

ความหลากหลายของเฟิร์นและพืชใกล้เคียงเฟิร์นบริเวณเขานันใหญ่ อุทยานแห่งชาติเขานัน

จังหวัดนครศรีธรรมราช



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สถาบันวิทยบริการ

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต

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ลิขสิทธิ์ของจุฬาลงกรณ์มหาวิทยาลัย

DIVERSITY OF FERNS AND FERN ALLIES AT KHAO NAN YAI, KHAO NAN
NATIONAL PARK, NAKHON SI THAMMARAT PROVINCE



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สถาบันวิทยบริการ

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ชนิดา สงวนทรัพย์: ความหลากหลายของเฟิร์นและพืชใกล้เคียงเฟิร์นบริเวณเขานันใหญ่ อุทยานแห่งชาติเขานัน จังหวัดนครศรีธรรมราช (DIVERSITY OF FERNS AND FERN ALLIES AT KHAO NAN YAI, KHAO NAN NATIONAL PARK, NAKHON SI THAMMARAT PROVINCE) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: ศ. ดร. ทวีศักดิ์ บุญเกิด, 233 หน้า.

จากการศึกษาความหลากหลายของเฟิร์นและพืชใกล้เคียงเฟิร์นบริเวณเขานันใหญ่ อุทยานแห่งชาติเขานัน ซึ่งมีความสูงจากระดับน้ำทะเล 330-1,385 เมตร ได้เก็บตัวอย่างระหว่างเดือนกรกฎาคม 2550 ถึงเดือนเมษายน 2551 ได้ทั้งหมด 221 ตัวอย่าง สามารถจำแนกได้ 24 วงศ์ 58 สกุล 131 ชนิด 3 พันธุ์ จัดเป็นเฟิร์น 22 วงศ์ 56 สกุล 120 ชนิด 3 พันธุ์ และพืชใกล้เคียงเฟิร์น จำนวน 2 วงศ์ 2 สกุล 11 ชนิด วงศ์ที่พบมากที่สุด คือ Polypodiaceae, Hymenophyllaceae, Woodsiaceae, Aspleniaceae และ Dryopteridaceae จำนวน 23, 12 และ 10 ชนิด ตามลำดับ สามารถจำแนกตามลักษณะถิ่นอาศัยได้ 3 แบบ คือ ขึ้นบนดิน 45 ชนิด 1 พันธุ์ พืชอิงอาศัย 37 ชนิด 2 พันธุ์ ขึ้นบนหิน 14 ชนิด และพบพืชกลุ่มนี้ที่มีลักษณะถิ่นอาศัยมากกว่า 1 แบบขึ้นไป จำนวน 35 ชนิด นอกจากนี้ยังสามารถจำแนกพืชกลุ่มนี้ตามสภาพป่าได้ 2 แบบ คือ ป่าดิบชื้น จำนวน 68 ชนิด และป่าดิบเขา จำนวน 46 ชนิด และพบ 17 ชนิด ที่สามารถพบได้ในป่าทั้งสองแบบ ในจำนวนทั้งหมดนี้มีเฟิร์น 1 ชนิด ที่จัดเป็นพรรณไม้ถิ่นเดียวของประเทศไทย คือ *Ctenopterella khaoluangensis* (Tagawa & K. Iwats.) Parris นอกจากนี้พบเฟิร์นที่จัดเป็นการรายงานครั้งแรกของประเทศไทย จำนวน 5 ชนิด คือ *Cyathea glabra* (Blume) Copel, *Cyathea hymenodes* (Willd.) Sw., *Huperzia coralia* (Spring) J. Holub, *Huperzia hippuris* (Christ) J. Holub และ *Hymenophyllum treubii* Racib. ในการศึกษาครั้งนี้ได้จัดทำบรรยายลักษณะของพันธุ์ไม้แต่ละชนิดพร้อมข้อมูลทางนิเวศวิทยา การกระจายพันธุ์ ชื่อพื้นเมือง พร้อมทั้งภาพประกอบ ได้จัดทำรูปวิธานเพื่อจำแนกสกุลและชนิด ตัวอย่างพันธุ์ไม้ที่เก็บได้ เก็บไว้ที่พิพิธภัณฑ์พืชศาสตราจารย์กสิณ สุวตะพันธุ์ ภาควิชาพฤกษศาสตร์ คณะวิทยาศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย และหอพรรณไม้ กรมอุทยานแห่งชาติ สัตว์ป่า และพันธุ์พืช

ภาควิชา.....พฤกษศาสตร์.....ลายมือชื่อนิสิต.....

สาขาวิชา.....พฤกษศาสตร์.....ลายมือชื่อ.ที่ปรึกษาวิทยานิพนธ์หลัก.....

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CHANIDA SANGUANSAB: DIVERSITY OF FERNS AND FERN ALLIES AT KHAO NAN YAI, KHAO NAN NATIONAL PARK, NAKHON SI THAMMARAT PROVINCE. ADVISOR: PROF. THAWESAKDI BOONKERD, Ph. D., 233 pp.

Diversity of ferns and fern allies at Khao Nan Yai, Nakhon Si Thammarat Province was carried out from July 2007 to April 2008 at elevations ranging from 330 to 1,385 m above mean sea level. A total of two hundred and twenty one specimens were collected. These specimens were identified and classified into 131 species, 58 genera and 24 families. Among these 11 species in 2 genera are fern allies, while 120 species and 3 varieties in 56 genera were ferns. The most common families were Polypodiaceae, Hymenophyllaceae, Dryopteridaceae and Woodsiaceae which included 23, 12 and 10 species, respectively. The collected species can be further classified in to 45 terrestrials and 1 variety, 37 epiphytes and 2 varieties and 14 lithophytes. However, 35 species thrived in more than one habitat. It can be concluded that 68 species were found in tropical evergreen forest, and 46 species grow naturally in hill evergreen forest. Moreover, 17 species grew in both forest types. It is noted that *Ctenopterella khaoluangensis* (Tagawa & K. Iwats.) Parris is the only endemic species for Thailand. Five species are new records for Thailand, i.e. *Cyathea glabra* (Blume) Copel., *Cyathea hymenodes* (Willd.) Sw., *Huperzia coralia* (Spring) J. Holub, *Huperzia hippuris* (Christ) J. Holub and *Hymenophyllum treubii* Racib. Key to the genera and the species were constructed. Full Description, together with ecological data, distribution, local name, and photographs of each species were prepared. The voucher specimens are deposited at the Professor Kasin Suvatabhandhu Herbarium, Department of Botany, Faculty of Science, Chulalongkorn University (BCU) and the Forest Herbarium (BKF), National Park, Wildlife and Plant Conservation Department.

Department.....Botany.....Student's Signature.....*Chanida Sanguansab*
 Field of study.....Botany.....Advisor's Signature.....*Thawesakdi Boonkerd*
 Academic Year.....2008.....

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LIST OF ABBREVIATIONS AND ACRONYMS

auct.	<i>auctorum</i> , of authors
BCU	Professor Kasin Suvatabhundbu Herbarium, Department of Botany, Faculty of Science, Chulalongkorn University
BKF	Forest Herbarium National Park, Wildlife and Plant Conservation Department, Bangkok, Thailand
°C	Degree Celsius
c.	about, approximately
cm	centimeter
cv.	cultivar
comb. nov.	combination, new combination of name and epithet
e.g.	<i>example gratia</i> , byway of example, for example
et al.	<i>et aliorum</i> , and others
mm	millimeter
m	meter
p.p.	<i>pro parte</i> , partly, in part
SING	Herbarium and Library, Singapore Botanic Gardens
sp.	species
syn.	synonymon, synonymy
UKMB	Herbarium, Department of Botany, Universiti Kebangsaan Malaysia, Bangi, Selangor, Malaysia

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CHAPTER I

INTRODUCTION

Thailand is positioned between latitudes N 5°36' to 20°27' and longitudes E 97°20' to 105°37', in the center of Indo-Chinese Peninsula, covering a land area of 513,115 km² and extends about 1,640 kilometers from north to south and 780 kilometers from east to west, with a coastline of approximately 997 kilometers on the gulf of Thailand and 1,037 kilometers along the Indian Ocean (ราชบัณฑิตสถาน, 2545). As one of the tropical countries located near the Equator in Southeast Asia region, it tends to be rich in plant diversity (รัชชชัย สันติสุข, 2532). It is estimated that there are about 10,243 species of vascular plant throughout the country (Santisuk et al, 1991). Of these 671 species are ferns and fern allies (Boonkerd and Pollawatn, 2000).

Geographically, Thailand borders the Lao People's Democratic Republic and the Union of Myanmar to the North, the Kingdom of Cambodia and the Gulf of Thailand to the East, the Union of Myanmar and the Indian Ocean to the West, and Malaysia to the south (ราชบัณฑิตสถาน, 2545). It seems likely that Thailand does not have unique floristic element due to its great variation in topographies and landforms, as well as the diverse climate. Previously, the country is considered as a collective center of botanical diversity from three major floristic elements, i.e. Indo-Chinese, Indo-Burmese and Malesian regions (รัชชชัย สันติสุข, 2532).

Due to human population growth and economic pressure, there has been a high rate of biological resource destruction in Thailand. The country has carried out many measures to protect the natural habitats, for example setting up protected areas, i.e. National parks and wildlife sanctuaries, in supporting of the conservation and sustained utilization of biological resources. However, a national conservation management needs to obtain vital biodiversity information. It is generally accepted that botanical inventories are important sources of information for conservation of natural resources.

Khao Nan National Park is situated in about the middle of the Malay Peninsula, covers an approximated area of 436 km² and parts of 3 districts of Nakhon Si Thammarat

Province, i.e. Tha Sala, Sichol, and Nopitam. In general, the park is the mountainous area with many high peaks. Khao Nan Yai is the highest peaks of this mountain range and ranging in elevations from 60 to 1,438 m above mean sea level. It consists of 2 vegetations, viz. tropical rain forest, and hill evergreen forest or lower montane forest. The climate of the area is a tropical climate with average high rainfall year round and indistinct dry season. This kind of environment promotes growth of many plant groups, especially ferns and fern allies. However, only two explorations of ferns and fern allies in Nakhon Si Thammarat Province, i.e. Sunantha water fall area, Khao Nan National Park and Kahrom Water fall, Khao Luang National Park, were reported (วรวิทย์ รามศรี, 2524; อรุณช รัตนะ, 2549).

It can be seen that data of pteridophyte diversity in this area is scarce and rather small as compared with the other protected areas (for example, Ratchata and Boonkerd, 2002; Rattanathirakul, 2002; Yuyen and Boonkerd, 2002; Khwaiphan and Boonkerd, 2008). So, it is necessary to gain more data of pteridophyte biodiversity in southern Thailand. The data obtained from this study will be useful in biodiversity conservation and management of this focal site in the near future.

Aims of Thesis:

To conduct a botanical inventory of ferns and fern allies at Khao Nan Yai, Khao Nan National Park, Nakhon Si Thammarat Province.

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CHAPTER II

LITERATURE REVIEW

Previous studies of Ferns and Fern Allies in Thailand

The first record of pteridophyte and the other plant groups collected in Thailand was carried out in 1899-1900 by J. Schmidt from Koh Chang, Trat Province. Most of the collected specimens were kept at the Botanical Museum in Copenhagen. The first report of those ferns and fern allies was in the Flora of Koh Chang part III by H. Christ in 1900. Subsequently, this work was revised in 15 years later by Carl Christensen and was published in Flora of Koh Chang Part X (Schmidt, 1900-1916).

Holttum (1954) enumerated 108 genera, and 468 species of ferns in "*The Ferns of Malaya.*" This flora is a good basis for Pteridophyte Flora of Thailand, since there are many species in common between Thailand and Malaysia, especially ferns occurring in the southern provinces. During 1957-1960, Thailand and Denmark jointed a project entitled "Studies in the Flora of Thailand." Professor Holttum was invited to join this project. It was the first time that fern collections from various parts of the country were studied. He listed 157 species of ferns many of them were reported for the first time, and a new species were described (Bruun, 1961). In 1968, Smitinand reported 20 genera and 25 species of ferns and fern allies from Khao Yai. Then, Sawyer and Chermisrivatana (1969) enumerated 21 genera and 33 species of ferns from Doi Suthep and Doi Pui in Chiang Mai Province. Boonkerd (1975) reported a list of 19 families, 32 genera, 66 species and 2 varieties of ferns and fern allies from Sakaerat Environmental Research Station, Nakhon Ratchasima Province during 1977-1979, of these 3 species were new records for Thailand.

During 1979-1989, Tagawa and Iwatsuki studied the existing herbarium specimens and their own collection of pteridophytes from Thailand. Thirty four families, 132 genera, 633 species were reported. There were 25 new species and 21 of these species were endemic to Thailand. Of the 633 enumerated species, 238 species of pteridophytes were collected from Nakhon Si Thammarat Province (Tagawa and Iwatsuki, 1979, 1985, 1988, 1989).

Ramsri (1981) explored diversity of vascular plant at Kahrome Waterfall, Khao Luang National Park, Nakhon Si Thammarat Province. In this work, he reported 13 families, 17 genera, 17 species of ferns and 2 families, 2 genera, 5 species fern allies (วรวิทย์ งามศรี, 2524). Next, vascular plants of Tarutao National Park in the Andaman Sea were explored. A total of 869 species were reported. Of these 15 families, 28 genera, 47 species of ferns and 2 families, 2 genera, 2 species of fern allies were found (Congdon, 1982).

Boonkerd and Pollawatn (2000) compiled data from various sources as well as from their own field trips. A total of 671 species, 4 subspecies, and 28 varieties in 139 genera from 35 families were enumerated. This checklist included 27 new records of Thailand.

Yuyen and Boonkerd (2002) explored diversity of ferns and fern allies at Huaiyang Waterfall National Park, Prachaup Khiri Khan Province during 1999-2000. Twenty six families, 63 genera, 128 species were recorded.

During 2000-2001, Sooksoi (2001) studies taxonomy of ferns and spore morphology at Phuchongnayoi National Park, Ubon Ratchathani Province. Twenty families, 36 genera and 70 species were enumerated. It was found that some characters of spore were useful for pteridophytes classification i.e. aperture, size, shape and exine sculpturing (ส่องศรี สุภสร้อย, 2545).

In 2004, Leeratiwong and Jornead studies species diversity of vascular plants at Tum-nang Waterfall in Si Phang-nga National Park, Phangnga Province. This area is the Tropical Rain Forest with altitudes ranging from 50 to 350 m above mean sea level. Sixteen families, 26 genera, 48 species of ferns and fern allies were reported (จรัล ลีรัตวิวงศ์ และสายใจ จรเอี่ยม, 2547).

Rattana (2006) conducted a pteridophytes diversity survey at Sunantha Waterfall in Khao Nan National Park, Nakhon Si Thammarat Province. A total of 19 families, 28 genera, 44 species, and 1 variety were reported. Among these, there are 17 families, 26 genera, 41 species 1 variety of ferns and 2 families, 2 genera, 3 species of fern allies. (อรนุช รัตน์นะ, 2549)

Sathapattayanon and Boonkerd (2006) investigated diversity of pteridophytes along a gradient of disturbance within mines in Thong Pha Phum. Twenty families, 40 genera, 65 species, 1 subspecies, and 5 varieties from all studied sites were recorded. It

was concluded that species richness and species diversity in natural forest were significantly higher than those along natural gas pipeline and abandoned mines. Subsequently, Vannasri and Boonkerd (2007) explored diversity of ferns and fern allies in natural forest and along natural gas pipeline in Thong Pha Phum District, Kanchanaburi Province. Seventeen families, 31 genera and 46 species of ferns and fern allies were reported (อรวรรณ วรรณศรี และ ทวีศักดิ์ บุญเกิด, 2550). Then, Khwaiphan and Boonkerd (2008) explored diversity of ferns and fern allies at Khao Khiao area in Khao Yai National Park, Nakhon Ratchasima Province at elevation ranging from 600-1,250 m. Twenty five families, 59 genera, 113 species and 6 varieties were noted.

Boonkerd, Chantanaorapint and Khwaiphan (2008) explored diversity of pteridophytes in lower tropical rain forest of Khao Nan National Park from 60 to 600 m altitudes. A total of 27 families, 67 genera, 205 species, 1 subspecies and 7 varieties were reported. Among these, 24 families, 63 genera, 190 species, 1 subspecies and 6 varieties were ferns, while 3 families, 4 genera, 15 species and 1 variety were fern allies.

From the above information it can be seen that information of ferns and fern allies diversity from Khao Nan Yai area in Khao Nan National Park is still lacking. Tropical montane cloud forest at Khao Nan Yai area is considered as the important habitat for biodiversity, particularly the endemic species due to its uniqueness nature and the appearances as the limited and fragmented area. More site-specific plant collections are needed to determine the distribution of the pteridophytes flora. Therefore, Khao Nan Yai area is an interesting site for the objective of diversity exploration and tends to add up the pteridophyte diversity in Thailand.

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CHAPTER III

STUDY SITE

3.1 Location and vegetation

Khao Nan National Park is located on Nakhon Si Thammarat Range, on the east coast of peninsular Thailand (Figure 3.1), and covers an area of approximately 436 km². The park occupied Kung Ching, Nopphitam, and Taling Chun Subdistricts in Tha Sala District; Plain, Chalong, Theparaj, and Khao Noi Subdistricts in Sichon District, Nakhon Si Thammarat Province. It is situated approximately by the geographical coordinates of 8° 41' - 8° 58' north latitude and 99° 30' - 99° 99' east longitude. It is bounded on the north by Sikead National Park and agricultural lands in Kanchanadit District, Surat Thani Province; on the south by Khao Luang National Park and Plai Kratoon Wildlife Sanctuary; on the east by agricultural lands in Sichon and Tha Sala Districts; and on the west by Tai RomYen National Park, Surat Thani Province (Boonkerd, Chantanaorapint and Khwaiphan, 2008).

The highest peak of Khao Nan National Park is about 1,438 m (amsl) and was called Khao Nan Yai (Figure 3.1). Previously, the forest at base of Khao Nan Yai was disturbed and turned to agricultural land. Most of them are Para rubber plantations intermixed with oil palm plantations. The vegetation of Khao Nan National Park in the vicinity of Khao Nan Yai includes tropical evergreen forest and lower montane forest which usually occurs above 800 m altitude (Figure 3.3).

3.2 Geology

The geology of the Khao Nan area is rather complex. The underlying bedrock Cambrian period comprises Tarutao group, such as sandstone quartzite of the Nopphitam Subdistrict. The Ordovician period comprises Thungsong series, such as limestone. During the Permian period this bedrock was overlaid by limestone shale then forming the Ratburi series and igneous rock were occurred from the last volcanic activity. There is also the rich source of minerals, for examples, tin, barite and wolfram (กรมทรัพยากรธรณี, 2550).



Figure 3.1 Map of Thailand showing location of Khao Nan National Park, Nakhon Si Thammarat Province (Number 7 is the area of Khao Nan Yai).

3.3 Climate

The climate of the region is mainly rainy season throughout the year. This begins in May and becomes heavier from October through December, but usually decreases in January. The quantity of rain is scarce during February-April compared with the rest of the year. Most of the area consists of tropical rainforest which causes high humidity in the air and continuous heavy rain so that the weather in this area is rather humid all the year round (Meteorological Department, 2007).

The climatologically data during 1978-2007 (Figure 3.2) shows the average annual relative humidity of about 83%, while the average minimum relative humidity was 77% and average maximum relative humidity was 86.23%. The average annual temperature was 27.6 °C. The average maximum annual temperature was 34.3 °C and the average minimum annual temperature was 21.4 °C. The average annual monthly rainfall was 202 mm. The highest average annual monthly rainfall of approximately 610 mm was observed in November. The lowest annual monthly rainfall of about 64.7 mm and a few rainy days were observed in February which is the driest month (Meteorological Department, 2007).

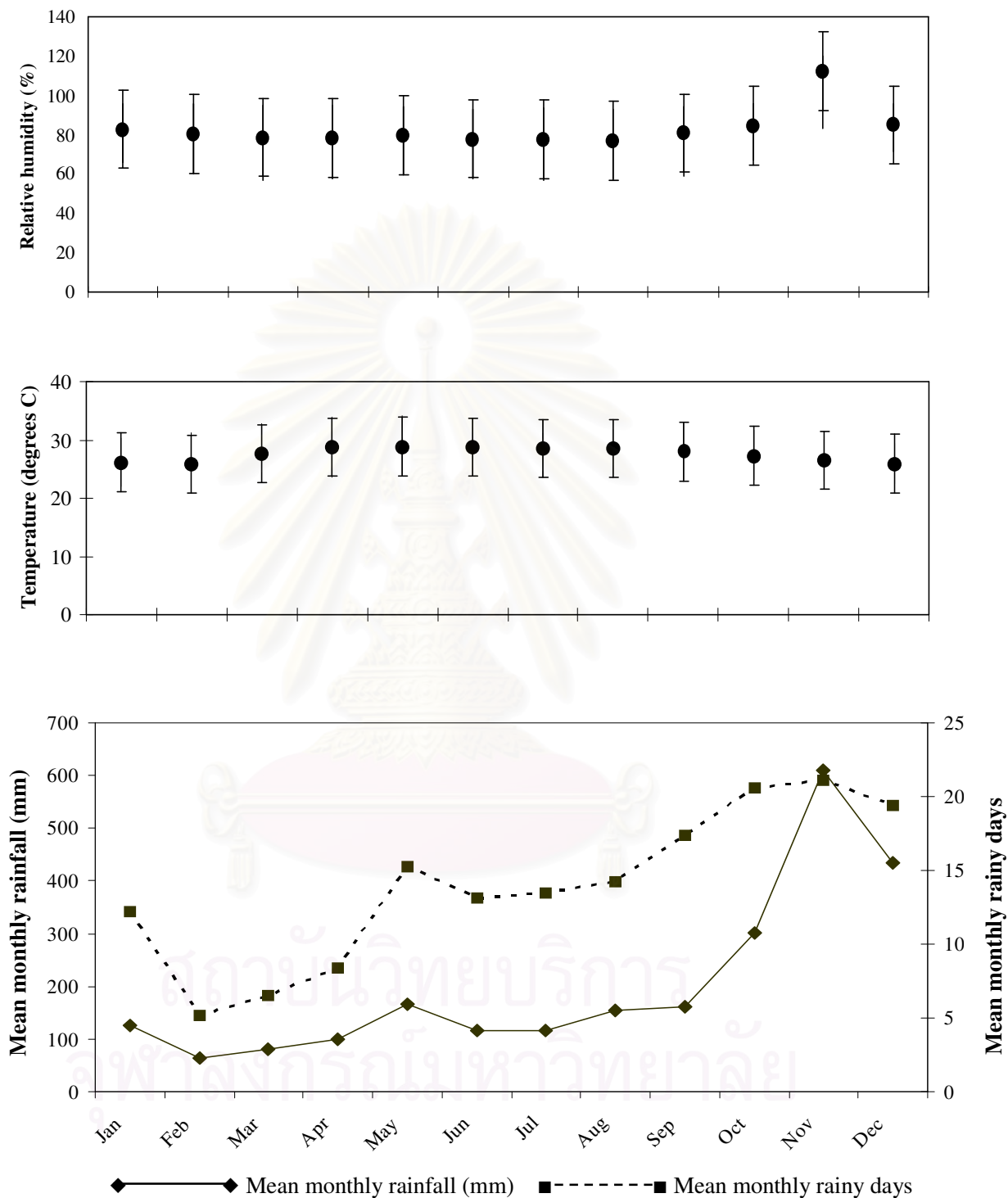


Figure 3.2 Climatological data during the period, 1977-2007, from Nakhon Si Thammarat Meteorological Station (Data from the Department Meteorology, Bangkok, Thailand).

3.4 Vegetation

The summit of Khao Nan Yai, Khao Nan National Park, Nakhon Si Thammarat Province is situated around 1,400 meters above mean sea level. This peak is occasionally classified as cloud forest because the forest vegetation is covered with mist and cloud most of the day and nearly all year round, especially during rainy season. Ninety percent of the total area of the park is the tropical rainforest which has many valuable plants, for example ‘Yang’ (*Dipterocarpus macrocarpus* Vesque), ‘Malacca teak’ (*Intsia palembanica* Miq), ‘Chestnut iron wood’ (*Mesua nervosa* Planch & Triana), ‘Wild champak’ (*Michelia champaca* L.), *Parashorea stellata* Kurz, and *Heritiera sumatrana* Kosterm. More over, there is a plant called ‘Pra’ (*Elalerospermum tapos* Blume), its fruit is popular among villagers as delicious fruit and somewhat expensive during out of season. Normally, this plant is rarely found in cluster elsewhere. So the presence of *E. tapos* in big cluster in the area of Khao Nan meant a lot for the living of the nearby villagers.

At high altitude of tropical mountains, the trees typically decrease in height, and leaves tend to become smaller, harder and thicker (Whitmore, 1989). With increasing elevations, plant species change from lowland to montane species with decreasing in tree stature and leaf size, but the epiphyte load tends to increase. As elevation increase, percent of epiphyte cover tree trunk increase. Epiphyte includes bryophytes, pteridophytes, and orchidaceous species etc. Cloud forest trees are twisted, gnarled and often have umbrella-like crown (see Prathet et al., 2007). Characteristic tree species includes Fagaceae, Theaceae, Mrytaceae, Lauraceae, Moraceae and Rubiaceae (สืบพงศ์ ธรรมชาติ และคณะ, 2550). In addition, Zingiberaceae is a significant component of the herbaceous ground flora. They mostly grow in damp and humid shady places. They are also found from the lowlands, secondary forests, to the high elevations of tropical rain forests (Kittipanangkul and Ngamriabsakul, 2008).

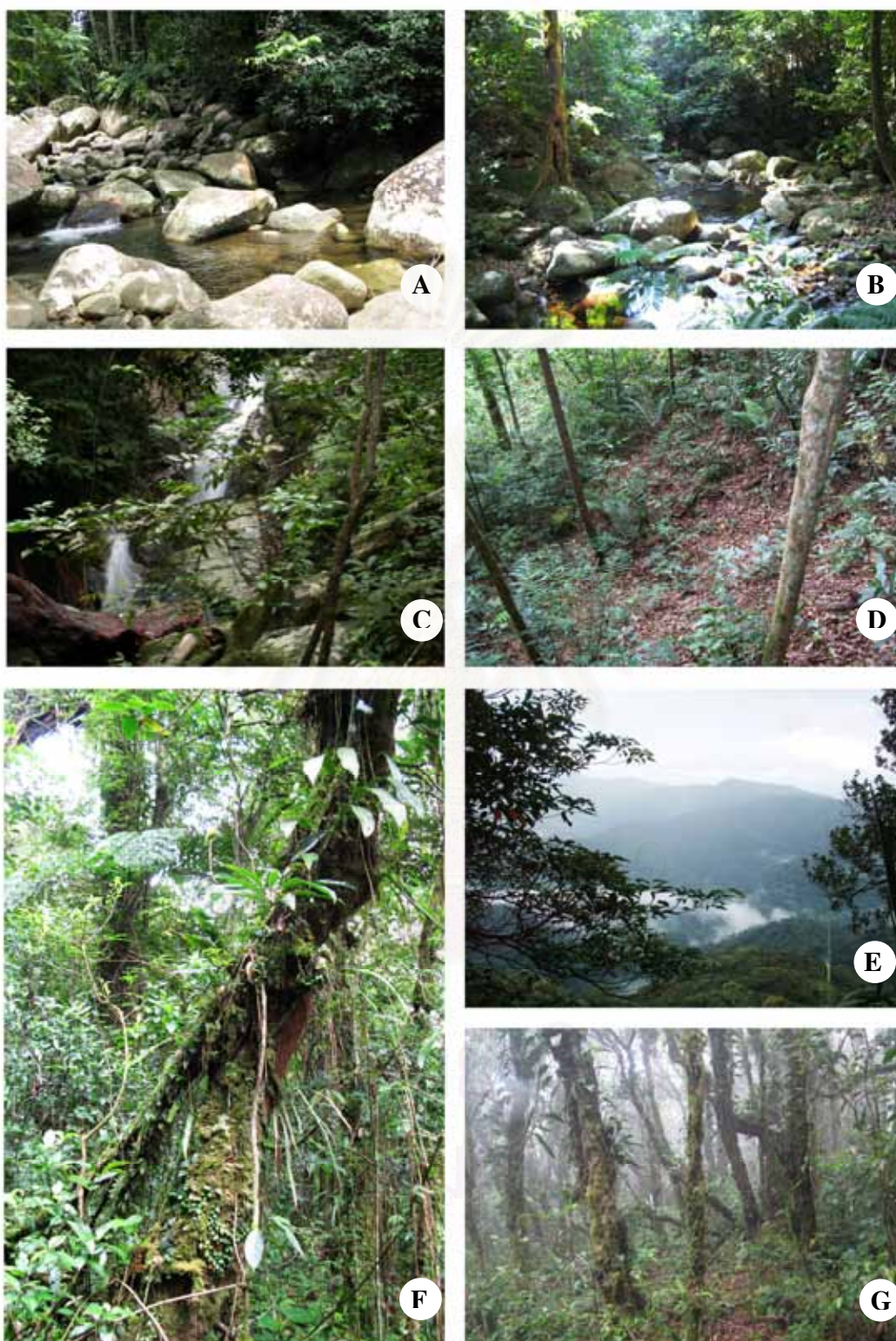


Figure 3.3 The study sites: A-D. Tropical Evergreen Forest; A. Sop Nam I at 330 m altitude; B. Pha Kang Dum at 600 m; C. Nhan Chong Lom at 700 m; D. steep slope at 800 m; E. View from the summit of Khao Nan Yai, at 1,385 m; F-G. Hill Evergreen Forest at 1,250 m.

CHAPTER IV

MATERIALS AND METHODS

4.1 Materials

4.1.1 Specimen collecting equipments

- A plant press, 30 cm x 45 cm in size
- Sheets of newspapers
- Corrugated cardboard
- Hand pruner
- Spade
- Plastic bags
- Field note
- Digital camera, model; Nikon D 70 and Coolpix 4500
- The Global Position System (GPS) receiver, Garmin 60CSx
- Collector's number card

4.1.2 Herbarium specimen preparing equipments

- Deep freezer (-40° C)
- Hot air oven
- Mounting paper, 30 cm x 42 cm in size
- Species covers and Genus covers, 30 cm x 42 cm in size
- Mounting glue (latex mixed with synthetic glue in ratio 1:1 by volume)
- Label pad, about 10.5 cm x 13.5 cm in size
- Needle and thread
- Sand bags

4.1.3 Identification equipments

- Dissecting microscope
- Dissecting needles
- Razor blades
- Petri dishes
- Microscopic slides and cover glasses
- Related taxonomic literatures of ferns and ferns allies
- Voucher specimens deposited in herbaria: Forest Herbarium (BKF) and Professor Kasin Suvathabhandhu Herbarium (BCU)

4.2 Methods

4.2.1 Literature review

Related taxonomic literatures were searched from the libraries at the Professor Kasin Suvathabhandhu Herbarium, Department of Botany, Chulalongkorn University (BCU) and from online CU-reference database via internet. The general information of the studied site, such as location, area, boundary, topography, climate, vegetation, and transportation were studied from the park's pamphlet and related book.

4.2.2 Exploration and collection

Field collection of ferns and fern allies were conducted from July 2007 to April 2008 at Khao Nan Yai, Khao Nan National Park. Specimens were collected along existing forest trails, extending about 5 m from both sides. Some moist areas were frequently visited, such as the mountain summit, waterfalls and the headwaters. Field notes viz. ecological data, habit, habitat and some diagnostic characters of each species were recorded.

4.2.3 Laboratory study

Dried herbarium specimens were prepared as described in Boonkerd et al. 1987 (ทวีศักดิ์ บุญเกิด และคณะ, 2530) and were deposited at BCU. Morphological characters of ferns and fern allies were studied from herbarium specimens, then identifications were made using keys and descriptions from Flora of Thailand, Vol. 3, Part 1-4 (Tagawa and Iwatsuki, 1979, 1985, 1988, 1989) and the other taxonomic literatures, such as Flora of Malaya, Flora of Malesiana, etc.

The collected specimens were proved for identity by comparison to the voucher herbarium specimens deposited at BCU, BKF, SING and UKMB. Authors of scientific names and abbreviations used in this thesis are according to the author of plant names (Brummitt and Powell, 1992). Classification of ferns and fern allies were according to Boonkerd and Pollawatn (2000) and some up-to-date revision works. The voucher specimens were deposited at the Professor Kasin Suvatabhandhu Herbarium, Department of Botany, Faculty of Science, Chulalongkorn University (BCU) and the Forest Herbarium, National Park, Wildlife and Plant Conservation Department (BKF). Dichotomous keys to genera and species were constructed based on their qualitative morphological characters. Descriptions of families, genus and species were undertaken based mainly on the collected specimens.

CHAPTER V

RESULTS

A total of 221 specimens of fern and fern allies were collected and were classified into 24 families, 58 genera, 131 species and 3 varieties. Details of each species, i. e. habit, habitat and its abundance were present in Table 5.1.

Table 5.1 List of the ferns and fern allies at Khao Nan Yai area in Khao Nan National Park.

