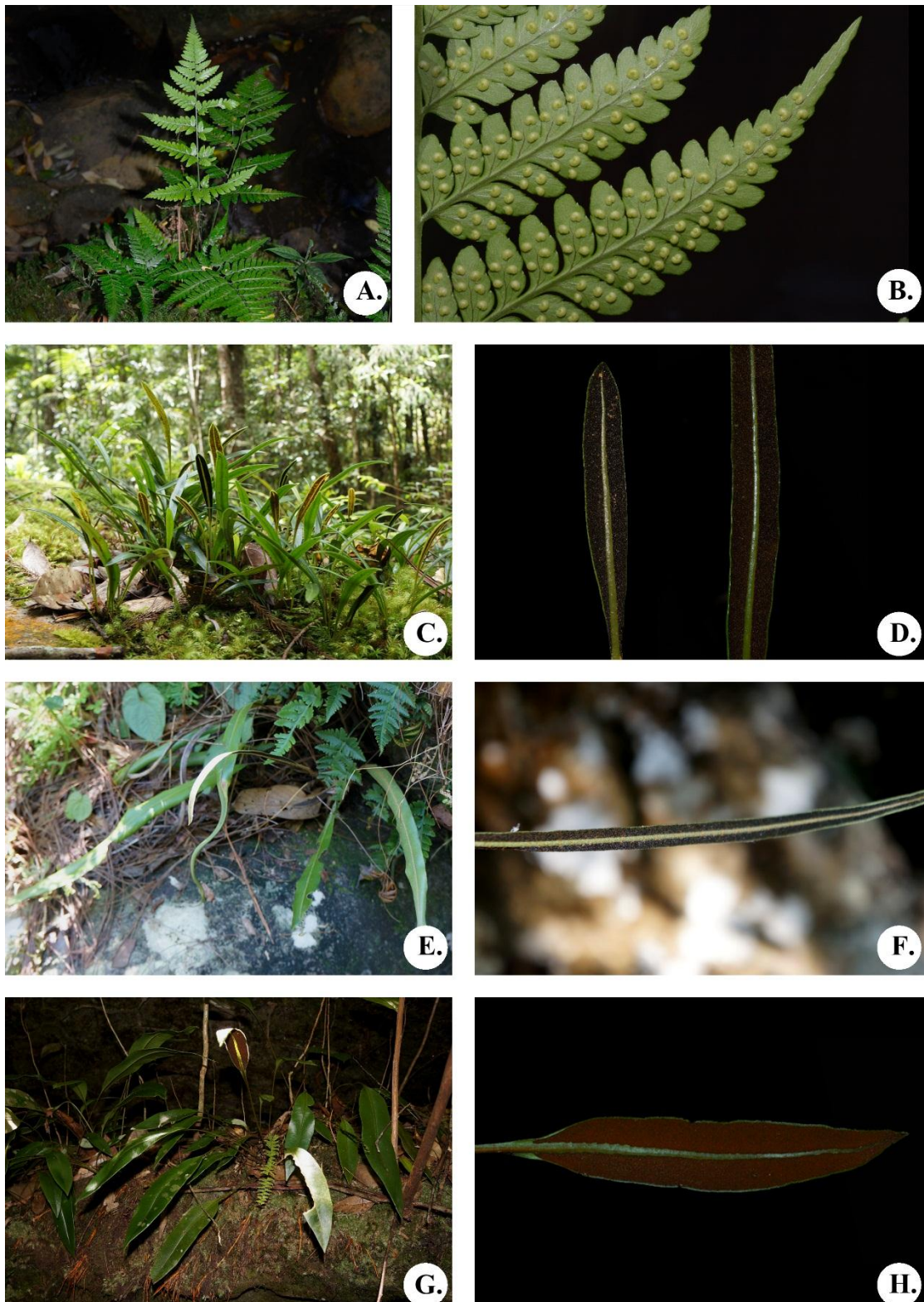


Figure 5. 14 A-B: *Dryopteris sparsa*, A: habitat, B: sori orbicular reniform; C-D: *Elaphoglossum dumrongii*, C: habitat, D: sori covering the lower surface of lamina; E-F: *E. stelligerum*, E: habitat, F: sori on abaxial surface; G-H: *E. subellipticum*, G: habitat, H: sori covering the abaxial surface.

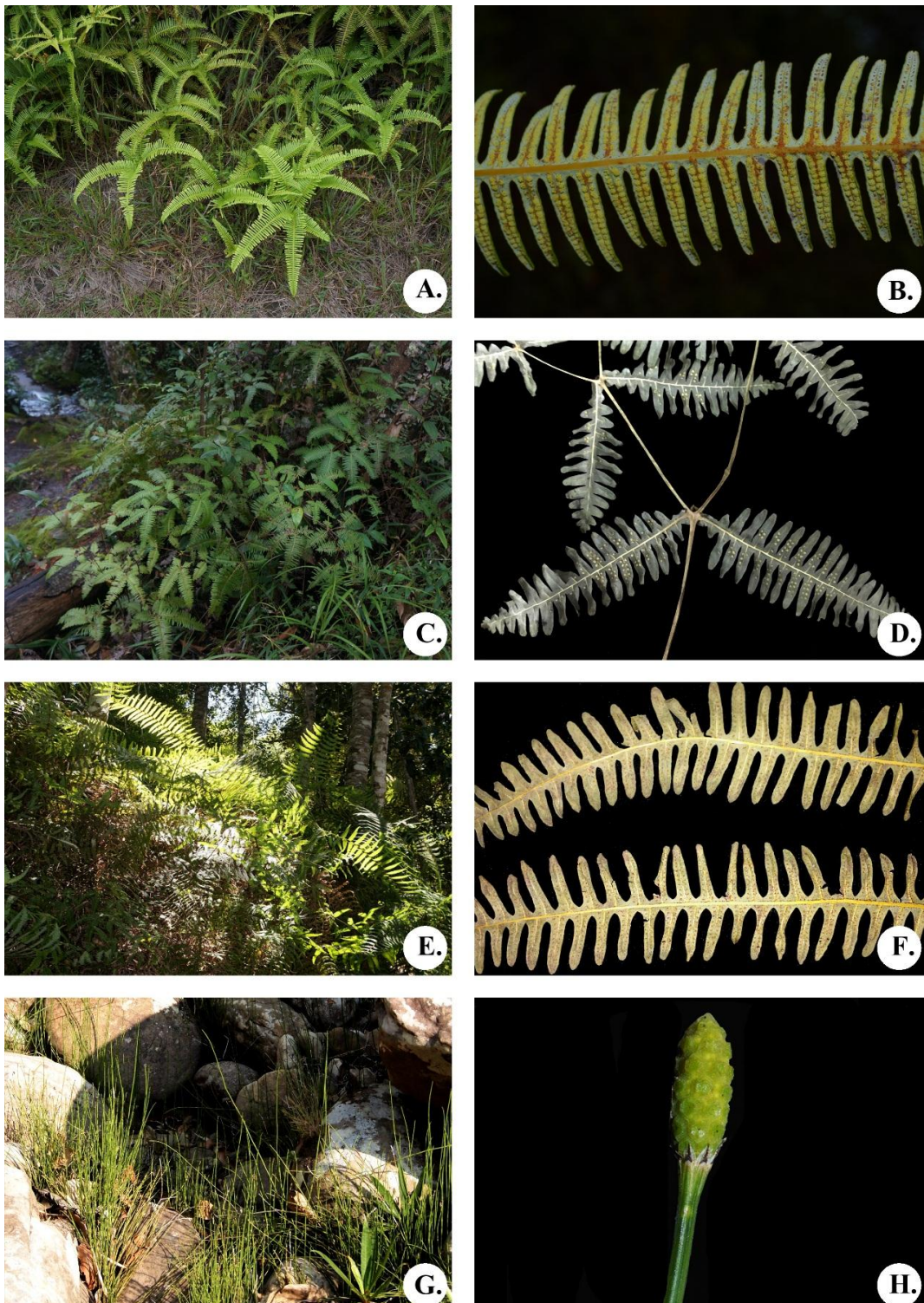


Figure 5. 15 A-B: *Dicranopteris linearis* var. *linearis*, A: habitat, B: close-up sori; C-D: *D. linearis* var. *tetraphylla*, C: habitat, D: sori on abaxial surface; E-F: *Diplopterygium blotianum*, E: habitat, F: abaxial surface of lamina with sori; G-H: *Equisetum ramosissimum* subsp. *debile*, G: habitat, H: close-up of strobili.

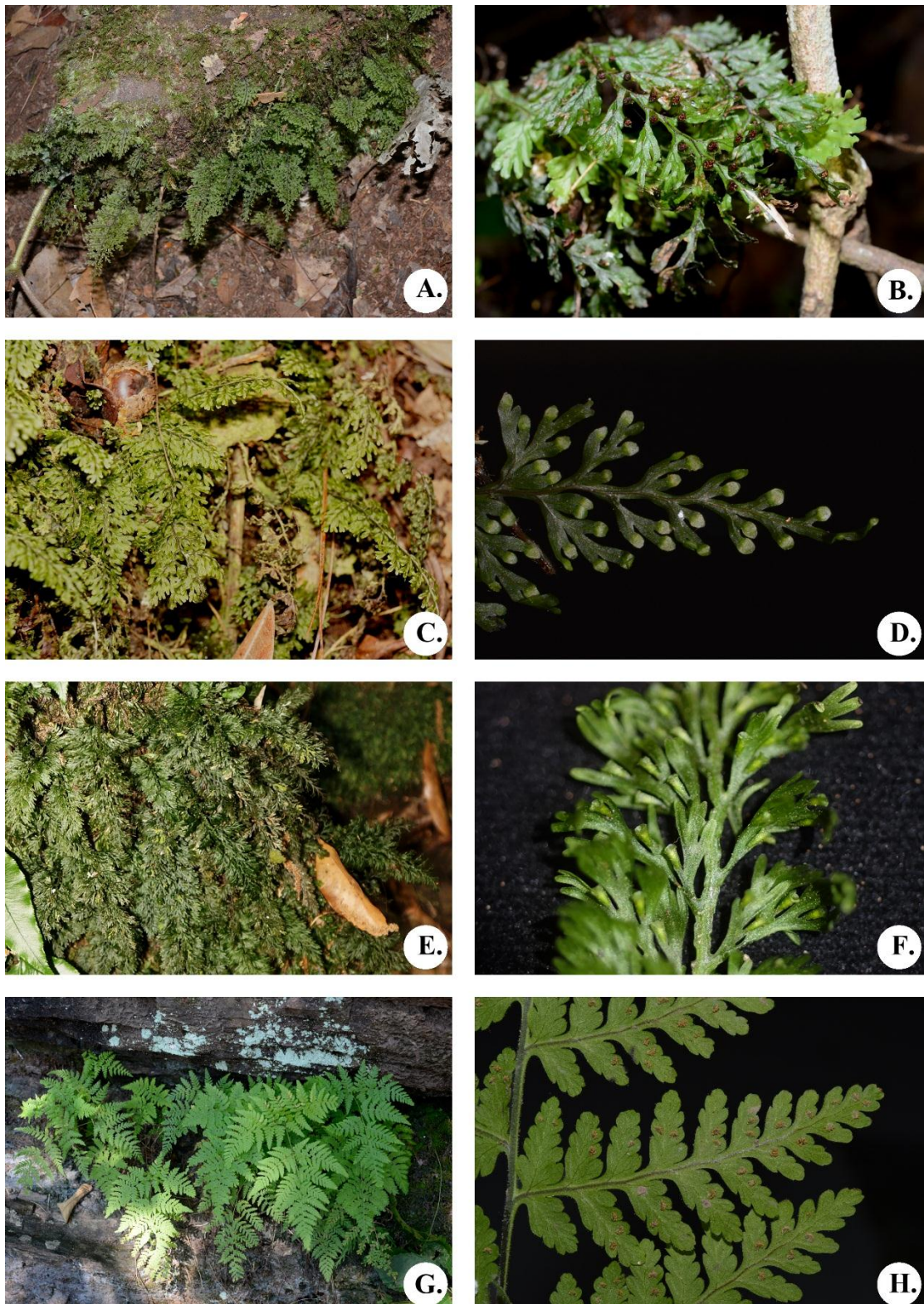


Figure 5. 16 A-B: *Hymenophyllum exsertum*, A: habitat, B: involucres bivalvate ; C-D: *H. polyanthos*, C: habitat, D: involucres bivalvate; E-F: *Vandenboschia striata*, E: habitat, F: involucres tubular; G-H: *Hypodematium glanduloso-pilosum*, G: habitat, H: close-up of abaxial surface of lamina and sori.