Habit: Terrestrial herb = T, Epiphyte herb = E, Lithophyte herb = L

Habitat: Tropical evergreen forest = 1, Hill evergreen forest = 2

Abundance: R = rarely found, UC = uncommon, C = common, LA = Local abundance

Taxon	Habit	Habitat & Abundance
Lycopodiaceae		
<i>Huperzia coralia</i> (Spring) J. Holub	E	2,C
<i>Huperzia hippuris</i> (Christ) J. Holub	E	1,UC
<i>Huperzia nummulariifolia</i> (Blume) T. Chambers	E	1,UC
<i>Huperzia phlegmaria</i> (L.) Rothm	E	2,UC
<i>Huperzia pinifolia</i> Trevis.	E,L	1,R
<i>Huperzia</i> sp.1	E	2,UC
<i>Huperzia</i> sp.2	E	2,UC
Selaginellaceae		
<i>Selaginella argentea</i> (Wall. ex Hook. & Grev.) Spring	L	1,UC
<i>Selaginella helferi</i> Warb.	T	1,UC
<i>Selaginella intermedia</i> (Blume) Spring	T	1,2,C
<i>Selaginella willdenowii</i> (Desv. ex Poir.) Baker	T	1,C
Ophioglossaceae		
<i>Helminthostachys zeylanica</i> (L.) Hook.	T	1,UC

Taxon	Habit	Habitat & Abundance
Marattiaceae		
<i>Angiopteris evecta</i> (G. Forst.) Hoffm.	T, L	1,C
Hymenophyllaceae		
<i>Cephalomanes obscurum</i> (Blume) K. Iwats.	L	2,UC
<i>Crepidomanes auriculatum</i> (Blume) K. Iwats.	E,L	2,C
<i>Crepidomanes bipunctatum</i> (Poir.) Copel.	E	1,UC
<i>Crepidomanes latemarginale</i> (Eaton) Copel.	E	2,C
<i>Crepidomanes maximum</i> (Blume) K. Iwats.	L	2,UC
<i>Crepidomanes pallidum</i> (Blume) K. Iwats.	E, L	2,UC
<i>Hymenophyllum acanthoides</i> (Bosch) Rosenst.	E,L	1,UC
<i>Hymenophyllum exsertum</i> Wall. ex Hook.	E	2,LA
<i>Hymenophyllum javanicum</i> Spreng.	E	2,LA
<i>Hymenophyllum polyanthos</i> (Sw.) Sw.	E,L	2,C
<i>Hymenophyllum treubii</i> Racib.	E	2,UC
<i>Trichomanes bimarginatum</i> Bosch	L	1,C
Gleicheniaceae		
<i>Dicranopteris splendida</i> (Hand- Mazz.) Tagawa	T	2,UC
<i>Gleichenia norrisii</i> Mett. ex Kuhn	T	2,UC
<i>Gleichenia longissima</i> Blume	T	2,UC
Schizaeaceae		
<i>Lygodium polystachyum</i> Wall. ex T. Moore	T	1,C
<i>Lygodium salicifolium</i> C. Presl	T	1,C
Denstaedtiaceae		
<i>Histiopteris incisa</i> (Thunb.) J. Sm.	T	2,UC
<i>Microlepia speluncae</i> (L.) T. Moore	T	1,UC
<i>Microleopia strigosa</i> (Thunb.) C. Presl	T	1,2,C
Lindsaeaceae		
<i>Lindsaea doryphora</i> Kramer	T	1,UC
<i>Lindsaea lucida</i> Blume	T	1,UC
<i>Lindsaea oblanceolata</i> v. A. v. Ros.	T, E	2,UC

Taxon	Habit	Habitat & Abundance
Lindsaeaceae (continued)		
<i>Lindsaea repens</i> (Bory) Thwaites var. <i>pectinata</i> (Blume) Mett. ex Kuhn	T, E	2,UC
Cyatheaceae		
<i>Cyathea glabra</i> (Blume) Copel.	T	2,LA
<i>Cyathea hymenodes</i> Mett.	T	1,2,C
<i>Cyathea latebrosa</i> (C. Presl) Copel.	T	1,C
Adiantaceae		
<i>Adiantum latifolium</i> Lam.	T	1,C
<i>Taenitis blechnoides</i> (Willd.) Sw.	T	1,UC
Pteridaceae		
<i>Pteris biaurita</i> L.	T	1,C
<i>Pteris ensiformis</i> Burm. f.	T,L	1,C
<i>Pteris grevilleana</i> Wall. ex J. Agardh	T	1,C
<i>Pteris mertensioides</i> Willd.	T	1,UC
<i>Pteris scabripes</i> Wall. ex J. Agardh	T	1,C
<i>Stenochlaena palustris</i> (Burm. f.) Bedd.	E	1,UC
Vittariaceae		
<i>Anthrophum callifolium</i> Blume	E, L	1,UC
<i>Vittaria angustifolia</i> Blume	E,L	2,C
<i>Vittaria elongata</i> Sw.	E	1,2,C
<i>Vittaria ensiformis</i> Sw.	E	1,2,C
<i>Vittaria flexuosa</i> Fée	E,L	1,UC
<i>Vittaria scolopendrina</i> (Bory) Schkur ex Thwaites	E	2,C
Aspleniaceae		
<i>Asplenium affine</i> Sw.	E,L	1,C
<i>Asplenium confusum</i> Tardieu & Ching	E,L	2,C
<i>Asplenium grevillei</i> Wall. ex Hook. & Grev.	T,E	1,C
<i>Asplenium nidus</i> L. var. <i>nidus</i>	E	1,2,C
<i>Asplenium normale</i> D. Don	T, E	2,UC

Taxon	Habit	Habitat & Abundance
Aspleniaceae (continued)		
<i>Asplenium perakense</i> Matthew & Christ	E	2,LA
<i>Asplenium salignum</i> Blume	E,L	1,C
<i>Asplenium tenerum</i> G. Forst.	E, L	1,C
<i>Hymenasplenium apogamum</i> (N. Murak. & Hatan.) Nakaike	T	1,C
Blechnaceae		
<i>Blechnum orientale</i> L.	T, L	1,UC
Lomariopsidaceae		
<i>Bolbitis appendiculata</i> (Willd.) K. Iwats.	L	1,2,C
<i>Bolbitis heteroclita</i> (C. Presl) Ching	L	1,C
<i>Bolbitis sinuata</i> (C. Presl) Hennisman	L	1,UC
<i>Bolbitis virens</i> (Wall. ex Hook. & Grev.) Schott	L	1,UC
<i>Elaphoglossum malayense</i> Holttum	E	2,C
Dryopteridaceae		
<i>Didymochlaena truncatula</i> (Sw.) J. Sm.	T	1,2,C
<i>Heterogonium sagenioides</i> (Mett.) Holttum	T	1,UC
<i>Pleocnemia irregularis</i> (C. Presl) Holttum	T	1,C
<i>Pleocnemia</i> sp.	T	2,UC
<i>Polystichum prolificans</i> v.A.v. Ros.	T, L	1,2,UC
<i>Pteridrys australis</i> Ching	T	1,C
<i>Tectaria polymorpha</i> (Wall. ex Hook.) Copel.	T	1,UC
<i>Tectaria semipinnata</i> (Roxb.) Morton	T	1,C
<i>Tectaria singaporeana</i> (Wall. ex Hook & Grev.) Ching	T	1,C
Thelypteridaceae		
<i>Christella dentata</i> (Forssk.) Holttum	T	1,UC
<i>Christella papilio</i> (C. Hope) Holttum	L	1,UC
<i>Mesophlebian crassifolium</i> (Blume) Holttum	T	1,UC
<i>Pronephrium repandum</i> (Fée) Holttum	T	1,C
Woodsiaceae		
<i>Diplazium bantamense</i> Blume	T	1,2,C

Taxon	Habit	Habitat & Abundance
Woodsiaceae (continued)		
<i>Diplazium cordifolium</i> Blume	T	1,C
<i>Diplazium crenatoserratum</i> (Blume) T. Moore	T	1,C
<i>Diplazium dilatatum</i> Blume	T,L	1,UC
<i>Diplazium donianum</i> (Mett.) Tardieu	T	1,C
<i>Diplazium silvaticum</i> (Bory) Sw.	T	1,C
<i>Diplazium simplicivenium</i> Holttum	L	2,UC
<i>Diplazium sorzogonense</i> (C. Presl) C. Presl	T	1,2,C
<i>Diplazium tomentosum</i> Blume	T	1,C
<i>Diplazium xiphophyllum</i> (Baker) C. Chr.	T	1,UC
Davalliaceae		
<i>Davallia corniculata</i> Moor	E,L	2,UC
<i>Davallia embolostegia</i> Copel.	E, L	1,2,C
<i>Davallia repens</i> (L. f.) Kuhn	E, L	1,2,C
Oleandraceae		
<i>Nephrolepis biserrata</i> (Sw.) Schott	T,L	1,C
<i>Nephrolepis davalliodes</i> (Sw.) Kunze	E,L	2,C
<i>Nephrolepis</i> sp.	T	2,R
<i>Oleandra neriiformis</i> Cav.	T, E	2,UC
Dipteridaceae		
<i>Dipteris conjugata</i> Reinw.	T	2,C
Polypodiaceae		
<i>Aglaomorpha coronans</i> (Wall. ex Mett.) Copel.	E,L	1,2,LA
<i>Belvisia spicata</i> (L. f.) Mirbel ex Copel.	E,L	1,2,C
<i>Colysis pedunculata</i> (Hook. & Grev.) Ching	E, L	1,C
<i>Colysis wui</i> (C. Chr.) Ching	E, L	2,C
<i>Drynaria rigidula</i> (Sw.) Bedd.	E	1,C
<i>Goniophlebium</i> sp.1	E,L	2,UC
<i>Goniophlebium</i> sp.2	E	2,UC
<i>Lepisorus longifolius</i> (Blume) Holttum	E	1,UC

Taxon	Habit	Habitat & Abundance
Polypodiaceae (continued)		
<i>Leptochilus decurrens</i> Blume	E	1,UC
<i>Loxogramme avenia</i> (Blume) C. Presl	L	1,C
<i>Microsorium insigne</i> (Blume) Copel.	L	1,2,C
<i>Microsorium pteropus</i> (Blume) Copel.	L	1,UC
<i>Microsorium punctatum</i> (L.) Copel.	E, L	1,2,C
<i>Phymatosorus nigrescens</i> (Blume) Pic. Serm.	E	1,C
<i>Phymatosorus</i> sp.	E	1,UC
<i>Pyrrosia adnascens</i> (Sw.) Ching	E	1,C
<i>Pyrrosia albicans</i> (Blume) Ching.	L	1,C
<i>Pyrrosia lingua</i> (Thunb.) Farwell var. <i>heteractis</i> (Mett. ex Kuhn) Hovenkamp	E,L	2,C
<i>Pyrrosia nummularifolia</i> (Sw.) Ching	E	1,UC
<i>Pyrrosia lanceolata</i> (L.) Farwell	E	1,C
<i>Pyrrosia piloselloides</i> (L.) M. G. Price	E	1,UC
<i>Selliuea laciniata</i> (C. Presl) Hovenkamp	E	2,LA
<i>Selliuea triloba</i> (Houtt.) M. G. Price	E	2,LA
Grammitidaceae		
<i>Acrosorus friderici-et-pauli</i> (H. Christ) Copel.	E	2,C
<i>Calymmodon cucullatus</i> (Nees & Blume) C. Presl	E	2,C
<i>Ctenopterella khaoluangensis</i> (Tagawa & K. Iwats.) Parris	E	2,LA
<i>Oreogrammitis adspersa</i> (Blume) Parris	E	2,C
<i>Prosaptia alata</i> (Blume) H. Christ	E, L	1,R
<i>Prosaptia contigua</i> (G. Forst.) C. Presl	E	2,LA
<i>Prasaptia obliquata</i> (Blume) Mett.	E	2,LA
<i>Scleroglossum pusillum</i> (Blume) Alderw.	E	2,UC

The following are descriptions and keys to taxa found in this study.

FERN ALLIES

CLASS LYCOPODIOPSIDA

ORDER LYCOPODIALES

LYCOPODIACEAE

P. Beauv. ex Mirb., Hist. Nat. Veg. 4: 293. 1802; B. Øllg., Fam. Gen. Vasc. Pl. I. 31. 1990.

Terrestrial or epiphytic. Erect to pendulous herbs or climbers. Stems dichotomously branched. Leaves simple, with one simple vein, arranged in spirals or irregular whorls, or decussate, homophyllous or heterophyllous or anisophyllous. Sporophyll like the foliage leaves or modified, sometime specialized and aggregated into distinct strobilus. Sporangia solitary, in the leaf axils or on the upper side of the sporophyll base.

HUPERZIA

Bernh., J. Bot. (Schrader). 1800(2): 126. 1801; B. Øllg., Fam. Gen. Vasc. Pl. I. 33. 1990.

Sporophyte terrestrial or epiphytic, pendent, erect, or ascending, isotomously branched throughout. Sporophylls and vegetative leave alike, or the sporophylls gradually or abruptly smaller than the foliage leaves, without mucilage cavities, persistent; sporangia axillary, reniform, isovalvate, with a slender stalk.

KEY TO THE SPECIES

1. Leaves ovate to suborbicular, round to very moderately acute at apex
..... **3. H. nummularifolium**
1. Leaves linear-lanceolate, acuminate to pointed at apex
 2. Vegetative leaves oblong-lanceolate, sporophyll narrowly ovate subdeltoid
..... **4. H. phlegmaria**
 2. Vegetative leaves linear, sporophyll acuminate at apex

- 3. Veins indistinct on both surfaces
 - 4. Leaves linear-lanceolate, margin curved.....**3. H. coralia**
 - 4. Leaves aciculate or linear, margin not curved
..... **5. H. pinifolia**
- 3. Vein distinct on upper surfaces or on both surfaces
 - 5. Strobilus quadrangular; Sporophyll rhomboid with long tail apex..... **6. H. sp.1**
 - 5. Strobilus not quadrangular; Sporophyll ovate acuminate at apex..... **7. H. sp.2**

1. Huperzia coralia (Spring) J. Holub, Folia Geobot. Phytotax. 20(1): 71. 1985. **Fig. 5.1 A-B.**

Stem pendulous, *c.* 2 mm in diameter near base, two-three dichotomously branching. **Leaves** frequently, linear-lanceolate, acuminate at apex, 7.5 cm long, 2.0 mm broad at the broadest portion, patent, curved margin entire, acuminate at apex, vein indistinct on both surfaces, glossy on upper surface, texture coriaceous, yellow green to light green. **Strobilus** *c.* 1.7-3.5 cm long, terminal on the branchlets, twice forked. **Sporophyll** ovate, acuminate at apex, patent, *c.* 2 mm long, 1.0 mm broad.

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

Distribution.— Malaysia.

Ecology.— On tree-trunks in hill evergreen forest at 1,250 m altitudes.

GPS location.— 08° 52' 51.40"N 99° 42' 02.14"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 214, 217 [BCU].

2. Huperzia hippuris (Christ) J. Holub, Folia Geobot. Phytotax. 20(1): 73. 1985. **Fig. 5.1 C.**

Stem pendulous, dichotomously branching. **Leaves** narrowly lanceolate, acute at apex narrowing towards sessile base, patent, *c.* 1.0-1.2 cm long, 1.0-1.5 mm broad, chartaceous in texture, margin entire, midrib distinct on lower surface. **Strobilus** slightly distinct. **Sporophyll** usually smaller than microphyll or much reduced, ovate reduced at apex 0.6 mm long, 1.5 mm broad.

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

Distribution.— Malaysia.

Ecology.— Epiphyte on mossy-tree trunk in tropical evergreen forest at 850 m altitudes.

GPS location.— 08° 52' 20.86"N 99° 42' 17.63"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 427 [BCU].

3. *Huperzia nummulariifolium* (Blume), T. Chambers, Jermy & Crabbe, Brit. Fern Gaz. 10: 176. 1971.— *Lycopodium nummulariifolium* Blume, Enum. Pl. Java 2: 263 (1828); Tagawa & K. Iwats. Fl. Thailand 3(1): 11. 1979. **Fig. 5.1 D.**

Stem pendulous, *c.* 1-1.5 mm in diameter near the base, irregularly branching dichotomously, to more than 25 cm long. **Leaves** ascending, ovate to suborbicular, round to very moderately acute at apex, round at sessile base, 0.9 cm long, 0.6 cm broad, entire; veins visible on both surfaces; texture thick, fleshy, and green. **Strobilus** at the apex of vegetative branches which become slender in transition to the strobilus, 1 mm in diameter, to 4 cm long, a few times dichotomously branching. **Sporophylls** smaller, adpressed, ovate with acute at apex, to 1 mm long, often crisped on the lower surface in the dried condition.

Thailand.—PENINSULAR: Nakhon Si Thammarat (Khiriwong, Khao Luang), Narathiwat (Waeng), Yala (Betong, Khao Kalakhiri).

Distribution.— Malesia (type from Java) to Polynesia.

Ecology.— On tree-trunks in tropical evergreen forest at 700 m altitudes.

GPS location.— 08° 52' 11.04"N 99° 42' 20.90"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 184, T. Boonkerd 77 [BCU]; C. F. van Beusekom & C. Phengkhilai 883; T. Smitinand 697 [BKF].

4. *Huperzia phlegmaria* (L.) Rothm., Feddes Repert. Spec. Nov. Regni Veg. 54: 62. 1944. — *Lycopodium phlegmaria* L., Sp. Pl.: 1101. 1753; Alston in Fl. Gén. I. C. 7(2): 551. 1951; Tagawa & K. Iwats., Fl. Thailand 3(1): 10. 1979. **Fig. 5.1 E-F.**

Stem pendulous, more than 23 cm long, *c.* 2 mm in diameter near the base, dichotomously branching. **Leaves** narrowly oblong-lanceolate to ovate-subdeltoid, acuminate at apex, round to truncate at base or rarely cordate, patent, sessile or very shortly stalked, 0.7 cm long, 4 mm broad, entire, texture chartaceous, green to yellow green, veins distinct on both surfaces. **Strobilus** distinct, located at apex of sterile branches, dichotomously branching a few times, slender, more than 10 cm long by 1 mm in diameter. **Sporophylls** ovate subdeltoid, adpressed, about 1 mm long.

Thailand.— NORTHERN: Lampang; NORTH-EASTERN: Loei (Wang Saphung, Phu Luang, Phu Kradung), Nong Khai; SOUTH-EASTERN: Prachin Buri (Khao Yai), Chon Buri (Hup Bon Hills), Chantaburi (Khao Soi Dao); PENINSULAR: Chumphon (Tha San), Surat Thani (Song Phi Nong), Phangnga (Khao Thong Lang), Krabi (Ko Pu, Nai Sa, Nai Chong), Phuket (air port), Nakhon Si Thammarat (Khao Luang), Phattalung (Khao Soi Dao, Khao Pok), Satun (Thung Nui, Tarutao), Yala (Betong.)

Distribution.— Old world tropics (type from Ceylon), north to South Japan.

Ecology.— On mossy-tree trunks or on rocks in shade and in dense mossy forest at 1,200 m altitudes.

Vernacular.— Chong nang khli (ชองนางคลี) (South-western); kelt nakkharat (เกล็ดนาคราช) (North-eastern); raya (ระย้า) (Peninsular); yomdoi (ยมโดย) (Central).

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 185, 215; T. Boonkerd 77 [BCU]; C. Niyomdham, P. Phudjaa & S. Chonkunjana 6074 [BKF].

5. *Huperzia pinifolia* Trevis., Atti Soc. Ital. Sci. Nat. 17: 247. 1874, as a *nom. nov.* for *Lycopodium pinifolium* Blume, non Kaulf. — *Urostachys pinifolius* (Blume) Herter; Bot. Arch. 3: 16 (1923). — *Lycopodium piscium* (Herter) Tag. & Iwatsuki, Acta Phytotax. Geobot. 22: 103. 1967; Tagawa & K. Iwats. Fl. Thailand 3(1): 10. 1979. — *Urostachys piscium* Herter, Index Lyc. 75 (1949). **Fig. 5.1** G-H.

Stems pendulous, 10-20 cm long, without leaves, a few times dichotomously branching. **Leaves** linear-oblong, margin curved, acuminate at apex, narrowing towards sessile base, patent, *c.* 0.9 mm long, 0.1 mm broad, chartaceous in texture, margin entire, midrib less distinct on lower surface. **Strobilus** slightly distinct, 2-7 cm long. **Sporophyll** usually smaller than microphyll or much reduce, ovate with long acuminate at apex, 0.5 mm long, 1.0 mm broad.

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

Distribution.— Borneo (Mt. Kinabalu, etc.)

Ecology.— Epiphyte on mossy-tree trunk in tropical evergreen forest at 700 m altitudes.

GPS location.— 08° 52' 11.04"N 99° 42' 20.90"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 449 [BCU]; E. Hennipman 3865 [BKF].

6. *Huperzia* sp. 1. Fig. 5.2 A-B.

Stem pendulous, dichotomously branching a few times. **Leaves** linear-lanceolate, acuminate at apex, 0.8 cm long, 2.0 mm broad, patent, margins entire, acuminate at apex, curled, veins distinctly and glossy on upper surfaces, texture coriaceous, green. **Strobilus** up to 12 cm, quadrangular, dichotomously branching a few times, slender. **Sporophylls** usually smaller than the tropophylls, rhomboid with long tail apex, 3 mm long, 1.5 mm broad.

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

Distribution.— -

Ecology.— On tree-trunks in hill evergreen forest at 1,100 m altitudes.

GPS location.— 08° 52' 36.31"N 99° 42' 13.85"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab
216 [BCU]

Note.— *Huperzia* sp.1 is an epiphytic plant on tree-trunks in hill evergreen forest at 1,200 m altitudes. It is similar to *Huperzia phyllantha* (W. J. Hook. & Walker-Arnott) Holub but *Huperzia* sp.1 has acuminate leaf apex, revolute margin, sporophyll is rhomboid with long tail apex. These characters are different from *Huperzia phyllantha* (W. J. Hook. & Walker-Arnott) Holub.

7. *Huperzia* sp. 2. Fig. 5.2 C-D.

Stem pendulous, c. 2.5 mm in diameter near base, dichotomously branching a few times. **Leaves** frequently, linear-lanceolate, acuminate at apex, 0.75 cm long, 1.5 mm broad, patent, margins entire, veins distinctly on upper surfaces, texture coriaceous, green. **Strobilus** 2 cm distinct, quadrisulcate, located at apex of sterile branches, dichotomously branching a few times, slender, more than 12 cm long by 2 mm in diameter. **Sporophylls** usually smaller than the tropophylls, ovate acuminate at apex, 3 mm long, 1.5 mm broad.

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

Distribution.—

Ecology.— On tree-trunks in hill evergreen forest at 1,000-1,200 m altitudes.

GPS location.— 08° 52' 36.31"N 99° 42' 13.85"E, 08° 52' 51.02"N 99° 42' 01.86"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab
186 [BCU].

Note.— *Huperzia* sp.2 is an epiphytic plant on tree-trunks in hill evergreen forest at 1,000 -1,200 m altitudes. It is similar to *Huperzia phlegmaria* (L.) Rothm., but their details of microphyll, sporophyll and strobilus are different.

CLASS SELAGINELLAOPSIDA**ORDER SELAGINELLALES****SELAGINELLACEAE**

Willk, Anleit. Stud. Bot. 2: 163. 1854; Devol, Fl. Taiwan vol. 1. 2nd ed.: 45. 1980.

Stems slender, creeping, rooting at intervals, or erect, usually without branches on lower part, rooting near base, or with a short, stout stem made up a cluster of branches about the same length, which roll up when dry. Leaves small, simple, with a single vein, always bearing an inconspicuous ligule on the adxial side at its base; vegetative leaves alike or more often dimorphic and usually arranged in two median and two lateral rows on the branches, the median leaves usually smaller and of a different shape from the lateral leaves; the single axillary leaf borne at the forking of each branch, being somewhat different from other leaves. Sporophylls borne in compact strobili; microsporophylls with a single microsporangium, which contains a large number of microspores; megasporophylls with four megaspores; microspores being much smaller and usually of a different color than that of the megaspores; sporangia round or oval.

SELAGINELLA

P.Beauv., Mag. Enc. 4: 478. 1804; Tagawa & K. Iwats., Fl. Thailand 3(1): 14. 1979.

Stem elongate, bearing leaves and rhizophores, branching dichotomously or pinnately, usually of foliar appearance; rhizophores geotropic, dichotomously branching, bearing roots in the earth; leaves microphyllous, monomorphic and spirally arranged in four rows, the ventral two patent or ascending large, the dorsal two smaller, adpressed to stems, directed distally; sporophylls uniform and arranged spirally forming cylindrical strobili, uniform and arranged in four rows forming squarroid spikes, or dimorphic and arranged in four rows, the dorsal and ventral rows unequal.

KEY TO THE SPECIES

1. Stems scandent
3. Plants without iridescent blue colour; sporophylls ovate-lanceolate
 **2. S. helferi**
3. Plants with iridescent blue colour; sporophylls broad ovate
 **4. S. willdenowii**
1. Stems not scandent
2. Ventral leaves at base of main stem distant, adpressed; Dorsal leaves white-margined..... **1. S. argentea**
2. Ventral leaves at base of main stems usually near to the next ones or even overlapping, spreading; Dorsal leaves usually long mucronate
 **3. S. intermedia**

1. Selaginella argentea (Wall. ex Hook. & Grev.) Spring, Bull. Acad. Roy. Sci. Bruk. 10: 137. 1843; Alston in Fl. Gén. I.-C. 7(2): 571. 1951; Tagawa & K. Iwats., Southeast As. St. 3(3): 71. 1965; Tagawa & K. Iwats., Fl. Thailand 3(2): 25. 1985. — *Lycopodium argenteum* Wall. ex Hook. & Grev. in Hook., Bot. Misc. 2: 384. 1831.
Fig. 5.2 E.

Plant to more than 35 cm tall. **Stems** in 2 position, rhizome and erect stems; creeping under ground, 2 mm in diameter, sparsely bearing brown leaves; main stem to 20 cm long, stramineous; leaves on stems more or less adpressed, patent even in dried condition; lateral branches tripinnate glabrous, ultimate branches 1.5 mm in wide. **Ventral leaves** ovate-oblong with falcate upper portion about 2.5 mm broad, ciliate, dorsal leaves ciliate, with distinct white margin oblong up to 1 by 0.3 mm, acute at apex, texture papyraceous yellowish green. **Strobilus** about 1 mm in diameter; sporophylls ovate-subtriangular with apex about 1 mm.

Thailand.— NORTHERN: Chiang Mai (Fang, Doi Chiang Dao, Doi Suthep), Lampang, Phitsanulok (Thung Salaeng Luang); SOUTH-EASTERN: Trat (Koh Chang); SOUTH-WESTERN: Kanchanaburi (Wang Ka, Kha Thalai), Prachuap Khiri Khan; PENINSULAR: Nakhon Si Thammarat (Khao Nan), Satun (Num Tok Boriphat), Trang (Khao Chong).

Distribution.— Myanmar, Malaya (type from Penang) and Indochina (Laos & Cambodia).

Ecology.— Terrestrial or epiphyte on tree-trunks in tropical evergreen forest up to about 700-800 altitudes.

GPS Location.— 08° 51' 44.32"N 99° 41' 32.98"E

Vernacular.— Kapkae (กั๊บแก๊), phokha ti mia (พ่อค้าตีเมีย) (Northern).

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphon 257, 475; O. Rattana 53; O. Thaithong 73; Y. Yuyen 169 [BCU]; J. F. Maxwell 85-1027 [BKF].

2. *Selaginella helferi* Warb. *Monsunia* 1: 107, 121. 1900; Alston in *Fl. Gén.* I-C. 7(2): 582. 1951; Tagawa & K. Iwats., *Southeast As. St.* 3(3): 71. 1965: 31. 1967. —?; Tagawa & K. Iwats., *Fl. Thailand* 3(2): 18. 1985. **Fig. 5.2 F.**

Stem scandent, sometimes forming thicket of more than 2 m in height, 1-3 mm or rarely to more than 5 mm in diameter, very sparsely bearing leaves; branches to more than 70 cm long, tripinnate, glabrous; leaves borne sparsely on the main branches but densely on the lateral branches. **Ventral leaves** patent, oblong, more or less falcate, acuminate at apex, round to subtruncate at sessile base, usually bearing small auricles forming pale hooks at acroscopic base, 2.5-4 mm long, to 1.5 mm broad, distinctly margined with cartilaginous membrane, entire, glabrous. **Dorsal leaves** adpressed, falcate, acuminate at apex, 0.7-2.3 mm long, 2.5 mm broad. **Strobilus** solitary at apex of lateral branchlets, c. 2 mm in diameter; sporophylls ovate-lanceolate, c. 2.5 mm long, 1.5 mm broad, acuminate at apex.

Thailand.—NORTHERN: Chiang Rai (Doi Tung, Nam Mae Kok, Doi Phacho), Chiang Mai (Fang, Doi Chiang Dao, Doi Suthep, Doi Phra Dieng), Nan (Pha Sing), Phitsanulok (Thung Salaeng Luang), Tak (Mae Sot, Doi Musoe, Rahaeng); NORTH-EASTERN: Loei (Phu Luang); CENTRAL : Saraburi (Muak Lek); SOUTH-EASTERN: Chon Buri (Si Racha).

Distribution.— Assam, Myanmar (type), S. China (Kweichow & Kwangsi), and Indochina.

Ecology.— Climbing up bushes in tropical evergreen forest at 500 m altitudes.

GPS Location.— 08° 51' 23.67"N 99° 41' 48.28"E

Vernacular.— Ya rong hai (หญ้าร้องไห้) (Peninsular).

Specimens examined.— T. Boonkerd s.n. [BCU]; M. Tagawa T 1103; K. Iwatsuki et al. T 8607 [BKF].

3. *Selaginella intermedia* (Blume) Spring, Bull. Acad. Roy. Sci. Brux. 10: 144. 1843; Alston in Fl. Gén. I.-C. 7(2): 565. 1951; Tagawa & K. Iwats., Southeast As. St. 5: 29. 1967. Tagawa & K. Iwats., Fl. Thailand 3(2): 21. 1985.

Stem creeping; main stem about 1.5-2 mm in diameter, sparsely bearing dorsal and ventral leaves near base, subdichotomously branching, ultimate branchlets narrowing toward apex about 1.5 cm long, to 0.6 cm wide. **Ventral leaves** patent or slightly ascending, oblong or less falcate, acuminate at apex, widened at base to 5 mm long, 2 mm broad, with transparent edges, minutely denticulate at margin; pseudovein present at both sides of veins, though in some specimens obscure, dorsal leaves imbricate, ovate-oblong with long acuminate at apex, to 2.5 mm long except the needle-like apices, margin dentate. **Strobilus** more than 2 cm long, about 1.5 mm 1 mm broad, sporophylls uniform, ovate-subtriangular, acuminate.

Thailand.—NORTHERN: Lampang; NORTH-EASTERN: Loei (Phu Kra-dung); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chantaburi (Khao Soi Dao), Trat (Ko Chang); PENINSULAR: Chumpon (Khao Tong), Ranong (Khao Phota Chong Dong), Phangnga (Khao Katha Khwam, Khao Nang Hong), Nakhao Si Thammarat (Khao Luang), Trang (Khao Chong), Songkhla (Namtok Khao Kaeo), Pattani (Bukit), Narathiwat (Bajo Waterfall, Sg. Padi).

Distribution.— Myanmar (Tenasserim), Indochina, Malaya, Sumatra, Java (type), Borneo and Celebes.

Ecology.— Terrestrial on humus rich ground or rather dry slopes at 400-1,385 m altitudes.

GPS Location.— 08° 51' 37.24"N 99° 42' 40.52"E, 08° 52' 05.08"N 99° 42' 21.70"E, 08° 52' 58.08"N 99° 41' 50.15"E

Vernacular.— Hi moi sao kae (หีมอยสาวเก้) (north-eastern).

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 165,438: T. Boonkerd 1140, 1517 [BCU]; Tatemi Shimizu, Hideo Toyokuni, Hiroshige Koyama, Tetsukazu Yahara 7: Chawalit Niyomdham T 26426 [BKF].

4. *Selaginella willdenowii* (Desv.) Baker, Grad. Chron. 783, 950: 1867; Tagawa & K. Iwats., Fl. Thailand 3(1): 19. 1985. **Fig. 5.2** G-H.

Stem scandent, sometimes forming bushes of more than 2 m in height, 1-3 mm or rarely to more than 5 mm in diameter, very sparsely bearing leaves; branches to more than 70 cm long, tripinnate, glabrous; leaves borne sparsely on the main branches but densely on the lateral branches. **Ventral leaves** patent, oblong more or less falcate, acuminate at apex, round to subtruncate at sessile base, usually bearing small auricles forming pale hooks at acroscopic base, 2.5-4 mm long, to 1.5 mm broad, margin leaves not or inconspicuously cartilaginous; dorsal leaves adpressed, falcate acuminate at apex, 0.7-2.3 mm long. Spikes solitary at apex of lateral branchlets, about 2 mm in diameter; sporophylls ovate, acute at apex, about 1 mm in length and breadth, herbaceous in texture.

Thailand.— SOUTH-EASTERN: Chantaburi (Ban Huay Ta); SOUTH-WESTERN: Prachuap Khiri Khan (Bang Saphan); PENINSULAR: Chumphon, Surat Thani (Ko Tao, Ko Phangan, Ban Don), Phangnga (Thap Put), Phuket, Krabi (Ao Luk), Nakhon Si Thammarat (Thung Song, Khiriwong, Khao Luang, Ronphibun), Trang (Khao Chong), Phattalung, Satun, Pattani (Bukit), Narathiwat (Bajo Falls), yala (Bannang Sta).

Distribution.— Myanmar, Indochina, Malaya, Sumatra, Java (type) and the Philippines.

Ecology.— Forming thickets among undergrowths in tropical evergreen forest at 330-500 m altitudes.

GPS Location.— 08° 51' 29.27"N 99° 42' 44.44"E, 08° 51' 58.31"N 99° 42' 30.52

Vernacular.— Rang kai (รั้งไค้) (Peninsular).

Specimens examined.— O. Rattana 24: T. Boonkerd 1124, 1475 [BCU]; Kyoji Yoda 701: K. Iwatsuki, H. Koyama, M. Hutoh & A. Chintayungkun T 8499 [BKF].

FERNS

CLASS POLYPODIOPSIDA ORDER OPHIOGLOSSALES

OPHIOGLOSSACEAE

Holttum, Rev. Fl. Malaya 2: 38. 1954.

Rhizome subterranean, short, erect or creeping. Fronds simple or variously divided. Sporangia large borne on a simple or branched and usually erect stalked, spike attached near the base of the blade.

HELMINTHOSTACHYS

Kaulf., Enum. Filic. 28. 1824; Tagawa & K. Iwats., Fl. Thailand 3(1): 38. 1979.

Rhizome creeping, fleshy; trophophyll tripartite, each branch with a terminal lobe and a few pairs of lateral lobes; venation free; sporophyll with stalks usually longer than the sterile lobes, bearing crowded short lateral branches with sporangia; sporangia sessile, round, opening by a longitudinal slit.

Helminthostachys zeylanica (L.) Hook., Gen. Fil.: t. 47b.1840; Bedd., Tardieu & C. Chr. in Fl. Gén. I. –C. 7(2): 10. f. 1, 1-2. 1939; Holttum, Rev. Malaya 2: 42. f. 2. 1954; Tagawa & K. Iwats., Fl. Thailand 3(1): 38. 1979. — *Osmunda zeylanica* L., Sp. Pl. 2: 1063. 1753. **Fig. 5.3 A.**

Rhizome creeping, bearing the numerous fleshy roots and frond in each year. **Phyllomophore** 20-45 cm long, fleshy, green or purplish brown; trophophyll 16-20 cm long, 30 cm wide, tripartite, each with a terminal lobe and one or two pairs of sessile lateral lobes, rachis winged; lobe oblong to oblong-lanceolate, round to acute at apex, cuneate and more or less decurrent at base, 16-20 cm long, 3-5 cm broad; veinlets once or twice forked, all free; texture softly herbaceous. **Sporophyll** with

stalks 15 cm in length, placed at base of tripartite trophophyll, spikes up to 20 cm long; with numerous short branches bearing round sessile sporangia.

Thailand.— NORTHERN: Chiang Rai, Chiang Mai (Doi Chiang Dao), Lampang (Ngao); NORTH-EASTERN: Loei (Phu Luang, Phu Kradung); SOUTH-EASTERN: Chantaburi (Khao Sabap); SOUTH-WESTERN: Kanchanaburi (Hin Dat, Sai Yok, Khao Sok, Kroeng Kawia); PENINSULAR: Ranong, Surat Thani (Ko Tao, Bang Bao), Phangnga (Ko Ra), Nakhon Si Thammarat (Chawang, Thung Song), Trang (Chum Khet), Narathiwat (Waeng, Sg. Padi).

Distribution.— Palaeotropics, from Ceylon (type) and Assam to New Caledonia and Queensland.

Ecology.— Terrestrial on humus-rich slopes in light shade in tropical evergreen forest at 400-500 m altitudes.

GPS Location.— 08° 51' 58.31"N 99° 42' 30.52"E

Vernacular.— Kut chong (กูดจ็อง), kut sang (กูดซัง), kut tin hung (กูดตีนฮุ้ง), phak tin kwang (ผักตีนกวาง), (Northern); tin nok yung (ตีนนกยุง) (South-eastern, Peninsular); phak nok yung (ผักนกยุง) (Eastern).

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 3, 335; T. Boonkerd 573, 1151 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T 1107 [BKF].

ORDER MARATTIALES

MARATTIACEAE

Bercht. & J. Presl, *Prir Rostlin* 272. 1820; Devol, *Fl. Taiwan* vol. 1. 2nd ed.: 73. 1980.

Eusporangiate, terrestrial ferns; caudex short, globose, erect; or rhizome fleshy, creeping to suberect. Fronds pinnately compound, often very large, circinate when young, base of stipes with 2 large leathery persistent stipules; pulvinus at or near base of stipes and pulvini at base of rachillae. Sporangia in closely arranged, elongate or circular sori, or synangia.

ANGIOPTERIS

Hoffm. Comm. Soc. Reg. Gott. 12: 29. 1796; Tagawa & K. Iwats., Fl. Thailand 3(1): 41. 1979.

Rhizome short, massive, bearing several large fronds in tuft; stipes fleshy, green, swollen at base, with scattered whitish streaks at both sides; fronds bipinnate; pinnae and pinnules swollen at base; veins all free; sori with two close rows of sporangia; sporangia dehiscing along slit on the side facing the veins.

Angiopteris evecta (G. Forst.) Hoffm., Comm. Soc Reg. Gott. 12: 29. t. 5. 1796; Holttum, Rev. Fl. Malaya 2: 44. f. 3. 1954; Tagawa & K. Iwats., Fl. Thailand 3(1): 41. 1979.—*Polypodium evectum* G. Forst., Fl. Ins. Austr. Prod.: 81. 1786. — *Angiopteris crassipes* Wall. ex C. Presl, Suppl. Tent. Pterid.: 23 1845; Tradieu & C. Chr. In Fl. Gén. I. —C. 7(2): 20. 1939. — *Angiopteris helferiana* C. Presl, Suppl. Tent. Pterid.: 22. 1845. — *Angiopteris* sp.; C. Chr., Contr. U. S. Nat. Herb.26: 329. 1931.

Fig. 5.3 B.

Rhizome short, erect, massive, bearing several large fronds in a tuft. **Stipes** smooth, green with scattered whitish streaks, c.1 m long. **Fronde**s bipinnate, c.1.8 m long, to 1-1.2 m wide; rachis green, fleshy, glabrous; pinnae to 53 cm long, bearing pinnules c. 13-16 by 2.6-3 cm, oblong-lanceolate, long acuminate apex, each with short swollen fleshy stalk, base unequal, the basiscopic side usually rounded and approaching the rachis a little nearer than the more cuneate acroscopic side, edges parallel for most of their length, with small blunt tooth to each vein-ending, more strongly tooth end apex; texture subcoriaceous, green, pale below, glabrous, sometimes grooved along sporangia line in the upper surface; veins simple or forked, nearly at the right angles to costa, raised on both surface; recurrent vein slender, usually not distinct much beyond the sori, indistinct darker line. **Sori** c.1 mm from the edge, usually 12-20 sporangia.

Thailand.— This species is common throughout Thailand.

Distribution.— Malaysia and Polynesia.

Ecology.—Terrestrial in light shade by streams in tropical evergreen forest about 300-500 m altitudes.

GPS Location.— 08° 51' 29.72"N 99° 42' 46.72"E

Vernacular.—wan kip ma (ว่านกีบม้า), wan kip raet (ว่านกีบแรด) (Central); kip ma lom (กีบม้าลม), kip raet (กีบแรด) (Northern); duku (ดูคู) (Malay/ Peninsular).

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 25: T. Boonkerd 447: Y. Yuyen 42 [BCU]; K. Iwatsuki & N. Fukuoka 7205, 4507 [BKF].

ORDER HYMENOPHYLALES

HYMENOPHYLLACEAE

Link, Handbuch 3: 36. 1833; Holttum, Rev. Fl. Malaya 2: 72. 1954.

Rhizome usually slender and long-creeping with distant fronds, the young parts covered with hairs, sometimes rootless. Fronds of many shapes, from very small and simple to fairly large and highly divided, the ultimate divisions always small, in most cases one-veined; frond one cell in thickness except for the veins. Sori terminal on the ultimate one-veined lobes, or marginal at vein-endings on leaflets with many veins; receptacle columnar, more or less elongated, its base enclosed in the tubular or conical hollow base of the indusium, the apical part of the indusium more or less dilated, often more or less deeply divided into two lips; sporangia with oblique annulus.

KEY TO THE GENERA

1. Involucres bilabiate throughout or to the middle, receptacles include **3. Hymenophyllum**
1. Involucres tubular, receptacles extruded
 2. Venation anadromous; fronds medium to large
 3. Rhizome long-creeping, or short but slender; plant epiphytic or lithophytic.....**2. Crepidomanes**
 3. Rhizome creeping but short and thick; plant terrestrial **1. Cephalomanes**
 2. Venation catadromous, fronds generally smaller..... **4. Trichomanes**

1. CEPHALOMANES

Presl, Hymen.: 17. pl. 5. 1843; Tagawa & K. Iwats., Fl. Thailand 3(1): 87. 1979.

Rhizome stout, short, erect; fronds simply pinnate: pinnae unequal-sided, usually rhomboid in outline, subentire or serrate at margin, harsh in texture; involucre cylindrical, with truncate mouth: receptacle long extruded.

Cephalomanes obscurum (Blume) Copel., Phil. J. Sci. U. Tokyo III. 13:547. 1985. Tagawa & K. Iwats., Fl. Thailand 3(4): 611. 1989. — *Selenodesmium obscurum* (Blume) Copel., Phil. J. Sci. 67: 81. 1938; Tagawa & K. Iwats., Fl. Thailand 3(1): 99. 1979. — *Trichomanes obscurum* Blume, En. Pl. Jav.: 227. 1828; Tardieu & C. Chr. in Fl. Gén. I. –C. 7(2): 69. 1939; Holttum, Rev. Fl. Malaya 2: 108. f. 44. 1955. **Fig. 5.3** C-D.

Rhizome very short, creeping or ascending, bearing many wiry roots and stipes, covered with dark hairs, 1-1.2 mm diameter. **Stipes** stiff, stramineous, wingless, covered with brownish hairs, the hairs dense at base, 0.7-1.3 mm in diameter, sometimes more than 10 cm long but often dwarfed. **Fron**ds oblong-subdeltoid, gradually narrowing towards acute apices, broadly cuneate or subtruncate at base, the larger ones more than 9.6 cm long, 5.8-8 cm wide, tripinnatifid, or more finely dissected; rachis narrowly winged, pinnae with very short stalks, oblong-lanceolate, acute at apex, cuneate at base, 3.6-5 cm long, 1-1.5 cm wide; pinnules with several segments, the bases decurrent to form narrow wings of costae; texture coarse, dark green in colour. **Sori** apical on apical segments, cup-shaped, 1.2 mm long, 0.5 mm diameter, indusium narrowly winged, cylindrical, narrowed at the base, the apex truncate.

Thailand.— NORTHERN: Loei (Phu Kaduang); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Trat (Koh Chang); PENINSULAR: Ranong (Khao Nom Sao, Khao Phota Luang Kaeo), Nakhon Si Thammarat (Khao Luang), Satun, Yala (Ban Chana, Khao Kalakhiri).

Distribution.— Widely distributed in the tropics of the World (type from Java.)

Ecology.— On wet sandy ground near steams in hill evergreen forest at 1,250 altitudes.

GPS Location.— 08° 52' 51.40"N 99° 42' 02.14"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 233 [BCU]; K. Iwatsuki, H. Koyama, M. Hutoh & A. Chintayungkun T 8360 [BKF].

2. CREPIDOMANES

C. Presl., Epim.: 258. 1849; Tagawa & K. Iwats., Fl. Thailand 3(1): 87. 1979.

Rhizome long-creeping. Filiform, hairy, usually rootless; fronds dwarfed and digitate to medium sized and pinnately compound, the ultimate segments or lobes entire at margin; false veinlets present either marginal or oblique; involucre obconic to campanulate, winged with bilabiate mouth; receptacles extruded.

KEY TO THE SPECIES

- 1. Hairy axial pads covering the under surface of laminae..... **5. C. pallidum**
- 1. Hairy axial pads absent
 - 2. False veinlet present
 - 3. Fronds smaller, less than 2 cm long..... **3. C. latemarginale**
 - 3. Fronds usually more than 3 cm long..... **2. C. bipunctatum**
 - 2. False veinlet absent
 - 4. Fronds linear to lanceolate, simply pinnate to bipinnate
..... **1. C. auriculatum**
 - 4. Fronds tripinnate or more compound..... **4. C. maximum**

1. Crepidomanes auriculatum (Blume) K. Iwats., J. Fac. Sci. U. Tokyo III. 13: 528. 1985; Tagawa & K. Iwats., Fl. Thailand 3(4): 613. 1989. —*Trichomanes auriculatum* Blume, En. Pl. Jav.: 225. 1828; Tagawa & K. Iwats., Fl. Thailand 3(1): 83. 1989; Holttum, Rev. Fl. Malaya 2: 105. f. 41. 1955. **Fig. 5.3 E.**

Rhizome very long, climbing to several meters, 1.2-1.8 mm diameter, densely hairy on the ventral side. **Stipes** 2-5 cm apart, very narrowly winged in the upper

parts, hairy when young, usually less than 1 cm in length. **Fron**ds simply pinnate, linear-lanceolate, acuminate at apex, gradually narrowing towards base, 34 cm long, 2.5 cm wide: pinnae sessile, rhomboid to oblong, oblique, round at apex, truncate acroscopically and cuneate basiscopically and cuniate basiscopically at base, to 2 cm long, 1.1 cm broad, lobed to varying degree, the incisions reaching a quarter of the way or nearly to the costae, the margin of lobes serrate, each tooth containing a single veinlet; green to deep green. **Sori** terminal on veinlets; involucre tubular with dilated mouth, sessile, narrowly winged, *c.* 3 mm long, 0.5 mm diameter; receptacles long extruded, slender, curved.

Thailand.— NORTHERN-EASTERN: Loei (Phu Kraduang); SOUTH-EASTERN: Chathaburi (Khao Sao Doi); PENINSULAR: Chumphon (Ban Kraya), Surat Thani (Khao Nong), Nakhon Si Thammarat (Khao Luang), Pattani (Bacho), Trang (Khao Chong), Yala (Ban Chana).

Distribution.— N. India to Japan, southwarda to Malesia throughout (type from Java) to New Guinea.

Ecology.— On mossy tree-trunks in hill evergreen forest at 1,150-1,250 m altitudes.

GPS Location.— 08° 52' 45.31"N 99° 42' 06.00"E, 08° 52' 51.40"N 99° 42' 02.14"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 436: T. Boonkerd 346, 1497 [BCU]; K. Iwatsuki, H. Koyama, M. Hutoh & A. Chintayungkun T 8346 [BKF].

2. *Crepidomanes bipunctatum* (Poir.) Copel; K. Iwats., J. Fac. Sci. U. Tokyo III. 15: 536. 1985 Syn. *C. Bilabiatum* (Nees & Blume) Copel.; Tagawa & K. Iwats., Fl. Thailand 3(4): 613. 1989; Tagawa & K. Iwats., Fl. Thailand 3(1): 90. 1979; Holttum, Rev. Fl. Malaya 2: 99. f. 35. 1955. — *Trichomanes bipunctatum* Poir. in Lamk., Enc. 8: 69. 1808. **Fig. 5.3** F-G.

Rhizome *c.* 0.6 mm diameter, covered with dark brownish hairs. **Stipes** 2-3 cm long, winged almost to the base, bearing short hairs. **Fron**ds variable in shape and size, ovate to oblong, round to acute at apex, tripinnatifid, usually 4-8 cm long, 3-5 cm wide, often dwarfed with sori; pinnae 5-8 in pairs, the large ones 1.5-3 cm long,

1-5 cm wide, shortly stalked or sessile in the upper ones; pinnules oblong to subdeltoid, with *c.* 8-10 segments; ultimate segments linear-lanceolate, at a narrow angle to each other, acute at apex, entire and flat at margin; false veinlets marginal continuous, occupying two rows of marginal cells, the other striae few. Sori on the apices of short axillary lobes; involucre tubular, 1-2 mm long, winged, the mouth bilabiate, the lips round to acute, as wide as long.

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

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

Ecology.— On mossy tree-trunks or rocks in tropical evergreen forest at 630 m altitudes.

GPS Location.— 08° 52' 05.08"N 99° 42' 21.70"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 431: T. Boonkerd 40, 1466 [BCU]; E. Hennipman 3923 [BKF].

3. *Crepidomanes latemarginale* (Eaton) Copel., *Phil. J. Sci.* 67: 60. 1938; Tagawa & K. Twats., *Fl. Thailand* 3(4): 613. 1989; Tagawa & K. Iwats., *Fl. Thailand* 3(1): 90. 1979. — *Trichomanes latemarginale* Eaton, *Proc. Am. Acad.* 4: 111. 1858; Tardieu & C. Chr. In *Fl. Gén. I. -C.* 7(2): 63. 1939; Holttum, *Rev. Fl. Malaya* 2: 101. 1954. **Fig. 5.3 H.- Fig. 5.4 A.**

Rhizome very slender densely covered with short brownish hairs. **Stipes** *c.* 0.5-1 mm apart, 2-5 mm long, very narrowly winged in the upper part, hairy especially in the basal part. **Fronde**s almost circular to oblong-subdeltoid in outline,

less than 2 cm long, 1.2-1.6 cm wide, often digitate in appearance but typically pinnate in branching; segments 5-12, linear-lanceolate, round to moderately acute at apex, entire but sometimes obscurely crisped at margin, with a single vein, 1-1.2 mm wide; false veinlets marginal, continuous, with two rows of marginal cells outside the false veinlets. **Sori** sunk in the apices or segment; involucre tubular with bilabiate mouth, c. 2 mm in diameter, the mouth just wider than the segments.

Thailand.— NORTH-EASTERN: Loei (Phu Luang); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); PENINSULAR: Surat Thani (Ko Tao), Trang (Palian).

Distribution.— Assam to South China (type from Hongkong) including Taiwan, south to Malaya.

Ecology.— On muddy or mossy rocks in hill evergreen forest at 1,000 m altitudes.

GPS Location.— 08° 52' 36.31"N 99° 42' 13.85"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 164; Y. Yuyen 67 [BCU]; K. Iwatsuki & N. Fukuoka T 7105 [BKF].

4. *Crepidomanes maximum* (Blume) K. Iwats., J. Fac. Sci. U. Tokyo III. 13: 531. 1985; Tagawa & K. Iwats., Fl. Thailand 3(4): 613. 1989. — *Trichomanes maximum* Blume, En. Pl. Jav.: 228. 1828; Tagawa & K. Iwats., Fl. Thailand 3(1): 83. 1989; Tardieu & C. Chr. In Fl. Gén. I. -C. 7(2): 63. 1939. **Fig. 5.4 B-C.**

Rhizome creeping, thick, 2 mm or more diameter, densely covered with stiff dark brownish hairs when young. **Stipes** rather close to each other, stramineous, very narrowly winged in the upper part, hairy at base, 10-24.5 cm long. **Fronde**s oblong-subdeltoid, acute at apex, one or two pairs of basal pinnae smaller than the next above forming round outline the base, 15-29 cm long 10-16 cm wide, finely decomposed to quadripinnatifid; rachis narrowly winged throughout, wing entire and flat; pinnae oblong-subdeltoid to oblong-lanceolate, acute to acuminate at apex, unequally cuneate and stalked at base, larger ones 10-12 mm long, 3.3 cm wide; ultimate segments c. 0.5-0.7 mm broad, at a narrow angle to the next larger division of the fronds, round to moderately acute at apex, often curved inwardly; the wings of various axes narrower than the ultimate lobes, entire, flat. **Sori** on short axillary lobes usually near the pinna-

or pinnule-rachis; involucre tubular, with short stalk and dilated mouth, narrowly winged, *c.* 2-3 mm long, 0.7-1 mm diameter.

Thailand.— PENINSULAR: Ranong (Khao Phota Chongdong), Surat Thani (Khao Khieo Range), Phangnga (Khao Katha Khwam, Kapong), Nakhon Si Thammarat (Khao Luang, Huai Suai-Nai), Trang (Khao Chong), Pattani (Bacho), Yala (Khao Kalakhiri, Klong Chana).

Distribution.— In the tropics of E. Asia (type from Java) and Polynesia.

Ecology.— On rock near streams in hill evergreen forest at 1,250 m altitudes.

GPS Location.— 08° 52' 51.40"N 99° 42' 02.14"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 230 [BCU]; K. Iwatsuki, H. Koyama, M. Hutoh & A. Chintayungkun 14553 [BKF].

5. *Crepidomanes pallidum* (Blume) K. Iwats., *Acta Phytotax. Geobot.* 35: 174. 1984. Tagawa & K. Iwats., *Fl. Thailand* 3(4): 613. 1989. — *Trichomanes pallium* Blume, *En. Pl. Jav.*: 225. 1828; Tardieu & C. Chr. In *Fl. Gén. I.* –C. 7(2): 69. 1939; Holttum, *Rev. Fl. Malaya* 2: 108. f. 44. 1955. — *Pleurmanes pallium* (Blume) Presl; Tagawa & K. Iwats., *Fl. Thailand* 3(1): 86. 1979. **Fig. 5.4** D-E.

Rhizome wiry, *c.* 0.38 mm diameter, covered with light brownish hairs. **Stipes** dark stramineous, hairy at the base, 1.5-4 cm long, without wings. **Fronde**s bipinnate to subtripinnatifid, oblong to somewhat irregular in outline, *c.* 5-7.1 cm long, 1.5-3.1 cm wide, somewhat variable in size; pinnae oblong-lanceolate, round to acute at apex cuneate at sessile at base; ultimate segments linear-lanceolate, acute at apex, entire and flat at margin; undersurface of lamina part covered with powder, glaucous in appearance, densely covered with stellate or filiform hairs; marginal cells extremely modified. **Sori** terminal on short acroscopic axial lobes; involucre cup-shaped to tubular, subdeltoid, *c.* 1.5 mm long, the lips slightly dilated.

Thailand.— NORTHERN: Loei (Phu Kraduang); PENINSULAR: Krabi (Phanom Bencha), Surat Thani (Khao Nong, Khao Khieo range), Nakhon Si Thammarat (Khao Luang) Trang (Khao Song), Yala (Gunong Ina).

Distribution.— From Ceylon to Polynesia (type from Java), north to Taiwan.

Ecology.— On mossy tree-trunks or rocks in hill evergreen forest at 1,000-1,086 m altitudes.

GPS Location.— 08° 52' 28.14"N 99° 42' 15.02"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 175 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T 4819 [BKF].

3. HYMENOPHYLLUM

Sm., Mém. Acad. Turin. 5: 418. 1973; Tagawa & K.Iwats, Fl. Thailand 3(1): 74. 1979.

Rhizome slender, wiry; fronds pinnately compound, margin of segment toothed; sori at apex of ultimate segments; involucre bivalvate, deeply cleft to the base; receptacles intruded.

KEY TO THE SPECIES

- 1. Receptacle extruded, rachis wing throughout..... **1. H. acanthoides**
- 1. Receptacle included
 - 2. Stipe, rachis, and pinna rachis persistently hairy..... **2. H. exsertum**
 - 2. All axes glabrous
 - 3. Involucre distinctly as wide as long; frond 6-10 cm long, ultimate segments mostly 5-10 mm long..... **5. H. treubii**
 - 3. Involucre triangular to subdeltoid, longer than wide
 - 4. Wing of stipe and rachis crisped..... **3. H. javanicum**
 - 4. Wing of stipe and rachis undulate..... **4. H. polyanthos**

1. Hymenophyllum acanthoides (van den Bosch) C. Chr., Rosenst., Bull. Jard. Bot. Btzg. II. 2: 25. 1911; Holttum, Rev. Fl. Malaya 2: 20. f. 5: 5. 1955. Tagawa & K. Iwats., Fl. Thailand 3(4): 612. 1989. — *Didymoglossum acanthoides* van den Bosch, Pl. Jungh 1: 16. 1856. — *Meringium acanthoides* (van den Bosch) Copel.; Tagawa & K. Twats., Fl. Thailand. 3(1): 78. 1979. **Fig. 5.4 F.**

Rhizome slender, covered with brownish hairs when young. Stipes 1-3 cm apart, winged, 0.7-1.5 mm long. **Fron**ds variable in size and form, bipinnate to tripinnatifid, oblong-subdeltoid, moderately acute at apex, broadly cuneate to subcordate at base, 1-3 cm long and wide (at most 2.1 cm long in the largest ones); rachis winged; pinnae with several segments, ovate to oblong, round at apex, unequally cuneate at base; ultimate segments round or obtuse at apex, 0.5 mm or so wide, the margin sharply toothed and conspicuously crisped, the fronds never extending in a plane. **Sori** at apices of short acroscopic segments, usually in apical part of fronds; involucre tubular with bilabiate mouth, winged, also with a few accessory wings, the lips round and sharply toothed.

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

Distribution.— Tropics of Asia, Java (type), to New Guinea, north to Taiwan.

Ecology.— On mossy tree-trunks in tropical evergreen forest at 600 m altitudes.

GPS Location.— 08° 51' 44.32"N 99° 41' 32.98"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 422: P. Ratchata 344 [BCU]; E. Smith 914 [BKF].

2. *Hymenophyllum exsertum* Wall. ex Hook., Sp. Fil. 1: 109. pl. 38A. 1844; Tardieu & C. Chr. In Fl. Gén. I. –C. 7(2): 53. 1939; Holttum, Rev. Fl. Malaya 2: 86. f. 28. 1954; Tagawa & K. Iwats., Fl. Thailand 3(4): 611. f. 5: 13. 1989. — *Mecodium exsertum* (Wall ex Hook.) Copel., Phil. J. Sci. 67: 23. 1938; Tagawa & K. Iwats., Fl. Thailand 3(1): 73. 1979. **Fig. 5.4** G-H.

Rhizome wiry, hairy throughout, laxly branched, c. 0.3 mm in diameter. **Stipes** remote, hairy on the abaxial side, c. 3-5 cm long, sometimes winged on the upper part. **Fron**ds oblong-ovate to oblong-lanceolate, round to acute at apex, tripinnatisect, 7-10 cm long, 2.5-4 cm wide; rachis like the upper part of stipes, hairy throughout, more densely on abaxial side, wing throughout by flat wings, to 0.8 mm on both sides; pinnae many, more than twelve in pairs on lower fronds, oblong to oblong-lanceolate, slightly falcate, round to moderately acute at apex at most 2.5 cm long, 1 cm wide; pinnules with a few to several segments in larger ones pinnately

decompound; ultimate segments to 1.5 mm long, 1 mm broad, entire and flat; hairs on every axes, rather sparse on upper axes, brown, up to 1 mm long. **Sori** usually on upper side of pinnae, dispersing from near rachis outward, the base constricted; involucre bilabiate; lips subtriangular, moderately acute, entire and flat, to 2 mm long, 1 mm broad; receptacle clavate.

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

Distribution.— North India (type from Nepal), South China, Upper Myanmar, Indochina, south to Malaya.

Ecology.— On mossy tree-trunks in hill evergreen forest at 1,200-1,350 m altitudes.

GPS Location.— 08° 52' 51.02"N 99° 42' 01.86"E, 08° 52' 57.98"N 99° 41' 50.03"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 458; T. Boonkerd 93; Y. Yuyen 193 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T 6811 [BKF].

3. *Hymenophyllum javanicum* Spreng., Syst. Veg. 4: 132, 1827; Tardieu & C. Chr. In Fl. Gén. I. –C. 7(2): 54. 1939 Holttum, Rev. Fl. Malaya 2: 83. f. 24. 1955. Tagawa & K. Iwats., Fl. Thailand 3(4): 611. 1989. — *Mecodium javanicum* (Spreng.) Copel.; Tagawa & K. Iwats., Fl. Thailand. 3(1): 71. 1979. **Fig. 5.5** A-B.

Rhizome laxly branched, c. 0.48 mm diameter. **Stipes** remote, naked but the very base hairy, 2.5-4.5 cm long, winged except for the basal portion with undulate or crisped wings. **Fronde**s oblong-subdeltoid, acute to moderately acute at apex, tripinnate to quadripinnatifid, glabrous, 4-7 cm long, 4.4 cm wide at the widest basal portion; pinnae 9 pairs the basal one to 2.6 cm long, 1 cm wide, oblong-subdeltoid,

moderately acute to round apex, broadly cuneate to round at base, stalked, the upper one gradually smaller upwards, oblong in outline; ultimate segments narrow, round to obtuse at apex, entire but undulate or crisped at margin, of 0.6-1 broad, to 4 mm long. **Sori** scattered usually on the apical parts of pinnae: involucre subdeltoid to oblong, 0.5-1.6 mm long, to 1 mm broad, the lips finely toothed, receptacles clavate to filiform, wholly included in the involucre.

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

Distribution.— Throughout the tropics of Asia (type from Java) and Oceania.

Ecology.— On mossy tree-trunks in hill evergreen forest at 1,200-1,350 m altitudes.

GPS Location.— 08° 52' 51.02"N 99° 42' 01.86"E, 08° 52' 57.98"N 99° 41' 50.03"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 213 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T 4816 [BKF].

4. Hymenophyllum polyanthos (Sw.) Sw., Schrad. J. Bot. 1800(2): 102. 1801; Tardieu & C. Chr. In Fl. Gén. I. –C. 7(2): 54. 1939; Holttum, Rev. Fl. Malaya 2: 81. f. 23. 1954; Seidenf., Nat. Hist. Bull. Siam Soc. 19: 85. 1958; Tagawa & K. Iwats., Fl. Thailand 3(4): 611. 1989. — *Trichomanes polyanthos* Sw., Prod. Fl. Ind. Occ.: 137. 1788. — *Mecodium polyanthos* (Sw.) Copel.; Phil. J. Sci. 67: 19. 1938; Tagawa & K. Iwats., Fl. Thailand 3(1): 70. 1979. **Fig. 5.5 C.**

Rhizome slender, less than 0.2 mm in diameter with hairy rootlets. **Stipes** 2-3 cm long, wingless except the uppermost part, glabrous. **Fronds** very variable both in size and form, lanceolate, oblong or subdeltoid, acute to acuminate at apex, 3-9.5 cm long, 1.5-3.5 cm wide, usually tripinnatifid, light green, herbaceous; rachis winged throughout, wing very narrow, entire, flat; pinnae less than 8 pairs, the largest one in the middle of fronds, reducing in size both upward and downward, the larger ones oblong-subdeltoid or oblong-lanceolate, somewhat falcate; ultimate segments linear or narrowly lanceolate, round to obtuse at apex, the margin entire and flat, usually *c.* 1

mm in length. **Sori** usually longer than the breadth, deeply divided; lips round or moderately acute, entire or slightly crenate; receptacles clavate, included.

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

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

Ecology.— On mossy tree-trunks in hill evergreen forest at 1,000-1,350 m altitudes.

GPS Location.— 08° 52' 28.14"N 99° 42' 15.02"E, 08° 52' 57.98"N 99° 41' 50.03"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 318; T. Boonkerd 1052 [BCU]; M. Tagawa and K. Iwatsuki T 1040; K. Iwatsuki T 6262 [BKF].

5. *Hymenophyllum treubii* Racib., Pterid. Buitenz. 15: 1898; Holttum, Rev. Fl. Malaya 2: 84. f. 27. 1955. **Fig. 5.5** D-E.

Rhizome wiry, the rootlets densely hairy, 0.3-0.8 mm diameter. **Stipes** 1-4 cm long, narrowly winged towards the apex; rachis winged throughout, wing flat, widening toward the apex, rachis including its wing to 2 mm wide. **Fronde** 6-10 cm long, 2.5-5 cm wide; pinnae close but not overlapping, oblique, with few rather distant lobes; lobes simple or forked, 2 mm wide, the simple lobes commonly 5-10 mm long or even more; apices of sterile lobes notched, not toothed. **Sori** usually few; indusia cleft almost or quite to the base, the lip almost round and slightly irregularly toothed; receptacle short, its apex thickened.

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

Distribution.— Malaysia to New Guinea.

Ecology.— On mossy tree-trunks in hill evergreen forest at 1,033 m altitudes.

GPS Location.— 08° 52' 36.31"N 99° 42' 13.85"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 169 [BCU].

4. TRICHOMANES

L., Sp. Pl.: 1907. 1753; Tagawa & K.Iwats., Fl. Thailand 3(1): 82. 1979.
- *Vandenboschia* Copel., Phil. J. Sci. 67: 51. 1938.

Rhizome short to long-creeping, rather thick, usually densely hairy; fronds more or less remote, pinnately compound, small to medium in size; ultimate segments entire at margin, usually glabrous; involucre cup-shaped with long extruded receptacles.

Trichomanes bimarginatum van den Bosch, Ned. Kruid. Arch. 5: 143. 1861. Holttum, Rev. Fl. Malaya 2: 83. f. 24. 1955. Tagawa & K. Iwats., Fl. Thailand 3(4): 611. 1989. —*Microgonium bimarginatum* van den Bosch; Tagawa & K.Iwats., Fl. Thailand. 3(1): 95. 1979; Holttum, Rev. Fl. Malaya 2: 92. 1955. **Fig. 5.5 F.**

Rhizome irregularly branching, *c.* 0.3 mm diameter, densely covered with brownish hairs 0.3-0.5 mm long. Fronds 0.5-2 cm apart, simple, lobed to one-third (or very rarely to a half) way to costae, oblong to oblong-lanceolate, round to obtuse at apex, round to cuneate at base, the margin more or less crisped, 1.5-2 cm long, 6-8 mm broad; stipes 2-4 mm long, densely hairy; lateral veins a few to several in pairs, usually forked (or in larger fronds trifurcate); oblique false veinlets many, long, the marginal one continuous with a single row of marginal cells outside the strand, joining the ends of oblique ones. Sori one to several on the apical part of frond, terminal on the lateral veins; involucre tubular with dilated mouth, immersed in frond, 1.5-3 mm long, the mouth to 1 mm diameter.

Thailand.— PENINSULAR: Surat Thani (Khao Nong), Phangnga (Khao Bangto), Nakhon Si Thammarat (Khao Luang), Trang (Khao Chong), Yala (Khao Kalakhiri).

Distribution.— Widely distributed in S.E. Asia and Australia, Ceylon (type) to Samoa and Queensland.

Ecology.— On muddy surface of rocks usually in tropical evergreen forest at 300-400 m altitudes.

GPS Location.— 08° 51' 29.38"N 99° 42' 43.17"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 224; P. Ratchata 224 [BCU].

ORDER GLEICHENALES

GLEICHENIACEAE

(J. Presl) C. Presl, Reliq. Haenk. 1: 70. 1825; Holttum, Rev. Fl. Malaya 2: 61. 1954.

Rhizome long-creeping bearing fronds usually at long intervals, the apical part covered with stiff hairs or with scales; vascular strands simple. Fronds usually long, often forming thickets, scrambling or climbing; main rachis bearing opposite pairs of lateral branches, the growth of the rachis arrested during the development of each pair, the apical buds protected by hair or scale and often also by stipule-like leaflets; main rachis-branches, bearing leaflet pinnately arranged; or short, leafless and bearing a pair of branches like the main rachis with arrested terminal buds, the process continued several times and only the ultimate branches leafy; or repeatedly branches with branches below the terminal branch also leafy. Leaflets lobed almost to the costa, short and rounded or long and narrow, with costule and forked free lateral veins. Sori on the terminal veins or not, without indusium. Sporangia with complete oblique annuli, opening by a vertical slit.

KEY TO THE GENERA

1. Vein forked more than once, scales lacking..... **1. Dicarnopteris**
1. Vein simple or once forked; scales present, hair stellate..... **2. Gleichenia**

1. DICRANOPTERIS

Benh., Schrad. Neues J. 1(2): 26, 28. 1806; Tagawa & K.Iwats, Fl. Thailand 3(1): 53. 1979.

Rhizome creeping; fronds pinnate or pseudodichotomous; veins forked at least twice; hairs on young parts of plants multicellular, variously branched, scales wanting; sporangia 8-15 or more in a sorus.

Dicranopteris splendida (Hand- Mazz.) Tagawa, Acta Phytotax. Geobot. 8: 164. 1939; Tagawa & K.Iwats, Fl. Thailand 3(1): 54. 1979.— *Gleichenia splendida* Hand-Mazz., Tard. & C. Chr. in Fl. Gén. I.C. 7(2): 50. 1939. **Fig. 5.5** G-H.

Rhizome long-creeping, densely hairy with shining brown stiff hairs. Stipes c. 50 cm long, stramineous or brown, glabrescent. Pinnae twice forked; ultimate lobes bearing no accessory branches, narrowly oblong c. 30 cm long, 17 cm wide; ultimate segments linear, round to moderately acute at apex, entire and usually flat at margin, c. 24 cm long, 11.5 cm broad; costules 1.4 cm apart; veins pinnate, distinct on both surfaces, texture rigid, green, glabrous, lower surface glaucous. Sori more than one row at each side of costules.

Thailand.— PENINSULAR: Nakhon Si Thammarat (Khao Luang), Krabi (Phanom Bencha).

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

Ecology.— On slope along paths in semi-shaded places of hill evergreen forest at 1,200-1,345 m altitudes.

GPS Location.— 08° 52' 51.02"N 99° 42' 01.86"E, 08° 52' 57.98"N 99° 41' 50.03"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 444: T. Boonkerd 317 [BCU]; K. Yoda 378 [BKF].

2. GLEICHENIA

J. E. Smith, Mem. Acad. Turin. 5: 419. 1973; Tagawa & K. Iwats, Fl. Thailand 3(1): 51. 1979.

Terrestrial perennials; rhizome creeping, bearing peltate scales and stellate simple hairs; the branching system of fronds various; veins all free; sori with 2-5 large sporangia, naked; sporangia with oblique and complete annulus, mixed with simple or forked paraphyses.

KEY TO THE SPECIES

1. Resting buds of primary rachis covered with broad dark pale-fringed scales; leaflet 2-3 cm apart..... **2. G. longissima**
1. Resting buds of primary rachis covered with narrowed pale scales; leaflet 4 cm apart..... **1. G. norrisii**

1. *Gleichenia norrisii* Mett. ex Kun, Linnaea 36: 165. 1869; Holttum, Rev. Fl. Malaya 2: 67. 1955; Tagawa & K. Iwats, Fl. Thailand 3(1): 51. 1979. in Fl. Mal. II. 1: 15. f. 6. 1959. **Fig. 5.6 A-C.**

Rhizome widely creeping, bearing fronds remotely, scaly throughout; scales bright brown, lanceolate, long-acuminate at apex, toothed at margin. Stipes thick, to more than 1 m long, stramineous to pale green, scaly at base with the scales like those on the main axes; rachis scales oblong-lanceolate, concolourously dark brown, hairy; pinnae a few in opposite pairs, bipinnatifid, oblong-lanceolate, acuminate at apex, more than 1 m long, more than 80 cm wide; leaflets up to 21.3 cm long, 2.6 cm wide, shortly stalked, c. 2.5 cm apart, all reflexed, basal leaflets not stipuliform, or with broad blunt lobes; scales on resting buds 3 by 0.5 mm, narrow, brown, with short oblique concolourous setae at margin; lobes narrowly oblong, patent, round to moderately acute at apex, larger ones c. 11 mm long, 3 mm broad, separated by sinus less than 1 mm in width; veinlets once or twice forked, distinct on both surfaces, dark brownish stellate hairs often present on lower surfaces of veins and laminae. Sori dorsal on acroscopic branch of veinlets, round.

Thailand.— CENTRAL: Nakhon Nayok (Khao Yai); PENINSULAR: Nakhon Si Thammarat (Khao Luang).

Distribution.— Malaysia (type), Sumatra and North Borneo.

Ecology.— Forming thicket on mountain slopes along streams in or at edge of hill evergreen at *c.* 1,300 m altitudes.

GPS Location.— 08° 52' 39.83"N 99° 41' 32.91"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 189; T. Boonkerd 316, 1415 [BCU]. M. Tagawa, K. Iwatsuki & N. Fukuoka 4685 ; E. Hennipman 3914 [BKF].

2. *Gleichenia longissima* Blume, En. Pl. Jav.: 250. 1828; Holttum, Rev. Fl. Malaya 2: 67. 1955; in Fl. Malaya. II. 1: 13. f. 4 b-g, 5. 1959. **Fig. 5.6** D-F.

Rhizome widely creeping, bearing fronds remotely, scaly throughout; scales bright brown, lanceolate, long-acuminate at apex, toothed at margin. Stipes thick, to more than 1 m long, stramineous to pale green, scaly at base with the scales like those on the main axes; rachis scales oblong-lanceolate, concolourously dark brown, hairy; pinnae a few in opposite pairs, bipinnatifid, oblong-lanceolate, acuminate at apex, more than 1 m long, more than 80 cm wide; leaflets up to 20 cm long, 3 cm wide, shortly stalked, *c.* 1 mm apart, all reflexed, basal leaflets not stipuliform, or with broad blunt lobes; scales on resting buds 5 mm long, dark brown or nearly black, edges fringed with spreading pale hairs 2 mm wide; stipular leaflets much divided, with narrow acuminate lobes; leaflets close, 3 cm apart, not bent backwards.

Thailand.— NORTH-EASTERN Phrtchabun (Phu Miang); PENINSULAR: Nakhon Si Thammarat (Khao Luang), Krabi (Phanom Bencha).

Distribution.— Throughout Malesia (type from Java), to Polynesia and Australia.

Ecology.— Forming thicket on mountain slopes along streams in or at edge of hill evergreen at 1,100-1,380 m altitudes.

GPS Location.— 08° 52' 41.34"N 99° 42' 08.14"E, 08° 52' 58.08"N 99° 41' 50.15"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 191, 405; T. Boonkerd & R. Polawatn. 68 [BCU].

ORDER SCHIZAEALES

SCHIZAEACEAE

Kaulf., Wesen Farrenkr. 119. 1827; Holttum in Fl. Malaya II. 1: 49. 1959.

Rhizome usually short-creeping with closely-placed fronds, less often wide-creeping or some what erect, the young parts covered with thick septate hairs, structure dorsiventral or radial. Fronds of very varied structure, their branching showing varying gradations from dichotomous to pinnate; veins usually free; sporangia borne on specialized segments of the fronds (sorophores). Sorophores at the ends of veins of fertile leaflets, or in small pinnate groups at the apex of a fronds or of its branches, or confined to special due to subsequent extra-marginal growths, large, borne on short massive stalks or sessile, annulus of a single row of elongate thickened cells, dehiscing on a line from annulus to base.

LYGODIUM

Sw., Schrad. J. Bot. 1800(2): 106. 1801; Tagawa & K. Iwats., Fl. Thailand 3(1): 59. 1979.

Rhizome creeping, hairy but without scals; leaves monostichous, twining, of indefinite growth, the fronds usually a few meters long; primary rachis-branches shot, the apex dormant and covered with hairs, each bearing a pair of secondary branches; secondary rachis-branches bearing leaflets in a pinnate arrangement, or dichotomously branching bearings digitately lobed leaflets; sterile leaflets entire, toothed or lobed; veins free, or reticulate; fertile leaflets fringed along their edges with short narrow lobes, each lobes bearing two rows of sporangia, each attached to a short vein and covered by a small indusium.