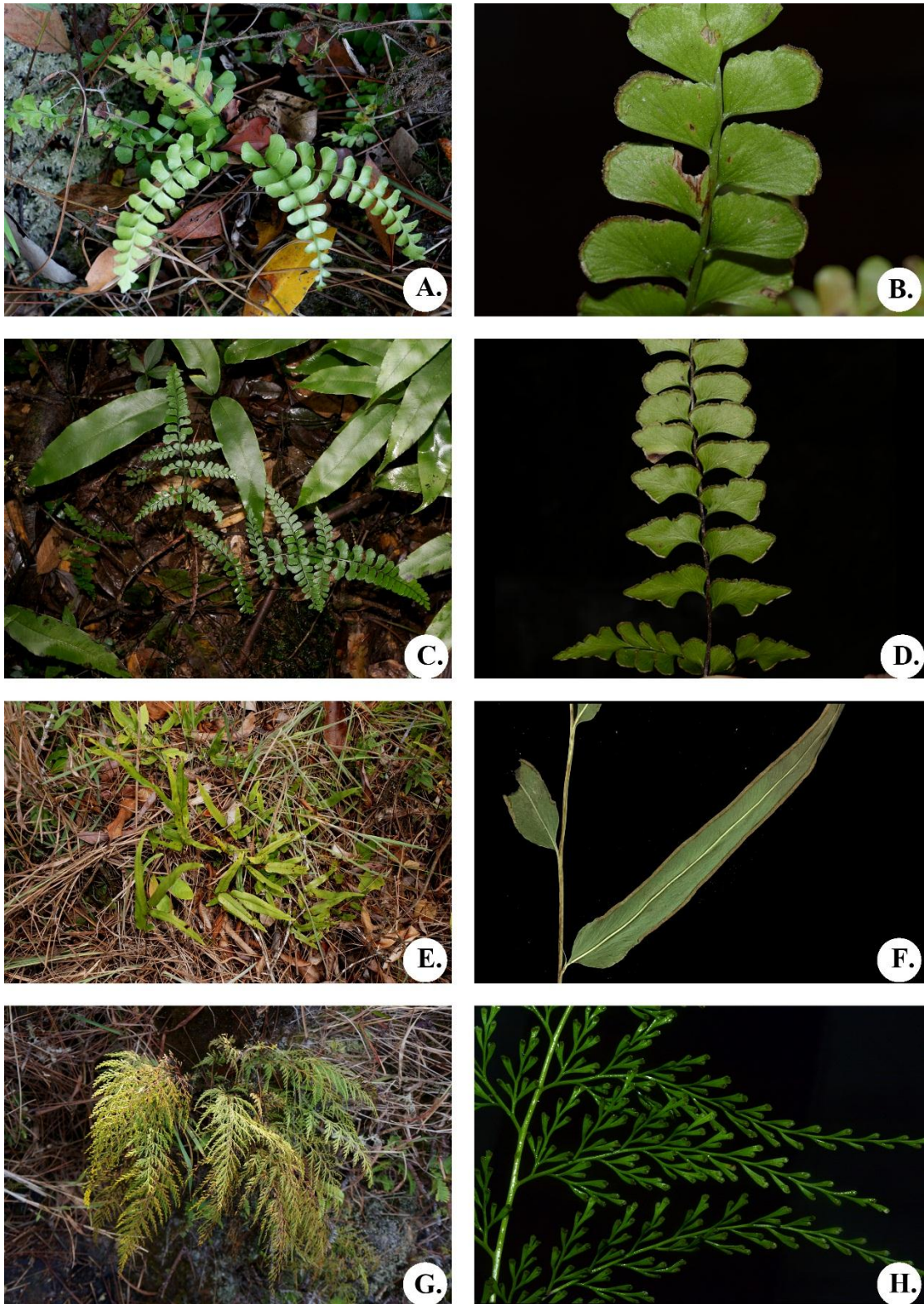


Figure 5.17 A-B: *Lindsaea chienii*, A: habitat, B: elongate sori along margin; C-D: *L. javanensis*, C: habitat, D: sori along margin; E-F: *L. ensifolia*, E: habitat, F: elongate sori; G-H: *Odontosoria chinensis*, G: habitat, H: sori at margin of lobes.

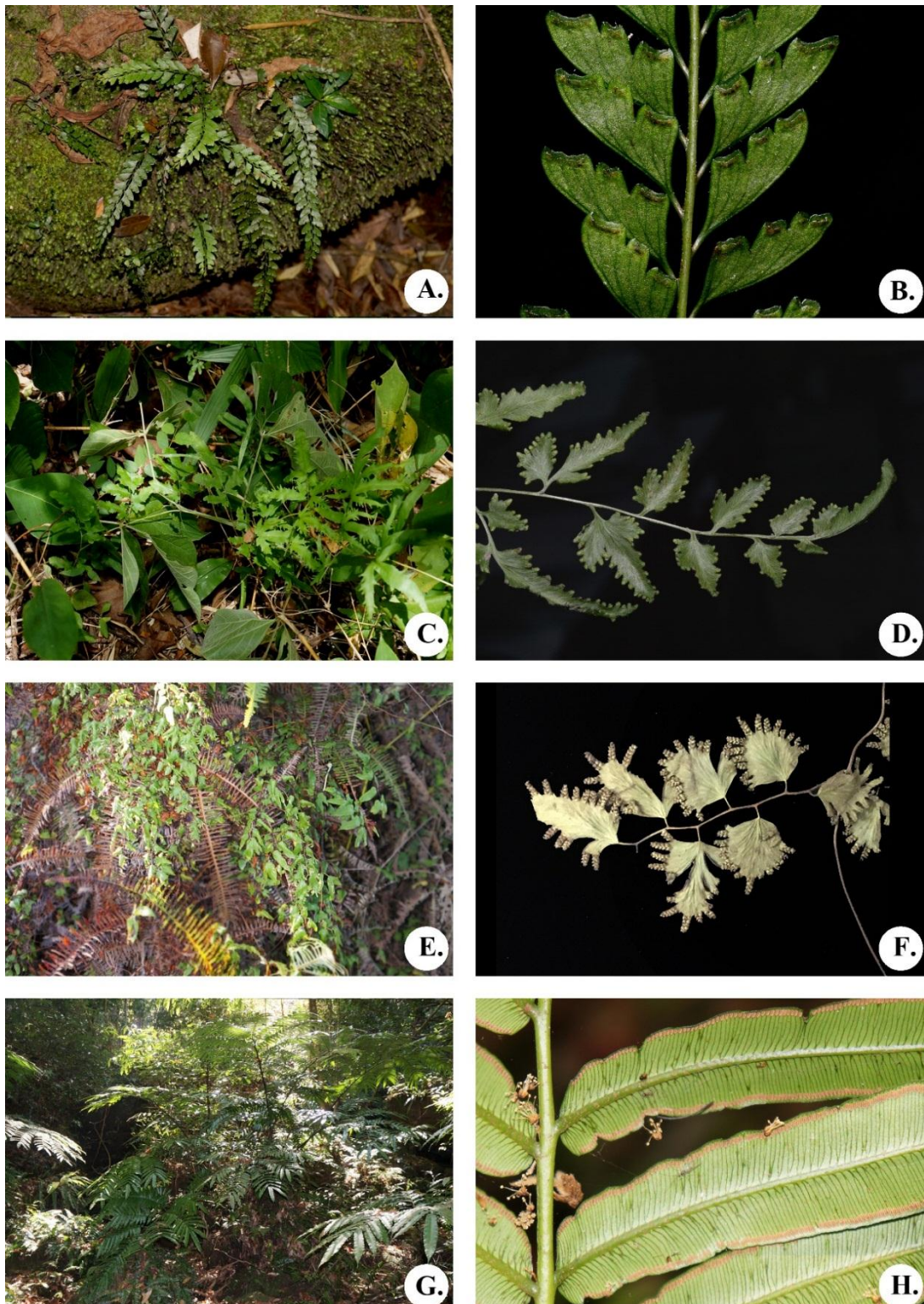


Figure 5. 18 A-B: *Osmolindsaea odorata*, A: habitat, B: part of lamina showing sori on abaxial surface of lamina; C-D: *Lygodium japonicum*, C: habitat, D: the part of lamina and sporangia at margin of protruding lobes; E-F: *L. microphyllum*, E: habitat, F: part of lamina and sporangia at margin of protruding lobes; G-H: *Angiopteris evecta*, G: habitat, H: synangia sori.

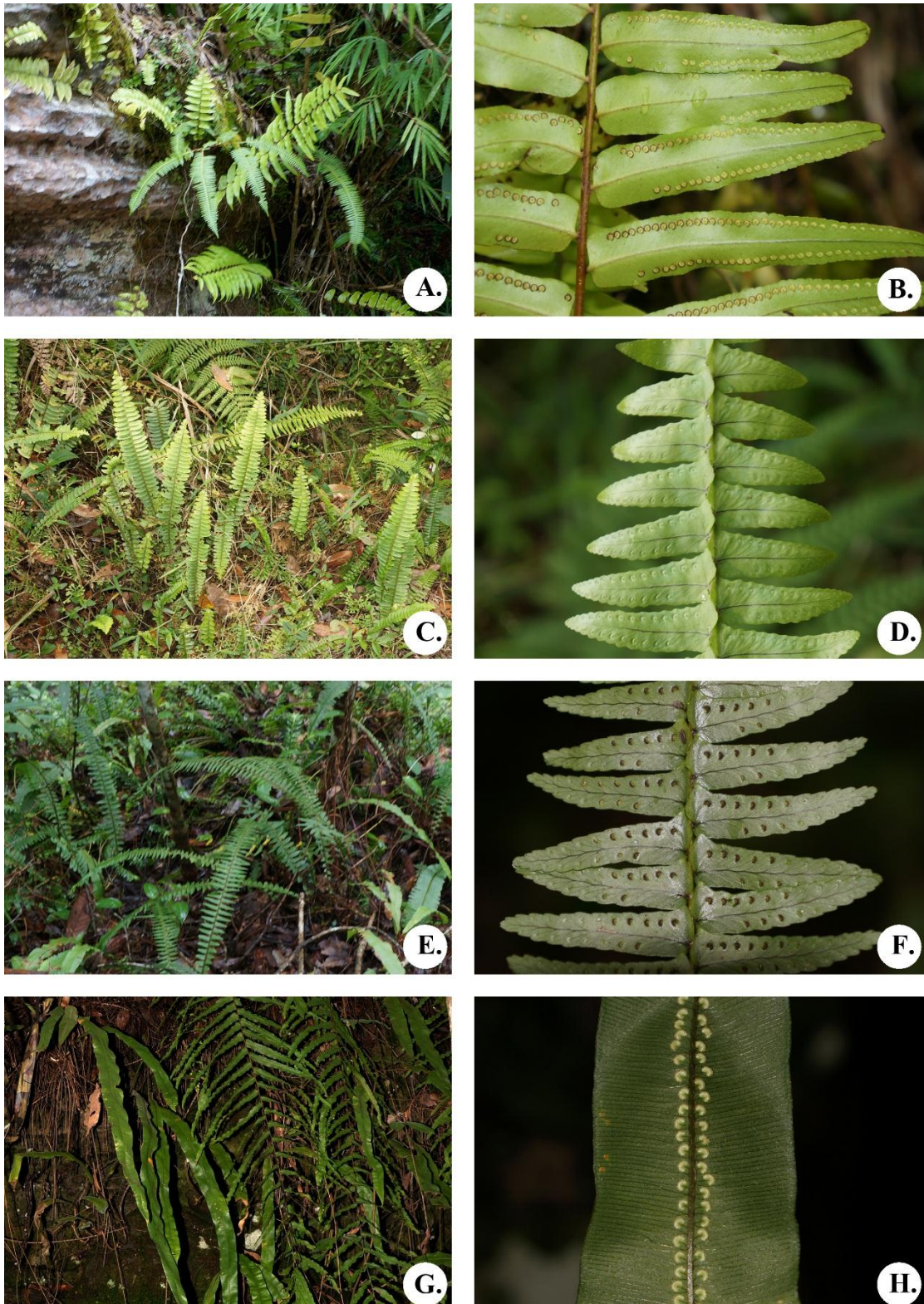


Figure 5. 19 A-B: *Nephrolepis biserrata*, A: habitat, B: close-up sori on abaxial surface; C-D: *N. cordifolia*, C: habitat, D: sori reniform; E-F: *N. undulata*, E: habitat showing long fronds, F: sori reniform; G-H: *Oleandra cumingii*, G: habitat, H: part of lamina showing sori near midrib.



Figure 5. 20 A-B: *Oleandra musifolia*, A: habitat, B: part of lower surface of lamina showing sori; C-D: *O. undulata*, C: habitat, D: part of frond showing sori and lower surface glabrous; E-F: *Oleandra* sp., E: habitat, F: part of frond showing sori and the lower surface of lamina hairy; G: *Ophioderma pendula*, habitat.

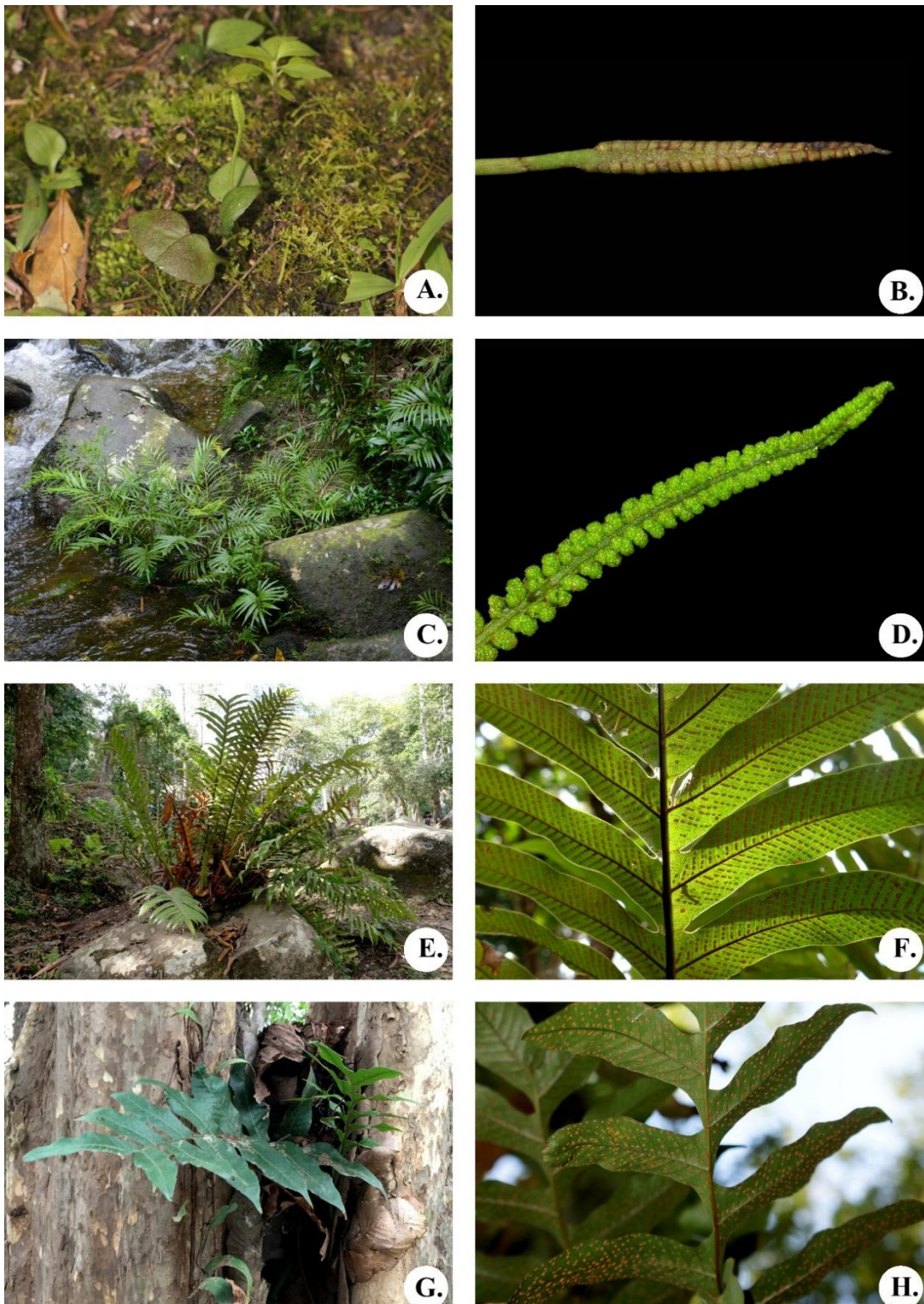


Figure 5. 21 A-B: *Ophioglossum petiolatum*, A: habitat showing dimorphic leaves, B: sporophore (spore-bearing portion); C-D: *Osmunda angustifolia*, C: habitat, D: fertile frond showing sori; E-F: *Aglaomorpha coronans*, E: habitat, F: sori on lower surface of lamina; G-H: *Drynaria bonii*, G: habitat showing dimorphic leaves, H: sori on lower surface of lamina.