KEY TO THE SPECIES

1. Secondary rachis-branches pinnate with pinnate 10-15 pairs of leaflets; axes terete and wingless throughout..... **1. L. polystachyum**
1. Secondary rachis-branches pinnate with a few leaflets; axes winged to some extent..... **2. L. salicifolium**

1. *Lygodium polystachyum* Wall. ex T. Moore, Gard. Chron. 671. 1859; Tardieu & C. Chr. In F. Gén. I.-C. 7(2): 40. 1939; Holttum, Rev. Fl. Malaya 2: 56. f. 10. 1954; in Fl. Males., Ser. II. 1: 46. f. 5c, 8 a-c. 1959; Tagawa & K. Iwats., Fl. Thailand 3(1): 59. 1979.

Rhizome shortly creeping, densely covered with black hairs. **Fronde**s climbing, sometimes more than 3 m in length; stipes 25-40 cm, brown densely hairs throughout, up to 4 mm in diameter, terete, wingless; hairs on stipes as well as on rachis setose, stiff, patent, multicellular, brown or paler, up to 2 mm long; rachis like the upper part of stipes, slender, paler, hairs less dense and short, terete; pinnae numerous, 15-20 cm apart; primary rachis-branches very short, usually 1-2 mm long, the apex densely, covered with brown hairs, dormant but occasionally a little protruding in the lower pinnae; secondary rachis-branches 20 cm long, densely hairy with short unicellular hairs, wingless; leaflets *c.* 7 pairs on secondary branches, with short stalks of 2 mm or so, oblong-subdeltoid, acute to moderately so at apex, subtruncate at base, indistinctly articulated at the junction of stalk and frond part, pinnately lobe to half way, hairy on veins and margin, 7 cm long and 2.5 cm wide at basal widest portion; ultimate lobes round at apex, entire. **Sorophores** narrow, 3-4 mm long, 1.5-2 mm wide; indusia densely covered with long pale hairs.

Thailand.— NORTHERN: Chiang Rai (Doi Tung, Nam Mae Kok), Chiang Mai (Doi Chiang Dao, Huai San, Doi Suthep, Doi Buak Ha, Tha Ko), Lampang, Phitsanulok (Thung Salaeng Luang); NORTH-EASTERN: Phetchabun (Phu Miang); SOUTH-EASTERN: Chon Buri (Si Racha); CENTRAL: Nakhon Nayok; SOUTH-Western: Prachup Khiri Khan (Bang Saphan); PENINSULAR: Chumphon, Surat Thani (Khao Tha Phet, Huai Mut, Ban Don, Ko Tao), Nakhon Si Thammarat (Ronphibun, Lan Saka), Phuket (Thalang), Songkhla (Khao Pak), Trang (Khao Chong), Narathiwat (Bacho).

Distribution.— Assam, Myanmar, South West China (Kwangsi & Yunnan), Indochina and Malaysia (type).

Ecology.— Terrestrial at the margin of tropical evergreen forest about 400-730 m altitudes.

GPS Location.— 08° 51' 37.24"N 99° 42' 40.52"E, 08° 52' 16.05"N 99° 42' 17.94"E

Vernacular.— Kut Khua (กุดเคื้อ), kut kong (กุดก้อง) (Northern); liphao (ลิเหาะ), liphao yong (ลิเหาะยอง) (Peninsular).

Specimens examined.— O. Rattana 19; O. Vannasri 32; C. Hamilton & G. Congdon 4 [BCU]; Ch. Charoenphol, Kai Larsen & E. Warncke 3561; M. Tagawa & I. Yamada T 161 [BKF].

2. *Lygodium salicifolium* C. Presl, Suppl. Tent Pterid.: 102. 1845; Tradieu & C. Chr. In Fl. Gén. I.-C. 7(2): 41 1939; Holttum In Fl. Males., Ser. II. 1: 51. f. 6. 10, 13a-b. 1959; Tagawa & K. Iwats., Fl. Thailand 3(1): 64. 1979. — *Lygodium flexuosum* auct. non (L.) Sw.: Christ, Bot. Tidsskr. 24: 112. 1901; Holttum, Rev. Fl. Malaya 2: 57. f. 10. 1954; p.p. — *Lygodium circinatum* auct. non (Burm. f.) Sw.: Christ, Bot. Tidsskr. 24: 112. 1901; Seidnf., Nat. Hist. Bull. Siam Soc. 19: 85. 1958. **Fig. 5.6 G.**

Rhizome shortly creeping, densely covered with blackish brown hairs. **Fronds** climbing, to various meters tall; stipes stramineous, minutely pubescent, very narrowly winged or with a distinct line as both sides; rachis like the upper part of stipes; 1.2-2 mm diameter; primary rachis-branches very short, up to 4 mm long, the apex dormant, covered with brown hairs; secondary rachis-branches pinnate, with about 4 pairs of leaflets and a terminal usually deeply lobed one; tertiary leaflets oblong-lanceolate, moderately acute at apex, cordate, subhastate or in extreme form 5-lobed at base, minutely dentate at margin, typically 8 cm long, 1.5-2 cm broad; stalks of leaflets distinct but wanting in smaller leaflets, c. 0.9 cm long, with a distinct junction at base of fronds; lamina herbaceous to soft papyraceous, fresh green, almost glabrous on both surfaces except the hairy margin; every axes higher than the secondary rachis-branches with narrow but distinct wings, pubescent throughout, somewhat swollen at every junction. **Sorophores** protruding at margin of tertiary leaflets, 2-3 mm long, about 1 mm broad; indusia glabrous.

Thailand.— NORTHERN: Chiang Rai (Doi Tung, Doi Chang, Nam Mae Kok), Chiang Mai (Doi Chiang Dao, Doi Suthep, Tha Ko), Phrae (Huai Ton Yang, Mae Sai); NORTH-EASTERN: Loei (Phu Luang); EASTERN: Nakhon Ratchasima; CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chantaburi (Makham, Khao Sabap), Chon Buri (Kroeng Kawai, Sai Yok), Prachuap Khiri Khan (Bang

Saphan); PENINSULAR: Surat Thani (Ban Don, Ko Tao), Phangnga (Khao Nang Hong), Nakhon Si Thammarat (Thung Song, Ron Phibun, Khiriwong), Trang (Khao Chong), Phatthalung, Satun (Tarutao), Narathiwat (Bacho Falls, Su-ngai Kolok), Yala (Bannag Sta).

Distribution.— Assam to Yunnan, Indochina, Hainan, Taiwan, throughout Malesia (type from Singapore), southeast to New Guinea and Micronesia.

Ecology.— Terrestrial in light shade in tropical evergreen forest about 500 m altitudes.

GPS Location.— 08° 51' 25.45"N 99° 41' 47.36"E

Vernacular.— Kut khue (กูดค็ือ), Saiphan phi (สายพานผี), U taphao (อุตะเถา) (Northern); Kachot (กะจอด), Kachot nu (กะจอดหนู) (South-eastern); Yan i-phao (ย่านอิเถา) Yan yai phao (ย่านยายเถา) (Peninsular); Libu (ลีบู) (malay/Peninsular).

Specimens examind.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 315: O. Rattana 12: Y. Yuyen 173 [BCU]; M. Tagawa & N. Kitagawa T 3873: T. Smitinand 6447: M. Tagawa & Y. Yamada T 146 [BKF].

ORDER DICKSONIALES

DENNSTAEDTIACEAE

Lots, Vortr. Bot. Stammesgesch 2: 655. 1909; Shieh, Fl. Taiwan vol. 1 2nd ed.: 240. 1980.

Terrestrial. Rhizome slender, creeping or erect, solenostelic or rarely dictystelic, clothed with hairs, Fronds pinnate to pinnately decomposed, not articulate to rhizome; veins free or anastomosing without included free veinlets. Sori terminal on the veins, with a cup-shaped or 2-lipped indusium, or the lower lip lacking, or the other continuous along the margin and on the connecting-veins, protected by the reflexed margin or with double indusium; sporangia developing in gradate or mixed sequence, with almost vertical annuli; spores tetrahedral or rarely bilateral.

KEY TO THE GENERA

1. Sori elongate along margin of lobe, protected by inner indusia wanting
 **1. Histiopteris**
1. Sori round, with submarginal; indusia thin, cup-shaped..... **2. Microlepia**

1. HISTIOPTERIS

(Ag.) J Smith., Hist. Fil.: 294. 1875; Copel., Gen. Fil: 60. 1947; Tagawa & K. Iwats., Fl. Thailand 3(1): 126. 1979.

Rhizome long creeping, solenostelic, covered with thick hairs; stipes long, usually very dark purplish, polished; rachis grooved on upper surface; fronds larger, growing indefinitely at apex, bipinnate to tripinnate, with opposite pinnae and pinnules; herbaceous, usually glaucous beneath; sori submarginal, linear, covered by the reflexed margin of lobes, without inner indusia.

Histiopteris incisa (Thunb.) J. Smith., Hist. Fil.: 295. 1875; Holttum, Rev. Fl. Malaya 2: 391. f. 227. 1955. — *Pteris incisa* Thunb., Prod. Fl. Cap.: 171. 1800. **Fig. 5.6 H.- Fig. 5.7 A.**

Rhizome long-creeping, covered with dark hairs. Stipes long *c.* 1 m or more in length, dark purplish, shining; Fronds quadripinnate, up to 0.78 m or more in length, climbing with well spaced opposite pinnae and pinnules; rachis, costae and costules grooved on upper surface, a pair of reduced stipule-like pinnules usually present at base of each pinnae; pinnae up to 76.8 cm long, 20.7 cm wide; veins copiously anastomosing, rather distinct below. Sori continuous at edge of lobes, linear, submarginal, covered by the reflexed edge of lobes.

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

Distribution.— Pantropic.

Ecology.— On rather dry exposed slopes usually at edges of hill evergreen forest at 1,100-1,380 m altitudes.

GPS Location.— 08° 52' 41.34"N 99° 42' 08.14"E, 08° 52' 58.08"N 99° 41' 50.15"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 200 [BCU]; E. Hennipman 3839; M. Tagawa, K. Iwatsuki & N. Fukuoka T 4632 [BKF].

2. MICROLEPIA

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

Rhizome creeping solenostelic, covered with short hairs. Stipes rather close, hairy. Frond pinnate to pinnately decompose, the ultimate pinnules usually obliquely incised in most cases hairy; axes grooves, grooves decurrent to those of the next order, vein all free. Sori terminal on veins, usually close to margin of lobes; indusia attached by sides and base, rather thin, thus half cup-shaped, often hairy.

KEY TO THE SPECIES

1. Fronds tripinnate, vein on lower surface of lobes distinctly raised, paler than the lamina..... **2. M. strigosa**
1. Fronds tripinnatifid, veins not so distinct on lower surface of lobes **1. M. speluncae**

1. *Microlepia speluncae* (L.) Moore, Ind. fil.: 93. 1857; Tard & C. Chr. In Fl. Gén. I. C. 7(2): 99. 1939; Sledge, Kew Bull. 11: 524. 1956; Holttum, Rev. Fl. Malaya 2: 314. 1955. — *Polypodium speluncae* Linn., Sp. Pl.: 1093. 1753.—*Microlepia speluncae* var. *hancei*. (Prantl) Holttum, Rev. Fl. Malaya 2: 315. f. 182. 1955. —*Microlepia speluncae* var. *villosissima* Holttum, Rev. Fl. Malaya 2: 315. 1955. **Fig 5.7 B-C.**

Rhizome wide-creeping, almost naked in the older part, deep brown, c. 5 mm diameter. Stipes stramineous or brownish, pubescent or glabrescent, 57 cm long, lamina large, tripinnatifid, more than 40 cm long, 41 cm wide; rachis stramineous to brownish, grooved on upper surface, more hairy; larger pinnae oblong-subtriangular,

broadly cuneate at base, broadest at lower second or third pinna, gradually narrowing towards caudately acuminate apex, with more than 19 pinnules, costa grooved on upper surface, more or less hairy, upper pinnae gradually narrowing toward apex, unequally cuneate at base, up to 20.5 cm long, 6.8 cm wide, distinctly stalked, apical secondary pinnules (segment) a little protruding; segments lobed to pinnatisect, oblong to subquadrangular, round to acute at apex, unequally cuneate at sessile base, typically 1 cm long, 6 mm wide; ultimate lobes round or spatulate, round to acute at apex, entire or undulate at margin of larger ones; papyraceous, deep green above, green below, variously hairy. Sori a little within the margin of lobes, small; indusia cup-shaped, hairy.

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

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

Ecology.— Usually on rather dry slopes in exposed areas or in light shade at 450 m altitudes.

Vernacular.— Kut phi (กุดผี), kut yi (กุดยี่), Hora phak kut (โหราผักกุด), (Central); (โชน) (South-western); Neraphusi (นระพูสี) (Pennisular).

GPS Location.— 08° 51' 45.45"N 99° 42' 39.17"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 136: T. Boonkerd, S. Chantanaorapint, W. Khwaiphan 90: T. Boonkerd 792: Y. Yuyen 144 [BCU].

2. *Microlepia strigosa* (Thunb.) Presl, Epim.: 95. 1849; Tard. & C. Chr. In Fl. Gén. I. C. 7(2): 98. 1938; Holttum, Rev. Fl. Malaya 2: 310. f. 177. 1954. — *Trichomanes strigosum* Thunb., Fl. Jap.: 339. 1784. **Fig. 5.7** D-E.

Rhizome wide-creeping, *c.* 3 mm diameter, densely covered with yellow brown setose hairs *c.* 2 mm long. Stipes stramineous or brownish, densely pubescent especially in the grooves on upper surface or glabrescent in older ones, up to 37.7 cm long, lamina bipinnate, or tripinnatifid in larger fronds, *c.* 30 cm or more long, 35 cm wide, ovate-oblong to oblong-lanceolate, acuminate at apex; rachis like the upper part of stipes, distinctly grooved on upper side, the groove not joined to that of pinna-rachis, densely pubescent below; lateral pinnae sometimes more than 20 in pairs, a few lower ones a little reduced or not, the upper ones gradually reducing in size, the largest one straight, ascending, distinctly stalked, linear-subtriangular, gradually narrowing towards long-caudate acuminate apex, cuneate at base, up to 20 cm long, 4.6 cm wide, the largest pinnules oblong to oblong-subdeltoid; oblique, moderately acute at apex, subtruncate anteriorly and very narrowly cuneate posteriorly at base, deeply lobed to pinnatisect, up to 3 cm long, 1 cm wide, sessile or petiolulate; ultimate lobes or round to spatuliform, obscurely undulate at margin; veins pinnate, veinlets forked, distinct on under surface of lobes, paler, hairy, softly chartaceous, deep green above, glabrous except on veins. Sori between the crenae of lobes, submarginal; indusia rather broadly cup-shaped, small, hairy.

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

Distribution.— Himalayas to Ceylon and Polynesia, northwards to Japan (type).

Ecology.— On mountain slopes usually in dense tropical evergreen forest about 450-1,090 m altitudes.

GPS Location.— 08° 51' 30.22"N 99° 42' 07.73"E, 08° 52' 15.28"N 99° 42' 18.07"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 155: T. Boonkerd 693, 1803 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T 3013 [BKF].

LINDSAEACEAE

Pic. Serm., *Webbia* 24(2): 707 -708. 1970; Shieh, *Fl Taiwan* vol. 1. 2nd ed.: 259. 1980.

Terrestrial. Rhizome creeping, clothed with narrow scales or with hairs (or both). Fronds pinnately divided, sometimes very finely, in a few cases simple, not articulated to rhizome; veins free or anastomosing without included free veinlets. Sori marginal or nearly marginal, terminal on the veins, simple (on apices of separate veins) or joined to form a fusion-sori (coenosori) of varying length, upon submarginal soral veins joining the ends of the normal veins; indusium always present, attached by its sides as well as base; sporangia developing in gradate sequence, with vertical annulus.

LINDSAEA

Dryand., *Trans. Linn. Soc.* 3: 39. 1797; Tagawa & K.Iwats., *Fl. Thailand* 3(2): 129. 1985.

Rhizome creeping, terrestrial or climbing covered with hairs or scales. Fronds simply pinnate to bipinnate, usually with dimidiate pinnae or pinnules, veins free or anastomosing, herbaceous to papyraceous, glabrous. Sori usually marginal, terminal on veinlets, joining the apex of veins to form fusion-sori along the margin of lobes; indusia opening outwardly.

KEY TO THE SPECIES

1. Rhizome short, terrestrials
 2. Fronds bipinnate or simply bipinnate fronds together on the same plant. Sori continuous..... **1. L. doryphora**
 2. Fronds all simply pinnate, pinnae more or less quadrangular. Sori discontinuous..... **2. L. lucida**
1. Rhizome long-creeping, climbing on tree-trunks
 3. Sori many, short, on single veins..... **3. L. repens**
 3. Sori continuous towards base, broken only towards apex
..... **4. L. oblanceolata**

1. *Lindsaea doryphora* Kramer, Blumea 15: 566. 1968. — *Lindsaea scandens* Hook var. *terrestris* Holttum, Rev. Fl. Malaya 2: 327. 1955; Tagawa & K. Iwats., Fl. Thailand 3(2): 140. 1985. **Fig. 5.7** F-G.

Rhizome terrestrial, short to rather long-creeping, 2.83 mm diameter, scaly; scales bright brown, up to 1.5 mm long, stiff. **Stipe** stramineous, up to 17.5- 30 cm or more long, usually longer than fronds. **Fronds** usually bipinnate, or rarely with simply pinnate fronds on the same plants, 15-35 cm long, up to 20 cm wide; pinnae up to 2-3 pairs, ascending, oblong, moderately acute at apex, very shortly stalked, 10-20 by 3-5 cm; pinnules 15-20 pairs, dimidiate and crescent-shaped, rounded at upper edge to apex, truncate at acroscopic base and dimidiate and curved at lower edge, 1.5-2.5 cm long, 0.7- 1 cm broad; terminal pinnae like lateral ones, usually large in size, chartaceous; veins all free, more or less visible on both surfaces. **Sori** continuous along margin of lobes on upper edge as well as at apex, a little inside the margin; indusia thin, not reaching the margin of lobes.

Thailand.— PENINSULAR: Satun (Khlung Ton), Surat Thani (Ban Don), Nakhon Si Thammarat (Ronphibun), Narathiwat (Sg. Padi), Yala (Betong).

Distribution.— Myanmar (Tenasserim), Malaya, Borneo (type), West Java and the Philippines.

Ecology.— Terrestrial in tropical evergreen forest at 400-600 m altitudes.

GPS Location.— 08° 51' 37.24"N 99° 42' 40.52"E, 08° 52' 04.31"N 99° 42' 18.59"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 141: T. Boonkerd 1117 [BCU].

2. *Lindsaea lucida* Blume, En. Pl. Jav.: 216. 1828; Tardieu & C. Chr. In Fl Gén. I. – C. 7(2): 122. 1939; Holttum, Rev. Fl. Malaya 2: 328. f. 187. 1954; Kramer in Fl. Males., Ser. II. 1: 233. 1971. Tagawa & K. Iwats., Fl. Thailand 3(2): 142. 1985. **Fig. 5.7 H-Fig. 5.8 A.**

Rhizome very short-creeping, c. 1.5-2.33 mm diameter, bearing stipes close together, scaly near apex, scales very narrow, up to 1 mm long, 0.25 mm broad, brown, shining. **Stipe** brown to castaneous and scaly at base, stramineous or pale-

green and quadrangular in section upwards, 3-7 cm long. **Lamina** simply pinnate, linear, up to 23 by 2.9 cm; rachis like the upper part of stipes; pinnae close, middle ones larger, patent, oblong to oblong-subdeltoid, 1.1 by 6.5 mm, the lower edge straight or curved, inner edge close to rachis, forming cuneate base with lower edge, rounded to moderately acute at apex; upper pinnae gradually becoming smaller, ascending, acute at apex; forming no terminal pinnae, lower ones more remote, smaller, patent or deflexed, herbaceous; veins distinct on both surfaces, free, except those joined by sori. **Indusia** narrow, thin, nearly reaching the margin of pinnae.

Thailand.— EASTERN: Buri Ram (Khao Krap); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chantaburi (Khao Kluea, Makham, Khao Sabap), Trat (Koh Chang, Koh Kut); PENINSULAR: Ranong (Kamphuan), Phuket (Koh Lanta Yai), Satun (Khuan Kalong), Nakhon Si Thammarat (Khao Nan), Narathiwat (Waeng), Yala (Ban Chana, Bacho).

Distribution.— India, Myanmar, Indochina, South China, Malaysia, Sumatra to the Moluccas (type from Java).

Ecology.— On sandy ground near stream in shade in tropical evergreen forest at 600-700 m altitudes.

GPS Location.— 08° 52' 04.31"N 99° 42' 18.59"E, 08° 52' 09.89"N 99° 42' 20.76"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 243: O. Rattana 55 [BCU]; C. Niyomdham 3200 [BKF].

3. *Lindsaea oblanceolata* v. A. v. Ros., Bull. Jard. Bot. Buit. II. 23 : 15. 1916; Tagawa & K. Iwats., Fl. Thailand 3(2): 144. 1985. — *Lindsaea pectinata* auct. non Bl.: Tardieu & C. Chr. in fl. Gén. I. -C. 7(2): 124. 1939. p.p.; Holttum, Rev. Fl. Malaya 2: 324. 1955. **Fig. 5.8** B-C.

Rhizome long-creeping or climbing, 1.5-2.27 mm diameter, bearing stipes 4 cm apart, shining dark brown, scaly throughout; scales narrowly subtriangular, up to 3 by 0.5 mm, entire, brown. **Stipe** up to 7.8 cm, castaneous to base, stramineous and quadrangular in section upwards. **Lamina** simply pinnate, linear or linear-lanceolate, up to 32 by 3.4 cm, gradually narrowing towards both apex and base; pinnae sessile, up to 36 pairs; middle ones larger, oblong or oblong-subdeltoid, up to 16 by 8 mm;

lower edge straight or curved, patent, inner edge close to rachis, forming with lower edge nearly right angles at base, moderately acute to rachis, forming with lower edge nearly right angles at base, moderately acute to rounded at apex, moderately rounded at upper edge, serrate in sterile ones, thin, herbaceous, green, but darker in dried specimens; veins distinct on both surface, all free except those joined by sori. Sori continuous along upper edge, placed a little inside the margin; indusia thin, not reaching the very margin of pinnae.

Thailand.— PENINSULAR: Surat Thani (Khao Luang), Nakhon Si Thammarat (Khao Luang), Yala (Gunung Ina).

Distribution.— Annam and Malesia throughout (type from Sumatra).

Ecology.— Terrestrial on humus-rich floor of forest, on rotten wood or mossy on trunks in hill evergreen forest at 1,200-1,380 m altitudes.

GPS Location.— 08° 52' 51.02"N 99° 42' 01.86"E, 08° 52' 58.08"N 99° 41' 50.15"E

Specimens examined. — T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 465: P. Sukkaruk 318 [BCU].

4. *Lindsaea repens* (Bory) Thwaites & Hook., En. Pl. Zeyl.: 388. 1864.; Tardieu & C. Chr. in fl. Gén. I. –C. 7(2): 120. 1939. Tagawa & K. Iwats., Fl. Thailand 3(2): 143. 1985. —*Lindsaea repens* Bory, Voy. 2: 323. 1804. — *Lindsaea macraeana* (Hook. & Arn.) Copel. Holttum, Rev. Fl. Malaya 2: 324. f. 185. 1955.

var. **pectinata** (Blume) Mett. ex Kun, Ann., Mus. Bot. Lugd. Bat. 4: 277. 1869; Kramer, Blumea 15: 568 et 11. cc. — *Lindsaea pectinata* Blume, En. Pl. Jav.: 217. 1828, not of later authors. **Fig. 5.8 D.**

Rhizome long-creeping or climbing, 1.2-1.8 mm in diameter, bearing stipes 2-4.4 cm apart, brown; scales linear c. 2 mm long, 3 mm broad, entire, brown, more or less shining. **Stipe** brown in lower and stramineous in upper parts, 1-2 cm long, quadrangular in section except for the basal portion. **Lamina** simply pinnate, linear, gradually acuminate at apex, gradually narrowing towards base, c. 15-27 by 2.5-6.5 cm; rachis pale green in upper part; pinnae closed up to 24 pairs, sessile, middle ones the largest, slightly oblique, quadrangular of gradually narrowing towards apex,

almost straight and entire at lower edge, inner edge straight, close to rachis, forming narrowly cuneate base with lower edge, rounded at apex, serrate at upper edge, upper pinnae smaller and more spaced, deflexed; each serration at margin including a single veinlet, herbaceous; veins a few times forked, visible on both surfaces, free except those united by sori. Sori usually of single veinlet, or joining of lobes, up to 1-2 mm long; indusia narrow, membranous, hidden under sori at maturity.

Thailand.— EASTERN: Buri Ram (Khao Krap); PENINSULAR: Surat Thani (Ban Don), Nakhon Si Thammarat (Khao Luang), Trang (Khao Chong).

Distribution.— Mascarenes (type), tropics of Asia and Oceania to Hawaii, north to Sikkim and Assam, south to Queensland.

Ecology.— Climbing on trees in dense evergreen forests usually at 1,200-1,380 m altitudes.

GPS Location.— 08° 52' 51.02"N 99° 42' 01.86"E, 08° 52' 58.08"N 99° 41' 50.15"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphon 225, 464; O. Wannasri 45 [BCU]; P. Suvarnakoses 609 [BKF].

ORDER CYATHEALES

CYATHEACEAE

Kaulf., Wesen Farrenkr. 119. 1827; Holttum, Rev. Fl. Malaya 2: 115.1954.

Rhizome erect, forming a massive trunk in most species, when old covered with a mat of black interlacing roots; apex of trunk and trunk bases of stipes covered more or less densely with scales. Stipes scaly at least near the base and when young, the bases of stipes closely arranged round the apex of the trunk. Fronds large, usually bipinnate, more or less deeply tripinnatifid, simply pinnate, more or less scaly on rachis and costae; costules of pinnules-lobes nearly at right angles to the costae, their veins strictly pinnate, simple or forked. Sori on the veins, the sporangia attached to a small raised receptacle, often mixed with hairs, without indusium or with a thin cup-shaped indusium which completely enclosed the sorus when young; sporangia with complete oblique annulus.

CYATHEA

Smith, Mem. Ac. Turin 5 (1793) 416; Holttum, Fl. Malesiana. II. 73. 1982.

Trunk always erect, short or tall. Scales present on lower and lateral surfaces of axes of frond, at least in early stages of growth, larger ones on stipe and rachis sometimes borne on spine-like outgrowths; hairs always on upper surfaces of all but smallest axes, antrorse, sometimes branched; hairs of various kinds sometimes on lower surfaces of axes and vein, rarely on lamina between veins. Fronds elliptical, lower pinnae always smaller than middle ones, sometimes gradually much reduced and than the stipe short; pinnae normally pinnate-bipinnatifid; pinnules almost symmetrical at the base, many on each pinna subequal, distal ones more or less abruptly decreasing; upper surface of pinna-rachis and costa raised; veins simple or branched, lower ones usually once forked, sometimes pinnate where pinnule-segment are deeply lobed. Sori usually at the fork of a vein, or seated on a simple vein, a branch of the vein always entering the receptacle and covering young sorus, opening to form a firm-edged cup or opening by irregular rupture, or attached on costular side of receptacle and of varying size, in some cases quite hidden by mature sorus, or lacking; receptacle erect, club-shaped to spherical.

KEY TO THE SPECIES

1. Stipe glaucous, Pinnules of base slightly unequal, subtruncate occasionally slightly auricled on upper side..... **1. C. glabra**
1. Stipe not glaucous, pinnae rather thin, less deeply cuneate
 2. Stipe with very short spines, lower pinnae slightly reduced; Sori close to costules indusia small..... **3. C. latebrosa**
 2. Stipe without spines, lower pinnae more reduced; Sori with cup-shaped indusia **2. C. hymenodes**

1. *Cyathea glabra* (Blume) Copel. Philip. J. Sc. 4 (1909) bot. 35; Holttum, Gard. Bull. S.S. 8 (1935) 316; Rev. Fl. Mal. 2: 127. 1954. — *Gymnoshaera glabra* Blume, Enum. Pl. Jav. 242. 1828. **Fig. 5.8** E-F.

Stipe dark purplish or glaucous, with roughened at base; scales fairly numerous but soon deciduous, scales 2.25 by 0.1 cm, dark with pale irregular edges; rachises dark to medium purplish brown, 40 cm long, sometimes much reduced, especially on young lowland plants. **Fronde** included middle pinnae to 1 by 0.8 m; pinnules of middle pinnae to 37 by 17 cm and occasionally smaller; on stalks 2 mm long, base slightly unequal, broadly rounded or subtruncate, occasionally slightly auricled on upper side, apex rather shortly narrowed and broadly toothed, edge subentire or slightly lobed, occasionally lobed as much as ¼ way the costa; lobes where present usually c. 3 mm wide at base, rounded, almost entire; veins 4 pairs, usually all simple, the basal vein on the side towards the pinna-rachis not usually springing directly from the costa (occasionally so towards apex of pinnule); texture thin but firm; scales on costae; scales at base of costae narrow, dark, with pale edges, sometimes with a few setae; scales on costules very small, narrow, with usually pale setae on margins; no bullate scales. **Sori** in one or more series on either side of costae, those on each vein-group being disposed in two close almost parallel rows, round, not or only slightly converging towards the margin; no indusia.

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

Distribution.— Western Malaysia (eastern limit uncertain).

Ecology.— Terrestrial semi-shade slope on humus-rich mountain slopes in hill evergreen forest at 1,000-1,385 m altitudes.

GPS Location.— 08° 52' 36.19"N 99° 42' 13.85"E, 08° 52' 58.08"N 99° 41' 50.15"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 429, 484 [BCU]; K. Larsen et al. 46011 [BKF].

2. *Cyathea hymenodes* Mett. Ann. Mus. Bot. Lugd-Bat. b. 57 : 1863. — *Cyathea ampicosmioides* v. A. v. R. Bull. S.S. 8. 305. 1935; Rev. Fl. Mal. 1.121: 1954. **Fig. 5.9** A-B.

Stipe not spiny, sometimes with a pair of short pinnae near base; scales 10 by 0.5 mm, dark, fragile edges soon disappearing. **Scale** and hairs: short crisped hairs more or less abundant on distal part of lower surface of pinna-rachis; scales near bases of costae elongate, usually entire but sometimes with a marginal seta, grading to

bullate scales distally bullate scales on costules, often deciduous from fertile pinnules; upper surface of costae always hairy. **Lamina** bipinnatifid, lower pinnae more reduced; longest 14.5 cm long, largest pinnules sessile, 18 by 7 mm, lowest segment almost free and often separated from next by a narrow wing along costa, rest of pinnule lobed almost to costa; costules 8 mm apart; lamina-segments rather thin, less deeply cuneate (lowest sometimes deeply lobed); vein forked, papyraceous. **Sori** near costules; indusium an almost circular brown disc about as wide as base of sorus, its edge entire, often somewhat asymmetric about the receptacle swollen, paraphyses short, apical ones sometimes flat at the base.

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

Distribution.— Malaysia: Sumatra, Malay Peninsular.

Ecology.— Terrestrial semi-shade slope on humus-rich in tropical evergreen forest and hill evergreen forest at 600-1,364 m altitudes.

GPS Location.— 08° 52' 04.31"N 99° 42' 18.59"E, 08° 52' 36.19"N 99° 42' 13.85"E, 08° 52' 58.08"N 99° 41' 50.15"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 242; T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 498 [BCU]; C. Niyomdham & P. Puudjaa 6547; David J. Middleton et al. 2701 [BKF].

3. *Cyathea latebrosa* (Wall. ex Hook.) Copel., Phil. J. Sci. 4: 52. 1909; Tradieu & C. Chr. in fl. Gén I. –C. 7(2): 85. 1939; Holttum, Rev. Fl. Malaya 2: 120. f. 48. 1995; Fl. Malesiana. II. 1: 115. 1963; Kew Bull. 19: 472. 1965; Tagawa & K. Iwats., Southeast As. St. 5: 45. 1967; Tagawa & K. Iwats., Fl. Thailand 3(2): 143. 1985. — *Alsophila latebrosa* Wall. ex Hook., Sp. Fil. 1: 37. 1844. **Fig. 5.9 C-D.**

Trunks 3-5 m or more tall. **Stipes** 30-40 cm long, with very short spines, yellowish brown to darker, scaly at base; scales linear, to 2 cm long, 1.2 mm broad, dark brown, shining, stiff, the edges paler, ferruginous; pneumathodes in a single row, separated or continuous, smooth, glabrescent or hairy on upper surface; lower pinnae reduced to 10 cm long, irregular in form, rather distant, larger pinnae c. 40 cm long, 14 cm wide, narrowly oblong, caudately acuminate at apex; pinna-rachis warty beneath hairy and sparsely scaly on upper surface; pinnules more than 25 pairs, larger ones c. 1.6 cm apart, oblong-lanceolate, gradually narrowing towards acuminate apex,

surface; pinnules more than 25 pairs, larger ones c. 1.6 cm apart, oblong-lanceolate, gradually narrowing towards acuminate apex, subtruncate at base, sessile, to 7 cm long, 1.7 cm wide, lobed nearly to costa; lobes oblique, falcate, round at apex, entire or slightly serrate at margin, to 1 cm long, 3 mm broad; costae hairy on upper surface, costae and costules scaly beneath with elongate, flat, brown scales in basal part, with pale bullate scales in distal part; texture papyraceous, deep green, paler beneath, veins forked or distal one simple. **Sori** close to costules; indusia small; scales at costular side of receptacle, hidden by mature sori.

Thailand.— NORTHERN: Chiang Mai (Doi Suthep); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao), Trat (Koh Chang); PENINSULAR: Chumpon (Thasan), Nakhon Si Thammarat (Khao Luang) Trang (Khao Chong, Khao Sung), Narathiwat (Sg. Padi), Yala (Muang Wieng, Khao Kalakhiri).

Distribution.— Cambodia, Hainan, Malaysia (type), Sumatra and Borneo.

Ecology.— On mountain slopes usually in dense tropical evergreen forest up 500 m altitudes.

GPS Location.— 08° 51' 23.67"N 99° 41' 48.28"E

Vernacular.— Kut ton (กูดตัน), Kut phrao (กูดพร้าว) (Northern); Maha sadam (มหาสดำ) (South-eastern).

Uses.— Fibrous trunk used for orchid media.

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 242: T. Boonkerd, S. Chantanaorapint, W. Khwaiphan, 498 [BCU]; K. Iwatsuki & N. Fukoka, T. Smitnand 923 [BKF].

ORDER PTERIDALES

ADIANTACEAE

Newman, Hist. Brit. Fern 5. 1840; Shieh, Fl. Taiwan vol. 1. 2nd ed.: 302. 1980.

Terrestrial ferns. Rhizome erect, oblique or creeping, solenostelic or dictyostetic, clothed with either hairs or narrow brownish scales. Fronds uniform or rarely subdimorphic, 1-4-pinnate or pedate, rarely simple, not articulate to rhizome;

vein free or rarely anastomosing without included free veinlets. Sori superficial, linear, following the course of veins, exindusiate or close to the margin, borne along the apical part of fertile veins on the underside of the sharply reflexed discoloured membranaceous or coriaceous leaf-margin, which protects the sori as a false indusia; sporangia with a vertical annulus, developing in mixed sequence; spores tetrahedral.

KEY TO THE GENERA

1. Sori protected by and born on reflexed margin of leaflets..... **1. Adiantum**
 1. Sori forming a broad band midway between costa and margin of pinna.. **2. Taenitis**

1. ADIANTUM

L., Sp. Pl.: 1094. 1753; Tagawa & K. Iwats., Fl. Thailand 3(2): 206. 1985.

Rhizome creeping to erect, scaly with small scales. Stipes not jointed to rachis. Fronds simple to pinnately decomposed or pedate, usually with dimidiate or flabellate leaflets; soft to papyraceous, glabrous or hairy, rarely glaucous beneath; vein free or rarely anastomosing. Sori along veins on inner face of reflexed marginal flaps (false-indusia), thus protected between this flap and laminar surface; spores tetrahedral.

Adiantum latifolium Lam., Encycl. 1: 43. 1783. Mickel and Beitel Pteridophyte Fl. of Oaxaca, Mexico. 3. 24. f. 41-D. 1988. **Fig. 5.9** E.

Rhizome long-creeping c. 2 mm in diameter, scaly at apex; scales linear-lanceolate, 1.5 by 0.5 mm, entire to sparsely, light brown which thick, dark brown edge. **Stipe** to 20 cm long, blackish-purple, glabrous or sparsely scaly at upper portion. **Lamina** grooved, subglabrous with pectinate scales, dentate-oblong, up to 18.5 by 15 cm, bipinnate pinnae 1-4 pairs, alternate, terminal pinnule confirm, basal pinnules reduced, short-stalked; lateral pinnae 10 by 4 cm, lateral pinnules 2.2 by 1.8 cm, tip acuminate, rachis hairy on both surface, each including 4 veinlets; papyraceous. **Sori** linear on upper and outer edges, 2-5 mm long; indusium glabrous.

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

Distribution.— Choapan, Ixtlán, Jamiltepec, Juchitán, Tehuantepec, Tuxtepec, Villa Alta; Mexico.

Ecology.— Terrestrial semi-shade in tropical evergreen forest at 500 m altitudes.

GPS Location.— 08° 51' 23.67"N 99° 41' 48.28"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 508; O. Rattana 26; T. Boonkerd 1188 [BCU].

2. TAENITIS

Willd. ex Spr., Ani. Kennt. Gew. 3:374. 1804; Tagawa & K. Iwats., Fl. Thailand 3(2): 186. 1985.

Rhizome creeping, the apex covered with black bristles. Stipes darker, grooved above. Fronds simply pinnate with terminal pinnae similar to lateral; pinnae simple, entire, papyraceous to coriaceous, glabrous; veins reticulate to form areoles without included free veinlets. Sori on a narrow longitudinal band about half-way between midrib and margin, exindusiate; paraphyses abundant, multicellular.

Taenitis blechnoides (Willd.) Sw., Syn. Fil.: 24, 220. 1806; Tardieu & C. Chr. in Fl. Gén. I. -C. 7(2) : 134. f. 16, 3-4. 1939; Holttum, Rev. Fl. Malaya 2 : 586. f. 346. 1954; Blumea 16: 89. f. 1. 1968; Seidenf., Nat. Hist. Bull. Siam Soc. 19: 87. 1058; Tagawa & K. Iwats., Fl. Thailand 3(2): 193. 1985. — *Pteris blechnoides* Willd., Phytogr.: 13. t. 9. f. 3. 1794. **Fig. 5.9 F.**

Rhizome creeping, c. 2-3 mm in diameter, covered with bristles in apical portion; bristles dark brown to nearly black, shining, stiff, c. 2 mm long. **Stipes** stramineous to green upwards, castaneous in lower part, glabrous in larger plant 37-70 cm long. **Lamina** simply pinnate, or simple one, 20-45 by 20 cm; grooves of rachis decurrent to that on costae; lateral pinnae 3-5 pairs, alternate at apex, very narrowly cuneate at base, stalked, entire or slightly undulate at margin, 14-30 by 2-3 cm in fertile pinnae; sterile pinnae broader, up to 3.5 cm broad; costa distinctly raised on lower surface, sunken on upper surface; veins copiously reticulate without included veinlets; texture thickly papyraceous to chartaceous, glabrous. **Sori** midway between costa and the margin of pinna, rarely interrupted, 1.5 mm in breadth.

Thailand.— NORTHERN: Phitsanulok (Salaeng Haeng); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi (Khombang, Makham, Khao Sabap), Trat (Huai Raeng, Koh chang); PENINSULAR: Chumphon (Tha Ko), Surat Thani (Koh Tao, Khao Ram, Ban Don), Nakhon Si Thammarat (Thung Song, Khao Soon, Chawang), Narathiwat (Su-ngai Padi), Yala (Ka Hat, Bannang Sta), Ranong (Nam Chuet, Koh Surin), Phuket (Koh Pu), Trang (Khao Chong), Satun (Khuan Kalong, Koh Adang).

Distribution.— Tropics from Ceylon to Fiji (type from South India).

Ecology.— Terrestrial by stream in tropical evergreen forest about 400-600 m altitudes.

GPS Location.— 08° 51' 37.24"N 99° 42' 40.52"E, 08° 52' 04.31"N 99° 42' 18.59"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 9, 319; O. Vannasri 61 [BCU]; K. Iwatsuki & N. Fukuoka T 7390 [BKF].

PTERIDACEAE

E. D. M. Kirchn., Schul-Bot. 109. 1831; Shieh, Fl. Taiwan vol. 1.2nd ed.: 281. 1980.

Rhizome creeping or erect, covered with hairs or scales. Lamina varied from small to very large; veins free, or anastomosing with a row of costal areoles without free veins in areoles. Sori elongate along margin of pinnae or sporangia covered the whole lower of fertile pinnae.

KEY TO THE GENERA

1. Sporangia in linear sori along margin of fronds..... **1. Pteris**
1. Sporangia coenosori, covering the whole undersurface of fronds... **2. Stenochlaena**

PTERIS

L., Sp. Pl.: 1073. 1753; Tagawa & K.Iwats., Fl. Thailand 3(2): 231. 1985.

Rhizome usually short, erect or creeping, scaly; scales usually small, concolorous or bicolored with pale ferruginous edges. Stipes, rachis and costae distinctly grooved on upper surface, the edge distinct, usually spinose on costae, the

grooves decurrent into those in the next order. Fronds in the most cases bipinnatisect in opposite pairs, or in some cases simple, pinnate, tripartite, each basal commissure, basal branches sometimes arising directly from costae. Sori continuous along margin of ultimate segments, indusiate; indusia formed by reflexed margin of lobes or pinnae, usually transparent, glabrous.

KEY TO THE SPECIES

1. Frond distinctly dimorphic, pinnae of sterile frond deeply lobed..... **2. P. ensiformis**
1. Frond hardly dimorphic
 2. Vein forming a regular series of narrow areoles on either side of the costae
..... **1. P. biaurita**
 2. Vein all free except those united apically by soral commissure
 3. Pinnae deeply lobed
 4. Basal pinnae with a pinnatisect branch almost the same as second pinna; plant medium..... **3. P. grevilleana**
 4. Basal pinnae deeply bipinnatisect-bipinnate; plant large
..... **4. P. mertensioides**
 3. Pinnae at most toothed, each basal pinna with one basisopic branches like pinnae..... **5. P. scabripes**

1. Pteris biaurita L., Sp. Pl.: 1076. 1753; Tardieu & C. Chr. In Fl. Gén. I. –C. 7(2): 159. 1940; Holttum. Rev. Fl. Malaya 2: 407. f. 237. 1954; Tagawa & K. Iwats., Fl. Thailand 3(2): 237. 1985. **Fig. 5.9 G - Fig. 5.10 A.**

Rhizome short, erect, bearing a few fronds in a tuft, densely scaly at apex; scales up to 3-5 by 0.5 mm, nearly black margined by pale ferruginous edges with toothed margin. **Stipe** 30-50 cm long, dark brown and scaly at apex, deeply bipinnatifid 30-60 cm or more in length, c. 20-30 cm wide. **Pinnae** opposite or nearly so, c. 6-12 pairs, straight, ascending, linear-lanceolate, broadly cuneate at base, gradually narrowing towards acuminate apex, c. 12.3-20 by 3.2-5 cm, deeply lobed to 5/6 way towards costa, basal pinnae bearing a long basisopic pinnule just like lateral ones; ultimate segments oblong, falcate, rounded or moderately acute at apex, with rounded sinus, up to 7 mm broad, firm green, glabrous; basal veinlets uniting with

those of opposite groups forming arches close to costa, bearing a few branches on posterior side, the other veinlets forked, all free. **Sori** marginal, usually continuous along segments except at bottom of sinus and at apex; indusia thin, pale.

Thailand.— NORTHERN: Chiang Rai (Mae Lao, Doi Tung, Mae Kok, Pang Kia, Doi Pacho), Chiang Mai (Doi Phahom Pok, Doi Chiang Dao, Wang Tao, Doi Suthep, Ban Mae Kom, Ban Nong Lu, Ban Yang), Lamphun (Doi Khun Tan), Phetchabun (Phu Miang), Tak (Huai Krasa, Mae Sot, Doi Musoe, Lan Sang); NORTH-EASTERN: Chon Buri (Si Racha), Chantaburi (Khao Sabap), Trat (Koh Chang); SOUTH-WESTERN: Kanchanaburi (Wangka, Sai Yok, Kroeng Kawia); PENINSULAR: Surat Thini (Khao Luang), Trang (Khao Chong).

Distribution.— Pantropic (type from tropical America).

Ecology.— On mountain slopes in light shade or in tropical evergreen forests at 600-700 m altitudes.

Vernacular.— Kut hang khang (กุดหางค่าง) (Northern); Phank kut khon khang phaya nak (ผักกูดขนคางพญานาค) (South-western).

GPS Location.— 08° 52' 04.31"N 99° 42' 18.59"E, 08° 52' 09.89"N 99° 42' 20.76"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphon 215, 474; T. Boonkerd 641 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T 6983 [BKF].

2. *Pteris ensiformis* Burm. f., Fl. Ind.: 230. 1768; Tardieu & C. Chr. In Fl. Gén. I. – C. 7(2): 149. 1940; Holttum, Rev. Fl. Malaya 2: 399. f. 231 1955; Tagawa & K. Iwats., Fl. Thailand 3(2): 234. 1985. **Fig. 5.10 B.**

Rhizome short-creeping, bearing rather close fronds. *c.* 3.5-5 mm diameter., densely scaly; scales up to 4 by 0.7 mm, lanceolate with long tail, brown, entire. Frond distinctly dimorphic. **Sterile frond:** stipe 7-15 cm long, brown and scaly at base, stramineous upwards, grooved on abaxial surface; lamina oblong, acute at apex tripinnatifid, *c.* 15-19.2 by 7-9.5 cm, pinnae 2-5 pairs, opposite, with a few pairs of pinnules and large apical segments; pinnules simple to trifoliolate, the ultimate segments oblong to oblong-lanceolate, apex moderately acute or acuminate in larger

ones, 7 by 0.9 cm, minutely serrate at margin; veins ascending, forked, all free, firm, green. **Fertile frond** taller: stipe 20-24.2 cm long; lamina bipinnate at base, 24-30 by 15-20 cm, pinnae a few pairs, simple to trifoliolate, ultimate segment linear, 7-17 by 0.5-1 cm caudately acuminate at apex, broadly cuneate to subtruncate at base, serrate at upper non-soriferous margin. **Sori** linear, submarginal, continuous almost from base to apex; indusia pale green.

Thailand.— NORTHERN: Chiang Mai (Doi Suthep, Kaeng Ka), Lampang, Tak (Lan Sang, Ban Na); NORTH-EASTERN: Loei (Phu Luang, Phu Kadueng), Kon Kaen (Pha Nok Khao), Nakhon Phanom; SOUTH-EASTERN: Chon Buri (Sri Racha) Rayong (Ban Phe), Chantaburi (Pong Nam Ron), Trat (Koh Chang); SOUTH-WESTERN: Uthai Thani (Kaen Pradu), Kanchanaburi (Klang Dong, Sai Yok) Prachuap Khiri Khan (Bang Saphan); PENINSULAR: Chumphon, Surat Thani (Koh Tao, Koh Samui), Phattalung, Nakhon Si Thammarat (Khao Luang, Chawang), Phangnga (Koh Talibong, Khao Thong Thai), Krabi (Khao Nang Hong, Trang (Khao Chong), Satun, Yala (Bannang Sata).

Distribution.— Tropics of Old World, Ceylon (type) to Australia and Polynesia throughout Malesia, north to India, South China, Indochina and the Ryukyus.

Ecology.— On mountain slopes or on floor of usually tropical evergreen forests at 600-700 m altitudes.

GPS Location.— 08° 52' 04.31"N 99° 42' 18.59"E, 08° 52' 09.89"N 99° 42' 20.76"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 203, 247; T. Boonkerd 1156 [BCU].

3. *Pteris grevilleana* Wall. ex J. Agardh, Rec. Pterid: 23 1839; Tardieu & C. Chr. In Fl. Gén. I. -C. 7(2): 153. 1940; Holttum, Rev. Fl Malaya 2: 402. f. 235. 1954; Tagawa & K. Iwats., Fl. Tailand 3(2): 247. 1985.

Rhizome short, erect, scaly at apex; scales small, c. 1.5-3 by 0.3-0.5 mm, dark brown, entire. **Frond** dimorphic. **Sterile frond**: stipe shining, deep purple to pale castaneous, glabrescent upwards, 8-14.6 cm long, narrowly winged in upper portion; lamina ovate in outline, c. 9-15 by 5-10 cm, each consisting in a terminal pinna deeply

lobed to 4/3 way towards midribs, acute at apex, cuneate and decurrent at base continuing to wings of stipes, c. 8-10 by 3.3 cm, lateral pinnae narrower, up to 7 by 2.5 cm, rounded to cuneate, the basispic projection c. 3-4 by 1.5 cm; pinnules or ultimate lobes oblong, rounded at apex, serrate at margin, up to 6 mm wide, deep green; veins forked, hardly visible. **Fertile frond** taller: stipe 18.5-30 cm long; lamina like sterile one, larger, c. 6.5-10 by 7.9-14 cm. **Sori** continuous along margin of lobes except at apex and at sinus; indusia pale brown, thin.

Thailand.— NORTHERN: Phitsanulok (Huai Ya, Tung Salaeng Luang); NORTH- EASTERN: Loei (Phu Luang); CENTRAL: Nakhon Nayok (Khao Yai); PENINSULAR: Surat Thani (Ban Don), Nakhon Si Thammarat (Khao Luang).

Distribution.— India(type) to South China and West Malesia, north to Taiwan and the Ryukyus.

Ecology.— On humus-rich mountain slopes in tropical evergreen forest at 400-600 m altitudes.

GPS Location.— 08° 51' 37.24"N 99° 42' 40.52"E, 08° 52' 04.31"N 99° 42' 18.59"E

Vernacular.— Ya rang kai (หญ้างวงไก่) (Penisular).

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 381, 510 [BCU].

4. *Pteris mertensioides* Willd., Sp. Pl. 5: 394. 1810; Holttum, Rev. Fl. Malaya 2: 404. 1955; Tagawa & K. Iwats., Fl. Thailand 3(2): 253. 246. f. 245. 4. 1985. **Fig. 5.10** C-D.

Rhizome short, ascending, scaly; scales up to 10 by 0.5 mm, dark brown, more or less waved and curled up, sharply toothed at margin. **Stipe** stout, densely scaly and warty at base, puberulous or glabrescent upwards, up to 70 cm or more in length. **Lamina** up to 1 m or more long, 65 cm wide, deeply bipinnatisect to bipinnate; lateral pinnae nearly opposite, up to 15 or more pairs, linear-lanceolate, up to 45 by 4-8 cm. basal pinnae bearing large basispic pinnules; rachis and costa castaneous to purplish, grooved on upper surface, hairy beneath; pinnules lanceolate, moderately acute to acute at apex, adnate at base decurrent to the next one with wings

of costa less than 1 mm broad, or free in large one, up to 50 by 7 mm, papyraceous to softly chartaceous, green; veins usually twice forked, distinct on both surfaces. **Sori** continuous nearly all the margin of pinnules except at apex and sinus; indusial narrow, pale, thin.

Thailand.— PENINSULAR: Chumphon (Phato), Surat Thani (Ban Kop Kaep), Nakhon Si Thammarat (Khao Luang), Ranong (Muang Wing), Yala (Kuala Badong, Betong, Ban Chana).

Distribution.— Ceylon, South India, Malesiana (type from Amboina) to Polynesia.

Ecology.— On damp slopes in tropical evergreen forests at 500-600 m altitudes.

GPS Location.— 08° 51' 23.67"N 99° 41' 48.28"E, 08° 52' 04.31"N 99° 42' 18.59"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 152, 276, T. Boonkerd 1130; A. Sthapattayanon 112 [BCU].

5. *Pteris scabripes* Wall. ex Ag. Rec. Pterid.: 11. 1839; Holttum, Rev. Fl. Malaya 2: 399. f. 233. 1954. Tagawa & K. Iwats., Fl. Thailand 3(2): 253. 1985. f. 20. 4. Fig. 5.10 E-F.

Rhizome short, erect; scales *c.* 2-5 mm long, thin but firm, deep brown. **Stipe** dark castaneous to deep purplish, sparsely scaly at base, puberulous upwards, 15-35 cm long on sterile frond, *c.* 33.4-50 cm on fertile one. **Lamina** with one or two opposite pairs of lateral pinnae and trifoliolate apical pinna; lateral pinnae simple, forked or trifoliolate, sessile or adnate, simple pinnae or branches linear-lanceolate, gradually narrowing towards base, caudately long-acuminate at apex, finely dentate at margin, the dentation evident at apical margin, in sterile 16.1-18 by 1.5 cm, in fertile 14.8-22 by 1 cm; rachis usually winged by the decurrent base of lamina, subcoriaceous, deep green; veins forked, nearly patent, close. **Sori** continuous along margin of long pinnae or pinnules; indusia pale brown, thin.

Thailand.— SOUTH-EASTERN: Chon Buri (Si Racha); PENINSULAR: Surat Thani (Koh Tao, Ban Don), Nakhon Si Thammarat (Khao Luang), Narathiwat (Bacho Falls).

Distribution.— Malaya (type).

Ecology.— On rocky mountain-slopes in tropical evergreen forests at 460-600 m altitudes.

GPS Location.— 08° 51' 53.63"N 99° 42' 35.24"E, 08° 52' 04.31"N 99° 42' 18.59"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 486; T. Boonkerd, Y. Sirichamorn and C. Sanguansab 145; T. Boonkerd 118; Ch. Apasutaya 173 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T 4497; K. Yoda 514; E. Hennipman 3796 [BKF].

2. STENOCHLAENA

J. Smith, J. Bot. 3: 401. 1841; Tagawa & K. Iwats., Fl. Thailand 3(2): 259. 1985.

Climbing plants; Rhizome creeping, green, scaly only at apex, scales peltate, with uneven margin. Stipes not jointed to rachis. Lamina simply pinnate, distinctly dimorphic; lateral pinnae jointed to rachis, sterile ones toothed at margin; fertile ones narrow. Linear, with sporangia covering the whole undersurface; texture coriaceous; veins forming costal areoles, other veins free.

Stenochlaena palustris (Burm. f.) Bedd., Ferns Br. Ind. Suppl.: 26. 1876; Holttum, Rev. Fl. Malaya 2: 412. f. 241. 1955; Tagawa & K. Iwats., Fl. Thailand 3(2): 259. 1935. — *Polypodium palustre* Burm. f., Fl. Ind.: 234. 1768. **Fig. 5.10** G-H.

Rhizome long-creeping, climbing on tree-trunks, green, scaly at apex; scale peltate at base, gradually attenuate at apex, with uneven margin. **Stipe** c. 33 cm long, sparsely scaly at base. **Lamina** imparipinnate, about 60-80 cm long, bearing pinnae 9-16 pairs and a similar terminal pinna, alternate at lower portion and subopposite at upper portion. **Sterile pinnae** shortly stalked, articulate, c. 20 by 2-2.5 cm, but variable in size, acuminate at apex, broadly cuneate at base, pellucid at sharply and irregularly serrate margin; texture papyraceous to coriaceous; shining above, the lower paler than the upper; veins simple or forked, forming a row of narrow costal areoles. **Fertile pinnae** c. 20 by 2 mm, with sporangia on the whole lower surface.

Thailand.— NORTH-EASTERN: Loei (Ban Na Luang); CENTRAL: Bangkok; SOUTH-EASTERN: Chanthaburi (Makham, Pong Nam Ron), Trat (Koh Chang); PENINSULAR: Surat Thani (Ban Don, Koh Tao), Nakhon Si Thammarat (Khao Luang), Krabi (Ao Luk), Trang (Khao Chong).

Distribution.— North and South India (type), Indochina, throughout Malesia and Polynesia to Australia.

Ecology.— Climbing on tree-trunks along stream in tropical evergreen forest 500 m altitudes.

GPS Location.— 08° 51' 23.67"N 99° 41' 48.28"E

Vernacular.— Prung suan (ปรุงสวน), Phak kut daeng (ผักกูดแดง), Phak kut mon (ผักกูดมอญ), Phak yot daeng (ผักยอดแดง) (Central); Pa ku ma ding (ปะกูดมะดิง) (Malay/Peninsular); Lamtheng (ลำหึ่ง) (Peninsular); Lam matheng (ลำมะหึ่ง) (Eastern, South-western).

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 36 ; O. Rattana 42; Y. Yuyen 123 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T 1989 [BKF].

VITTARIACEAE

(C. Presl) Ching, Sunyatsenia. 5(4): 210, 232. 1940; Devol & Kuo, Fl. Taiwan vol. 1. 2nd ed.:165. 1980.

Small ferns on rocks or tree trunks; rhizome creeping, usually short; roots covered with a mass of brown hairs; scales clathrate, usually very narrow and hair-pointed; stipitate or sessile, stipes usually reticulate, forming elongated areolae without included free veinlets. Fronds simple, somewhat succulent. Sporangia borne along the margin, or dichotomously forking veins, superficial or more often in soral grooves, paraphyses yellowish to brown, abundant, filiform or club-shaped, simple or branched.

KEY TO THE GENERA

1. Frond oblong-lanceolate, costa wanting. Sori usually in more than two rows
 **1. Antrophyum**
1. Frond linear, costa present. Sori in one row at the each side.
 **2. Vittaria**

1. ANTROPHYUM

Kaulf., Enum.: 197. 1824; Tagawa & K.Iwats., Fl. Thailand 3(2): 217. 1985.

Rhizome short-creeping, densely covered with clathrate scales. Frond broadly lanceolate or broader, rarely forked at apex; costa wanting or rarely partial; veins forming large elongate areoles without included veinlets. Sori elongate along vein.

Antrophyum callifolium Blume. En. Pl. Jav.: 111. 1828; Fl. Jav. Fil.: 83. t. 35. 1829; Tardieu & C. Chr. in Fl. Gén. I. -C. 7(2): 204. 1939; Holttum, Rev. Fl. Malaya 2. 605. f. 356. f. 90. 1954; Tagawa & K. Iwats., Fl. Thailand 3(2): 221. 1985. **Fig. 5.11** A-B.

Rhizome short-creeping, 3-4 mm in diameter, bearing a few to several fronds in a tuft, scaly; scales narrowly subtriangular, gradually narrowing from base towards long-tailed apex, 3.5-5.5 by 0.5-0.8 mm, dark brown to blackish, sharply toothed at margin. **Stipe** short, indistinctly merging with the basal portion of frond, scaly. **Frond** variable in outline, usually oblong-lanceolate to broadly oblanceolate, gradually, 17.9-30 by 3.7-8 cm, but soriferous even when less than 5 cm, leathery; costa distinct only on 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, i.e. near costa; paraphyses filamentous, long, numerous.

Thailand.— NORTHERN: Chiang Mai (Doi Suthep, Chiang Mai, Mae Taeng, Lamoo), Tak (Huai Krasa); NORTH-EASTERN: Nong Khai, Loei (Phu Luang, Phu Kradueng, Khao Huai Khae); CENTRAL: Nakhon Nayok (Khao Yai, Nang Rong Falls); SOUTH-EASTERN: Chantaburi (Khao Soi Dao, Khao Sabap), Trat (Koh Chang); SOUTH-WESTERN: Kanchanaburi (Khao Sakan, Song Tho);

PENINSULAR: Chumphon (Tha Ngo, Langsuan, Tako, Sapli), Surat Thani (Koh Tao, Ban Don, Ko Phangan), Nakhon Si Thammarat (Khiriwong, Khao Luang, Thung Song), Narathiwat (Su-ngai Padi), Phangnga (Thap Put), Phuket, Trang (Khao Chong), Satun, Yala (Bannang Sta).

Distribution.— Widely known from the tropics of the Old World (type from Java).

Ecology.— On muddy rock in tropical evergreen forest at 500-600 m altitudes.

GPS Location.— 08° 51' 23.67"N 99° 41' 48.28"E, 08° 52' 04.31"N 99° 42' 18.59"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 246; T. T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 154 [BCU]; E. Hennipman 3898; M. Tagawa, K. Iwatsuki & N. Fukuoka T 6806 [BKF].

2. VITTARIA

J. E. Smith, *Mém. Acad. Turin* 5: 413. pl. 9. f. 5. 1793; Tagawa & K. Iwats., *Fl. Thailand* 3(2): 222. 1985.

Rhizome short-creeping, bearing a mass of roots and numerous close fronds, densely covered with clathrate scales. Frond linear, simple, entire, leathery; costa distinct to the apex of frond, with a few lateral veins forming areoles without included veinlets; sori in a single row at each side of costa, dorsal or in marginal flaps; paraphyses usually abundant.

KEY TO THE SPECIES

1. Costa flat on upper surface. Frond usually less than 2 cm broad
 2. Costa flat or hardly visible on lower surface
 3. Sori immersed in two-lipped marginal grooves. Midrib distinct on upper surface..... **2. V. elongata**
 3. Sori submarginal in grooves. Midrib distinct on both surface **3. V. ensiformis**
 2. Midrib distinct on lower surface

4. Sori always on both edges. Frond 15-20 cm long, to 2 mm broad
 **1. V. angustifolia**
4. Sori intra-marginal. Frond 20-30 long, up to 1 cm broad
 **4. V. flexuosa**
1. Costa strongly raised on upper surface. Frond usually more than 2 cm broad
 **5. V. scolopendrina**

1. Vittaria angustifolia Blume, En. Pl. Jav.: 199. 1812; Holttum, Rev. Fl. Malaya 2: 610. 1955; Tagawa & K. Iwats., Fl. Thailand 3(2): 225. 1985. **Fig. 5.11 C-D.**

Rhizome creeping, usually 1.5-2.10 mm in diameter, bearing fronds rather sparsely, densely scaly throughout; scales narrow, gradually narrowing from base toward hair-pointed apex, up to 6 by 0.3-0.7 mm. fuscous, clathrate, minutely toothed at margin. Stipe short, green or dark at the very base. **Frond** linear, 8-20 cm long, to 2 mm or more broad, usually curved and pendulous, acute at apex, gradually narrowing downwards and merging into very narrow wings of stipe, leathery; costa visible on upper surface or hardly so, the margin flat or inrolled. **Sori** immersed in deep groove almost at margin of fronds, usually limited to the upper half.

Thailand.— SOUTH-EASTERN: Chanthaburi (Khao Soi Dao, Khao Sabap); PENINSULAR: Nakhon Si Thammarat (Khao Luang), Trang (Khao Chong), Krabi (Phanom Bencha), Yala (Khao Kalakhiri, Bla Hat).

Distribution.— Throughout Malesia (type from Java), east to New Caledonia.

Ecology.— On tree trunks, usually on old bark of trees at 730-1,200 m altitudes.

GPS Location.— 08° 52' 15.28"N 99° 42' 18.07"E, 08° 52' 36.31"N 99° 42' 13.85"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 159, 222; P. Ratchata 183 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T 6810 [BKF].

2. *Vittaria elongata* Sw., Syn. Fil.: 109, 302. 1806; Bedd., Handb.: 404. f. 238. 1883; Christ, Bot. Tidsskr. 24: 104. 1901; Tardieu & C. Chr. in Fl. Gén. I. -C. 7(2): 197. 1940; Holttum, Rev. Fl. Malaya 2: 614. f. 360. 1955; Dansk Bot. Ark. 20: 34. 1961, Seidenf., Nat. Hist. Bull. Siam Soc. 19: 87. 1958; Tagawa & K. Iwats., Southeast As. St. 5: 111. 1967; Acta Phytotax. Geobot. 23: 56. 1968. Tagawa & K. Iwats., Fl. Thailand 3(2): 223. 1985. **Fig. 5.11 E.**

Rhizome short-creeping, bearing fronds closely or up to 0.6 cm apart, 2-3 mm diameter, very densely scaly throughout; scales linear, gradually narrowing from cordate base towards long-tailed apex, 1.2-5.5 mm or more long, 0.5-1 mm broad, greyish-brown to dark, distinctly clathrate, minutely toothed at margin. **Stipe** usually short, indistinct from the lower portion of frond, green to darker. **Fron**d linear, variable in size, 0.5-2.3 cm broad, up to 40 cm or more long, gradually narrowing towards both ends, coriaceous to leathery; costa usually distinct above one the lower portion; 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 whole margin of frond.

Thailand.— NORTHERN: Chiang Rai, Chiang Mai (Doi Chiang Dao), Tak, Phitsanulok (Thung Salaeng Luang); NORTH-EASTERN: Nong Khai, Loei (Phu Kradueng); EASTERN: Nakhon Ratchasima (Pak Thong Chai); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Trat (Koh Chang); SOUTH-WESTERN: Kanchanaburi (Wang Ka); PENINSULAR: Surat Thani (Ban Don, Ko Tao, Khun Thale, Koh Samui), Nakhon Si Thammarat (Khao Luang, Thung Song), Satun (Koh Tarutao), Narathiwat (Waeng), Yala (Khao Kalakhiri, Ban Chana, Bla Hat).

Distribution.— Tropics of the Old World generally (type from India), north to Sikkim, Hainan and southern edge of Japan.

Ecology.— On mossy tree-trunks in light shade to hill evergreen forests at 730-1,250 m altitudes.

GPS Location.— 08° 52' 15.28"N 99° 42' 18.07"E, 08° 52' 43.27"N 99° 41' 39.43"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 157, 229; T. Boonkerd 682 [BCU]; T. Shimizu & A. Nalampoon T 8206; K. Yoda 476 [BKF].

3. *Vittaria ensiformis* Sw., Ges. Nat. Fr. Berl. Neu. Schr. 2: 134. t. 7. f. 1. 1799; Holltum, Rev. Fl. Malaya 2: 613. f. 359. 1955; Tagawa & K. Iwats., Fl. Thailand 3(2): 223. 1985. — *Vittaria hainanensis* C. Chr ex Ching, sinensia 1: 182. pl. 1. 1931; Tardieu & C. Chr. in Gén. I. -C. 7(2): 198. 1940. **Fig. 5.11 F.**

Rhizome short-creeping, slender 0.7-2.5 mm diameter, densely covered with a mass of roots, scaly throughout; scales linear, gradually narrowing from base towards long tailed apex, up to 7 by 0.7 mm, dark brown to nearly winged throughout. **Fron**d linear, 22-40 by 2.5-6 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.— SOUTH-EASTERN: Chanthaburi (Makham), Trat (Huai Raeng, Koh Chang); CENTRAL: Krung Thep; PENINSULAR: Karbi (Ko Pu), Surat Thani (Koh Tao, Ban Don), Phangnga (Khao Suang), Nakhon Si Thammarat (Khao Luang), Trang (Khao Chong), Phuket, Satun (Khuan Kalong, Boriphat Falls), Pattani (Khok Pho, Ban Sai Khao).

Distribution.— Tropics of the Old World (type from Mascarene Islands) the boundary is not certain.

Ecology.— On tree trunks in hill evergreen forest at 730-1,283 m altitudes.

GPS Location.— 08° 52' 15.28"N 99° 42' 18.07"E, 08° 52' 47.55"N 99° 41' 41.32"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 423; T. Boonkerd, Y. Sirichamorn and C. Sanguansab 157 [BCU]; Ch. Charoenphol, K. Larsen & E. Warncke 4957 [BKF].

4. *Vittaria flexuosa* Fée, 3^{me} Mem.: 16. 1852; Tardieu & C. Chr. in Fl. Gén. I. -C. 7(2): 199. 1940.; Tagawa & K. Iwats., Fl. Thailand 3(2): 225. 1985. **Fig. 5.12 A.**

Rhizome short, c. 3.4 mm diameter, bearing a mass of roots, densely scaly throughout; scales subulate at apex, up to 5 by 0.7 mm, dark brown to blackish, clathrate, minutely toothed at margin. Stipe narrowly winged throughout, dark at the very base. **Fron**d linear-lanceolate 15-45 cm by up to 30 cm, gradually narrowing towards acuminate apex, gradually narrowing downwards into wings of stipe, the

margin flat or slightly recurved, coriaceous or thicker; costa distinctly raised on lower surface, distinct on upper surface: veins hidden. **Sori** superficial, in submarginal grooved usually 1/5-1/4 way from margin to midrib, usually on upper half of frond except the very apex.

Thailand.— NORTHERN: Chiang Rai (Doi Chang), Chiang Mai (Doi Phahom Pok, Doi Suthep, Doi Inthanon), Lampang (Doi Luang), Tak (Ban Mosoe), Phetchabun (Phu Miang); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao), Trat (Khao Kuap); PENINSULAR: Nakhon Si Thammarat (Khao Luang).

Distribution.— East Himalaya (type) to Southwest and South China and Indochina, north to Japan, south to Malaya.

Ecology.— On tree-trunks or moist rocks usually in tropical evergreen forest at 720 m altitudes.

GPS Location.— 08° 52' 15.28"N 99° 42' 18.07"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 227; T. Boonkerd & R. Polawatn 57 [BCU]; T. Smitinand 887; K. Iwatsuki & N. Fukuoka T 3198 [BKF].

5. *Vittaria scolopendrina* (Bory) Schkuhr ex Thwaites, Enum. Pl. Zeyl. 381. 1864. Bedd., Handb. 408, fig. 241. Holttum, Rev. Fl. Malaya 2. 611. 1954. Tagawa & K.Iwats., Fl. Thailand 3(2): 228. 1985. — *Pteris scolopendrina* Bory, Voy. 2: 323. 1804. **Fig. 5.11 G.**

Rhizome short, creeping, c. 4-6 mm diameter; scales nearly black, dull, c. 1.3 cm long, 0.5 mm wide, the apical third hair-like, the basal cells with thinner walls than the rest, and paler. **Fronde** sessile, c. 57-80 cm long, 2-3 cm wide, tapering very gradually to both base and apex; midrib prominent throughout on the upper surface. **Sori** in a groove just within the margin, up to 2 mm wide at maturity, the thin edges of the frond more or less reflexed cover them when young or in dried specimens; paraphyses very copious, much branched, end-cells dark brownish, less than twice as long as wide.

Thailand.— PENINSULAR: Satun (Khao Khieo Range), Nakhon Si Thammarat (Khiriwong)

Distribution.— Widely distributed in the world tropics, Madagascar to Samoa, but not found in Indonesia; type from Bourbon.

Ecology.— On tree trunks in hill evergreen forest at 1,200-1,364 m altitudes.

GPS Location.— 08° 52' 51.02"N 99° 42' 01.86"E, 08° 52' 58.08"N 99° 41' 50.15"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 440 [BCU].

ORDER BLECHNALES

ASPLENIACEAE

Newman, Hist. Brit. Ferns. 1840; Devol and Kuo, Fl. Taiwan vol. 1. 2nd ed.: 476. 1980.

Terrestrial or epiphytic ferns of a wide variety of forms; rhizomes dictyostelic creeping or erect; scales usually clathrate, narrowly lanceolate, dark brown to black. Fronds simple, pinnate to decommpound; stipes not articulate to rhizome, with two vascular strands at base of stipes; venation usually free and frocking. Sori linear, borne on side of veinlets; indusia linear, narrow.

KEY TO THE GENERA

1. Rhizome erect or short-creeping; frond simple to decomppound..... **1. Asplenium**
 1. Rhizome long-creeping; frond 1-pinnate..... **2. Hymenasplenium**

1. ASPLENIUM

L., Sp. Pl.: 1078. 1753; Tagawa & K. Iwats., Fl. Thailand 3(2): 261. 1985.

Rhizome erect, short-creeping; scales clathrate, glabrous. Frond simple to pinnately compound; veins free, of uniting at apex to form submarginal veins. Sori elongate along veins, superficial, with indusia of the same shape; spores bilateral.

KEY TO THE SPECIES

1. Fronds simple
 2. Margin of fronds entire, minutely toothed at least in the upper part, scale clathrate or less clathrate
 3. Frond spatulate, vein all free..... **3. A. grevilleii**
 3. Frond narrowly elliptic, vein anastomosing..... **7. A. salignum**
 2. Margin of fronds entire, not toothed, fronds large size, scale membranous **4. A. nidus**
1. Fronds pinnate or more compound
 5. Frond pinnate
 6. Midrib of pinna not grooved above but usually raised, scale bicolor
 7. Pinnae toothed..... **8. A. tenerum**
 7. Pinnae lobed, proliferous..... **5. A. normale**
 6. Midrib of pinna grooved above, stipe and rachis densely scaly **6. A. perakense**
 5. Frond bipinnate or more compound
 8. Frond bipinnate, lower pinnae oblong, rounded moderately acute at apex **1. A. affine**
 8. Frond tripinnatifid, secondary pinnules spatulate, rounded and toothed at apex..... **2. A. confusum**

1. Asplenium affine Sw., Schrad. J. Bot. 1800(2): 56. 1801; Bedd., Handb.: 157. 1883; Sledge, Bull. Brit. Mus. (nat. Hist.) Bot. 3: 269. f. 2. 1965; Holttum, Rev. Fl. Malaya 2. 2: 634. 1968. — *Asplenium spathulinum* J. Smith ex Hook., Sp. Fil. 3: 170. 1860, non Kunze 1848: Tardieu & C. Chr. in Fl. Gén. I. –C. 7(2): 238 1940; Holttum, Rev. Fl. Malaya 2: 439. f. 257. 1955. **Fig. 5.12** B-C.