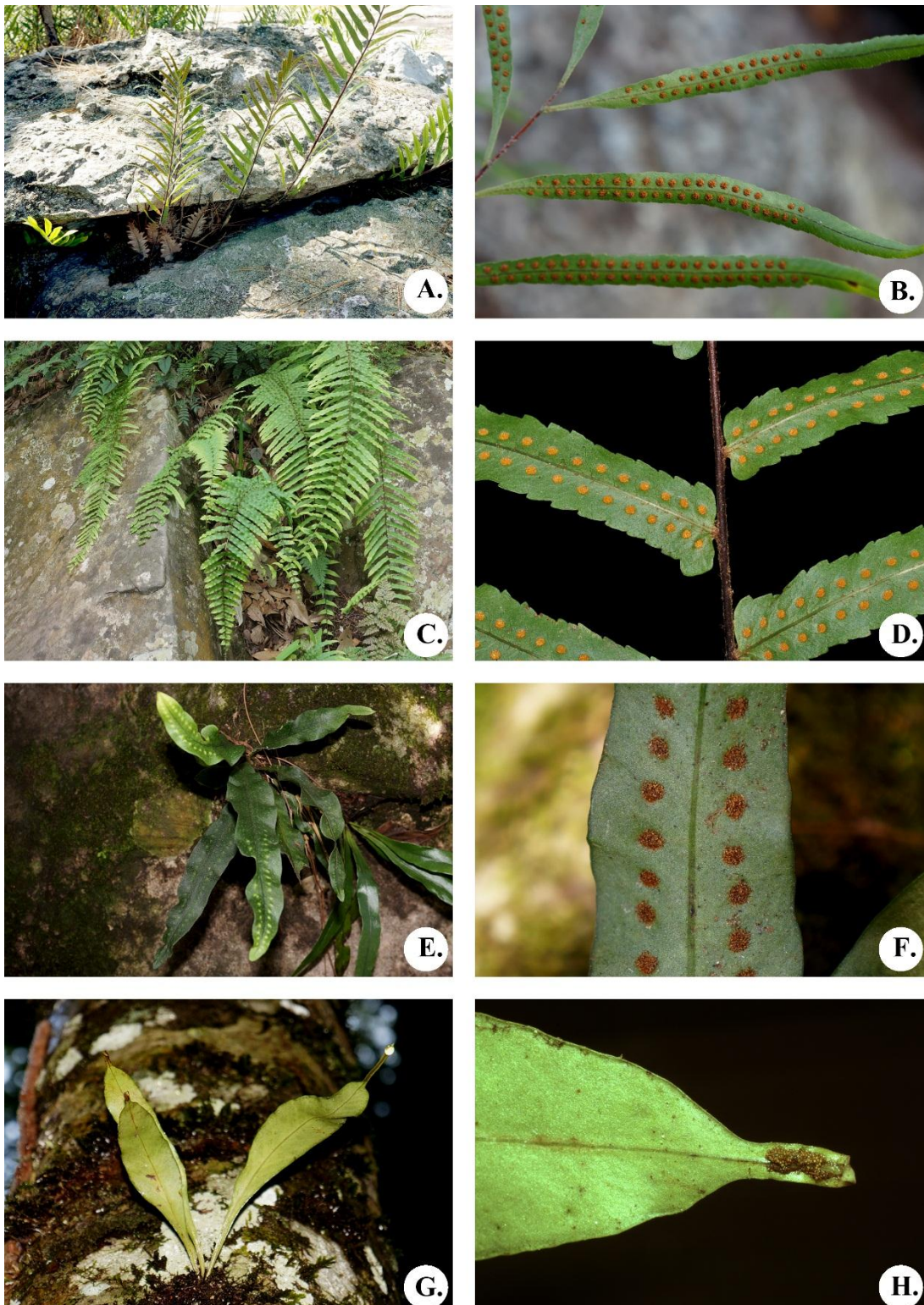


Figure 5.22 A-B: *Drynaria rigidula*, A: habitat showing dimorphic fronds, B: close-up of sori; C-D: *Goniophlebium subauriculatum*, C: habitat, D: close-up of sunken sori; E-F: *Lepisorus bicolor*, E: habitat, F: sori round or oblong; G-H: *L. henryi*, G: habitat, H: sori on abaxial surface at apex of frond.

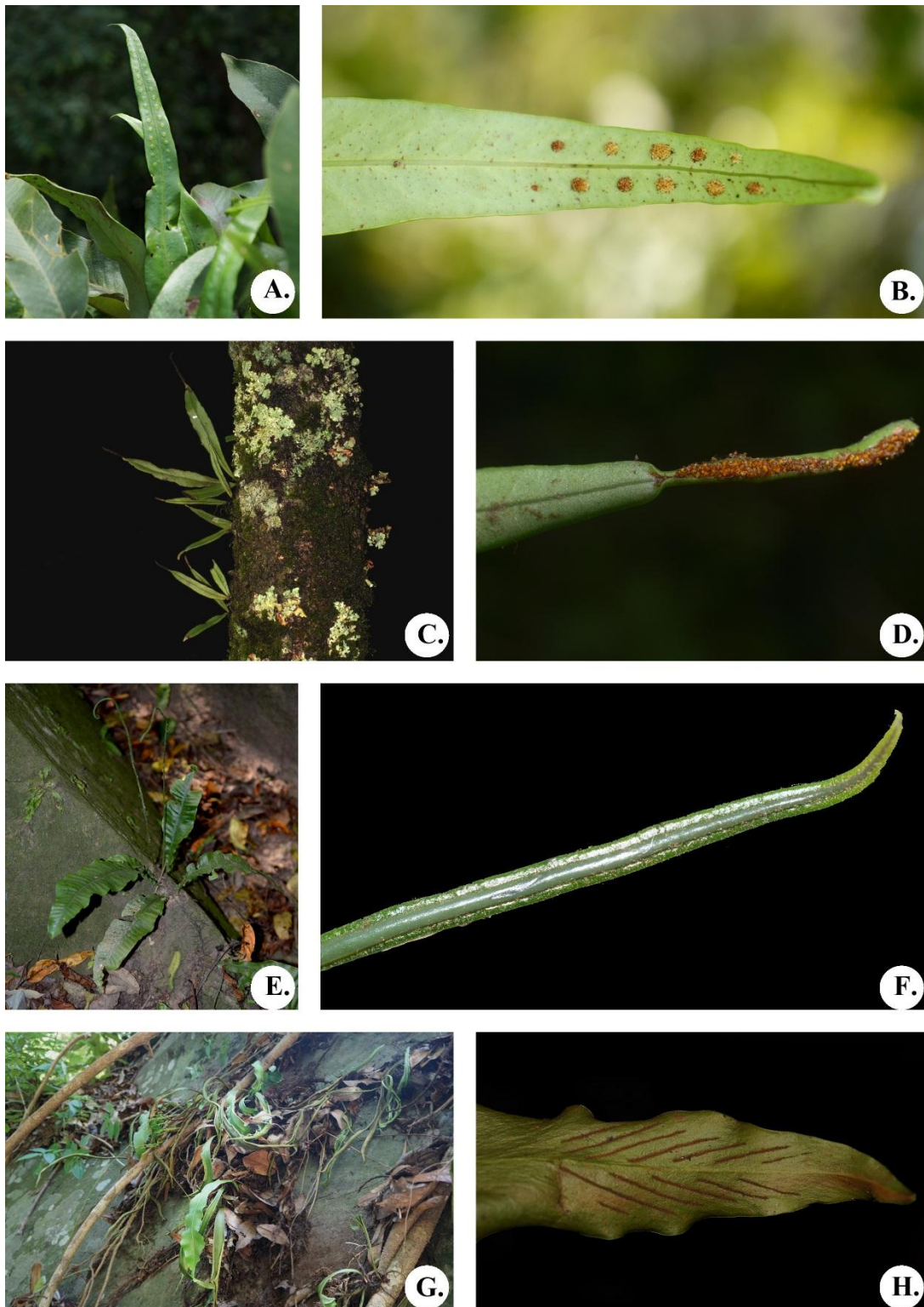


Figure 5. 23 A-B: *Lepisorus nudus*, A: habitat with sori hallowed on the upper surface, B: sori round on lower surface; C-D: *L. spicata*, C: habitat, D: sori on abaxial surface at apex of frond; E-F: *Leptochilus decurrens*, E: habitat showing dimorphic fronds, F: sori acrostichoid; G-H: *Loxogramme duclouxii*, G: habitat, H: elongate sori abaxial surface at the upper part of frond.

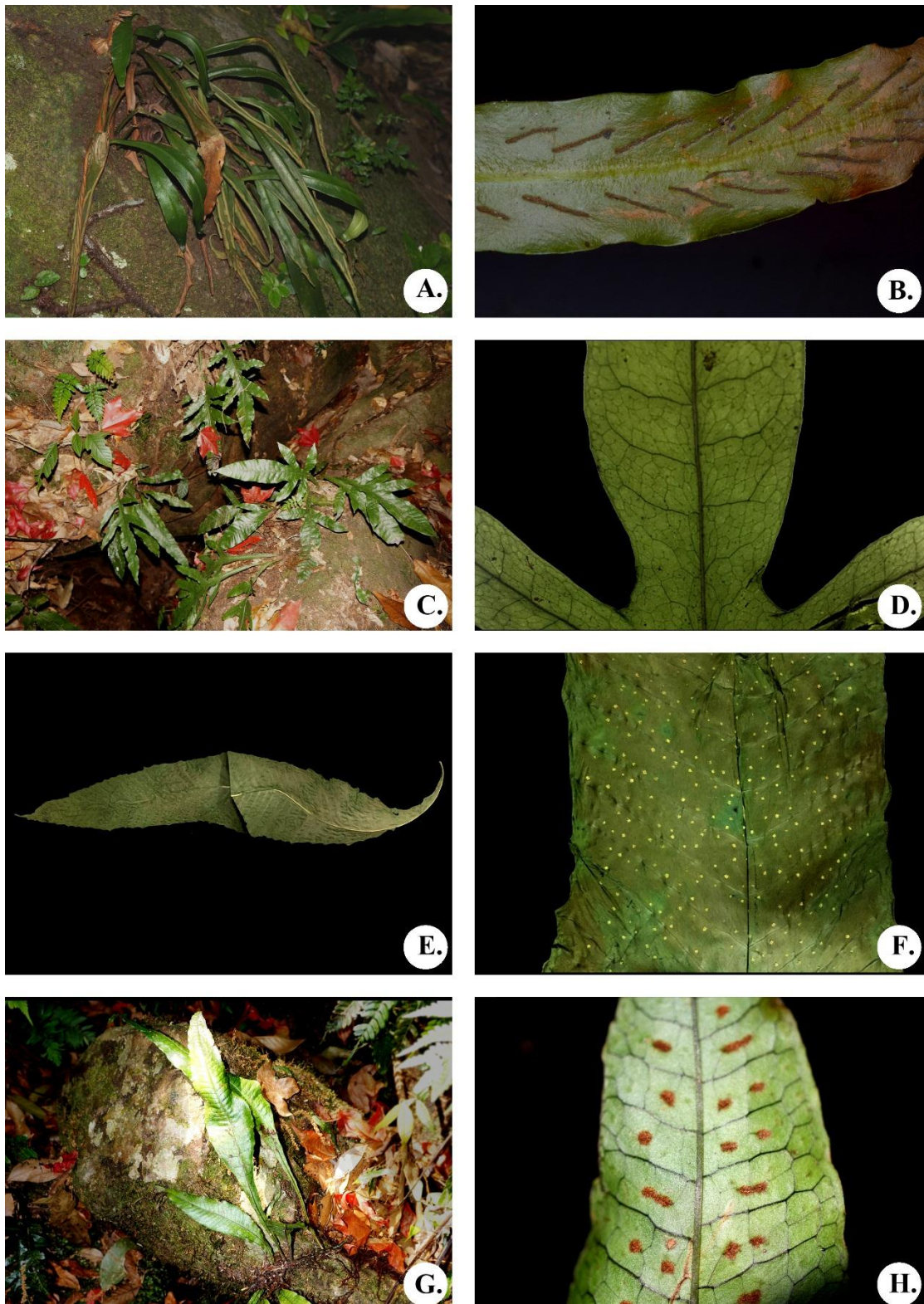


Figure 5. 24 A-B: *Loxogramme salicifolia*, A: habitat, B: elongate sori; C-D: *Microsorium insigne*, A: habitat, B: abaxial surface of lamina showing anastomosing veins; E-F: *M. membranaceum*, E: whole frond, F: sori scattered on lower surface; G-H: *M. pteropus*, G: habitat, H: sori round to elongate.