Rhizome short-creeping, ascending, densely covered with scales at apex; scales linear, gradually narrowing towards hair-pointed apex, up to 3 by 0.6 mm, dark brown, clathrate, entire, more or less crisped at upper portion. **Stipe** dark green to nearly black, minutely scaly or glabrescent, c. 1.5-15.5 cm long. **Lamina** subtriangular, narrowing towards apex 4.5-33 cm long, 4.5-15 cm, bipinnate; pinnae more or less 16 pairs, lowest one the largest, stalked, oblong-subtriangular, acuminate

at apex, broadly cuneate at base, shortly stalked or sessile, lobed 1/4-1/3, or deeply lobed to have an acroscopic lobe, *c.* 3.1-15 by 1.5-6 mm; lobes acute to moderately acute at apex, serrate with one-nerved teeth, chartaceous; veins distinct on both surface, a few times forked. Sori many, up to 3.5 mm long; indusia pale, stiff and persistent.

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

Distribution.— Madagascar, Mascarene Island (type), Seychelles, Ceylon, S. India, Hainan, Cambodia, Malesia to New Hebrides and Fiji.

Ecology.— On mossy tree-trunks in moist tropical evergreen forests at 600-980 m altitudes.

GPS Location.— 08° 52' 04.31"N 99° 42' 18.59"E, 08° 52' 28.13"N 99° 42' 15.13"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 153, 313; T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 500 [BCU].

2. *Asplenium confusum* Tard. & Ching, Not. Syst. 5: 148. pl. 4. f. 3. pl. 7. 1936; Holttum, Rev. Tardieu & C. Chr. in Fl. Gén. I. -C. 7(2): 240 1940; Tagawa & K. Iwats., Fl. Thailand 3(2): 289. 1985. **Fig. 5.12** D-E.

Rhizome short, ascending, densely scaly; scales narrow, gradually narrowing towards hair-pointed apex, *c.* 1.3 by 0.4 mm, entire, greyish to dark brown, crisped. **Stipe** *c.* 14 cm long, polished dark brown purple or nearly black, grooved above. **Lamina** elliptic to oblong-subtriangular, acuminate, *c.* 21 or more long, *c.* 12.2 cm wide, tripinnate; rachis glabrous, grooved; lower pinnae 6 cm from the next ones, ascending, oblong-subtriangular, subtruncate at base, gradually narrowing and bending up towards caudately acuminate apex, stalked, 8 by up to 3 cm: larger pinnules stalked, oblong-subtriangular, acute at apex, cuneate at base, pinnatifid to pinnate, up to 1.7 by 0.9 cm; ultimate segments (or secondary pinnules) spatulate, round and toothed at apex, cuneate and sessile at base, up to 8 by 4 mm, sometimes lobed to half-way, subcoriaceous; veins raised on both surfaces. **Sori** up to 3 mm

long, usually nearly to midrib close together but rarely confluent; indusia thin but firm persistent.

Thailand.— NORTHERN: Phitsanulok (Thung Salaeng Luang), Tak (Mae Sot, Huai Krasa); NORTH-EASTERN: Loei (Phu Luang, Phu Kradang); EASTERN: Buri Ram (Khao Krap); SOUTH-EASTERN: Chon Buri (Si Racha), Prachin Buri (Ban Ban Hills), Chanthaburi (Khao Sabap), Trat (Ko Chang); SOUTH-WESTERN: Prachuap Khiri Khan; PENINSULAR: Chumpon (Ban Krayae), Surat Thani (Koh Tao, Khlong Bakatae, Koh Samui, Ban Don), Phangnga (Pulao Tiban).

Distribution.— Indochina (type).

Ecology.— On mossy tree-trunks in hill evergreen forest at 1,000-1,100 m altitudes.

GPS Location.— 08° 52' 36.19"N 99° 42' 13.85"E, 08° 52' 41.34"N 99° 42' 08.14"E

Vernacular.— Kraprok hang maeo (กะปรอกหางแมง) (South-eastern).

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 160, 171; T. Boonkerd 174 : Y. Yuyen 176 [BCU]; E. Hennipman 3684; J. F. Maxwell 00-413 [BKF].

3. *Asplenium grevillei* Wall. ex Hook. & Grev., Ic. Fil.: t. 228. 1831; Tardieu & C. Chr. in Fl. Gén. I. -C. 7(2): 217. 1940; Tagawa & K. Iwats., Fl. Thailand 3(2): 266. 1985. **Fig. 5.12 F.**

Rhizome short, erect, bearing several fronds in a tuft, covered with scales ; scales brown, up to 4.5 by 2.5 mm. indistinctly clathrate, bearing hair-like projections at margin. **Stipe** dark brown to nearly black, 14-32 cm long, very narrowly winged almost to the base, bearing small scales when young. **Fronde** spatulate, broadest at middle to upper 2/3, narrowing towards caudately acuminate apex, gradually narrowing towards attenuate base and then decurrent on stipe as wing, up to 30 cm long including stipe, up to 6 cm broad, the edges subentire or slightly undulate, papyraceous or thicker, green, paler below, minutely scaly when young glabrescent; midrib green to darker, a little raised below, veins hardly visible on both surfaces, unusually once forked near midrib, joining at apex forming submarginal vein *c.* 0.5

mm inside margin. **Sori** elongate along veins, extending from near midrib to *c.* 2.5 cm from margin on the whole under surface; indusia *c.* 1 mm broad.

Thailand.— NORTHERN: Chiang Rai (Doi Tham Yup), Chiang Mai (Doi Chiang Dao), Phitsanulok (thung Salaeng Haeng); NORTH-EASTERN: Khon Kaen (Pha Nok Khao); SOUTH-EASTERN: Trat (Koh Chang); SOUTH-WESTERN: Kanchanaburi (Sai Yok, Wangka); PENINSULAR: Chumphon (Khao Khlong, Chaiyaburi), Surat Thani (Ban Kop Kaep), Nakhon Si Thammarat (Khao Luang), Trang (Khao Chong), Pattani (Ban Sai Khao)

Distribution.— Myanmar (Tenasserim, type) and Indochina (Laos & Cochichaina).

Ecology.— Terrestrial in tropical evergreen forests at 300-600 m altitudes.

GPS Location.— 08° 51' 29.72"N 99° 42' 46.72"E, 08° 52' 04.31"N 99° 42' 18.59"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 98, 241: Charn Apasutaya 175: A. Sathapattayanon 165 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T 4527 [BKF].

4. *Asplenium nidus* L. var. *nidus*, Sp. Pl.: 1079. 1753; Tardieu & C. Chr. in Fl. Gén. I. –C. 7(2): 219. 1939; Holttum. Rev. Fl. Malaya 2: 419. 1954. Tagawa & K. Iwats., Fl. Thailand 3(2): 266. 1985. — *Thamnopteris nidus* (L.) C.Presl, Epim.: 68. 1849.
Fig. 5.12 G-H.

Rhizome short, erect or ascending, stout, bearing a rosette of fronds, usually with a mass of roots on which are growing various epiphytes, scaly; scales brown to darker, membranous, clathrate. **Stipe** stramineous to darker, 1-5 cm long, scaly at base. **Frond** simple, up to 0.86 m or more long, 6-20 cm broad, broadest at middle, gradually narrowing towards both apex and base, coriaceous, grass-green when living, paler below; midrib raised on upper surface, flat below, veins once or rarely twice forked, the first forking near midrib and then running parallel, uniting at apex to form submarginal veins *c.* 0.5 mm inside leaf margin. **Sori** elongate along veins, extending from near midrib, half-way to the margin, usually on every vein; indusia *c.* 1 mm broad, with a space of 0.5 mm or wider between.

Thailand.— NORTHERN: Chiang Rai (Doi Pacho), Chiang Mai (Doi Chiang Dao, Ban Du, Doi Suthep), Lampang; NORTH-EASTERN: Loei (Phu Luang, Phu Kraduang), Nong Khai (Naong Khai Ploi); CENTRAL: Saraburi (Muak Lek); SOUTH-EASTERN: Chon Buri (Si Racha), Chanthaburi (Khao Soi Dao), Trat (Huai Raeng); SOUTH-WESTERN: Kanchanaburi (Sai Yok, Wanfka, Khao Num Tok); PENINSULAR: Surat Thani (Koh Tao, Koh Phu), Nakhon Si Thammarat (Khao Luang).

Distribution.— Throughout the Old World tropics (type from Java).

Ecology.— Usually on tree-trunks or on rocks in dense forests or under heavy crowns of trees light shade at 340-1,200 m altitudes.

GPS Location.— 08° 51' 29.27"N 99° 42' 44.44"E, 08° 52' 20.86"N 99° 42' 17.63"E, 08° 52' 51.02"N 99° 42' 01.86"E

Vernacular.— Katae tai hin (กะแตใต้หิน) (North-eastern); Kaprok hua long (กะปรอกหัวลง), Kaprok hang sing (กะปรอกหางสิงห์) (Sout-eastern).

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 137; O. Rattana 17; Y. Yuyen 122; W. Khwaiphan 107 [BCU]; E. Hennipman 3790; M. Tagawa, K. Iwatsuki & N. Fukuoka T 386 [BKF].

5. *Asplenium normale* D. Don, Prod. Fl. Nepal.: 7. 1825; Tardieu & C. Chr. in Fl. Gén. I. –C. 7(2): 225. 1939; Holttum, Rev. Fl. Malaya 2: 436. f. 254. 1954; Tagawa & K.Iwats., Fl. Thailand 3(2): 280. 1985. **Fig. 5.13 A.**

Rhizome short, erect, scaly; scales gradually narrowing form base towards hair-pointed apex, up to 3 by 0.5 mm, bicoloured, the central portion black, with longitudinal cells, the edges brown to dark brown. **Stipe** very deep castaneous to nearly black, more or less polished, c. 4.5-14 cm long, grooved with two rows but distinct ridges on adaxial surface. **Fronde**s lanceolate to narrower, pinnate, slightly narrowing at base, gradually narrowing upwards, caudately acuminate at apex, up to 30 by 1.7-2.5 cm; rachis wingless throughout, viviparous; lateral pinnae up to 25 pairs, sessile, patent or slightly reflexed, oblong, rounded at apex, lobe 1/5 way on both margins, narrowly cuneate at basisopic base, auricled and truncate at acroscopic base, c. 12 by 4.5 mm; midrib rarely viviparous; veinlets simple or forked, not running to the very top of lobes. Sori up to 3 mm long; indusia thin.

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

Distribution.— Old World tropics throughout, north to Himalaya (type) and Japan.

Ecology.— Terrestrial on rather dry slopes, humus-rich slopes, on wet muddy rocks, or mossy basal tree-trunks in hill evergreen forest at 1,006 m altitudes.

GPS Location.— 08° 52' 36.69"N 99° 42' 13.52"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 439 ; T. Boonkerd, Y. Sirichamorn and C. Sanguansab 114 ; Y. Yuyen 79 ; Charn Apasutaya 172 [BCU]; E. Hennipman 3862 ; M. Tagawa, K. Iwatsuki & N. Fukuoka T 4834 [BKF].

6. *Asplenium perakense* Matthew & Christ, J. Linn. Soc. Bot. 39: 214. 1909; Holttum, Rev. Fl. Malaya 2: 429. f. 248. 1955; Tagawa & K. Iwats., Fl. Thailand 3(2): 286. 1985. **Fig. 5.13** B-C.

Rhizome short, suberect, bearing a tuft of fronds, densely scaly; scales gradually narrowing from base towards hair-pointed apex, brown, entire, or with a few long projections near base, up to 10 by 1 mm at base. **Stipe** dark brownish-purple, scaly throughout, grooved, up to 20 cm long. **Fron**d narrowly lanceolate, acute to acuminate at apex, pinnate; rachis like the upper part of stipe, up to 40 by 10 cm; rachis like the upper part of stipe, scaly with long tails; pinna more than 15 pairs stalked, middle ones the largest, ascending, narrowly subtriangular, caudately acuminate at apex, auricled at acroscopic and cuneate at basiscroscopic bases, lobed nearly to costa, up to 8 by 2.5 cm; lobes oblong or quadrangular, oblique, crenate at apex, usually 4 mm wide; softly chartaceous, veins visible. **Sori** long, crescent-shaped, 2-3 for each lobe; indusia herbaceous.

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

Distribution.— Malaysia (type).

Ecology.— On mossy tree-trunks or on moist rocks in hill evergreen forest at 1,000-1,380 m altitudes.

GPS Location.— 08° 52' 36.19"N 99° 42' 13.85"E, 08° 52' 58.08"N 99° 41' 50.15"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphon 442; T. Boonkerd, Y. Sirichamorn and C. Sanguansab 180; T. Boonkerd 39; Y. Yuyen 189 [BCU]; E. Hennipman 3848; M. Tagawa, K. Iwatsuki and N. Fukuka T 4785; K. Iwatsuki, H. Koyoma and A. Chintayungkun T 8396 [BKF].

Note.— *Asplenium perakense* is an epiphytic plant on tree trunks in hill evergreen forest. It is closely related to *Asplenium yoshinagae* Makino but differ in rachis densely scaly throughout, size of frond greater than the other, pinna with sparsely scales on both surfaces.

7. *Asplenium salignum* Blume., En. Pi. Jav.: 175. 1828; Holttum. Rev. Fl. Malaya 2: 421. f. 243. 1955; Tagawa & K. Iwats., Fl. Thailand 3(2): 272. 1985. **Fig. 5.13 D.**

Rhizome short, ascending, scaly; scales appressed, narrowly subdeltoid, long-acuminate at apex, *c.* 12 by 2.5 mm, dark brown and more or less clathrate centrally, the edges paler, thin walled, irregularly margined. **Stipe** 6.5-16.5 cm long, green to stramineous, darker towards base, wingless, minutely scaly. **Lamina** simple to simply pinnate, simple frond like the terminal pinna of pinnate frond up to 22 by 19 cm in pinnate form; lateral pinnae up to 5 pairs, shortly stalked or sessile, linear, falcate, up to 16.5 by 1.2-2.5 cm, long-acuminate at apex, cuneate at base, entire, or minutely serrate above; terminal pinna gradually narrow in towards long-acuminate apex, attenuate to cuneate at base, up to 15 by 2.2 cm, chartaceous, light green, minutely scaly; midrib raised below, hardly so above, glabrous; veins forked near midrib, visible on both surfaces but not raised. **Sori** along acroscopic branches of veins, up to 10 mm long; indusia up to 1 mm broad, pale brown, thin but firm, persistent.

Thailand.— SOUTH-EASTERN: Trat (Koh Chang); PENINSULAR: Surat Thani (Khao Nong), Phangna (Nop Pring), Nakhon Si Thammarat (Khao Luang, Khiriwong), Satun (Boriphat Falls), Yala (Ban Chana).

Distribution.— South China, Myanmar and Malesia (type from Java).

Ecology.— On moist mossy rocks in humid places usually along streams in tropical evergreen forests at 500-600 m altitudes.

GPS Location.— 08° 51' 58.06"N 99° 42' 30.55"E, 08° 51' 29.40"N 99° 41' 36.92"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 506; T. Boonkerd, Y. Sirichamorn and C. Sanguansab 225; C. Thorat 210; T. Boonkerd 333 [BCU]; M. Tagawa K. Iwatsuki & N. Fukuoka T 5290 [BKF].

8. *Asplenium tenerum* Forst., Prod.: 80. 1786; Handb.: 147. f. 74. 1883; Tardieu & C. Chr. in Fl. Gén. I. –C. 7(2): 226. 1940; Holttum. Rev. Fl. Malaya 2: 432. 1955; Tagawa & K. Iwats., Fl. Thailand 3(2): 273. 1985. **Fig. 5.13** E-F.

Rhizome short, ascending, up to 6 mm diameter; scales narrownig from base towards long-acuminate apex, c. 3 by 1 mm, dark brown, clathrate, and the edges bearing long projections. **Stipe** up to 16 cm long, pale green, scaly throughout with smaller scales or glabrescent. **Fronde** pinnate, usually widest at base, acuminate at apex, up to 26 by c. 6 cm; rachis winged throughout, minutely scaly, lateral pinnae more than 16 pairs, patent, falcate, acuminate at apex, auricled and subtruncate at acroscopic base, up to 1 cm and subdimidate at basiscropic base, regular serrate with a single veinlet in each tooth, the upper one smaller; chartaceous, green, glabrescent; costa raised above, veins visible on both surfaces, simple or basal acroscopic one forked; crenate at margin, oblique, rounded at apex, one-nerved. **Sori** elongate along veins, up to 3 mm long, from near costa to below sinus; indusia thin but persistent, up to 0.5 mm broad.

Thailand.— NORTHERN: Phitsanulook (Salaeng Haeng); SOUTH-EASTERN: Chanthaburi (Pong Nam Ron); PENINSULAR: Surat Thani (Pang Wan), Nakhon Si Thammarat (Khao Luang), Narathiwat (Sg. Padi), Trang (Khao Chong), Yala (Khao Kalakhiri, Khao Korewang).

Distribution.— Ceylon and South India to Polynesia (type), north to Tonkin and Taiwan.

Ecology.— On mossy tree-trunks or on rocks in tropical evergreen forests at 330-800 m altitudes.

GPS Location.— 08° 51' 28.94"N 99° 42' 44.08"E, 08° 52' 20.86"N 99° 42' 17.63"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 133,158; T. Boonkerd 1135 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T 4683 [BKF].

2. HYMENASPLENIUM

Bot. Mag. (Tokyo) 41. 712. 1927.

Plant terrestrial, epiphytic rhizome creeping, from green to blackish, with to rows of alternately arranged petiolets on the dorsal surface, scaly near at apex bearing root either the ventral dorsal or connecting meristeles; petiole terete scaly at base, glabrous distally, greenish atropurpureous, the base swollen and often persisting after the leaf has fallen and decayed; lamina usually 1-pinnate or simple and cordate; rachis not or very shallowly grooved with or without perpendicular or flat green wings, lacking buds; costae bordered by a flange of green tissue that is decurrent on the adaxial surface of the rachis; decurrent margins of the pinnae not thickened; veins free or anastomosing. Sori along with indusia.

Hymenasplenium apogamum (N. Murak. & Hatan.) Nakaike, New Fl. Japan, Pterid.: 841: 1992; Tagawa & K. Iwats., Fl. Thailand 3(4): 620. 1989. — *Asplenium unilaterale* auct. non Lam.: Tagawa., & K. Iwats., Fl. Thailand 3(2): 277. 1985. — *Asplenium apogamum* N.Murak. & Hatan. J. Fac. Sci. Univ. Tokyo, Bot., 14(3): 193 (1988). 1988. **Fig. 5.13 G.- Fig. 5.14 A.**

Rhizome long-creeping, c. 2.5 mm diameter, bearing many roots on ventral and two rows of fronds on dorsal surfaces, scaly; scales gradually narrow from base towards hair-pointed apex, up to 3 by 0.5 mm, dark brown to nigrescent, clathrate. Stipe close or up to 4 mm apart, castaneous to purplish, polished scaly near the base, 9 cm long. **Frond** pinnate, lanceolate, broadest at basal 1/5 portion, almost parallel or slightly narrowing upwards and then rather suddenly narrowing to caudate apex, 21 cm long, c. 4.2 cm wide; rachis terete throughout; pinnae usually 26 pairs, roundly quadrangular, posterior half of lower portion dimidiate, truncate and slightly auricled

at acroscopic base, rounded at apex, lobed to 1/5 way at upper and anterior half of lower margin, lobes rounded, oblique, moderately acute to rounded at apex, commonly 2.8 by 0.8 mm, a few lowest pairs shortly stalked, slightly smaller, more or less reflexed, thin, herbaceous, light green; veins visible. **Sori** 3.5 mm long; indusia herbaceous, pale, opening towards anterior side.

Thailand.— NORTHERN: Chiang Rai (Doi Pha Cho), Ching Mai (Doi Phahum Pok, Doi Chiang Dao, Doi Suthep, Doi Inthanon), Lampang, Tak (Doi Muser); CENTRAL: Nakhao Nayok (Khao Yai); SOUTH-EASTERN: Chantaburi (Pong Nam Ron, Khao Soi Dao); SOUTH-WESTERN: Kanchanaburi (Wangka); PENINSULAR: Chumphon (Tha San), Ranong (Khao Phota Luang Kaeo, Tha Um), Trang (Khao Chong), Pattani (Bacho), Yala (Bannang Sta).

Distribution.— Widely distribution throughout the Old World Tropics (type from Comoros), north to central Japan).

Ecology.— Terrestrial on wet sandy slopes on moist muddy rocks along streams in tropical evergreen forest at 480 m altitudes.

GPS Location.— 08° 51' 23.67"N 99° 41' 48.28"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 507 ; W. Khawaiphan 39 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka 6833 [BKF].

BLECHNACEAE

Devol, Fl. Taiwan vol. 1 2nd ed.: 149. 1980.

Stock erect, rather stout; base of stipes covered with scales. Lamina pinnate; fertile fronds of the same shape as sterile or much narrower. Sori elongate, near the costa of pinna or the costules of it lobes, with indusium attached on the side of the sorus.

BLECHNUM

L., Sp. Pl.: 1077. 1753. Tagawa & K. Iwats Fl. Thailand 3(3): 297. 1988.

Rhizome stout, erect, scaly; scales narrow entire, margin with pale cartilaginous edges. Lamina imparipinnate; veins free, usually once or a few times forked. Sori linear, parallel and close to costa; indusial attached on the side away from costa and opening inwards.

Blechnum orientale L., Sp. Pl. : 1077. 1753 ; Holttum, Rev. Fl. Malaya 2 : 446. f. 262 1955; Bedd., Handb.: 132. f. 66. 1969; Devol, Fl. Taiwan vol. 1. 2nd ed.: 149. 1980; Tagawa & K. Iwats Fl. Thailand 3(3): 298. 1988.

Rhizome thick, ascending or suberect, densely covered with scales, scales linear gradually narrowing towards apex, c. 1 cm or more long, up to 1 mm broad, tailed at apex brown, toothed at margin. **Stipes** stout, stramineous, purplish at base up to 60 cm long, densely scaled at base, bearing small auricles (reduce pinnae) throughout. **Lamina** 1-pinnate, up to 85 by 34 cm oblong, acuminate at apex, lateral pinnae many in number, close, 2-3 cm apart from each other, ascending, linear, gradually narrowing toward long-tailed apex, round or subtruncate at sessile base, or decurrent at posterior base and adnate in the upper ones, entire, up to 20 by 1.5 cm; vein simple or forked usually near costa, distinct on both surfaces, very closed, up to 0.5 apart; texture coriaceous, green, glabrous throughout. **Sori** narrow, long continuous along costa; indusial narrow, brown, usually broken before maturity.

Thailand.— NORTHERN: Chiang Rai (Doi Tung), Chiang Mai (Kong Kat, Doi Suthep, Mae Rim), Tak (Ban Musoe, Raheng); NORTH-EASTERN: Loei (Phu Reua, Phu Luang, Phu Kradueng), Nong Khai (Phon Phisai), Udon Thani; EASTERN: Chaiyaphum (Khao Kong); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN; Chanthaburi (Laem Sing, Phriu Waterfall, Makham, Khao Sabap), Trat (Koh Kut, Koh Chang); PENINSULAR: Chumphon (Lang Suan, Ban Pak Chan), Ranang), Surat Thani (Ban Don), Nakhon Si Thammarat (Khao Luang, Thap Chang), Phangnga (between Thanun and Phangnga), Trang (Khao Chong), Satun, Narathiwat (Waeng, Sugai Padi), Yala (Betong, Bannang Sata).

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

Ecology.— On rather dry open slopes in light shade in tropical evergreen forest at 400-600 m altitudes.

GPS Location.— 08° 51' 45.45"N 99° 42' 39.17"E, 08° 52' 04.31"N 99° 42' 18.59"E

Vernacular.— Kut khang fan (กูดข้างฟาน) (Northern); Kut doi (กูดดอย); mahasadam (มหาสดำ) (South-Eastern).

Specimens examined.— Y. Yuyen 22; T. Boonkerd 532, 331 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T 4504, T 4678 [BKF].

LOMARIOPSIDACEAE

Alston, Taxon 5: 25. 1956; Holttum, Rev. Fl. Malaya 2: 115.1954.

Rhizome creeping, dorsiventral in structure, rooting only on the ventral surface (often a row of roots on each side) and with 2 or more rows of leaves on the dorsal surface, the leaf-bases more or less decurrent as ridges on the upper surface of the rhizome or jointed to it young parts of rhizome covered with small to fairly large thin brown scales, peltate attached near the base. Stipes containing several vascular strands arranged in a U-shaped when seen in transverse section. Frond of mature plants simply pinnate or simple; pinnae (when present) entire or more or less deeply lobed, in some case jointed to the rachis; basiscopic edges of pinnae decurrent on a wing or ridge on either side of the rachis. Vein free or anastomosing; if anastomosing, the areoles without free veins, or with free vein directed away from the midrib of pinna. Fertile fronds acrostichoid, the pinnae usually very narrow.

KEY TO THE GENERA

1. Frond simple, plant epiphytic. Stipe usually jointed to rhizome
..... **2. Elaphoglossum**
1. Frond pinnate to decompose. Stipe usually not jointed to rhizome..... **1. Bolbitis**

1. BOLBITIS

Schott, Gén. Fil.: ad. t. 14. 1834; Tagawa & K.Iwats., Fl. Thailand 3(3): 310. 1988.

Rhizome creeping, dorsiventral, bearing two rows of close rounds on dorsal surface and numerous roots on ventral surface, scaly; scale usually concolorous, hardly clathrate, glabrous. Fronds dimorphic, usually not jointed to rhizome, simple to bipinnatifid, often viviparous near apex. Sporangia acrostichoid on the whole under surface, or rarely restricted to marginal portion of fertile pinnae or fronds.

KET TO THE SPECIES

- 1. Veins all free, apex of fronds not elongate..... **1. B. appendiculata**
- 1. Veins anastomosing
 - 2. Areoles included free veinlets..... **3. B. virens**
 - 2. Areoles not included free veinlets
 - 3. Apex of frond particularly elongate, with a bud..... **2. B. heteroclita**
 - 3. Apex of frond not particularly elongate, without bud.... **4. B. sinuata**

1. Bolbitis appendiculata (Willd.) K. Iwats., Acta Phytotax. Geobot. 18: 48 1959; Hennipman, Fl. Males., Ser. II. 1: 322. f. 26b, 27 d-f. 1978; Tagawa & K. Iwats., Fl. Thailand 3(3): 316. 1988. — *Acostichum appendiculata* Willd., Sp. Pl. 5: 114. 1810. — *Egenolfia appendiculata* (Willd.) J. Sm., Ferns Br. For.: 111.1866; Tardieu & C.Chr. in Fl. Gén. I. –C. 7(2): 426. 1941; Holttum, Rev. Fl. Malaya 2: 459. f. 270. 1954. **Fig. 5.14 B-C.**

Rhizome creeping; scales light brown or greyish, linear, up to 4.5 by 0.5 mm
Sterile frond: stipe stramineous, sparsely scaly 5 - 13 cm long, lamina lanceolate, acuminate at apex, 10 – 20 cm by 3.5 - 10 cm; rachis scaly beneath, winged at least on upper part, sometimes viviparous near apex; pinnae 15 - 22 pairs, basal ones slightly shorter than the next above, middle ones the largest, patent or ascending, stalked, oblong to longer, rounded to acute at apex, more or less auricled at acroscopic and dimidiate at basisopic bases, margin shallowly lobed, 1.5 by 0.55 cm, the apical pinna variable in shape and size, usually narrowly subtriangular; veins pinnate, all free; lobes shallow, round, with a distinct tooth at each sinus; papyraceous, deep

green, dark when dried. **Fertile frond:** taller stipe up to 11.6 cm long; lamina linear-lanceolate, 14 - 20 by 2 - 5 cm; rachis wingless, seldom viviparous; pinnae stalked or sessile, linear or narrowly oblong, often moniliform, patent, straight or a little falcate, 1 cm by 1.5 mm; veins simple, forked or pinnate; sporangia dispersed on the lower surface of pinna or lobes.

Thailand.— NORTHERN: Chiang Mai (Doi Suthep, Doi Inthanon), Lampang; NORTH-EASTERN: Phetchabun (Phu Miang), Loei (Phu Luang), Sakhon Nakon (Pha Kham Hom); EASTERN: Nakhon Ratchasima (Pak Thong Chai), Chaiyaphum; SOUTH-EASTERN: Chanthaburi (Khao Sabap), Trat (Koh Chang); SOUTH-WESTERN: Kanchanaburi (Sai Yok, Mae Nam Noi); PENINSULAR: Chumphon (Khao Nom Sao, Ban Krayae), Phangnga (Takua pa, Ko Talibong, Khao Phra Mi), Phuket (Thalang), Nakhao Si Thammarat (Khao Luang, Khao Khi No, Khiriwong, Chawang), Trang (Khao Chong), Songkhla, Satun.

Distribution.— South China, India to SE. Asia generally, throughout Malesia, northwards to Taiwan and the Ryukyus (type from India).

Ecology.— On muddy rocks near streams in dense forest at 330-1,200 m altitudes.

GPS Location.— 08° 51' 28.94"N 99° 42' 44.08"E, 08° 52' 09.89"N 99° 42' 20.76"E, 08° 52' 51.40"N 99° 42' 02.14"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 494; T. Boonkerd, Y. Sirichamorn and C. Sanguansab 178; T. Boonkerd 1465; Y. Yuyen 53 [BCU]; K. Iwatsuki & N. Fukuoka 5486; E. Hennipman 3835 [BKF].

2. *Bolbitis heteroclita* (C. Presl) Ching ex C. Chr., Ind. Fil. Suppl. III. 48. 1934.; Tardieu & C. Chr. in Fl. Gén. I. -C. 7(2): 434. 1941; Holttum, Rev. Fl. Malaya 2: 462. f. 271. 1954; Hennipman., in Fl. Males., Ser. II. 1: 325. f. 25d, 31 a-g. 1978; Tagawa & K. Iwats., Fl. Thailand 3(3): 320. 1988. — *Acostichum heteroclitum* Presl, Rel. Haenk. I.: 15. pl. 2. f. 2. 1825. **Fig. 5.14 D.**

Rhizome long-creeping, scaly; scales nearly black with narrow brown ferruginous margin, linear, up to 4 by 1 mm. **Sterile frond:** stipe 15-25 cm long, stramineous; lamina simple or imparipinnate with one pairs or more than of lateral pinnae; lateral pinnae oblong-lanceolate, cuneate and shortly stalked at base, caudate

at apex, 15-30 by 3-6 cm, almost entire or irregularly shallowly waved, terminal pinna oblong, or very long-tailed with narrow linear tails *c.* 30-45 cm long, up to 15-20 cm long excluding the tail, 5 cm broad; rachis narrowly winged, glabrescent; costa naked, sometimes viviparous; veins distinct on both surfaces, finely reticulated, without included free veinlets; herbaceous or softly papyraceous, glabrous, deep green, blackish as or when dry. **Fertile frond:** stipe nearly the same as those of sterile ones; lateral pinnae *c.* 3 pairs, oblong *c.* 7 by 1.6 cm, apical pinna a little larger than lateral ones, veins reticulate; sporangia spread over the whole undersurface of pinnae.

Thailand.— NORTHERN: Chiang Rai (Mae Kok), Chiang Mai (Doi Chiang Dao), Lampang, Phitsanulok (Nakhon Thani, Thung Salaeng Luang); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chon Buri (Si Racha), Chantaburi (Nam Tok Takhamao, Pong Nam Ron), Trat (Phriu Waterfall, Huai Raeng); SOUTH-WESTERN: Kanchanaburi (Khao Yai), Prachuap Khiri Khan (Khao Luang); PENINSULAR: Nakhon Si Thammarat (Khao Luang), Trang (Khao Chong).

Distribution.— N. India, Upper Myanmar, South and Southwest China, Taiwan, Ryukyo, Indochina, throughout Malesia (type from Luzon) to New Guinea.

Ecology.— On wet ground or on muddy moist rocks usually near streams in dense forests at 500 m altitudes.

GPS Location.— 08° 51' 58.06"N 99° 42' 30.55"E

Vernacular.— Kut pao (กูดป่า), kut hang nok kaling (กูดหางนกคะลิง) (Northern)

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 380 ; O. Rattana 29 ; T. Boonkerd & R. Polawatn 66; Y. Yuyen 69 [BCU] ; K. Iwatsuki 10915; David J. Middleton et al. 1726 [BKF].

3. *Bolbitis sinuata* (Presl) Hennisman, *Blumea* 18: 148. 1970; *Leid. Bot. Ser. 2*: 232. f. 61-62. 1977; in *Fl. Mal. II* 1: 326. f. 27j. 1978; Tagawa & K. Iwats., *Fl. Thailand* 3(3): 320. 1988. — *Polypodium sinuatum* Presl, *Rel. Haenk. I*: 21. 1825. — *Bolbitis diversifolia* (Blume) Schott, *Gen. Fil.: ad.t.* 13. 1835; Holttum, *Rev. Fl. Malaya* 2: 465. f. 273. 1955. — *Acostichum diversifolium* Blume, *En. Pl. Jav.:* 103. 1828. **Fig. 5.14 E.**

Rhizome creeping, ascending, scaly; scales greyish-brown, rather stiff, lanceolate, up to 5 by 1 mm. **Sterile frond** simple or tri-foliate; stipe stramineous or darker, 9-21 cm long, sparsely scaly; simple laminae or terminal pinnae broadly oblanceolate, acuminate at apex, gradually narrowing towards base, 15-46 by 5-8 cm, subentire at margin; midrib scaly beneath; main veins distinct but other veins obscure on both surfaces, reticulate without included veinlets, areoles irregular, many; thickly papyraceous, glabrous. **Fertile frond** nearly the same height as sterile ones; stipe 15-45 cm long; lamina simple or imparipinnate with 2-3 lateral pinnae and a large terminal pinna; lateral pinnae lanceolate, gradually narrowing towards both ends, sessile, up to 7 by 1 cm, terminal or simple pinna lanceolate, *c.* 15 by 2 cm, veins reticulate, obscure.

Thailand.— PENINSULAR: Ranong (Khao Sai Daeng), Nakhon Si Thammarat (Khao Luang), Trang (Khao Chong), Satun, Yala (Ban Mae Wing).

Distribution.— Malaya, Sumatra, eastwards to the Philippines (type).

Ecology.— Lithophyte near streams in tropical evergreen forests about 330 m altitudes.

GPS Location.— 08° 51' 28.94"N 99° 42' 44.08"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 43, 107; T. Boonkerd 1515 [BCU].

4. *Bolbitis virens* (Wall. ex Hook. & Grev.) Schott, Gen. Fil: ad t. 14. 1834; Holttum. Rev. Fl. Malaya 2: 468. f. 275. 1955; Tagawa & K. Iwats., Southeast As. St. 3(3): 85. 1967; Hennipm., Blumea 18: 149. 1970; Leid. Bot. Ser. 2: 180. f. 47-48. 1977; Tagawa & K. Iwats., Fl. Thailand 3(3): 315. 1988. — *Acostichum virens* Wall. ex Hook. & Grev., Ic. Fil. II: pl. 231. 1831. — *Camium virens* (Wall. ex Hook. & Grev.) Presl, Tent. Pterid.: 239. 1836; Copel., Phil. J. Sci. 37: 388. f. 39. 1928. — *Bolbitis costata* auct. non (Presl) Ching: Holttum, Dansk Bot. Ark. 20: 30. 1961. **Fig. 5.14 F.**

Rhizome creeping, thick, densely scaly; scales thin but firm, dark brown, 5 by 1 mm. **Sterile frond:** stipe 20-25 cm long, densely scaly throughout scales on upper portion light brown, ferruginous, appressed, irregular in shape; lamina oblong-ovate to oblong, 35-60 by *c.* 30 cm; lateral pinnae 5-6 pair, stalk, straight, ascending or patent in lower ones, oblong to oblong lanceolate, caudate at apex, narrowly cuneate

or unequally rounded at base, up to 12 by 3 cm, toothed at margin, more or less waved; costa minutely scaly beneath, veins slightly raised on undersurface, reticulate with a few included veinlet in each areole; subcoriaceous, glabrous, green both in living and dried condition, terminal pinna like lateral ones or slightly larger, viviparous near apex. **Fertile frond:** nearly as high as the sterile ones: stipe up to 26 cm long; lamina up to 15 by 13 cm; pinnae about 5 pairs, linear, acuminate at apex, stalked, up to 6.5 by 0.5 cm; sporangia dispersed on the whole undersurface of pinnae.

Thailand.— NORTHERN: Chiang Mai (Doi Chiang Dao, Doi Suthep), Lampang (Doi Khun Tan), Phrae (Mae Sai), Tak (Huai Krasa); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng); SOUTH-EASTERN: Chantaburi (Khao Soi Dao), Trat (Phriu Waterfall, Huai Raeng); SOUTH-WESTERN: Kanchanaburi (Khao Yai, Sai Yok); PENINSULAR: Surat Thani (Khao Hua Khwai).

Distribution.— Yunnan, Chittagong, and Myanmar (type).

Ecology.— Lithophyte near streams in tropical evergreen forests about 500 m altitudes.

GPS Location.— 08° 51' 58.06"N 99° 42' 30.55"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 245: Yuyen 32; T. Boonkerd 1537 [BCU] ; M. Tagawa, K. Iwatsuki & N. Fukuoka T-372, 1086 [BKF].

2. ELAPHOGLOSSUM

Schott, Gén. Fil.: ad. t. 14. 1834; Tagawa & K. Iwats., Fl. Thailand 3(3): 303. 1988.

Rhizome creeping, bearing two rows of fronds on dorsal surface, scaly. Fronds close together or remote, simple, entire, usually coriaceous, dimorphic. Stipes swollen at base, jointed to rhizome; veins simple or forked, parallel or anastomosing in some species. Sporangia acrostichoid, covering the whole lower surface of fertile fronds.

Elaphoglossum malayense Holttum, Blumea 14: 322. 1966; in Fl. Males., Ser. II. 1 : 308. 1978. — *Elaphoglossum callifolium* auct. non (Blume) Moore: Tardieu & C. Chr. in Fl. Gén. I. –C. 7(2): 541. 1939; Holttum, Rev. Fl. Malaya 2: 459. f. 269. 1954. **Fig. 5.14 G - Fig. 5.15 A.**

Rhizome short, densely covered with scales; scales brown, membranous, oblong-lanceolate, up to 1.3 by 0.2 cm, entire or with irregular projections at margin. **Sterile frond:** Stipe 8-12 cm long, stramineous with dark base, slightly winged on upper part, scales at base dense like those on rhizome becoming more sparse upwards; lamina oblong-lanceolate, gradually narrowing towards both ends, 3 by 5.9 cm, entire, narrowly marginate with cartilaginous membrane; midrib raised on 30-48 by 2.5-5.5 cm, entire, narrowly marginate with cartilaginous membrane; midrib raised on both surfaces, very sparsely minutely scaly or glabrescent; coriaceous, veins visible on both surfaces, green, usually brownish in dried specimens. **Fertile frond:** stipe 12-15 cm long; lamina elliptic, gradually narrowing towards both ends, 19 cm long, *c.* 2.05 cm broad.

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

Distribution.— Annam and Malaysia (type)

Ecology.— Epiphyte on mossy tree-trunks in hill evergreen forest about 1,000-1,380 m altitudes.

GPS Location.— 08° 52' 36.19"N 99° 42' 13.85"E, 08° 52' 58.08"N 99° 41' 50.15"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 432; T. Boonkerd, Y. Sirichamorn and C. Sanguansab 2; T. Boonkerd 1492 [BCU]; K. Iwatsuki, H. Koyama, M. Hutoh & A. Chintayungkun T 8377 [BKF].

DRYOPTERIDACEAE

Herter, *Revista Sudamericana de Botánica* 9:15. 1949; Holttum, *Rev. Fl. Malaya* 2: 115.1954.

Stock short, more or less erect, usually densely scaly at apex; scales brown to nearly black, sometimes hairy on the edges, never latticed. Stipes often scaly; vascular strands several. Fronds usually bipinnate or more amply divided, costae grooved, grooves with raised edges which are decurrent upon the edge of the rachis-groove, the

lamina decurrent on the sides of the rachis; leaflets usually unequal-sided at the base; veins free; frond often scaly. Sori round; indusium kidney-shaped or peltate.

KEY TO THE GENERA

1. Frond usually pinnate, bipinnate; veins free; costa grooved
 2. Sori round, pinnae not articulate..... **1. Didymochlaena**
 2. Sori elongate, pinnae articulate..... **4. Polystichum**
1. Frond pinnate, bipinnate, imparipinnate; veins free or anastomosing; costa raised on upper surface
 3. Veins all free; basal posterior vein of a vein-group running from costule; pinna not jointed to rachis; prominent sinus-teeth present**5. Pteridrys**
 3. Veins anastomosing; the basal posterior vein of a vein-group running from costal areoles
 5. Sinus teeth present..... **3. Plecnemia**
 5. Sinus teeth absent between lobes of pinna or pinnule
 6. Basal pinna lobed with short basal posterior lobes or pinnules..... **2. Heterogonium**
 6. Basal pinna unlobed or when lobed the basal basiscopic lobes or pinnules longest..... **6. Tectaria**

1. DIDYMOCHLAENA

Desv., Berl. Mag. 5: 303. 1811; Tagawa & K.Iwats., Fl. Thailand 3(3): 331. 1988.

Rhizome short, ascending to erect, scaly; scales broad, entire, glabrous, concolorous, those on stipe lacerate at margin. Lamina oblong, bipinnate with pinnate apex, glabrescent; veins forked, all free, ending in enlarged submarginal apices, Sori terminal on veinlets, with elongate receptacles, slightly sunken; indusia elliptic, fixed to veinlets along medial line, rounded at distal end, cordate at base, firm, glabrous.

Didymochlaena truncatula (Sw.) J. Bot. 4: 196. 1841; Tardieu & C. Chr in Fl. Gén. I. –C. 7(2): 331. f. 36, 4-5. 1941; Holttum Rev. Fl. Malaya 2: 483. f. 285. 1955; Tagawa & K.Iwats., Fl. Thailand 3(3): 331. 1988. — *Aspidium truncatulum* Sw., Schrad. J. Bot. 1800(2): 36. 1801. **Fig. 5.15** B-C.

Rhizome massive, bearing a group of fronds like a small tree fern, covered densely with scales; scales up to 5 by 0.5 mm, brown or sometimes black-brown in central portion, glabrous, entire. **Stipe** stramineous or dark, very densely covered with scales and downy hairs, up to 30 cm long, grooved on adaxial surface. **Lamina** oblong or narrower, up to 83 by 48 cm, bipinnate; rachis densely covered with narrower scales downy hairs; pinnae 20 or more pairs, joined to rachis, linear-lanceolate, acuminate at apex, subtruncate at base, up to 24 by 4.3; pinna rachis grooved, grooves not decurrent in to those on rachis; leaflet jointed to rachis, uniform in size and form throughout, nearly oblong, about 2.1 by 1 mm, rounded at apex, entire or very slightly serrate at margin; thick, dark green but brown in dried specimens, glabrous, bearing distinct spines at base of leaflets. **Sori** terminal on anterior branch of veins, elongate, somewhat hollowed; indusia glabrous, about 2 mm long.

Thailand.— NORTHERN: Chiang Rai (Doi Phacho), Chiang Mai (Doi Suthep, Doi Inthanon); SOUTH-EASTERN: Chantaburi (Khao Soi Dao, Pong Nam Ron); PENINSULAR: Nakhon Si Thammarat (Khao Luang), Trang (Khao Chong), Phangnga (Khao Phota Luang Kaeo), Yala (Bacho, Khao Sai Khao).

Disribution.— Pantropic (type from Java).

Ecology.— On humus-rich mountain slopes in tropical evergreen forests and hill evergreen forest at 600-1,200 m altitudes.

GPS Location.— 08° 52' 05.08"N 99° 42' 21.70"E, 08° 52' 36.31"N 99° 42' 13.85"E, 08° 52' 51.02"N 99° 42' 01.86"E

Vernacular.— Kut khap (กุดขาก) (Penisular).

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 419; T. Boonkerd 1494 [BCU].

2. HETEROGONIUM

C. Presl, Epim.: 142. 1851; Tagawa & K. Iwats. Fl. Thailand 3(3): 360. 1988.

Rhizome short, erect, with dark castaneous scales. Stipes usually fuscous, hairy with articulate hairs, scaly at base. Fronds catadromous in plan (the basal anterior pinnules interior to the basal posterior one), monomorphic to subdimorphic, pinnate to bipinnatifid, herbaceous, hairy at margin, on axes and on upper surface; basal basiscropic veins sometimes springing directly from costa. Sori dorsal on veins, round or elongate, with reniform indusia or naked.

Heterogonium sageniodes (Mett.) Holttum, Rev. Fl. Malaya 2: 520. f. 306. 1955 p.p.; Tagawa & K. Iwats., Fl. Thailand 3(3): 362. 1988.— *Aspidium sagenioides* Mett., Abh. Senckenb. Naturf. Ges. 2: 397. 1858. **Fig. 5.15** D-E.

Rhizome short, ascending or suberect; scales oblong, gradually narrowing towards long tailed apex, dark brown, stiff paler and somewhat ferruginous at margin hairy, up to 3 by 1 mm. **Stipe** deep purple, polished, 30 cm long, minutely pubescent throughout. **Lamina** bipinnatifid, oblong-lanceolate, caudate at apex, truncate at base, deeply lobed nearly to costa; basal pinna 10 by 4.5 cm, middle pinnae 10 by 3 cm, upper one gradually becoming smaller, adnate at base, forming indistinct apical portion; pinnules oblong-subdeltoid, acute at apex, entire in larger one, herbaceous, deep green, hairy on both surfaces, costules and veins hairy, veinlets forked; hairs on upper surface of lamina of one kind, multiseptate, **Sori** dorsal on veinlets, medial, round exindusiate; indusia small, fugacious, densely hairy.

Thailand.— EASTERN: Chaiyaphum. PENINSULAR: Nakhon Si Thammarat (Khao Nan).

Distribution.— Hainan, Indochina to West Malesia (type from Java).

Ecology.— In tropical evergreen forest at about 460-800 m altitudes.

GPS Location.— 08° 51' 24.23"N 99° 41' 55.78"E, 08° 52' 20.86"N 99° 42' 17.63"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 239; A. Sathapattayanon 1 [BCU].

3. PLEOCNEMIA

C. Presl, Tent. Pterid.: 182. pl. 7. f. 12. 1836; Tagawa & K. Iwats., Fl. Thailand 3(3): 384. 1988.

Rhizome short, massive, erect, scaly; scales very narrow, long, margin with short subpatent teeth, often twisted; lamina bipinnate-tripinnatifid, basal basispic pinnules of basal pinnae much enlarged; sinus teeth present at bottom of sinus between two lobes; vein anastomosing to form costal, and sometimes also costular areoles; hair multicellular, short, coarse; glandular hairs on costa and veins beneath usually yellow, cylindrical; sori not terminal, on free or anastomosing and veins round, indusiate or exindusiate, paraphyses with large cylindrical yellow glandular apical cells.

KEY TO THE SPECIES

1. Frond bipinnatifid; vein copiously anastomosing to form areoles other than costal and costular; glabrous at margin..... **1. P. irregularis**
1. Frond tripinnatifid; vein anastomosing in costal and costular areoles only; hairy at margin..... **2. P. sp.**

1. Pleocnemia irregularis (C. Presl) Holttum, Kew Bull. 29: 347. 1974; Tagawa & K. Iwats. Fl. Thailand 3(3). 387. 1988. — *Polypodium irregulare* C. Presl, Rel. Haenk. 1: 21. 1825. — *Arcypteris irregularis* (C. Presl) Holttum Reinwardtia 1: 193. f. 1-3. 1951; Rev. Fl. Malaya 2: 538. f. 317-318. 1955. **Fig. 5.15** F-G.

Rhizome thick, erect, short, densely scaly; scales linear, up to 12 by 1.5 mm, dark brown, thin and more or less crisped, entire or irregularly toothed at margin, **Stipe** up to 80 cm long, dark and scaly at base, stramineous upwards. **Lamina** bipinnate at base, oblong-subdeltoid, usually more than 0.70-1 m long, 50-70 cm wide at base, basal pinnae the largest, asymmetrically subdeltoid with large basispic pinnules, middle pinnae oblong-lanceolate, acute to acuminate at apex, shortly stalked, with several free pinnules, apical portion large, pinnatifid; rachis and pinna-rachis glabrescent; pinnules sessile or more or less adnate, oblong-subdeltoid, falcate, caudate at apex, cuneate at base, waved at margin, usually about 10 by 1.2 cm;

chartaceous, green to yellow green, brownish in dried specimens, glandular hairy at margin and on lower surface; veins forming copious anastomosing, a distinct broad tooth at each sinus between pinnules and between crenate of pinnules. **Sori** small, dorsal on anastomosing veins, scattered irregularly; exindusiate.

Thailand.— NORTHERN: Chiang Mai (Doi Chiang Dao), Phitsanulok (Thung Salaeng Luang); CENTRAL: Nakhon Nayok (Salika Falls, Khao Yai); SOUTH-EASTERN: Chon Buri (Ang Chang Nam), Chantaburi (Khlung, Khao Soi Dao), Trat (Koh Chang); SOUTH-WESTERN: Kanchanaburi (Khao Ngi Yai); PENINSULAR: Chumphon (Khao Tong), Ranong (Thap Li, Lam Liang, Khlong Kam Phuan), Surat Thani (Ban Don), Phuket (Tha Nun), Phangnga (Khlong Nang Yon), Nakhon Si Thammarat (Thung Song, Khao Luang, Khao Nan, Ron Phibun), Trang (Khao Chong), Satun, Pattani, Narathiwat (Waeng), Yala (Bannang Sata).

Distribution.— Myanmar (Tenasserim), Cambodia, Malesia throughout (type from Philippines) to Fiji.

Ecology.— On rather dry slopes in tropical evergreen forests at 400-700 m altitudes.

GPS Location.— 08° 51' 45.45"N 99° 42' 39.17"E, 08° 52' 11.04"N 99° 42' 20.90"E

Specimens examined.— T. Boonkerd, S.Chantanaorapint and W. Khwaiphan 28; O. Rattana 8; K. Lukchant 18 [BCU]; K. Iwatsuki & N. Fukuoka T 7195 [BKF].

2. *Pleocnemia* sp. Fig. 5.16 A.

Rhizome thick, erect, scaly; scales up to 3 cm long and 0.6 mm broad, brown, herbaceous, toothed at margin in upper part. **Stipe** up to 34 cm long or more long, densely scaly at base, scales pubescent upwards, stramineous. **Lamina** c. 45 cm long, tripinnate; pinnae lanceolate 17 by 10.5 cm; rachis and pinna-rachis grooved on upper surface, densely pubescent, pinnules lanceolate, caudate at apex, shortly stalked or sessile, the base hardly or slightly narrowing, 8 by 2 cm in larger ones, lobes almost to costa, segment oblong, round or moderately acute at apex, subentire, papyraceous, deep green, sparsely hairy at margin; veins anastomosing to from costal and costular areoles or sometimes with one or more rows of areoles formed outside the other veins free. **Sori** dorsal on veins, a single row at each side of midrib, medial, naked.

Thailand.— Nakhon Si Thammarat (Khao Nan).

Distribution.— -

Ecology.— On mountain slope in hill evergreen forest at 1,033 m altitudes.

GPS Location.— 08° 52' 38.35"N 99° 42' 13.36"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 401; T. Boonkerd, Y. Sirichamorn and C. Sanguansab 166[BCU].

Note.— *Pleocnemia* sp. was a terrestrial plant in hill evergreen forest. It is closely related to *Pleocnemia hemiteliiformis* (Racib.) Holttum, but differed in having lamina tripinnate, pinnule-segment with sparse hairs at margin.

4. POLYSTICHUM

Roth, Arch. Bot. 2(1): 106. 1799; Tagawa & K. Iwats., Fl. Thailand 3(3): 333. 1988.

Rhizome short, usually ascending or erect, bearing a tuft of fronds at apex; scales usually rather broad, lacerate. Stipes densely scaly. Fronds usually oblong, narrow at base, anadromic in sequence, pinnate, coriaceous, with mucronate apex of ultimate lobes; veins all free, usually bearing fibroid scales. Sori commonly dorsal on veins round; indusial round, peltate, or rarely wanting.

Polystichum prolificans v. A. v. Ros., Bull. Jard. Bot. Buit. III. 2: 170. 1920; Holttum, Rev. Fl. Malaya 2: 490. f. 290. 1955; Tagawa & K. Iwats., Fl. Thailand 3(3): 336. 1988. **Fig. 5.16 B-C.**

Rhizome short, ascending; scales large oblong-subdeltoid, acuminate to tailed at apex, up to 13 by 6.5 mm, entire bicoloured, central portion shining black, rigid and tough, margin brown, thinner. **Stipe** stramineous, 48 cm long, the sub-basal part at least bearing narrow brown scales, never nigrescent, dense. **Lamina** to 66 cm long, 26 cm wide, bipinnate, sub-basal pinnae largest, upper pinnae very gradually reduced, one of them bearing a bud in its axil. Pinnae to about 18.5 cm long, 4.3 cm wide at the base shortly stalked, pinnae almost throughout; pinnules to 2.4 cm long, shortly stalked, falcate, the base auriculate on the acroscopic side, narrowly cuneate below, the edges above the basal auricle rather shallowly crenate-lobate, the apices of the

lobes never aristate and often blunt; vein-groups in each lobe several times alternately forked, bearing several, chartaceous to fleshy; rachises and lower surface bearing rather copious very narrow hair-like brown scales with a small round base. **Sori** in the larger lobes, one only (apical on the acroscopic vein, rather near the costa) opposite the smaller distal lobes.

Thailand.— PENINSULAR: Nakhon Si Thammarat (Khao Luang), Phangnga (Khao Phra Mi), Trang (Khao Chong), Yala (Khao Kala Khiri).

Distribution.— West Malaysia and Sumatra (type).

Ecology.—Terrestrial on humus-rich floor or on rocks in tropical evergreen forest and hill evergreen forest at 650-1,200 m altitudes.

GPS Location.— 08° 51' 32.55"N 99° 41' 32.76"E, 08° 52' 51.02"N 99° 42' 01.86"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 163; T. Boonkerd 1493, 46 [BCU]; T. Shimizu, H. Toyokuni, H. Koyama, T. Yahara & C. Niyomdham T 26766 [BKF].

5. PTERIDRYS

(C. Chr.) C. Chr. & Ching, Bull. Fan Mem. Inst. Biol. 5: 125. 1935; Tagawa & K. Iwats. Fl. Thailand 3(3). 388. 1988.

Rhizome short, ascending or erect, scaly; scales narrow, concolorous brown to darker, usually entire; stipe scaly or glabrescent. Lamina oblong in outline, bipinnatifid with distinct, pinnatisect apical pinnae narrowly elliptic, basal basisopic pinnules not distinctly larger, chartaceous, dark green or deep glass-green above and paler beneath, glabrous; rachis grooved, hairy below with septate multicellular hairs; venation campteriod, i.e basisopic branch of anterior basal vein meeting at sinus with that of posterior basal vein of next segment but never actually uniting, basal veins sometimes springing directly from costa; a prominent deltoid tooth at each sinus between adjacent pinnules. Sori round, dorsal or terminal on short acroscopic branch of veins, one row at each side of costule; indusial round-reniform.

Pteridrys australis Ching, Bull. Fan Mem. Inst. Biol. 5: 142. pl. 15, 16, 19(12-13). 1934; Tardieu & C. Chr. in Fl. Gén. I. –C. 7(2): 306. 1941; Holttum, Rev. Fl. Malaya 2: 532. f. 313. 1955; Tagawa & K. Iwats. Fl. Thailand 3(3) 390. f. 391. 1988.

Rhizome short creeping, rather thick, scaly narrowed at apex; scales lanceolate, long tailed at apex, up to 10 by 1.5 mm, dark-brown, stiff. **Stipe** stramineous or darker, scaly at base, glabrescent above, 45-52 cm long. **Lamina** oblong, hardly or a little narrowing at base, pinnate with very deeply lobed pinnae, up to 75-80 by 30 cm; rachis like the upper part of stipe, hairy throughout; pinnae 18 or more pairs, lanceolate, caudate at apex, broadly cuneate to subtruncate at base, sessile or very shortly stalked, deeply lobed to $\frac{3}{4}$ way towards costa, c. 18-22 by 2.5-3 cm; costa and costule raised on both surfaces, hairy beneath; segments oblong to oblong-lanceolate, oblique to falcate, moderately acute at apex, serrate at margin; veins once or twice forked, the basal ones springing from the base of costule; the basal acroscopic branches soriferous, stopped at various positions between costule and margin, glabrous. **Sori** round, c. 1 mm diameter, a row in medial position at each side of costule; indusial reniform, hairy.

Thailand.— NORTHERN: Chiang Mai (Doi Chiang Dao), Lampang; SOUTH-EASTERN: Chanthaburi (Khao Soi Dao, Makham); PENINSULAR: Nakhon Si Thammarat (Khao Luang), Ranong (Khlung Kamphuan), Phangnga (Takua Pa), Yala (Ban Chana).

Distribution.— South China (type from Kwangtung), Myanmar, North Vietnam and West Malaysia.

Ecology.— On mountain slopes in tropical evergreen forests at 400-500 m altitudes.

GPS Location.— 08° 51' 37.24"N 99° 42' 40.52"E, 08° 52' 11.04"N 99° 42' 20.90"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphon 96, 377; T. Boonkerd 454 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T 5305 [BKF].

6. TECTARIA

Cav., Ann. Hist. Nat. 1 : 115. 1799; Tagawa & K. Iwats., Fl. Thailand 3(3): 364. 1988.

Rhizome usually thick, short, erect to short-creeping, scaly at apex. Stipes stramineous to ebeneous. Fronds simple to amply divided, usually broad or pentagonal in outline; all axes hairy with articulated multicellular hairs; veins free to variously anastomosing with or without included veinlets. Sori terminal on included free veins, dorsal on veins or compital on connected veins usually round-reniform.

KEY TO THE SPECIES

1. Frond simple, entire..... **3. T. singaporeana**
 1. Frond deeply lobed to pinnately or more compound
 2. Frond pinnate or more compound; entire at margin..... **2. T. semipinnata**
 2. Frond deeply lobes, lobes connected by a wing decurrent on stipe; entire or rarely coarsely dentate at margin..... **1. T. polymorpha**

1. Tectaria polymorpha (Wall. ex Hook.) Copel., Phil. J. Sci. 2C: 413. 1907. Tardieu & C. Chr. in Fl. Gén. I. –C. 7(2): 417. 1941.; Tagawa & K. Iwats., Fl. Thailand 3(3): 379. 1988. — *Aspidium polymorphum* Wall. ex Hook. Spec. Fil. 4: 54. 1862. **Fig. 5.16 D.**

Rhizome short, ascending to suberect; scales linear-subtriangular, about 9 by 2 mm, brown, stiff, margin with pale thinner edges. **Stipe** stramineous to brown, densely pubescent on adaxial surface, glabrescent beneath, 22 cm long. **Lamina** imparipinnate, ovate-oblong. 32.5 by 25 cm; rachis densely pubescent on upper surface, glabrescent beneath; lateral pinnae oblong-lanceolate, caudate at apex, cuneate to rounded at base, sessile, broadest at 1/3 way from apex; usually about 29 by 11.4 cm, subentire, or rarely coarsely dentate, or each basal pinna sometimes with single large basispic lobe, terminal pinna a little larger, broadest at 2/3 way from apex, up to 13.3 by 6.4 cm, papyraceous, green, glabrous; costa and main veins distinctly raised beneath, glabrous. **Sori** on cross veins or sometimes on included free veins, irregularly scattered on lower surface of pinnae, round; indusia small, fugacious, pubescent.

Thailand.— NORTHERN: Ching Rai (Mae Suai, Mae Kok, Doi Phacho), Ching Mai (Doi Chang, Tha Ton, Khun Khong Sang, Doi Chiang Dao, Mae Son, Huai Sai), Tak (Ban Na, Ban Musoe), Phitsanulok (Thung Salaeng Luang), Nakhon Sawan (Pa Ma Kham Pom); NORTH-EASTERN: Loei (Phu Luang, Sam Phai, Phu Kraduang); CENTRAL: Nakhon Nayok (Khao Yai), Saraburi (Muak Lek); SOUTH-EASTERN: Chantaburi (Khao Soi Dao, Khao Sabap, Takha Mao Falls); SOUTH-WESTERN: Kanchanaburi (Song Tho); PENINSULAR: Chumphon (Khao Tong), Surat Thani (Ban Don), Nakhon Si Thammarat (Chawang), Trang (Khao Chong), Yala (Bannang Sata).

Distribution.— E. Himalaya (type) to South China and Taiwan, south to Sri Lanka and West Malaysia.

Ecology.—On mountain slopes usually in dry places in tropical evergreen forests at 400-500 m altitudes.

GPS Location.— 08° 51' 37.24"N 99° 42' 40.52"E, 08° 51' 25.45"N 99° 41' 47.36"E

Vernacular.— Kut kaeo (กูดแก้ว), Kut taem (กูดเต็ม), kut kai (กูดไค้), Kut hua lek (กูดหัวเหล็ก), (Northern); Kut hok (กูดหอก) (Shan/Northern); Seng-khia-du (เซ็งเคี้ยวดู) (Karen/Northern).

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphon 59, 76; T. Boonkerd, Y. Sirichamorn and C. Sanguansab 209 [BCU]; K. Iwatsuki & N. Fukuoka T 7321 [BKF].

2. *Tectaria semipinnata* (Roxb.) Morton, Contr. U. S. Nstl. Herb. 38. 286. 1974; Fl. Males. Ser. II. 2(1): 78. 1991. — *Acrostichum semipinnatum* Roxb., Calcutta J. Nat. Hist. 4. 480. 1844. — *Gymnogramma maingayi* Baker, Syn. Fil. d. 2. 517. 1874.— *Tectaria maingayi* (Baker) C. Chr., Index Filic. Suppl. 3. 182 1934; Holttum, Rev. Fl. Malaya 2: 509. (f. 302), 513, 626. 1955; Tagawa & K. Iwats., Fl. Thailand 3(3): 382. 1988. **Fig. 5.16** E-F.

Rhizome short erect; fronds of smaller plants with wholly winged rachis, the stipe also at least partly winged, basal pinnae of largest plant free with slightly decurrent bases or joined to the rachis wing. **Stipe** of largest fronds up to 60 cm long, basal scales c. 10 by 1 mm, the lowest with fertile margin. **Lamina** to 60 cm long,

thin consisting of 3-5 lobes which when nearly free are narrowed towards their bases; basal pinnae sometimes with a winged stalk-like base and a large basiscopic lobe. pinnae or lobes of fertile frond narrower than those of sterile ones which about 7 cm wide; minute hairs present on both surfaces of costae only; main veins of pinnae 8-10 mm apart along the costa, upcurved, the cross-veins rather regular with many areoles between them. **Sori** numerous, very irregular in shape, on free veins, often coalescent to linear forms, exindusiate.

Thailand.— Nakhon Si Thammarat (Khao Nan).

Distribution.— Peninsular Thailand; Malesia, Malay Peninsular and North Sumatra.

Ecology.— In mountain slopes often near streams in tropical evergreen forests at 340-700 m altitudes.

GPS Location.— 08° 51' 29.27"N 99° 42' 44.44"E, 08° 52' 11.04"N 99° 42' 20.90"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 249, Y. Yuyen 44 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka 5573 [BKF].

3. *Tectaria singaporeana* (Wall. ex Hook. & Grev.) Ching, *Sinensia* 2: 25. 1931; Holttum, *Rev. Fl. Malaya* 2: 512. 1955; Tagawa & K. Iwats., *Fl. Thailand* 3(3): 380. 1988. **Fig. 5.16 G - Fig. 5.17 A.**

Rhizome short, ascending to suberect, bearing a tuft of fronds at apex, scaly; scales gradually narrowing from base towards apex, brown, thin but stiff, up to 7 by 1 mm, the margin ferruginous or hairy. **Stipe** castaneous, more or less polished, up to 45 cm in fertile and 35 cm in sterile ones, scaly at base, appressed hairy upwards. **Lamina** simple, entire, broadly lanceolate, caudate-acuminate at apex, attenuate at base, up to 40 by 10 cm, the fertile ones usually narrower; papyraceous, green to deep green, glabrescent; rachis like the upper part of stipe, glabrescent, distinctly raised beneath; main veins beneath, venation copiously anastomosing with main areoles and smaller areoles bearing rarely branched included free veinlets. **Sori** usually dorsal on reticulate veinlets, two rows between adjacent cross veins and 4-5 rows between main veins, round, *c.* 1.5 mm diameter; indusia small, glabrous.

Thailand.— PENINSULAR: Surat Thani (Ban Don), Krabi (Koh Lanta), Nakhon Si Thammarat (Thung Song, Chawang, Khao Luang), Trang (Khao Chong), Satun (Khlong Ton, Bukit Tingki), Narathiwat (Waeng), Yala (Bannang Sata).

Distribution.— Western Malesia (type from Singapore).

Ecology.— On mountain slopes often near streams in tropical evergreen forests at 340-600 m altitudes.

GPS Location.— 08° 51' 29.27"N 99° 42' 44.44"E, 08° 52' 04.31"N 99° 42' 18.59"E

Vernacular.— Tan loi (ตานลอย) (Peninsular)

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 34, 132 [BCU]; K. Yoda 530; K. Iwatsuki, H. Koyama, M. Hutoh & A. Chintayungkun T 8439 [BKF].

THELYPTERIDACEAE

Ching ex Pic.Serm. *Webbia* 24: 709. 1970; Kuo, Fl. Taiwan vol. 1. 2.nd ed.: 401. 1980; Holttum, in Fl. Males., Ser. II. 1: 331. 1981.

Terrestrial ferns, rhizome short-creeping or long-creeping; rarely scandent; scales usually thin not peltate. Stipes not articulated to rhizome, contain two vascular bundles at base and uniting into a U-shaped bundle in the upper part. Fronds usually pinnate crenate or lobed pinnae, upper surface of costae grooved or not, if grooved, not open to admit grooves of rachis; lowest pinnate without enlarged basiscopic basal pinnules; hairs normally unicellular; veins free in deeply lobed pinnae, or basal veins in adjacent lobes anastomosing to form an excurrent vein, which may be joined by other veins, terminating at the base of a sinus-membrane. Sori borne on abaxial surface of veins, indusiate or not; indusia reniform, glabrous or bearing hairs and or glands.

KEY TO THE GENERA

1. Gland or setae usually present on body of sporangia, vein anastomosing
 2. Indusia round-reniform, not or hardly elongate, or wanting..... **1. Christella**
 2. Indusia elongate..... **3. Pronephrium**
1. No glands or hair on body of sporangia, vein all free..... **2. Mesophlebion**

1. CHRISTELLA

H. Lév., Fl. Kouy-Tcheou 472. 1915; Kuo, Fl. Taiwan vol. 1. 2nd ed.: 402. 1980.

Rhizome erect, suberect or creeping or slender and wide-creeping; scales almost always narrow with many superficial hairs. Fronds 1-5 pairs of lower pinnae gradually decrescent, the lower usually auricled on the acroscopic base, areophores absent; largest pinnae shallowly to deeply lobed, bearing erect acicular hairs on all parts of the lower surface, between veins on the upper surface, small capitate hairs; vein anastomosing or free. Sori indusiate, sporangia lacking hairs or glands distally but bearing unicellular elongate glandular hairs on their stalks.

KEY TO THE SPECIES

1. Undersurface of lamina densely hairy; lower pinnae not reduced..... **1. C. dentata**
1. Undersurface of lamina glabrous or subglabrous; lower pinnae reduced
..... **2. C. papilio**

1. Christella dentata (Forssk.) Brownsey & Jermy, Brit. Fern Gaz. 10: 338. 1973; Holttum, Kew Bull. 31: 314. 1976; in Fl. Males. II. 1: 557. f. 1 p, 20a. 1981. — *Polypodium dentatum* Forssk. Fl. Aegypt. Arab, 185. 1773. — *Cyclosorus subpubescens* auct. non (Blume) Ching; Holttum, Rev. Fl. Malaya 2: 273. f. 157. 1955. — *Theypteris dentata* (Forssk.) St. John, Amer. Fern J. 26: 44. 1966; Tagawa & K. Iwats., Southeast As. St. 3(3): 79. 1965; 5: 65. 1967; Tagawa & K. Iwats., Fl. Thailand 3(3): 427. 1988. **Fig. 5.17 B.**

Rhizome short, erect, ascending, or shortly creeping, with a tuft of fronds; scales narrow, *c.* 4 by 1 mm, pale brown, hairy. **Stipe** *c.* 30-45 cm long, bearing reduced pinnae on upper portion, scaly at base, hairy throughout. **Lamina** narrowly oblong, acute at apex, gradually narrowing towards downwards, up to 75 by 26 cm; lateral pinnae *c.* 17 pairs, patent to ascending, sessile, linear-lanceolate, more or less auricled at base, gradually narrowing towards long-acuminate apex, up to 15 by 1.5-2 cm, lobed 1/3 to 2/3 way to costa; lower pinnae gradually becoming smaller downwards but rarely reduced to more auricles; segments oblong-subdeltoid, oblique, rounded at apex, entire; herbaceous to softly papyraceous, yellow green to green, densely pubescent on both surfaces; basal veinlets and basal second anterior ones uniting below callous-membrane. **Sori** medial, round; indusia large, densely hairy.

Thailand.— NORTHERN: Chiang Rai (Mae Kok, Ban Nong Lu), Chiang Mai (Doi Suthep, Mae Klang), Mae Hong Son (Khun Yuam), Lamphun (Doi Khun Tan), Lampang (Mae Ang), Phrae (Mae Sai), Tak (Ban Musoe, Mae Sot), Phitsanulok (Thung Salaeng Luang); NORTH-EASTERN: Phetchabun (Phu Miang), Loei (Phu Luang, Dan Sai), Khon Kaen (Pha Nok Khao); CENTRAL: Nakhon Nayok (Khao Yai), Saraburi (Krabin, Bu Phram), Chanthaburi (Khao Soi Dao, Khao Sabap), Trat (Ko Chang); SOUTH-WESTERN: Kanchanaburi (Bang Krasi, Wangka, Phomphi, Thung Kang Yang); PENINSULAR: Surat Thani (Ban Don), Nakhon Si Thammarat (Khao Luang, Thung Song), Phangnga, Trang, Satun.

Distribution.— Pantropic (type from Arabia).

Ecology.— Terrestrial semi-shade in tropical evergreen forest at 500-700 m altitudes.

GPS Location.— 08° 51' 25.45"N 99° 41' 47.36"E, 08° 52' 11.04"N 99° 42' 20.90"E

Specimens examined T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 217; Y. Yuyen 5 [BCU].

2. *Christella papilio* (C. Hope) Holttum, in Nayar & Kaur, Comp. Bedd. Handb.: 208. 1974; Kuo, Fl. Taiwan vol. 1. 2nd ed.: 402. 1980; Holttum in Fl. Mal. II. 1: 556. f. 20 d-e. 1981. — *Nephrodium papilio* Hope. J. Bombay Nat. Hist. Soc. 12. 625. t. 12. 1899. — *Thelypteris papilio* (C. Hope) K. Iwats., Mem. Coll. Sci. Univ. Kyoto B. 31: 175. 1965; Tagawa & K. Iwats., Fl. Thailand 3(3): 379. 1988. **Fig. 5.17** C-D.

Rhizome short, erect, ascending, with a tuft of fronds; scales broad, about 10 by 0.5 mm membranous, usually appressed, hairy. **Stipes** about 9 cm long, bearing reduced pinnae scaly at base, hairy throughout. **Lamina** oblong acute at apex, gradually narrowing downwards, up to 44 by 30 cm; lateral pinnae about 16 pairs, patent to ascending, sessile, lanceolate, auricled at base, gradually narrowing towards long-acuminate apex, up to 6.6 by 2 cm lobed 1/3 way to costa; lower reduced pinnae butterfly-shaped, usually opposite in pairs; segments oblong, oblique, rounded at apex, entire; paperaceous, green, glabrous on both surfaces; venation goniopteroid, basal 2 pairs anastomosing below callous-sinus. **Sori** medial, round; indusia rather sparsely hirsute.

Thailand.— NORTHERN: Chiang Mai (Doi Inthanon, Doi Suthep); SOUTH-WESTERN: Kanchanaburi (Khao Ngi Yai).

Distribution.— Sri Lanka, Himalaya (type), Taiwan and Malaysia.

Ecology.— Lithophytes near steramlets at edge of tropical evergreen forests at 600-700 m altitudes.