Figure 5. 25 A-B: *Microsorium punctatum*, A: habitat, B: scattered sori; C-D: *Neolepisorus zippelii*, C: habitat, D: round sori; E-F: *Paragramma longifolia*, E: habitat, F: sori in one row along each side of midrib; G-H: *Platycerium wallichii*, G: habitat showing dimorphic leaves, H: fertile leaves and sori mixed with stellate hairs.



Figure 5. 26 A-B: *Pyrrosia adnascens*, A: habitat, B: close-up sori; C-D: *P. lingua* var. *heteractis*, C: habitat, D: close-up round sori; E-F: *P. porosa*, E: habitat, F: sori on abaxial surface; G-H: *P. stigmosa*, G: habitat, H: close-up of abaxial surface of lamina.



Figure 5. 27 A-B: *Selligiea oxyloba*, A: habitat, B: sori on abaxial surface; C-D: *S. rhynchophylla*, C: habitat, D: sori round; E-F: *S. trisecta*, E: habitat, F: close-up of young sori; G-H: *Psilotum nudum*, G: habitat, H: 3-lobed of sporangia.

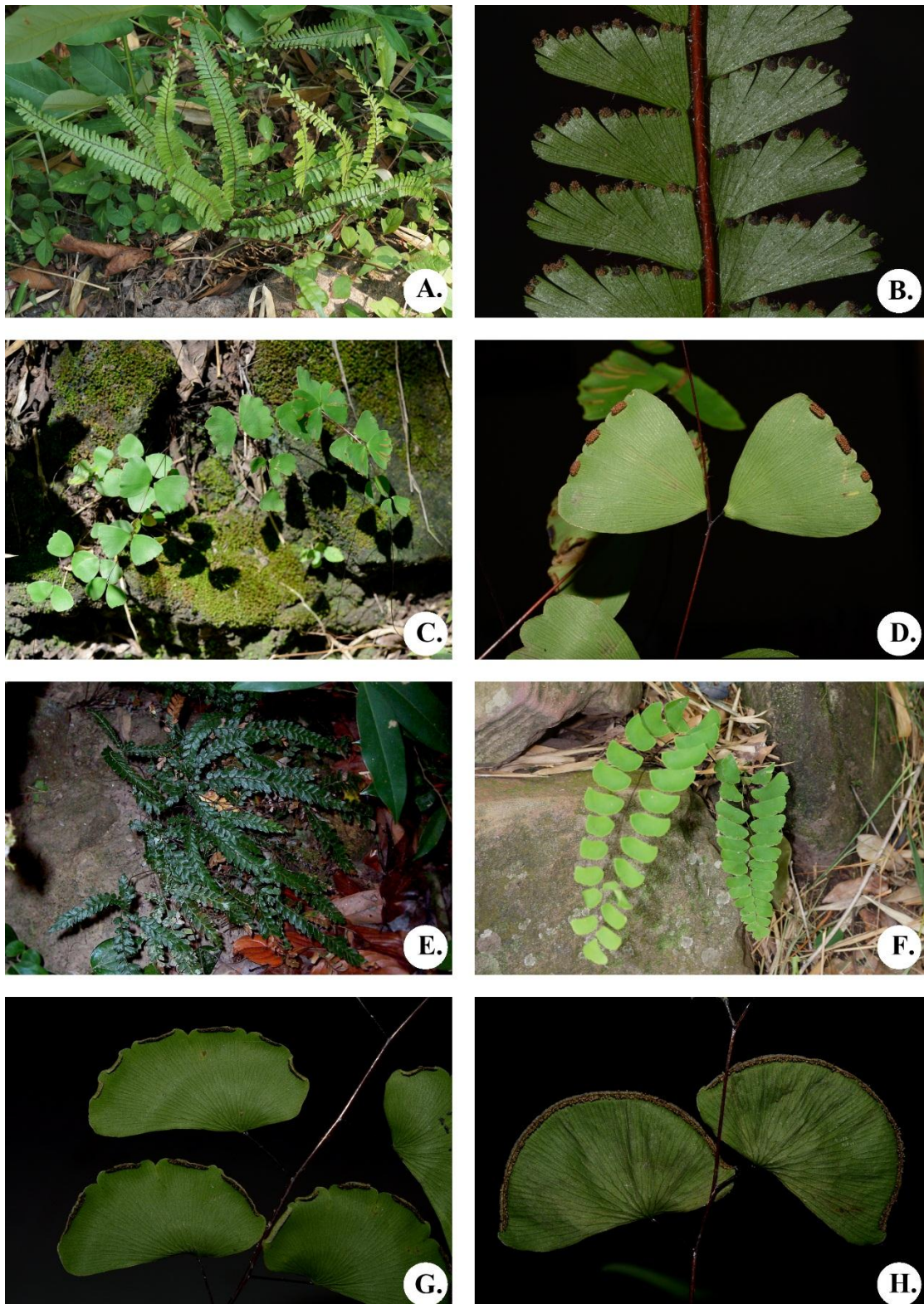


Figure 5. 28 A-B: *Adiantum caudatum*, A: habitat, B: sori in reflex margin of lobes; C-D: *A. erylliae*, C: habitat, D: sori in marginal flaps along margin; E: *A. hispidulum*, habitat; F-H: *A. philippense*, E: habitat, F: sori elongate discontinuous or continuous along margin.

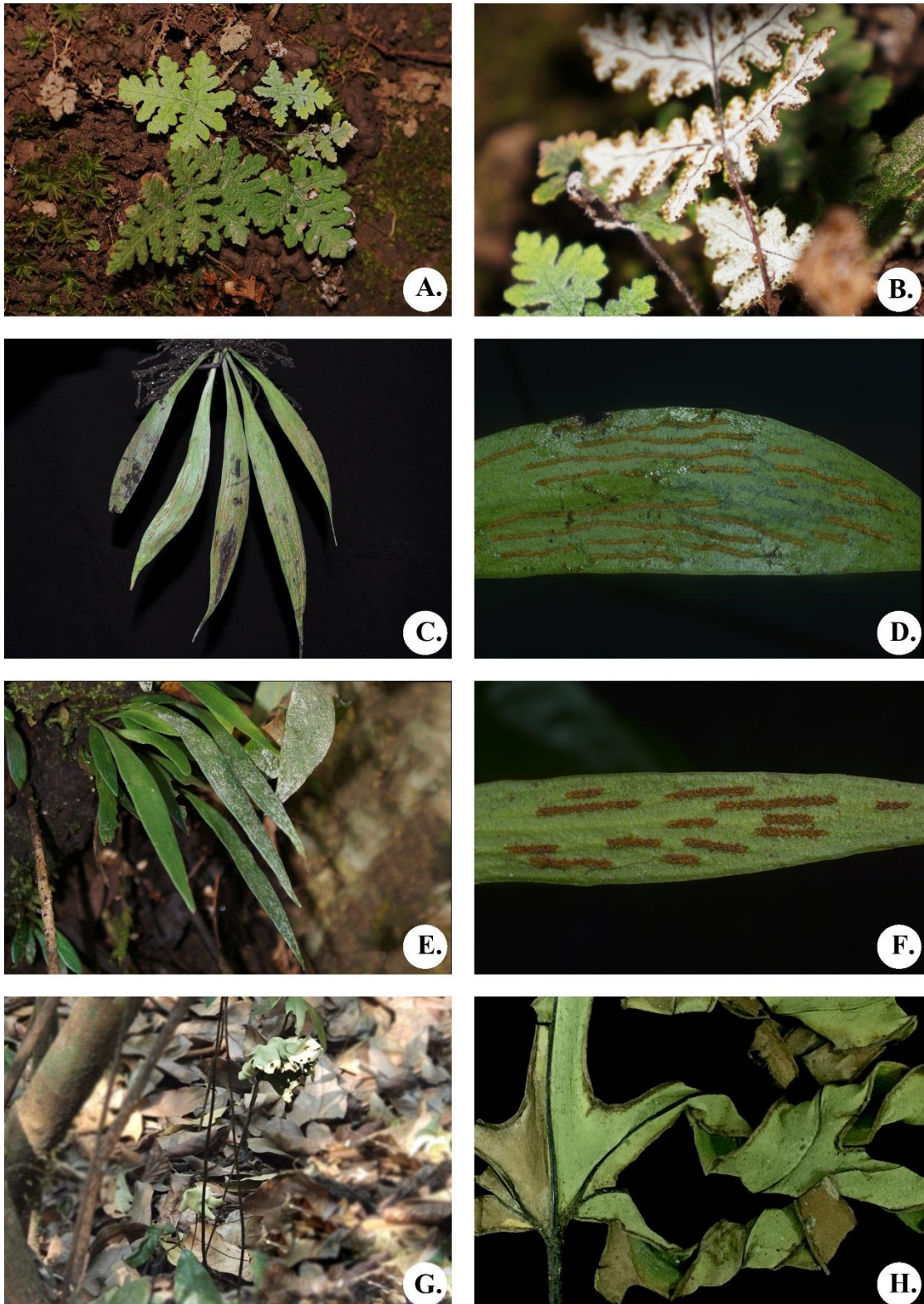


Figure 5. 29 A-B: *Aleuritopteris anceps*, A: habitat, B: close-up sori on abaxial surface; C-D: *Antrophyum callifolium*, C: whole plant, D: sori elongate along veins; E-F: *A. parvulum*, E: habitat, F: close-up sori elongate along veins; G-H: *Calciphlopteris ludens*, G: habitat, H: sori along margin on abaxial surface.



Figure 5.30 A-B: *Haplopteris amboinensis*, A: habitat, B: sori elongate near margin; C-D: *H. elongata*, C: habitat with very long linear fronds, D: close-up of abaxial surface; E-F: *H. ensiformis*, E: habitat, F: sori elongate along margin; G-H: *H. sikkimensis*, G: habitat, H: close-up of abaxial surface of lamina showing elongated sori.



Figure 5.31 A-B: *Pteris biaurita*, A: habitat, B: sori elongated along margin of lobes; C-D: *P. cretica* var. *leata*, C: sterile frond showing margin undulate and serrate, D: fertile frond showing sori and very undulate margin; E-F: *P. ensiformis*, E: habitat showing dimorphic fronds, F: sori linear along margin covered by reflex margin of lobes; G-H: *P. longipes*, G: habitat, H: sori along margin of lobes.



Figure 5. 32 A-B: *Pteris venusta*, A: habitat, B: sori along margin; C-D: *P. wallichiana*, C: habitat, D: sori on abaxial surface elongate along margin of lobes; E-F: *Tectaria fuscipes*, E: habitat, F: part of lamina with sori; G-H: *T. herpetocaulos*, G: habitat, H: close-up of round sori.

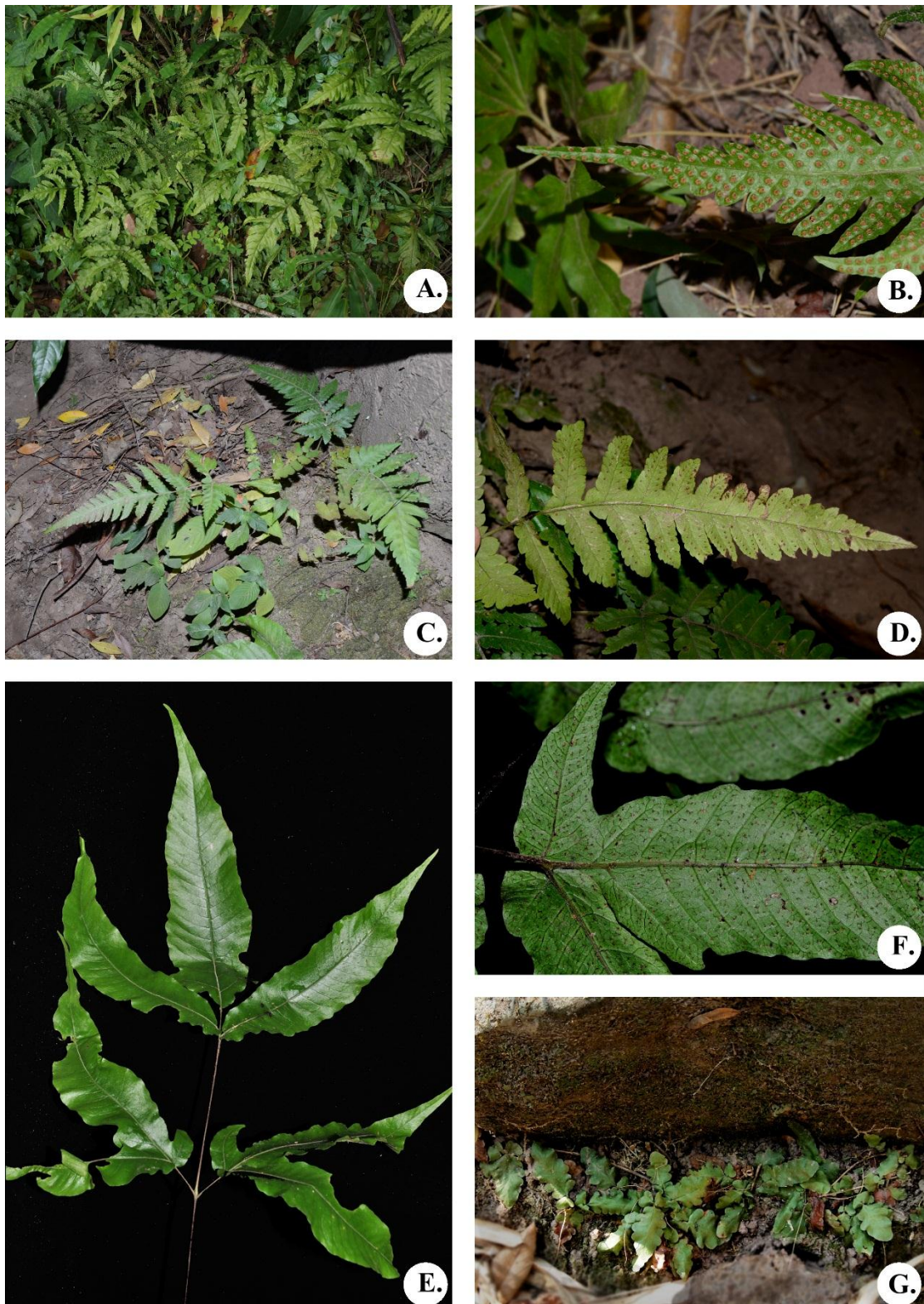


Figure 5. 33 A-B: *Tectaria impressa*, A: habitat showing dimorphic fronds, B: sori; C-D: *T. sagenioides*, C: habitat, D: sori on lower surface of lamina; E-F: *T. simonsii*, E: whole frond with two lobes of lower pinnae, F: close-up of abaxial surface of lamina showing sori; G: *T. zeilanica*, habitat showing sterile fronds.

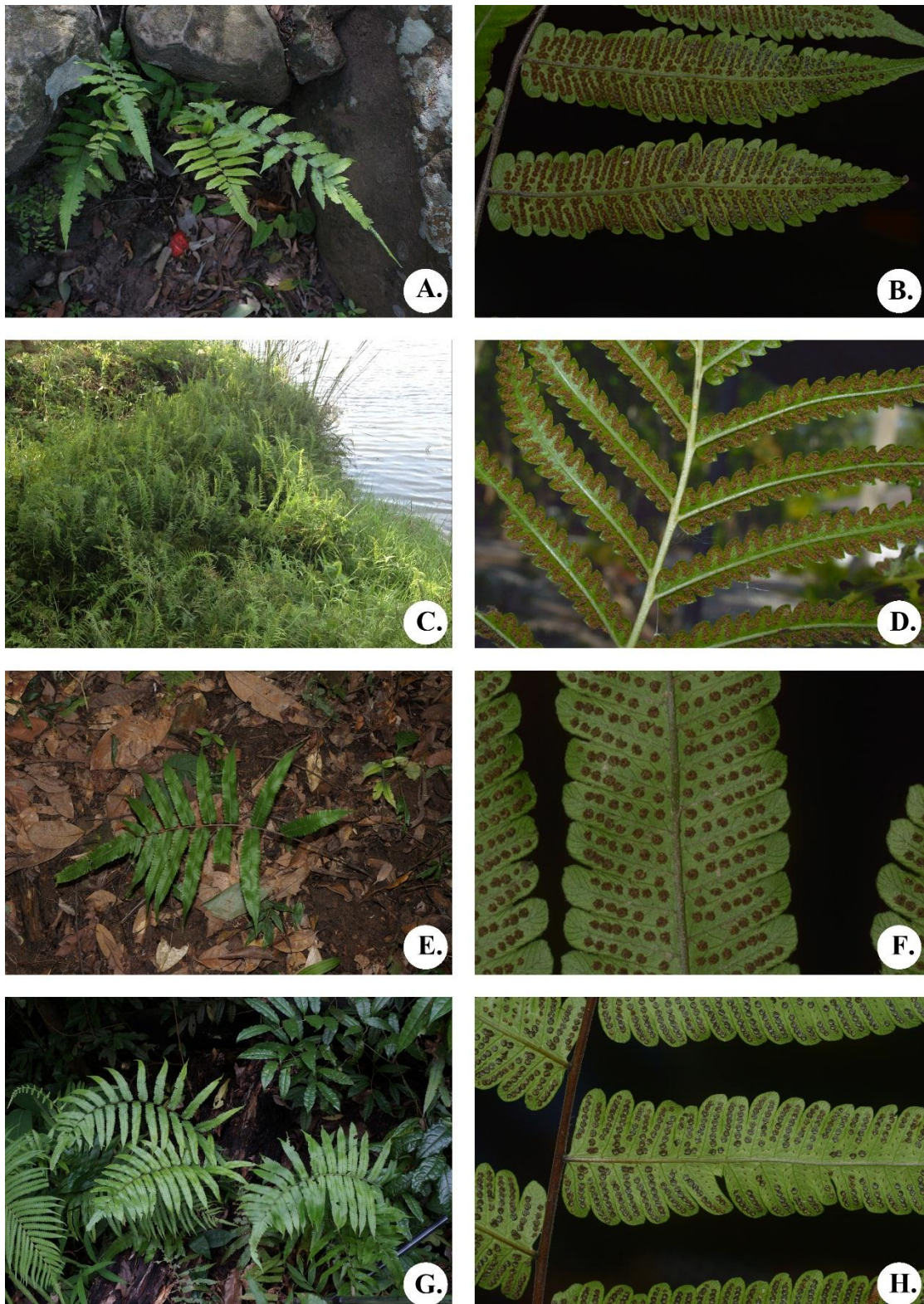


Figure 5. 34 A-B: *Cyclosorus clarkei*, A: habitat, B: pinnae with sori on abaxially; C-D: *C. interruptus*, C: habitat, D: sori on abaxial surface; E-F: *C. parasiticus*, E: habitat, F: sori medial on veinlet; G-H: *C. subelatus*, G: habitat, H: sori round.



Figure 5. 35 A-B: *Cyclosorus terminans*, A: habitat, B: sori at segment of lobes; C-D: *Metathelypteris flaccida*, C: habitat, D: lower surface of pinnae showing sori; E-F: *Pronephrium triphyllum*, E: habitat, F: sori elongate along united veinlets.

CHAPTER VI

DISCUSSION & CONCLUSION

The diversity of pteridophytes in Phu Kra dueng National Park, Loei province during December 2014 to February 2016 was explored. A total of 288 specimens were collected and identified into 26 families, 60 genera and 138 species. Among these, 2 families, 4 genera and 16 species are lycophytes, while 24 families, 56 genera, 122 species are monilophytes. In this study, the most common family was Polypodiaceae (25 species) and the second most common family was Pteridaceae (18 species). In contrast, the families of which only 2 species found were Blechnaceae, Lygodiaceae and Ophioglossaceae. Some species grew in the specific environment conditions e.g. the area that near water source, low temperature, high humidity and light shade. There were some families found only one species per family because of the limited of routes near streams and waterfalls e.g. Cibotiaceae, Cyatheaceae, Equisetaceae, Hypodermatiaceae, Marattiaceae, Osmundaceae and Psilotaceae (Figure 6. 1).

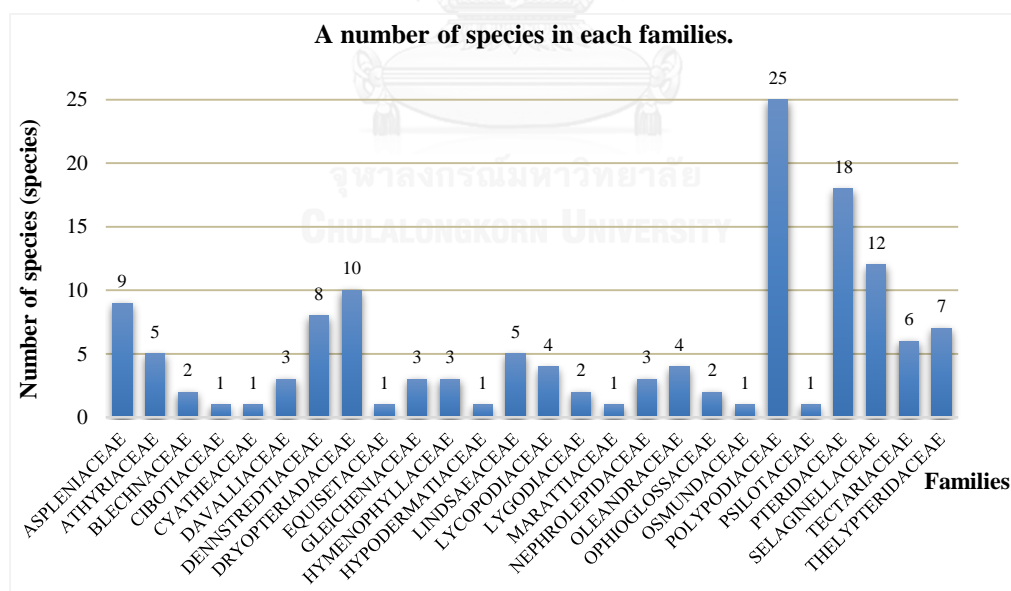


Figure 6. 1 Species number of pteridophytes in Phu Kra dueng National Park.

6.1 Habitat and diversity of pteridophytes

Pteridophytes can be separated into three main groups based on their habitats; they are terrestrials, epiphytes and lithophytes. Even though, some species were found in more than one habitat. From the study found 68 species were terrestrials, 42 species were lithophytes, 13 species were epiphytes and 15 species were found in more than one habitat (Figure 6.2).

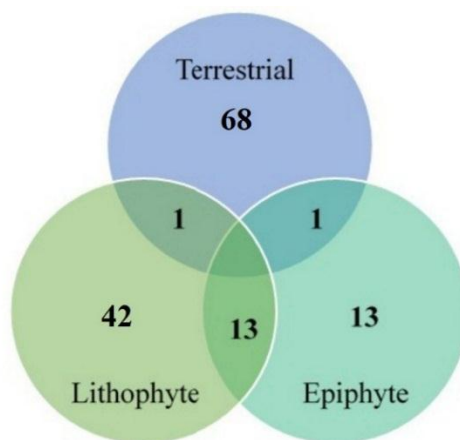


Figure 6. 2 Habitats of pteridophytes in Phu Kradueng National Park, Loei province.

6.1.1 Terrestrials

A total of 68 terrestrial species were found in this study. The common species of terrestrial pteridophytes that usually found along the nature trails were *Dicranopteris linearis* (Burm. f.) Underw. var. *linearis*, *Palhinhaea cernua* (L.) Carv. Vasc & Franco, *Pteridium aquilinum* (L.) Kuhn and *Selaginella siamensis* Hieron. They can grow on rather dry ground in exposed area usually on the summit of Phu Kradueng. The species in some families e.g. Blechnaceae, Hypodermatiaceae, Lygodiaceae and Ophioglossaceae were inhabit in sandy soil with the light strongly shone down. The common species such as *Dicranopteris linearis* (Burm. f.) Underw. var. *linearis* and *Pteridium aquilinum* (L.) Kuhn usually found near the water source along the routes and can be grow densely in the forest fire areas. This may be the reason of the wild fire was cleared area useful for the growth of these two exposed species (Masuthon, n.d.).

Moreover, *Pteridium aquilinum* (L.) Kuhn is the pioneer species that has wide creeping rhizome on ground, this can prevent soil erosion in the area (Biodiversity Center in commemoration of 72 nd anniversary Queen Sirikit. Yala Rajabhat University, 2012).

6.1.2 Epiphytes

Thirteen species of epiphytic pteridophytes were found. The most common families were Aspleniaceae and Polypodiaceae. Many species were found in dry evergreen forest such as *Ophioderma pendula* (L.) C. Presl, *Drynaria bonii* Christ, *Microsorium membranaceum* (D. Don) Ching, *Platynerium wallichii* Hook., *Pyrrosia costata* (C. Presl ex Bedd.) Tagawa & K. Iwats. and *P. porosa* (C. Presl) Hovenkamp. For the areas near stream or shady area under tree, the species found were *Asplenium affine* Sw., *A. confusum* Tardieu & Ching, *A. normale* D. Don, *A. scortechinii* Bedd., *Lepisorus henryi* (Hieron. ex C. Chr) Li Wang, *L. spicatus* (L. f.) Li Wang, *Antrophyum parvulum* Blume. In addition, *Ophioderma pendula* (L.) C. Presl and *Psilotum nudum* (L.) P. Beauv. were found in nest leaves of *Plathynerium wallichii* Hook. in deciduous dipterocarp forest. This habitat was similar to the previous reports in Phu Phan National Park, Sakon Nakhon province (Makgomol, 2006) and Nam Nao National Park, Petchaboon province (Makgomol & Thangthong, 2008). From this study found epiphytic pteridophytes usually face to drought stress and they have an adaptive behavior to protect themselves. For example, *Platynerium wallichii* Hook. and *Pyrrosia porosa* (C. Presl) Hovenkamp have special scales covering rhizomes, stellate hairs covering leaves and leaves curled when dried.

6.1.3 Lithophytes

Forty-two species were lithophytes. The lithophytic pteridophytes mostly grown on rocks especially near streams and waterfalls. For example, *Elaphoglossum dumrongii* Tagawa & K. Iwats., *Hymenophyllum exsertum* Wall. ex Hook., *H. polyanthos* (Sw.) Sw., *Nephrolepis undulata* (Afzel.) J. Sm., *Oleandra musifolia* (Blume) C. Presl, *Osmolindsaea odorata* (Roxb.) Lehtonen & Christenh., *Selaginella involvens* (Sw.) Spring and *Selliguea rhynchophylla* (Hook.) Fraser-Jenk. were found in lower montane forest, and remark for *Oleandra musifolia* (Blume) C. Presl, which

grows on half shaded rock found in every routes. The lithophytic species usually face to the drought but they have many morphological adaptations. For example, curling leaves in drought stress found in *Lepisorus henryi* (Hieron. ex C. Chr) L. Wang, *L. spicata* (L. f.) L. Wang and *Loxogramme duclouxii* Christ. Another adaptation character is by dropping off their leaves from the rhizomes found in *Oleandra* spp., *Goniophlebium subauriculatum* (Blume) C. Presl and *Davallia trichomanoides* Blume var. *lorrainii* (Hance) Holttum. In addition, some genera have special long and thick scales covering rhizomes or have special scales or hairs like stellate hairs on leaves surfaces as found in *Pyrrosia* spp.

6.1.4 Ferns inhabit in many habitats

Fifteen species of pteridophytes found in Phu Kradueng National Park grew in more than one habitat. For example, *Aglaomorpha coronans* (Wall. ex Mett.) Copel, *Asplenium nidus* L. var. *nidus* and *Drynaria rigidula* (Sw.) Bedd. can be found on tree-trunks in light shade under the tree canopy and can grow on rocks in exposed area. Furthermore, *Psilotum nudum* (L.) P. Beauv. was found to be both terrestrial and epiphytic pteridophytes on route number 1 and 5. Moreover, *Nephrolepis undulata* (Afzel.) J. Sm. was terrestrial and lithophytic pteridophytes.

6.2 The distribution of pteridophytes on each route.

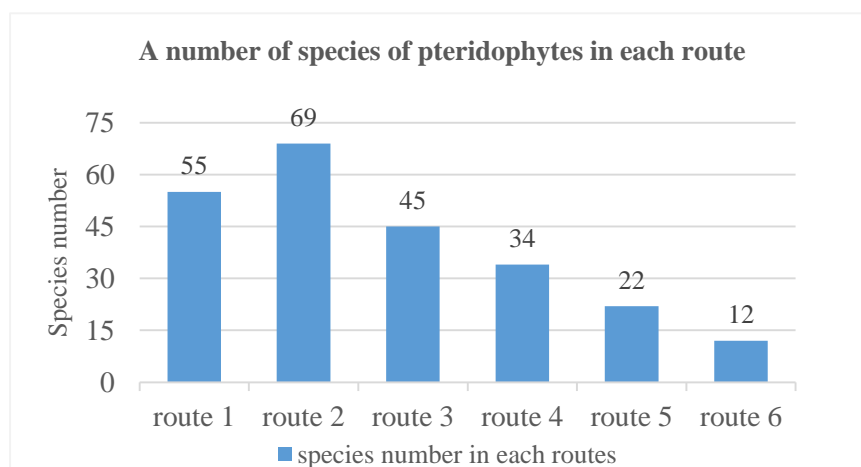


Figure 6. 3 A number of species of pteridophytes in each routes of Phu Kradueng.

From the six surveying routes, the highest species diversity of pteridophytes was found in the route from Wang Kwang visitor center to many waterfalls like Pen Pob Mai waterfall and Tham Yai waterfall (route number 2), there were 69 species found (Figure 6.3). This route has altitudes ranges from 1,000 to 1,200 m, it is in the lower montane forest and there are many waterfalls along the route e.g. Wang Kwang waterfall, Pen Pob Mai waterfall, Phon Pob waterfall and Tham Yai waterfall. This route has high humidity and the temperature is rather cool all year round. We found 24 species of lithophytes, the highest when compare to other routes. Because the rocks near streams were covered by mosses and humus that provided high humidity and have enough mineral for their growth. Thirty species were found as terrestrial due to moist ground and light shade that are suitable conditions for most species of pteridophytes. The species that can be found only in this route e.g. *Vandenboschia striata* (D. Don) Ebihara, *Diplazium donianum* (Mett.) Tardieu and *D. mettenianum* (Miq.) C. Chr.

The second most species diversity, with 55 species found (Figure 6.3) was the route from Si-Tham to Lang Pae and Wang Kwang visitor center (route number 1) that has the altitudes ranges from 260 to 1,200 m. There were different types of forest at the different altitudes from lowest to highest as follows: deciduous dipterocarp forest, mixed deciduous forest, dry evergreen forest and lower montane forest. The species number of pteridophytes vary in each forest type. Thirty species were found as terrestrial habit, was same as route number one. This route was rather steep and open with more sunlight. It passes through many types of forest but the number of species were less than route number two because it is the main route for tourists to trek up to the summit. Another reasons were the cutting away of plants along the route by the staff and the paving of forest area along the nature trails to facilitate the tourists. There were also wild fires during the dry season, especially in the deciduous forest at the altitude of 260 to about 800 m. There were many species found only in this route e.g. *Adiantum caudatum* L., *Hypodematium glanduloso-pilosum* (Tagawa) Ohwi and *Selaginella ostenfeldii* Hieron.

On the route from Wang Kwang visitor center to Anodard pond, Sor Neua waterfall and Lomsak cliff (route number 3), 45 species of pteridophytes were found

(Figure 6.3) and on the route around Hong Thong waterfall to Khun Phong waterfall (route number 4), 34 species were found (Figure 6.3). They are the third and fourth ranks of species diversity. The altitudes are ranging from 1,100 to 1,200 m for both routes. These areas are mostly pine forests and grassland. Only a few streams around Tham Saw waterfall. The route number 4 passed through Hong Thong waterfall and Khun Phong waterfall. There are more species found along the streams and waterfalls when compare to pine forests. This means that humidity had an effect to species diversity of pteridophytes.

On the route from Wang Kwang visitor center to Song Lok cliff (route number 5), there were 22 species found (Figure 6.3) and 12 species were found along the route from Wang Kwang visitor center to LomSak cliff (route number 6) (Figure 6.3). Species diversity were lower when compare to the other routes. The altitudes are ranging from about 1,100 to 1,200 m. The route number 5 was the route along the cliff, from the visitor center to Nok Aen Cliff and Song Lok Cliff. The route number 6 was the route along the cliff too. The route starts from the visitor center passed Mak Duk Cliff, Jum Sil Cliff, Na Noi Cliff, Yiap Mek Cliff, Daeng Cliff and Lom Sak Cliff. These routes are mostly pine forests and grassland, with only some areas that passed the small streams.

There are some species that have more than one habitats which can be found in more than one routes, for example *Davallia repens* (L. f.) Kuhn was found in every route. It was both epiphyte on tree-trunks and lithophyte on rocks. *Aglaomorpha coronans* (Wall. ex Mett.) Copel can be epiphytic and lithophytic pteridophytes found in route number 1, 2, 3 and 5. And also *Psilotum nudum* (L.) P. Beauv. can be terrestrial or epiphytic pteridophytes that found in route number 1 and 5.

6.3 Distribution of pteridophytes from the geography in nearby countries

From its location, Thailand stands in the middle of many phytogeographic regions: Indo-Burmese subregion on the northwest, Indo-Chinese subregion on the

northeast and Indo-Malayan subregion on the south (Forest Herbarium Department of National Parks Wildlife and Plant Conservation, 2017). This study found that Phu Kradueng National Park is a preferable place for pteridophytes as species from all neighboring phytogeographic regions can be found here.

Phu Kradueng National Park is a distinctive mountain with the plain foothills surrounded the mountain area, which the higher altitudes will have a steep conditions. There are steep mountain edges and steep cliffs towards the summit. Hence the wind clash here and the spore would disperse with the wind fallen. After that, if there is an appropriate condition the spores will grow (Wang *et al.*, 2006). The example of species that distributed from each subregion are mentioned below.

Indo-Burmese subregion

Some species present at Phu Kradueng are species that distributed in Indo-Burmese subregion which including Himalayas such as *Selaginella pennata* (D. Don) Spring occurs in Yunnan, North-East India, Myanmar, Nepal (Zhang *et al.*, 2013) and was found in Chiang Mai, Mae Hong Son, Phrae, Nan, Phitsanulok, Tak, Loei, Nakhon Nayok and Kanchanaburi of Thailand (Tagawa and Iwatsuki, 1979). Also *Selaginella amblyphylla* Alston distributed in South China, Myanmar (Zhang *et al.*, 2013) and was found in Chiang Rai, Chiang Mai, Lampang, Loei, Nakhon Ratchasima, Trat and Krabi (Tagawa and Iwatsuki, 1979). *Lepisorus bicolor* (Takeda) Ching occurs in Himalayas, Myanmar throughout the southern of South China (Zhang *et al.*, 2013) and was found in Chiang Mai, Loei and Chanthaburi of Thailand (Tagawa and Iwatsuki, 1989).

Indo-Chinese subregion

These species are distributed in Indo-Chinese subregion, including most of mainland Southeast Asia, Myanmar, Thailand, Laos, Vietnam, and Cambodia, as well as the southern China. The example of members are *Alsophila podophylla* Hook. occurring in South China, Japan, Vietnam, Laos, Cambodia and Thailand (Loei, Ubon Ratchathani, Nakhon Nayok, Chanthaburi, Trat, Surat Thani, Phangnga, Nakhon Si Thammarat) (Tagawa and Iwatsuki, 1979; Zhang *et al.*, 2013). *Hypodematium*

glanduloso-pilosum (Tagawa) Ohwi occurs in South China, Japan, Korea (Zhang et al., 2013) and Thailand (Loei, Prachuap Khiri Khan, Ranong) (Tagawa and Iwatsuki, 1988). *Lindsaea chienii* Ching. can be distributed from China, Japan, Vietnam and Chiang Mai, Loei, Nakhon Si Thammarat of Thailand. Moreover, *Monachosorum henryi* Christ occurs in South China, Bhutan, North-East India, Myanmar, Nepal, Vietnam (Zhang et al., 2013) and found in Phu Kradueng.

Indo-Malayan subregion

These pteridophytes species are distributed in Malesian or Indo-Malayan subregion. The area includes most of the south of Southeast Asia and into the southern parts of East Asia. The example species are *Dryopteris pseudocaenopteris* (Kunze) Li Bing Zhang occurs in China, Bhutan, India, Indonesia, Malaysia, Myanmar, Nepal, New Guinea, Philippines, Sri Lanka, Vietnam (Holltum, 1968; Zhang et al., 2013) and was found in Mae Hong Son, Chiang Mai, Loei, Prachuap Khiri Khan, Nakhon Nayok, Chanthaburi, Chumphon, Ranong, Krabi, Nakhon Si Thammarat of Thailand (Tagawa and Iwatsuki, 1988). Also, *Asplenium scortechinii* Bedd. occurs in South China, India, Malaysia, Myanmar, Vietnam (Holltum, 1968; Zhang et al., 2013) and was reported from Chiang Rai, Chiang Mai, Lamphun, Tak, Phitsanulok, Phetchabun, Loei, Khon Kaen, Chanthaburi, Nakhon Si Thammarat, Trang, Pattani, Yala of Thailand (Tagawa and Iwatsuki, 1985). These species are Indo-Malayan species.

In addition, pteridophytes that have wide distribution throughout Indo-Burmese, Indo-Chinese and Indo-Malayan subregion were also found, for example *Oleandra musifolia* (Blume) C. Presl, *Pteris wallichiana* J. Agardh and *Pyrrosia adnascens* (Sw.) Ching. Nevertheless, some species were widely distributed in tropics and subtropics of the world e.g. *Palhinhaea cernua* (L.) Carv. Vasc & Franco, *Hymenophyllum polyanthos* (Sw.) Sw. and *Psilotum nudum* (L.) P. Beauv. (Tagawa and Iwatsuki, 1979; 1985; 1988; 1989).

6.4 Status of pteridophyte species

Phu Kradueng National Park is the area which has richness pteridophytes (Tagawa and Iwatsuki, 1979; 1985; 1988; 1989; Office of National Park. Department of National Parks Wildlife and Plant Conservation, 2016). However, the species of pteridophytes found in different status in this area.

6.4.1 A few species number

From the survey, 25 species are rare, found only in some particular areas with a few number of individuals in each population. There are two species that were found only once during the surveys and the population are less than 10 plants, i.e. *Monachosorum henryi* Christ, that grows on shady moist rocks near stream in route number 2, and *Cheilanthes pseudofarinosa* (Ching & S. K. Wu) K. Iwats., was found on the humus rich ground in the route number 1. (Table 5.1). Furthermore, there were 62 uncommon species which can be found in many trails but with a few number of individuals in each population or can be found in one area with many individuals in each population (Table 5.1).

6.4.2 Abundance species

Fifty one species were the common species found in many routes with high number of plants. Among these, 8 species of pteridophytes are commonly found in every route, i.e. *Palhinhaea cernua* (L.) Carv. Vasc & Franco, *Selaginella siamensis* Hieron., *Davallia repens* (L. f.) Kuhn, *Dicranopteris linearis* (Burm. f.) Underw. var. *linearis*, *Drynaria rigidula* (Sw.) Bedd., *Oleandra musifolia* (Blume) C. Presl, *Pteridium aquilinum* (L.) Kuhn and *Pyrrosia lingua* (Thunb.) Farw. var. *heteractis* (Mett. ex Khun) (Table 5.1).

6.4.3 Endemic species

There were three endemic species to Phu Kradueng including *Asplenium siamense* Tagawa & K. Iwats. (Figure 5. 6 E-F) which can be found on rock crevices or in the hole of rocks near the cliff. It was a rare species because it was found only at

the southern part of the summit. It has been concern because it was growing on the rock near Lom Sak cliff where many tourist come to visit. Moreover, *Dryopteris rheophila* Mitsuta ex Darnaedi (Figure 5. 13 G-H) grows on humus rich ground along stream in many waterfalls and *Elaphoglossum dumrongii* Tagawa & K. Iwats (Figure 5. 14 C-D) grows on moist rock along streams. (Tagawa and Iwatsuki, 1979; 1985; 1988; 1989). *Dryopteris rheophila* and *Elaphoglossum dumrongii* can be found at many waterfalls on routes number 2 and 3 but they grows along the nature trails that have high risk of being disturbed and easily destroyed by tourists. Furthermore, *Selliguea trisecta* (Baker) Fraser-Jenk. is an endemic species to Thailand found on rocks in route number one. This species can be found in Chiang Mai, Chiang Rai, Tak, Phitsanulok and Phu Kradueng (Tagawa and Iwatsuki, 1985; 1988)

6.4.4 New localities

There were 40 species that have ever been reported from Phu Kradueng National Park for example *Equisetum ramosissimum* Desf. subsp. *debile* (Roxb. ex Vaucher) Hauke that can be found in the nearby areas like Phetchabun and Chaiyaphum. *Hymenasplenium cheilosorum* (Kunze ex Mett.) Tagawa occurs in Chiang Rai, Chiang Mai, Mae Hong Son, Phetchabun, Phitsanulok Chanthaburi, Prachuap Khiri Khan and Nakhon Si Thammarat. *Diplazium kappanense* Hayata which was found in Khao Yai, Nakhon Nayok province in Thailand.

6.4.5 Unknown species

In addition, we found 3 unknown species namely *Selaginella* sp. (Figure 5. 4 G-H), *Asplenium* sp. (Figure 5. 6 G-H) and *Oleandra* sp. (Figure 5. 20 E-F), which cannot be determined to the species level, though many attempts was made to use keys determination from Flora of Thailand and neighboring countries Floras.

Selaginella sp. was found on sandy soil along nature trails on the summit of Phu Kradueng. It similar to *S. minutifolia* Spring and *S. chrysorrhizos* Spring but differs in having ventral leaves margin entire or minutely denticulate and not white-margined.

Asplenium sp. is found on sandy rock crevices near the waterfalls or on the crevices of cliff under the waterfall in shady place. It is similar to *A. siamense* Tagawa & K. Iwats. but differs in some morphological characters, such as laminae elliptic-oblong to oblong-lanceolate in outline, pinnae not overlap with each other, the acroscopic margin of pinnae subentire to irregularly shallowly lobed, indusia persistent, oblong, sometime hook at distal.

Oleandra sp. is similar to *O. wallichii* (Hook.) C. Presl. Both have rhizome scales squarrose but differ in many characters: the rhizome not covered with white waxy in older part, their roots branched and costa with a few small scales.

Three species mentioned above are probably new records or new species to Thailand and need more studies. All above species occur in the limited areas, and also occur along the nature trails or tourist routes. It is important to keep special attention of this plant group. The areas should be managed by the national park, including limit the number of tourists, waste water management and solid waste management. In order to protect the various vegetation and environment of the area.

6.4.6 The lost species of Phu Kradueng National Park

First of all, the nomenclature changed, six taxa reported in Flora of Thailand are considered to be synonyms, there are 1) *Pteridium aquilinum* (L.) Kuhn subsp. *wightianum* (J. Agardh) W. C. Shieh and *P. aquilinum* (L.) Kuhn subsp. *caudatum* (L.) Bonap. are synonyms of *Pteridium aquilinum* (L.) Kuhn. 2) *Belvisia spicata* (L. f.) Mirbel ex Copel. and *B. revoluta* Copel. are synonyms of *Lepisorus spicatus* (L. f.) L. Wang. and 3) *Polypodium beddomei* Baker and *P. subauriculatum* Blume are synonyms of *Goniophlebium subauriculatum* (Blume) C. Presl.

Forty nine less species are found in this study than the former reported (Appendix 1.). Some pteridophytes that have been reported in the Flora of Thailand were not found. This can due to many reasons. Furthermore, when comparing the specimens at the Forest Herbarium, it is found that three species was misidentified,

there were *Selaginella chrysorrhizos* Spring, *S. roxburghii* (Hook. & Grev.) Spring and *Tectaria polymorpha* (Wall. ex Hook.) Copel.

The other reasons that may cause the species number changed was the more arid environment than the past which some pteridophytes cannot survive. According to the data from Thai Meteorological Department, the climatic data were different from the past. The data between 1986–2014 and 2015 shows that the average temperature at Phu Kradueng National Park was increased about 0.74 °C, mean monthly rainfall was less than the past 35.17 mm and the relative humidity was 1.15 percent decreased (Figure 3. 3). This data shows that there is more drought in this area and this might cause some pteridophytes disappeared from Phu Kradueng, for example *Cheiropleuria bicuspis* (Blume) C. Presl, *Diplazium subsinuatum* (Wall. ex Hook. & Grev.) Tagawa and especially Hymenophyllaceae e.g. *Abrodictyum obscurum* (Blume) Ebihara & K. Iwats., *Crepidomanes bipunctatum* (Poir.) Copel., *C. minutum* (Blume) K. Iwats., *Hymenophyllum pallidum* (Blume) Ebihara & K. Iwats., *H. badium* Hook. & Grev., *H. riukiense* Christ and *Osmundastrum cinnamomeum* (L.) C. Presl that have been growing in moist humidity area around the waterfalls (Tagawa and Iwatsuki, 1979; 1985; 1988; 1989).

Moreover, habitat lost, it can be caused by wild fire in every year. The current causes of forest fires mostly due to the human action, for example; preparation of cultivated areas without the control, burning the forest in order to keep the contents of the forest, to let the animals escape from hiding places for hunting, for easy hiking and to let the grass sprouts to feed animals. The data from Loei Forest Fire Control Station shows that 713 times of forest fire occurred and 19,128.30 rai was damaged from 2002 to 2011 (Loei Forest Fire Control Station, 2016). As same as the office of Phu Kradueng National Park indicate that a total of forest fire happened from 2006 to 2015 was 455 times and the destroyed area was 6,609 rai (Phu Kradueng National Park, 2016). Many areas changed to grassland and some pteridophytes can be destroyed.

The other reason is that some pteridophytes species drop off their leaves in dry season and sprout again in rainy season. Accompany with the summit of Phu Kradueng National Park is closed between June to September every year due to the danger of flash

flood and wild animals especially wild elephants. From this reason we are not allowed to enter this place during those months (Office of National Park. Department of National Parks Wildlife and Plant Conservation, 2016). In the same way, some areas we can enter only once because we had to go with the park rangers only, to lead and support us, or protect us from the wild animals.

The next reason is from tourism. There is disturbance from tourists because this place is popular for tourists who like an adventure trip. Nowadays, many tourists like to come here, the average number of tourists visited here were about 55,197 person per year from 2007–2016 (Forest and Plant Conservation Research Office National Park Wildlife and Plant Conservation Department, 2016). So they can disturb and cause some pteridophytes decrease, or pteridophytes can be destroyed and extinct from this area.

This study found that a number of pteridophytes at Phu kradueng National Park area are decreased when compare to the published Flora of Thailand. This may be because of the environment has changed from the former times, the occurrence of forest fires every year, including interference from illegal wood cutting and tourism, which can cause pteridophytes to be disappeared from the area. For all these reasons, Phu Kradueng National Park should has the awareness to the effects of a forest fire and transfer information to the nearby communities. So that the people in nearby communities could help to preserve nature in order to support the ecotourism in the future. Moreover, the results of this study provide an additional database of pteridophyte in the north-eastern Thailand and also the database for Phu Kradueng National Park which can be used for tourism management in this area.

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APPENDIX



จุฬาลงกรณ์มหาวิทยาลัย
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Appendix 1 List of pteridophytes comparison between Flora of Thailand and this study.

No.	Taxon	Flora of Thailand	This study	Remark
LYCOPHYTES				
LYCOPODIACEAE				
1.	<i>Lycopodium cernuum</i> L.	/	/	Synonym of <i>Palhinhaea cernua</i> (L.) Carv. Vasc & Franco
2.	<i>L. clavatum</i> L.	/	-	
3.	<i>L. hamiltonii</i> Spreng.	-	/	Synonym of <i>Phlegmariurus hamiltonii</i> (Spreng. ex Grev. & Hook.) Li Bing Zhang
4.	<i>L. phlegmaria</i> L.	/	-	
5.	<i>L. serratum</i> G. Thunb.	/	/	Synonym of <i>Huperzia serrata</i> (Thunb.) Trevis.
6.	<i>L. squarrosum</i> Forst.	/	/	Synonym of <i>Phlegmariurus squarrosus</i> (G. Forst.) Á. Löve & D. Löve
SELAGINELLACEAE				
7.	<i>Selaginella amblyphylla</i> Alston.	/	/	
8.	<i>S. biformis</i> A. Br. Ex Kuhn.	/	/	
9.	<i>S. chrysorrhizos</i> Spring	/	-	Misidentified <i>Selaginella</i> sp.
10.	<i>S. ciliaris</i> (Retz.) Spring	-	/	
11.	<i>S. intermedia</i> (Bl.) Spring	/	/	
12.	<i>S. involvens</i> (Sw.) Spring	-	/	
13.	<i>S. monospora</i> Spring	-	/	
14.	<i>S. ostefeldii</i> Hieron.	/	/	
15.	<i>S. pennata</i> (D. Don) Spring	/	/	
16.	<i>S. repanda</i> (Desv. ex Poir.) Spring	/	/	
17.	<i>S. roxburghii</i> (Hook. & Grev.) Spring	/	-	Misidentified with <i>S. biformis</i> A. Br. Ex Kuhn.
18.	<i>S. siamensis</i> Hieron.	/	/	
19.	<i>S. tenuifolia</i> Spring	-	/	
20.	<i>Selaginella</i> sp.	-	/	
MONILOPHYTES				
ASPLENIACEAE				
21.	<i>Asplenium affine</i> Sw.	/	/	
22.	<i>A. confusum</i> Tardieu & Ching	/	/	
23.	<i>A. crinicaule</i> Hance	/	/	
24.	<i>A. nidus</i> L.	/	/	
25.	<i>A. normale</i> D. Don	/	/	

No.	Taxon	Flora of Thailand	This study	Remark
26.	<i>A. scortechinii</i> Bedd.	/	/	
27.	<i>A. siamense</i> Tagawa & K. Iwats.	/	/	
28.	<i>Asplenium</i> sp.	-	/	
29.	<i>Hymenasplenium cheilosorum</i> (Kunze ex Mett.) Tagawa	-	/	
ATHYRIACEAE				
30.	<i>Anisocampium cumingianum</i> C. Presl	-	/	Synonym of <i>Athyrium cumingianum</i> (C. Presl) Ching
31.	<i>Athyrium mackinnonii</i> (C. Hope) C. Chr.	/	-	
32.	<i>Diplazium dilatatum</i> Blume	/	/	
33.	<i>D. donianum</i> (Mett.) Tardieu	/	/	
34.	<i>D. mettenianum</i> (Miq.) C. Chr.	/	/	
35.	<i>D. silvaticum</i> (Bory) Sw.	/	-	
36.	<i>D. subsinuatum</i> (Wall. ex Hook. & Grev.) Tagawa	/	-	
37.	<i>D. taiwanense</i> Tagawa	-	/	Synonym of <i>Diplazium kappanense</i> Hayata
BLECHNACEAE				
38.	<i>Blechnum indicum</i> Burm. f.	/	-	
39.	<i>B. orientale</i> L.	/	/	
40.	<i>Brainea insignis</i> (Hook.) J. Sm.	/	/	
CIBOTIACEAE				
41.	<i>Cibotium barometz</i> (L.) J. Sm.	/	/	
CYATHEACEAE				
42.	<i>Cyathea podophylla</i> (Hook.) Copel.	/	/	Synonym of <i>Alsophila podophylla</i> Hook.
DAVALLIACEAE				
43.	<i>Davallia denticulata</i> (Burm.f.) Mett. ex Kuhn	/	/	
44.	<i>D. trichomanoides</i> var. <i>lorrainii</i> (Hance) Holttum	/	/	
45.	<i>Humata repens</i> (L. f.) Small ex Diels	/	/	Synonym of <i>D. repens</i> (L. f.) Kuhn
DENNSTREDTIACEAE				
46.	<i>Histiopteris incisa</i> (Thunb.) J. Sm.	/	/	
47.	<i>Hypolepis punctata</i> (Thunb.) Mett. ex Kuhn	/	/	
48.	<i>Microlepia herbacea</i> Ching & C. Chr. ex Tardieu & C. Chr.	/	-	
49.	<i>M. hookeriana</i> (Wall. ex Hook.) C. Presl	/	/	
50.	<i>M. marginata</i> (Panz.) C. Chr. var. <i>marginata</i>	-	/	

No.	Taxon	Flora of Thailand	This study	Remark
51.	<i>M. calvescens</i> (Wall. ex Hook.) C. Presl	/	/	Synonym of <i>M. marginata</i> (Panz.) C. Chr. var. <i>calvescens</i> (Wall. ex Hook.) C. Chr.
52.	<i>Microlepia speluncae</i> (L.) T. Moore	-	/	
53.	<i>Monachosorum henryi</i> Christ	-	/	
54.	<i>Pteridium aquilinum</i> (L.) Kuhn subsp. <i>wightianum</i> (J. Agardh) W. C. Shieh	/	/	Synonym of <i>Pteridium aquilinum</i> (L.) Kuhn
55.	<i>Pteridium aquilinum</i> (L.) Kuhn subsp. <i>caudatum</i> (L.) Bonap.	/		
DIPTERIDACEAE				
56.	<i>Cheiropleuria bicuspis</i> (Blume) C.Presl	/	-	
DRYOPTERIADACEAE				
57.	<i>Arachniodes cavalerii</i> (Christ) Ohwi	/	/	
58.	<i>A. chinensis</i> (Rosenst.) Ching	/	-	
59.	<i>Bolbitis angustipinna</i> (Hayata) H. Ito	/	-	
60.	<i>B. sinensis</i> (Baker) K. Iwats.	-	/	
61.	<i>B. virens</i> (Wall. ex Hook. & Grev.) Schott var. <i>virens</i>	/	/	
62.	<i>Diacalpe aspidioides</i> Blume	/	/	Synonym of <i>Dryopteris</i> <i>pseudocaenopteris</i> (Kunze) Li Bing Zhang
63.	<i>Dryopteris cochleata</i> (D. Don) C. Chr.	/	-	
64.	<i>D. neoassamensis</i> Ching	/	-	
65.	<i>D. polita</i> Rosenst.	/	/	
66.	<i>D. rheophila</i> Mitsuta ex Darnaedi M. Kato & K. Iwats.	/	/	
67.	<i>D. sparsa</i> (D. Don) Kuntze	/	/	
68.	<i>D. subtriangularis</i> (C. Hope) C. Chr.	/	-	
69.	<i>Elaphoglossum dumrongii</i> Tagawa & K. Iwats.	/	/	
70.	<i>E. malayense</i> Holttum	/	-	
71.	<i>E. stelligerum</i> (Wall. ex Baker in Hook. & Baker) T. Moore ex Alston & Bonner	/	/	
72.	<i>E. subellipticum</i> Rosenst.	/	/	
73.	<i>Polystichum attenuatum</i> Tagawa & K. Iwats.	/	-	
74.	<i>P. eximium</i> (Kuhn) C. Chr.	/	-	

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EQUISETACEAE				
75.	<i>Equisetum ramosissimum</i> Desf. subsp. <i>debile</i> (Roxb. ex Vaucher) Hauke	-	/	
GLEICHENIACEAE				
76.	<i>Dicranopteris linearis</i> (Burm. f.) Underw. var. <i>linearis</i>	/	/	
77.	<i>D. linearis</i> (Burm. f.) Underw. var. <i>tetraphylla</i> (Rosenst.) Nakai	/	/	
78.	<i>Gleichenia blotiana</i> C. Chr.	/	/	Synonym of <i>Diplopterygium blotianum</i> (C. Chr.) Nakai
HYMENOPHYLLACEAE				
79.	<i>Cephalomanes obscurum</i> (Blume) K. Iwats. var. <i>obscurum</i>	/	-	Synonym of <i>Abrodictyum obscurum</i> (Blume) Ebihara & K.Iwats.
80.	<i>Crepidomanes bipunctatum</i> (Poir.) Copel.	/	-	
81.	<i>C. minutum</i> (Blume) K. Iwats.	/	-	
82.	<i>Hymenophyllum pallidum</i> (Blume) Ebihara & K. Iwats.	/	-	
83.	<i>Mecodium badium</i> (Hook. & Grev.) Copel.	/	-	Synonym of <i>Hymenophyllum badium</i> Hook. & Grev.
84.	<i>M. exsertum</i> (Wall. ex Hook.) Copel.	/	/	<i>Hymenophyllum exsertum</i> Wall. ex Hook.
85.	<i>M. polyanthos</i> (Sw.) Copel.	/	/	<i>Hymenophyllum polyanthos</i> (Sw.) Sw.
86.	<i>M. riukiense</i> (Christ) Copel.	/	-	Synonym of <i>Hymenophyllum riukiense</i> Christ
87.	<i>Microgonium sublimbatum</i> (Müll. Berol.) Bosch	/	-	Synonym of <i>Didymoglossum sublimbatum</i> (Müll. Berol.) Ebihara & K. Iwats.
88.	<i>Vandenboschia auriculata</i> (Blume) Copel.	/	-	Synonym of <i>Crepidomanes auriculatum</i> (Blume) K. Iwats
89.	<i>V. birmanica</i> (Bedd.) Ching	/	/	Synonym of <i>Vandenboschia striata</i> (D. Don) Ebihara
HYPODERMATIACEAE				
90.	<i>Hypodematium glanduloso-pilosum</i> (Tagawa) Ohwi	/	/	
91.	<i>Leucostegia immersa</i> C.Presl	/	-	
LINDSAEACEAE				
92.	<i>Lindsaea chienii</i> Ching	/	/	
93.	<i>L. ensifolia</i> Sw.	/	/	
94.	<i>L. heterophylla</i> Dryand.	/	-	
95.	<i>L. javanensis</i> Blume	/	/	

No.	Taxon	Flora of Thailand	This study	Remark
96.	<i>L. odorata</i> Roxb.	/	/	Synonym of <i>Osmolindsaea odorata</i> (Roxb.) Lehtonen & Christenh.
97.	<i>L. orbiculata</i> (Lam.) Mett. ex Kuhn var. <i>commixta</i>	/	-	
98.	<i>Sphenomeris chinensis</i> (L.) Maxon var. <i>chinensis</i>	/	/	Synonym of <i>Odontosoria chinensis</i> (L.) J. Sm. var. <i>chinensis</i>
99.	<i>S. chinensis</i> (L.) Maxon var. <i>divaricata</i> (Christ) K. U. Kramer	/	-	
LYGODIACEAE				
100.	<i>L. flexuosum</i> (L.) Sw.	/	-	
101.	<i>L. japonicum</i> (Thunb.) Sw.	/	/	
102.	<i>L. microphyllum</i> (Cav.) R. Br.	/	/	
MARATTIACEAE				
103.	<i>Angiopteris evecta</i> (G. Forst.) Hoffm.	/	/	
NEPHROLEPIDACEAE				
104.	<i>Nephrolepis biserrata</i> (Sw.) Schott	-	/	
105.	<i>N. cordifolia</i> (L.) C. Presl	/	/	
106.	<i>N. delicatula</i> (Decne.) Pic. Serm.	/	/	Synonym of <i>Nephrolepis undulata</i> (Afzel.) J. Sm.
OLEANDRACEAE				
107.	<i>Oleandra cumingii</i> J. Sm.	-	/	
108.	<i>O. musifolia</i> (Blume) C. Presl	/	/	
109.	<i>O. undulata</i> (Willd.) Ching	/	/	
110.	<i>O. wallichii</i> (Hook.) C. Presl	/	-	
111.	<i>Oleandra</i> sp.	-	/	
OPHIOGLOSSACEAE				
112.	<i>Helminthostachys zeylanica</i> (L.) Hook.	/	-	
113.	<i>Ophioglossum pendulum</i> L.	-	/	Synonym of <i>Ophioderma pendula</i> (L.) C. Presl
114.	<i>O. petiolatum</i> Hook.	/	/	
OSMUNDACEAE				
115.	<i>Osmunda angustifolia</i> Ching	/	/	
116.	<i>O. vachellii</i> Hook.	/	-	Synonym of <i>Osmunda javanica</i> Blume
117.	<i>O. cinnamomea</i> L.	/	-	Synonym of <i>Osmundastrum cinnamomeum</i> (L.) C. Presl
118.	<i>Plagiogyria adnata</i> (Blume) Bedd.	/	-	
POLYPODIACEAE				
119.	<i>Aglaomorpha coronans</i> (Wall. ex Mett.) Copel.	/	/	

No.	Taxon	Flora of Thailand	This study	Remark
120.	<i>Belvisia henryi</i> (Hieron. ex C. Chr.) Tagawa	/	/	Synonym of <i>Lepisorus henryi</i> (Hieron. ex C. Chr.) L. Wang
121.	<i>B. spicata</i> (L. f.) Mirbel ex Copel.	/	/	Synonym of <i>L. spicata</i> (L. f.) L. Wang
122.	<i>B. revoluta</i> Copel.	/		
123.	<i>Drynaria bonii</i> Christ	/	/	
124.	<i>D. rigidula</i> (Sw.) Bedd.	/	/	
125.	<i>Lepisorus bicolor</i> (Takeda) Ching	-	/	
126.	<i>L. nudus</i> (Hook.) Ching	/	/	
127.	<i>L. suboligolepidus</i> Ching	/	-	
128.	<i>Leptochilus decurrens</i> Blume	-	/	
129.	<i>L. ellipticus</i> (Thunb.) Noot.	/	-	
130.	<i>Loxogramme duclouxii</i> Christ	-	/	
131.	<i>L. involuta</i> (D. Don) C. Presl	/	-	
132.	<i>L. lankokiensis</i> (Rosenst.) C. Chr.	/	-	
133.	<i>L. salicifolia</i> (Makino) Makino	-	/	
134.	<i>Microsorium insigne</i> (Blume) Copel.	-	/	
135.	<i>M. membranaceum</i> (D. Don) Ching	-	/	
136.	<i>M. pteropus</i> (Blume) Copel.	-	/	
137.	<i>M. punctatum</i> (L.) Copel.	/	/	
138.	<i>M. zippelii</i> (Blume) Ching	-	/	Synonym of <i>Neolepisorus zippelii</i> (Blume) L. Wang
139.	<i>Paragramma longifolia</i> (Blume) T. Moore	-	/	
140.	<i>Microsorium cuspidatum</i> (D. Don) Tagawa	/	-	Synonym of <i>Phymatosorus cuspidatus</i> (D. Don) Pic. Serm.
141.	<i>Platyserium wallichii</i> Hook.	-	/	
142.	<i>Polypodium beddomei</i> Baker	/	/	Synonym of <i>Goniophlebium subauriculatum</i> (Blume) C. Presl
143.	<i>P. subauriculatum</i> Blume	/		
144.	<i>Pyrrosia lanceolata</i> (L.) Farw	/	/	Synonym of <i>Pyrrosia adnascens</i> (Sw.) Ching
145.	<i>P. eberhardtii</i> (Christ) Ching	/	/	Synonym of <i>Pyrrosia lingua</i> (Thunb.) Farw. var. <i>heteractis</i> (Mett. ex Khun) Hovenkamp
146.	<i>P. mollis</i> (Kunze) Ching	/	/	Synonym of <i>Pyrrosia porosa</i> (C. Presl) Hovenkamp
147.	<i>Crypsinus hirsutus</i> Tagawa & K. Iwats.	-	/	Synonym of <i>Selliguea trisecta</i> (Baker) Fraser-Jenk.
148.	<i>C. oxylobus</i> (Wall. ex Kunze) Sledge	/	/	Synonym of <i>Selliguea oxyloba</i> (Wall. ex Kunze) Fraser-Jenk.
149.	<i>C. rhynchophyllus</i> (Hook.) Copel.	/	/	Synonym of <i>Selliguea rhynchophylla</i> (Hook.) Fraser-Jenk.

No.	Taxon	Flora of Thailand	This study	Remark
PSILOTACEAE				
150.	<i>Psilotum nudum</i> (L.) P. Beauv.	-	/	
PTERIDACEAE				
151.	<i>Adiantum capillus-veneris</i> L.	/	-	
152.	<i>A. caudatum</i> L.	-	/	
153.	<i>A. erylliae</i> C. Chr. & Tardieu	-	/	
154.	<i>A. flabellulatum</i> L.	/	-	
155.	<i>A. hispidulum</i> Sw.	-	/	
156.	<i>A. philippense</i> L.	/	/	
157.	<i>A. zollingeri</i> Mett. ex Kuhn	/	-	
158.	<i>Cheilanthes pseudofarinosa</i> (Ching & S. K. Wu) K. Iwats.	-	/	Synonym of <i>Aleuritopteris anceps</i> (Blanf.) Panigrahi
159.	<i>Antrophyum callifolium</i> Blume	/	/	
160.	<i>A. parvulum</i> Blume	/	/	
161.	<i>Doryopteris ludens</i> (Wall. ex Hook.) J. Sm.	-	/	Synonym of <i>Calciphlopteris ludens</i> (Wall. ex Hook.) Yesilyurt & H. Schneid.
162.	<i>Pteris biaurita</i> L.	/	/	
163.	<i>P. cretica</i> L. var. <i>leata</i> (Wall. ex Ettingsh.) C. Chr. & Tardieu	-	/	
164.	<i>P. ensiformis</i> Burm. f.	/	/	
165.	<i>P. longipes</i> D. Don	/	/	
166.	<i>P. venusta</i> Kunze	/	/	
167.	<i>P. wallichiana</i> J. Agardh	/	/	
168.	<i>Pteris</i> sp.	-	/	
169.	<i>Vittaria amboinensis</i> Fée	/	/	Synonym of <i>Haplopteris amboinensis</i> (Fée) X. C. Zhang
170.	<i>V. elongata</i> Sw.	/	/	Synonym of <i>H. elongata</i> (Sw.) E. H. Crane
171.	<i>V. flexuosa</i> Fée	/	/	Synonym of <i>H. flexuosa</i> (Fée) E. H. Crane
172.	<i>V. sikkimensis</i> Kuhn	/	/	Synonym of <i>H. sikkimensis</i> (Kuhn) E. H. Crane
TECTARIACEAE				
173.	<i>Heterogonium sagenioides</i> (Mett.) Holttum	-	/	Synonym of <i>Tectaria sagenioides</i> (Mett.) Christenh.
174.	<i>Quercifilix zeilanica</i> (Houtt.) Copel.	-	/	Synonym of <i>T. zeilanica</i> (Houtt.) Sledge
175.	<i>Tectaria fuscipes</i> (Wall. ex Bedd.) C. Chr.	/	/	
176.	<i>T. herpetocaulos</i> Holttum	/	/	
177.	<i>T. variolosa</i> (Wall. ex Hook.) C. Chr.	/	/	Synonym of <i>T. impressa</i> (Fée) Holttum
178.	<i>T. laotica</i> Tardieu & C. Chr.	/	-	

No.	Taxon	Flora of Thailand	This study	Remark
179.	<i>T. polymorpha</i> (Wall. ex Hook.) Copel.	/	-	Misidentified with <i>T. herpetocaulos</i> Holttum
180.	<i>T. simonsii</i> (Baker) Ching	-	/	
THELYPTERIDACEAE				
181.	<i>Thelypteris cylindrothrix</i> (Rosenst.) K.Iwats	/	/	Synonym of <i>Cyclosorus clarkei</i> (Bedd.) Ching
182.	<i>T. evoluta</i> (C. B. Clarke & Baker) Tagawa & K. Iwats.	/	-	Synonym of <i>C. evolutus</i> (C. B. Clarke & Baker) Ching
183.	<i>T. flaccida</i> (Blume) Ching	-	/	Synonym of <i>Metathelypteris flaccida</i> (Blume) Ching
184.	<i>T. hirtisora</i> (C. Chr.) K. Iwats.	/	-	Synonym of <i>Cyclosorus validus</i> (Christ) Ching
185.	<i>T. interrupta</i> (Willd.) K. Iwats.	-	/	Synonym of <i>C. interruptus</i> (Willd.) H. Itô
186.	<i>T. parasitica</i> (L.) Fosberg	/	/	Synonym of <i>C. parasiticus</i> (L.) Farw.
187.	<i>T. subelata</i> (Baker) K. Iwats.	/	/	Synonym of <i>C. subelatus</i> (Baker) Ching
188.	<i>T. terminans</i> (J. Sm. ex Hook.) Tagawa & K. Iwats.	/	/	Synonym of <i>C. terminans</i> (J. Sm.) Panigrahi
189.	<i>T. triphylla</i> (Sw.) K.Iwats.	/	/	Synonym of <i>Pronephrium triphyllum</i> (Sw.) Holttum
190.	<i>T. hirsutipes</i> (C. B. Clarke) Ching	/	-	
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