GPS Location.— 08° 52' 04.31"N 99° 42' 18.59"E, 08° 52' 11.04"N 99° 42' 20.90"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint, and W. Khwaiphan 476; Y. Yuyen 83 [BCU]; David J. Middleton, Somran Suddee, Stuart J. Davies & Chandee Hemrat 1048 [BKF].

2. MESOPHLEBION

Holtum. *Blumea* 29. 19. 1971; Holtum, *Fl. Males.*, Ser. II. 377. 1981.

Rhizome creeping, sometimes elongate; scales narrow, rather rigid but never spine-like, bearing short acicular hairs; similar scales at base of stipe, in a few species through stipe. Fronds simply pinnae, sometimes dimorphic; basal pinnae not reduced but \pm narrowed towards their asymmetric bases; aerophores often distinctly swollen on living fronds, collapsing on drying; all pinnae lobed, in some cases deeply; vein all simple and free, basal basiscopic vein arising from costa near the base of the costule to which it belongs; basal veins from adjacent costules usually both passing to base of sinus between their lobes, touching sides of the sinus-membrane, which may be slightly decurrent between them as a hairy ridge; lower surface of costae, costules and

veins always bearing many narrow scales in various degrees of reduction in addition to a varied complement of acicular unicellular hairs and in some cases sessile spherical orange glands; upper surface hairy on costa only; sori in almost all cases indusiate, the indusia in most cases thin and sometimes small; young sporangia often pale violet-purple; large spherical orange-red glands attached directly or by a hair to stalks of sporangia, no glands nor hairs on body of sporangia.

Mesophlebion crassifolium (Blume) Holttum, *Blumea* 22. 232. 1975. — *Aspidium crassifolium* Blume. *Enum. Pl. Jav.* 158. 1828. — *Thelypetris crassifolium* (Blume) Ching; Holttum, *Rev. Fl. Malaya* 2. 246. 1955; Tagawa & K. Iwats., *Fl. Thailand* 3(3): 403. 1988. **Fig. 5.17** E-F.

Rhizome creeping, up to 5.5 mm in diameter; scales linear-lanceolate, up to 2.5 by 1 mm, brown, hairy. **Stipe** stramineous with dark base, about 53.5 cm in soriferous fronds, 27.5 cm in sterile ones. **Lamina** oblong, attenuate at apex, up to 43.2 by 26 cm, narrower in soriferous fronds; lowest pinnae usually deflexed, lower pinnae distinctly stalked, narrowly oblong with acuminate apex and broadly cuneate base, up to 2/3 way towards costa; upper pinnae sessile, smaller, ascending; segments oblong, oblique to falcate, round at apex, entire, up to 7 by 2.5 mm; chartaceous, deep green, verrucose on lower surface; veins pinnate, veinlets simple, basal posterior ones springing directly from costa, running to sinus between segment. **Sori** medial, 1 mm diameter; indusia persistent, hairy.

Thailand.— PENINSULAR: Surat Thani (Khao Lak), Nakhon Si Thammarat (Khao Luang), Narathiwat (Sungai Padi), Satun.

Distribution.—West Malesia (type from Java).

Ecology.— On humus-rich mountain slopes in tropical evergreen forest at about 550 m altitudes.

GPS Location.— 08° 51' 24.23"N 99° 41' 55.78"E, 08° 51' 58.06"N 99° 42' 30.55"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 135, 142 [BCU]; T. Shimizu, K. Iwatsuki, N. Fukuoka & M. Hutoh M 13529; M. Tagawa, K. Iwatsuki & N. Fukuoka T 4783 [BKF].

3. PRONEPHRIUM

C. Presl, Abh. Konigl. Bohm. Ges. Wiss., ser. 5,6: 618-619. 1851; Holttum, Blumea 19: 34. 1971; l.c. 20: 105-106. 1972; in Fl. Males., Ser. II. 1: 507. f. 1 n-o. 14-16. 1981.

Rhizome creeping or suberect. Fronds simple or simply pinnate with free apical pinnae, basal pinnae not reduced but often narrowed at base on basiscopic side, pinnae entire or nearly so; venation goniopteroid, veinlets almost all anastomosing. Sori indusiate or exindusiate, sporangia often bearing short setae, less often bearing spherical gland or both glands and setae.

Pronephrium repandum (Fée) Holttum, Blumea 20. 108. 1972; in Fl. Mal. II. 1: 533. f.1 n, 16 i-j. 1981. — *Goniopteris repanda* Fée, Gen. Fil. 251. 1852. — *Thelypteris repanda* (Fée) Tagawa & K. Iwats., Acta Phytotax. Geobot. 26: 170. 1975. Tagawa & K. Iwats., Fl. Thailand 3(3): 413. 1988. **Fig. 5.17** G-H.

Rhizome short-creeping, fronds tufted at its apex; scales densely short-hairy with narrow very hairy scale at base, up to 11 by 1.5 mm. **Stipe** to 84.5 cm long, slightly flushed with dark scaly at base. **Lamina** to 50 cm long, firm, drying green except rachis, costae and costules brownish; apex pinna-like with asymmetric cuneate base; pinnae 5 pairs; lowest pinnae usually slightly smaller than the upper one, always more narrowed at base than the rest. Middle pinnae commonly 23.4 cm, largest 4.6 cm, widest at or more commonly above, the middle gradually narrowed to a rather abruptly cuneate base, apex abruptly acuminate; edges serrate with very narrow pale cartilaginous margin: costules 4 mm apart, at 45-60°, slightly curved; prominent both sides, slightly curved; at 45° to costule, excurrent veinlets often but not always free; lower surface of rachis and costae densely covered with erect pale hairs, similar hairs more sparse on costules, surface between veins finely pustular, bearing a variable number of short erect hairs some of which may be hooked; upper surface of rachis and costae hairy as lower surface, the rest glabrous, surface between veins minutely pustular, papery, firm, green. **Sori** medial or supramedial, not elongate, exindusiate; sporangia bearing short setae distally.

Thailand.— NORTHERN: Chiang Mai (Doi Inthanon, Doi Suthep); SOUTH-WESTERN: Kanchanaburi (Khao Ngi Yai).

Distribution.— Myanmar (Moulmein), North Vitenam, Malaysia (type), Sumatra, Boneo (var. *nitida*) and Philippines (var. *nitida*).

Ecology.— On humus-rich mountain slopes in tropical evergreen forest at about 330-800 m altitudes.

GPS Location.— 08° 51' 29.27"N 99° 42' 44.44"E, 08° 52' 16.47"N 99° 42' 17.91"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 143; T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 488; O. Rattana 8; K. Lukchant 18 [BCU]; K. Iwatsuki, H. Koyama, M. Hutoh & A. Chintaungkun T 14640; T. Shimizu, N. Fukuoka & A. Nalampoon 8185 [BKF].

WOODSIACEAE

(Hook.) Herter, Revista Sudamer. Bot. 9: 14. 1949. — *Athyriaceae* Alston, Taxon 5: 25. 1956; Devol, Fl. Taiwan vol. 1. 2nd : 441. 1980.

Rhizome usually short and stout, sometimes creeping and slender; scales thin, light brown to dark brown, lanceolate or ovate. Fronds usually thin, pinnate to decompose, rarely simple; veins usually free, goniopteroid or forming areolae, usually glabrous; rachis grooves generally open to receive rachilla grooves but not in all genera. Sori elongate or round to oblong. Indusia round-reniform or horse-shoe shaped or naked.

DIPLAZIUM

Sw., Schrad. J. Bot. 1800(2): 61. 1801: Tagawa & K. Iwats., Fl. Thailand 3(3): 449. 1988.

Rhizome creeping to erect, scaly; rhizome-scales entire or toothed; rachis grooved, grooves distinct, open. Fronds simple to pinnately compound; veins pinnate, or reticulate to form rather regular quadrangular areoles at each side of veinlets; usually glabrous or minutely scaly on axes. **Sori** elongate along veins; indusiate, often adjacent to the next ones, opening in opposite direction.

KEY TO THE SPECIES

1. Vein anastomosing; proliferous at junction between stipe and midrib
 **2. D. cordifolium**
1. Vein free or rarely anastomosing
 2. Rhizome creeping
 3. Frond pinnate; gemmae present..... **1. D. bantamense**
 3. Fronds imparipinnate-pinnate; gemmae absent..... **5. D. donianum**
 2. Rhizome short, erect or ascending
 4. Frond imparipinnate-pinnate
 5. Rhizome scales entire or irregular wave margin
 6. Rhizome scales irregular wave margin; lateral pinnae
 5-9 pairs, gemmae present at junction
 **6. D. xiphophyllum**
 6. Rhizome scales entire; lateral pinnae more than 4
 pairs
 7. Pinnae about 13-15 pairs, sori impressed
 **10. D. tomentosum**
 7. Pinnae about 18-20 pairs, sori superficial
 costa..... **9. D. sorzgonense**
 5. Rhizome scales tooth
 8. Rhizome scales tooth; pinnae distinctly
 auricled at base..... **3. D. crenatoserratum**
 8. Rhizome scales distinctly tooth; pinna less or
 moderately auricle at base..... **7. D. silvaticum**
 4. Frond bipinnate-tripinnate
 9. Lobes oblong with rounded apex, pinnules long-stalked;
 veinlets simple or forked..... **4. D. dilatatum**
 9. Lobes subquadrangular with obtuse apex, pinnules shortly or
 sessile stalked; veinlets all simple **8. D. simplicivenium**

1. *Diplazium bantamense* Blume, En. Pl. Jav.: 191. 1828; Tagawa & K. Iwats., Fl. Thailand 3(3): 455. 1988. — *Athyrium bantamense* (Blume) Milde, Bt. Zeit, Bot. 353; 1870. Holttum, Rev. Fl. Malaya 2: 558. f. 330. 1954. **Fig. 5.18** A-B.

Rhizome short, erect or ascending, bearing a few fronds at apex; scales narrow, 7 by 1.3 mm, concolorous, dark brown, minutely toothed at margin. **Stipe** 20-50 cm long, brownish darker in lower portion, grooved on adaxial surface. **Lamina** imparipinnate, oblong in outline, 26.5 by about 21 cm; rachis grooved on upper surface, minutely hairy, often gemmiferous at junction with costa; lateral pinnae 3 pairs, upper ones smaller ascending, shortly stalked, oblong, caudate at apex, round at base, subentire or serrate at posterior, grooved with minute hairs on upper surface; veins several times forked, all free. **Sori** elongate along veins, longest on basal acroscopic veinlets, usually on both sides of veins; indusia thin, brown.

Thailand.— PENINSULAR: Surat Thani (Khao Khieo Range), Nakhon Si Thammarat (Khao Luang), Trang (Khao Chong), Yala (Ban Chana, Ban Malao, Bannang Sata).

Distribution.— West Malesia (type from Java).

Ecology.— Terrestrial by stream in tropical evergreen forest and hill evergreen forest at 600-1,200 m altitudes.

GPS Location.— 08° 52' 04.31"N 99° 42' 18.59"E, 08° 52' 36.31"N 99° 42' 13.85"E, 08° 52' 51.02"N 99° 42' 01.86"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 147; T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 140; Y. Yuyen 190 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T 5303 [BKF].

2. *Diplazium cordifolium* Blume, En. Pl. Jav.: 190. 1828. — *Athyrium cordifolium* (Bl.) Copel., Phil. J. Sci. Bot. 3: 300. 1908; Holttum, Rev. Fl. Malaya 2: 548. f. 322. 1955. Tagawa & K. Iwats., Fl. Thailand 3(3): 453. 1988. **Fig. 5.18** C-D.

Rhizome short, erect, ascending, scaly in younger part, about 8 mm diameter; scales narrow, up to 8 by 1.5 mm, brown, entire. **Stipe** 20-25 cm or more long, stramineous or brownish in lower part, scaly or glabrescent upwards, grooved on adaxial surface. **Lamina** simple; narrowly oblong-subdeltoid, cordate at broadest

base, narrowing upwards towards acuminate apex, subentire to undulate at margin, about 23 by 6.5 cm; coriaceous, more or less fleshy; midrib distinctly raised beneath, glabrous; veins branching a few times, irregularly anastomosing in the marginal part; gemmae usually present at junction between stipe and midrib, viviparous. **Sori** elongate along veinlets up to 2.8 cm or more long, on both sides of each veinlet or on acroscopic side; indusia thin but persistent.

Thailand.— PENINSULAR: Surat Thani (Lang Suan), Nakhon Si Thammarat (Khao Luang), Trang (Khao Chong), Narathiwat (Waeng), Yala (Ban Chana).

Distribution.— Malesia throughout (type from Java) eastwards to the Solomon Islands.

Ecology.— On moist sandy mountain slopes in tropical evergreen forests at 500-600 m altitudes.

GPS Location.— 08° 51' 25.45"N 99° 41' 47.36"E, 08° 52' 04.31"N 99° 42' 18.59"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan. 491,136: T. Boonkerd 1516; Chan Apasutaya 322 [BCU]; C. F. van Beusekom & C. Phengkhlai 944; K. Iwatsuki, H. Koyama, M. Hutoh & A. Chintayungkun T 8402 [BKF]

3. *Diplazium crenatoserratum* (Blume) Moore, Ind, Fil. : 121. 1859; Tagawa & K. Iwats., Fl. Thailand 3(3): 459. 1988. — *Asplenium crenatoserratum* Blume, Enum. Pl. Jav. 177. 1828. — *Athyrium crenatoserratum* (Blume) Milde Bot. Zeit. 1870: 353; Holttum, Rev. Fl. Malaya 2: 561. f. 332. 1955. **Fig. 5.18** E-F.

Rhizome short, erect; scales narrow, up to 3 by 1 mm, concolorous, dark brown, irregularly toothed at margin. **Stipe** up to 21 cm long, stramineous with dark scaly base, glabrous. **Lamina** narrowly oblong-subtriangular, attenuate towards apex, widest at base, usually longer than stipe, up to 29 cm wide, pinnate without distinct terminal pinna; rachis grooved above, minutely hairy, usually viviparous at apical portion; lateral pinnae about 25 pairs, lower one stalked, narrowly oblong, acuminate at apex, distinctly auricled at acroscopic and auricled or cuneate at basiscopic bases, up to 29 by 15.5 cm, lobed to 1/3 way to costa or nearly entire; softly chartaceous;

veins pinnate with simple veinlets, glabrous. **Sori** practically on all veinlets, diplazoid usually only on basal anterior ones; indusia thin but firm, persistent.

Thailand.— PENINSULAR: Surat Thani (Ban Don, Klong Ton), Nakhon Si Thammarat (Khao Luang, Khao Huai Pampun, Chawang), Satun, Yala (Klong Bla Hot, Ban Mae Prik, Betong).

Distribution.— Malesia (type from Java).

Ecology.— On moist mountain slopes in tropical evergreen forests at 400-680 m altitudes.

GPS Location.— 08° 51' 37.24"N 99° 42' 40.52"E, 08° 52' 05.08"N 99° 42' 21.70"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 15; T. Boonkerd, Y. Sirichamorn and C. Sanguansab 144; T. Boonkerd 1536; Y. Yuyen 43 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T 4633 [BKF].

4. *Diplazium dilatatum* Blume, En. Pl. Jav. : 194. 1828; Tagawa & K.Iwats., Fl. Thailand 3(3): 464. 1988. — *Athyrium dilatatum* (Blume) Milde, Bot. Zeit. 1870: 353; Holttum, Rev. Fl. Malaya 2: 574. f. 2. 1880. **Fig. 5.18** G-H.

Rhizome massive, erect; scale about 12 by 2 mm, more commonly narrower, dark brown, black-margined, distinctly toothed. **Stipe** c. 70 cm high, densely scaly near base. **Lamina** c. 100 by 65 cm, bipinnate to tripinnatifid; pinnae narrowly oblong, acuminate at apex, basal pinnules usually a little reduced, subcordate at stalked at base, lobed halfway to costa, up to 12.5 by 2 cm; lobes subdeltoid, round to moderately acute at apex, subentire or serrate, up to 0.8 mm in breadth; veins pinnate with 5-9 pairs of simple or forked veinlets. **Sori** along veinlets c. 5 mm long.

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 Salaeng Luang, Phu Rom Rot), Tak (Ban Musoe); NORTH-EASTERN: Phetchabun (Phu Miang), Loei (Phu Luang, Phu Kadueng); EASTERN: Chaiyaphum (Thung Kamang), Nakhon Ratchasima (Khao Laem); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chantaburi (Khao Soi Dao); PENINSULAR: Surat Thani (Khao Khieo Range), Trang (Khao Chong).

Distribution.— India, Myanmar, South China, Taiwan, Ryukyu, South Japan, Indonesia throughout (type from Java) to North Australia.

Ecology.— On moist or humus-rich mountain slopes in tropical evergreen forests at 600- 700 m altitudes.

GPS Location.— 08° 52' 04.31"N 99° 42' 18.59"E, 08° 52' 11.04"N 99° 42' 20.90"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 176; T. Boonkerd 1339, 1213 [BCU].

5. *Diplazium donianum* (Mett.) Tardieu, Aspl. Tonkin: 58. t. 5. 1932; Tardieu & C.Chr. in Fl. Gén. I. –C. 7(2): 249. 1940; Tagawa & K. Iwats., Fl. Thailand 3(3): 455. f. 48. 4. 1988. — *Asplenium doianum* Mett., fil. Lechl. : 177. 1859. — *Athyrium bantamense* auct. non (Blume) Milde: Bedd., Handb.: 177. f. 86. 1883. **Fig. 5.19** A-B.

Rhizome creeping 6 mm in diameter, bearing a few fronds at apex; scales narrow, 5 by 1.4 mm, concolorous, blackish, scale on younger part. **Stipe** up to 27 cm long, brownish darker in lower portion, grooved on adaxial surface. **Lamina** imparipinnate, oblong in outline, 37 by about 19 cm; rachis grooved on upper surface, minutely hairy; lateral pinnae 3 pairs, stalked distinct, more than 3 mm long, cuneate at apex, coriaceous or fleshy; rachis never gemmiferous; **Sori** usually elongate along the whole length of veinlets; indusia thin, brown.

Thailand.— NORTHERN: Chiang Mai (Doi Suthep), Tak (Doi Musoe), Phitsanulok (Thung Salaeng Luang); NORTH-EASTERN: Loei (Phu Kradueng); CENTRAL: Nakhon Si Thammarat (Khao Luang, Ron Phipun, Khiriwong).

Distribution.— North India (type) to South China and Taiwan, north to South Japan, south to Indochina.

Ecology.— On mountain slopes in light shade or in tropical evergreen forests at lower than 590-700 m altitudes.

GPS Location.— 08° 51' 29.40"N 99° 41' 36.92"E, 08° 52' 11.04"N 99° 42' 20.90"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint, and W. Khwaiphan 248 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T 7392 [BKF].

6. *Diplazium silvaticum* (Bory) Sw., Syn Fil.: 92. 1806; Holttum, Gard. Bull. S.S. 11. 100. 1940; Holttum, Rev. Fl. Malaya 2: 560. f. 331. 1955; Tagawa & K. Iwats. Fl. Thailand 3(3): 459. 1988. — *Callipteris silvaticum* Bory in Belanger, Voy. Bot. 1: 282. 1804.

Rhizome short, erect; scales narrow, up to 5 by 0.5 mm, concolorous, dark brown, distinct toothed at margin. **Stipe** up to 27.5 cm long, stramineous with dark scaly base, glabrous. **Lamina** narrowly oblong-subtriangular, attenuate towards apex, widest at base, usually longer than stipe, up to 26 cm wide, pinnate without distinct terminal pinna; rachis grooved above, minutely hairy, usually viviparous at apical portion; lateral pinnae about 21 pairs, pinnae wider, up to 14.5 cm, thinner, less auricled at bases, up to 14 by 2.2 cm, lobed to 1/3 way to costa or nearly entire; softly chartaceous; veins pinnate with simple veinlets, glabrous. **Sori** practically on all veinlets, diplazoid usually only on basal anterior ones; indusia thin but firm, persistent.

Thailand.— NORTHERN: Phitsanulok (Thung Salaeng Luang); NORTH-EASTERN: Loei (Phu Kraduang); SOUTH-EASTERN: Chantaburi (Khao Soi Dao), Trat (Koh Chang); PENINSULAR: Chumphon (Khao Tong), Krabi (Phanom Bencha), Surat Thani (Klong Ton, Ban Don), Phangnga, Nakhon Si Thammarat (Khao Luang), Trang (Khao Chong), Satun, Yala (Betong).

Distribution.— Mauritius (type), India, Myanmar, Malaya, Borneo, Java, and Philippines.

Ecology.— On mountain slopes usually in moist places in dense tropical evergreen forests at 400-800 m altitudes.

GPS Location.— 08° 51' 37.24"N 99° 42' 40.52"E, 08° 52' 16.47"N 99° 42' 17.91"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 503, 395; T. Boonkerd 1113 [BCU].

7. *Diplazium simplicivenium* Holttum, Gard. Bull. S.S. 11. 100. 1940; Tagawa & K. Iwats. Fl. Thailand 3(3): 464. 1988. — *Athyrium simplicivenium* (Holttum) Holttum, Rev. Fl. Malaya 2: 573. f. 340. 1954. **Fig. 5.19** C-D.

Rhizome massive, erect, bearing a tuft of gigantic fronds; scales about 20 by 1.5 mm, brown, black-margined, toothed. **Stipe** up to 60 cm long, about 1 cm diameter near base. **Lamina** about 1.2 by 1 m, bipinnate; lower pinnae about 30 by 18 cm narrowly oblong with acute apex; larger pinnules shortly stalked or sessile, narrowly oblong-subtriangular, gradually narrowing towards a long acuminate apex, broadly cuneate to subtruncate or subcordate at base, usually shallowly lobed, up to 10.2 by 2 cm; lobes subquadrangular, obtuse at apex, subentire, 0.5 mm in breadth; softly papyraceous, green; veins pinnate with 5 pairs of simple veinlets; veinlets hardly reaching the margin of lobes, basal anterior ones stopping far below the sinus. **Sori** long *c.* 6 mm.

Thailand.— SOUTH-WESTERN: Kanchanaburi (Khao Ngi Yai), Uthai Thani (Ban Rai); PENINSULAR: Surat Thani (Klong Ton), Nakhon Si Thammarat (Khao Luang), Phangnga (Khao Pok), Trang (Khao Chong), Satun, Yala (Muang Wing).

Distribution.— Malaysia (type) and probably also in Borneo.

Ecology.— Terrestrial by stream in hill evergreen forest about 1,250 m altitudes.

GPS Location.— 08° 52' 51.40"N 99° 42' 02.14"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 151, 208; T. Boonkerd 535 ; Y. Yuyen 21 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T 6982 [BKF].

8. *Diplazium sorzogonense* (C. Presl) C. Presl, Tent. Pterid.: 114. 1836; Tardieu & C. Chr. In Fl. Gén. I. –C. 7(2) :254. f. 28, 3-4. 1940; Tagawa & K. Iwats., Fl. Thailand 3(3) 456. 1988. — *Asplenium sorzogonense* C. Presl, Rel Haenk. 1: 45. 1825. — *Athyrium sorzogonense* (C. Presl) Milde, Bot. Zeit. 1870: 354; Holttum, Rev. Fl. Malya 2: 552. f. 325. 1955. **Fig. 5.19** E-F.

Rhizome erect, about 20 cm tall; scales subtriangular, 0.8-1.3 by up to 1.2 mm, concolorous brown, black-margined. **Stipe** *c.* 40 cm long, dark stramineous, often nearly black near base, scaly throughout. **Lamina** pinnate, oblong-lanceolate with acute apex, 60-90 by up to 40 cm; rachis shallowly grooved above; pinnae *c.* 20 pairs, basal one or two pairs more or less deflexed, upper ones adnate at base or decurrent to

form indistinct apical portion, middle pinnae shortly stalked, patent to ascending, narrowly lanceolate, acuminate at apex, subtruncate to cordate deeply lobed to 4/5 way to costa, up to 18 by 4 cm at middle; costa grooved with distinct ridges and indistinct spines minutely scaly below, hairy or glabrescent; lobes narrowly oblong, oblique, obtuse to rounded at apex, dentate at margin, 10-17 by 5-6.5 mm; papyraceous to chartaceous, deep green, paler beneath; veins pinnate, dark and distinct below, veinlets 8-10 pairs, mostly simple. **Sori** elongate along veinlets, somewhat marginal, often not extending to main veins with 1-2 mm of naked veinlets, but nearly to the margin of lobes; indusia crescentic, attached by posterior side, pale but brown when dry.

Thailand.— PENINSULAR: Chumphon (Khao Tong). Nakhon Si Thammarat (Khao Luang), Phangnga (Khao Katha Khwam), Yala (Ban Malao, Khao Kalakhiri).

Distribution.— Vietnam to Malesia throughout (type from Philippines).

Ecology.— On rather dry mountain slopes in tropical evergreen forests and hill evergreen forest at 600-1,200 m altitudes.

GPS Location.— 08° 52' 05.08"N 99° 42' 21.70"E, 08° 52' 36.31"N 99° 42' 13.85"E, 08° 52' 51.02"N 99° 42' 01.86"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 33, 129 [BCU].

9. *Diplazium tomentosum* Blume, En. Pl. Jav.: 192. 1828; Tradieu & C. Chr. in Fl. Gén. I.-C. 7(2) : 257. 1940 ; Tagawa & K. Iwats., Fl. Thailand 3(3) 457. 1988. — *Athyrium tomentosum* (Blume) Milde, Bot. Zeit. 1870: 354 ; Holttum, Rev. Fl. Malaya 2 : 551. f. 324. 1955. **Fig. 5.19 G.**

Rhizome short, erect or ascending, bearing wiry roots ; scales narrow, up to 4 by 0.6 mm concolorous, dark brown, subentire or irregularly waved at margin. **Stipe** stramineous with dark castaneous lower portion, up to 35 cm long on soriferous fronds and 25 cm on sterile ones. **Fron**d pinnate-bipinnatifid, oblong-subdeltoid, attenuate at apex, with deflexed basal pinnae, up to 30 by 12 cm; rachis densely covered with short coarse multicellular hairs with brown septa; lowest pinnae deflexed, lanceolate, shortly stalked, auricled at acroscopic base, up to 7 by 2 cm;

lower and middle pinnae shortly stalked, patent, acute to acuminate at apex, auricled at acroscopic and rounded to cuneate at basisopic bases, lobed 1/5 - 2/3 way to costa, upper pinnae sessile to adnate at base; lobes oblique, oblong, moderately acute at apex, toothed, up to 10 by 4 mm; chartaceous, deep green, dark when dry, veins pinnate, veinlets simple or forked. **Sori** practically on all veinlets of fertile frond, usually only on basal acroscopic veinlets; indusia firm, persistent.

Thailand.— SOUTH-EASTERN: Chanthaburi (Khao Sabap), Trat (Bo Rai); PENINSULAR: Surat Thani (Khao Nom Sao), Krabi (Pranom Bencha), Nakhon Si Thammarat (Khao Luang), Trang (Khao sung), Narathiwat (Waeng).

Distribution.— Myanmar (Tenssarim), Malaya, Vietnam, Sumatra, Java (type), Borneo and Mindanao.

Ecology.— On mountain slopes in tropical evergreen forests at 550-800 m altitudes.

GPS Location.— 08° 51' 27.91"N 99° 41' 38.82"E, 08° 52' 16.47"N 99° 42' 17.91"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 82, 379; T. Boonkerd 1484; Charn Apasutaya 127 [BCU].

10. *Diplezium xiphophyllum* (Baker) C. Chr., Ind. Fil. : 241. 1905; Holttum, Grad. Bull. S.S. 11: 106. 1940; Tagawa & K. Iwats., Southeast As. St. 5: 102. 1967; Acta Phytotax. Geobot. 23: 56. 1968. — *Athyrium xiphophyllum* Baker, J. Bot. 1879: 40; Holttum, Rev. Fl. Malaya 2: 1955. **Fig. 5.19 H- Fig. 5.20 A.**

Rhizome short, erect; scales narrowing towards long-tailed apex, up to 6 by 2 mm, dark brown, entire. **Stipe** stramineous, scaly at base, 40-60 cm long. **Lamina** simply pinnate, with 4-9 pairs of lateral pinnae; lateral pinnae ovate, subentire or crenate at margin, slightly adnate to rachis, gradually narrowing towards narrowly cuneate base, with bud sometimes in their axils, acuminate at apex, 20-30 by up to 5 cm; chartaceous, deep green above, paler below, glabrous; costa grooved above, raised below; midrib pale, prominent and glabrous beneath, lateral veins near the costa into groups of three, at an angle of 45° to the costa, the middle one forked, the outer pair sometimes anastomosing with adjacent veins, but all ending within the

margin. **Sori** on basal pair of veins, commonly 3-4 sori on each vein-group, the sorus on the anterior basal vein only diplazoid.

Thailand.— PENINSULAR: Nakhon Si Thammarat (Khao Luang), Narathiwat (Ban Waeng), Yala (Ban Chana).

Distribution.— Malaysia and Borneo(type).

Ecology.— On muddy rocks or on earth by streams in tropical evergreen forests at 600 m altitudes.

GPS Location.— 08° 52' 05.08"N 99° 42' 21.70"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 241 [BCU].

ORDER DAVALLIALES

DAVALLIACEAE

Mett. ex A.B. Frank, Syn. Pflanzenk. (ed. 2) 3: 1453, 1474. 1877; Devol & Yang., Fl. Taiwan vol. 1. 2nd ed.: 270. 1980.

Mostly epiphytes with long creeping scaly rhizomes; stipes articulate to rhizome. Fronds usually broadly deltoid and often finely dissected, but sometimes simple, venation free. Sori submarginal, terminal on veinlets; indusia tubular, scale-like, or linear and continuous, opening towards margin.

DAVALLIA

Sm., Mem. Acad. Turin. 5: 414. 1793; Tagawa & K. Iwats., Fl. Thailand 3(2): 162. 1985.

Rhizome long-creeping, usually thick, densely scaly with peltate or cordate scales. Stipes naked, articulated to rhizome. Fronds usually deltoid, coriaceous to chartaceous, green, glabrous. Sori round, terminal on vein, usually close to margin; indusial attached by base and sides, cup-shaped.

KEY TO THE SPECIES

1. Fronds large, bipinnate or more compound
 2. False veinlet present, rhizome white waxy under the rhizome scales
..... **2. D. corniculata**
 2. False veinlet absent, rhizome not white waxy..... **1. D. embolostegia**
1. Fronds small, lobed almost to the midrib; fertile fronds hardly contracted as compared with sterile..... **3. D. repens**

1. Davallia corniculata T. Moore. Index fil. 292. 1861; Holttum, Rev. Fl. Malaya 2. 2. 359. 1966; Noot., Blumea 39. 177. 1944; Tagawa & K. Iwats., Fl. Thailand 3(2) 158. 1985. — *Davallia epiphylla* acut. Non SW.: Bedd., Handb.: 60. 1833. **Fig. 5.20** B-C.

Rhizome long-creeping *c.* 2.33-3 mm in diameter, white waxy under the scales. Scales red-brown, more or less patent, gradually narrowing from the base towards apex, often curling backward, peltate, 3-5 by 0.8-1 mm. **Stipe** dark brown, adaxially grooved, *c.* 21 cm long, glabrous or white few scales. **Lamina** bipinnate to tripinnate towards the base and in the middle part, deltoid and broadest toward the base, glabrous, *c.* 30-34.6 by 15-16.2 cm, longest petiolules 2.5 mm long; pinnae narrowly ovate, longest pinnae 10 by 2-5 mm. Pinnules of at least the larger pinnae anadromous, linear oblong or narrowly ovate; longest pinnules 18 by 10 mm; ultimate leaflets linear oblong, lobed almost to the midrib, or only shallowly lobed, ultimate segments or lobes obtuse or acute without a tooth, or acute and usually ending in a tooth, 0.5-5 by 1-4 mm; upper ridge at the junction of the costa and pinna-rachis not swollen, stipes glabrous, margins of the lamina of each leaflet thickened and decurrent on the edge of the grooved rachis, veins in sterile ultimate lobes pinnate, reaching the margin, false veins present. **Sori** separate, borne several on a segment, at the forking point of veins, indusium attached at the base and only part of the sides, or also attached along the sides, pouched-shaped, more or less triangular to rhomboid or oblong, about as wide as long, upper margin not elongated, truncate or slightly rounded, extending to lamina margin or not, lamina generally extending into a tooth at both sides or only at the outside of a sorus.

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

Distribution.— Southern Thailand; *Malesia*: Sumatra, Peninsular Malaysia, West Java, Borneo (Sabah, Mt. Kinabalu).

Ecology.— On fallen tree-trunks in half-shaded places on ridges in hill evergreen forest at 1,000-1,200 m altitudes.

GPS Location.— 08° 52' 36.19"N 99° 42' 13.85"E, 08° 52' 51.02"N 99° 42' 01.86"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 483; T. Boonkerd, Y. Sirichamorn and C. Sanguansab 167, 227 [BCU]; K. Iwatsuki, H. Koyama, M. Hutoh & A. Chintayungkun T 8383 [BKF].

2. *Davallia embolostegia* Copel. Philipp. J. Sci. 1 (Suppl. 2): 147, t. 3. 1906; Noot., Blumea. 39. 182. 1994; Noot. in Fl. Males., Ser. II. 3. 253. 1988. **Fig. 5.20 D.**

Rhizome creeping *c.* 6.36 mm in diameter, densely scaly throughout; scales linear-lanceolate, gradually narrowing towards long-tailed apex, up to 15.6 by 2.3 mm ciliate, pale brown. **Stipe** castaneous adaxially groove, up to 43.5 cm long. **Lamina** tripinnate, quadripinnatifid, deltoid and broadest towards the base, glabrous, 45.7 by 46 cm; basal pinnae the largest, deltoid, stalked, up to 8.2 by 4.2 cm wide; pinnules, deltoid, gradually narrowing from base to long acuminate apex, cuneate at moderately acute, lobe moderately acute, entire, glabrous; veins pinnate, without false veinlets. **Sori** terminal on veinlets; indusia cup-shaped, longer than wide, *c.* 1 by 0.5 mm.

Thailand.— EASTERN: Nakhon Ratchasima (Pak Chong, Khao Yai National Park).

Distribution.— Malesia, Sumatra, Borneo, Philippines, Moluccas, Pacific.

Ecology.— Epiphyte, generally in tropical evergreen forest, sometime epilithic at 330-1,384 m altitudes.

GPS Location.— 08° 51' 29.27"N 99° 42' 44.44"E, 08° 52' 36.31"N 99° 42' 13.85"E, 08° 52' 58.08"N 99° 41' 50.15"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 493; T. Boonkerd, Y. Sirichamorn and C. Sanguansab 138, 179; T. Boonkerd & R. Pollawatn 349 [BCU].

3. *Davallia repens* Kuhn, Fil. Deck. 27. 1867. — *Humata repens* (L. f.) Diels. in Pflanzenfam. 1(4): Tardieu & C. Chr. in Fl. Gén. I.-C. 7(2): 111. f. 13, 1. 1939; Holttum, Rev. Fl. Malaya 2: 371. f. 216. 1954; Seidenf., Nat. Hist. Bull. Siam. Soc. 19: 86. 1958; Tagawa & K. Iwats., Fl. Thailand 3(2): 166. 1985. — *Adiantum repens* L. f., Suppl.: 446. 1781. — *Davallia repens* (L. f.) Kuhn, Fil. Deck.: 27. 1867. — *Humata pinnatifida* Bedd., Handb. Suppl.: 12. 1892. — *Pachypleuria repens* (L. f.) M. Kato, Fac. Sci. Univ. Tokyo, Sect. 3, Bot. 13(5): 573. 1985. **Fig. 5.20** E-F.

Rhizome long creeping, c. 1.5-2.23 mm in diameter, glabrous, densely scaly throughout; scales acuminate at basal edges, long-acuminate at apex, up to 7 by 1.2 mm, brown. **Stipes** stramineous, terete, up to 7 cm long, sparse scaly. **Lamina** oblong-subdeltoid or roundly pentagonous, 2.5-10 by 2-7 cm; basal pinnae the largest, oblong-subdeltoid pinnatifid; upper pinnae shallowly lobed or entire, adnate; basal pinnae lobed in the large ones, coriaceous, glabrous. **Sori** marginal, small; indusia nearly semicircular, entire and free except for the bases, up to 1 mm broad.

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

Distribution.— Widely distributed in the tropics of the World: Madagascar and Seychelles, Mascarene Islands, Himalayas to South Japan (type), SE. Asia, generally through Malesia to Polynesia and Australia.

Ecology.— On mossy tree trunks or rather dry rocks in hill evergreen forests at 900- 1,385 m altitudes.

GPS Location.— 08° 52' 28.14"N 99° 42' 15.02"E, 08° 52' 36.31"N 99° 42' 13.85"E, 08° 52' 58.08"N 99° 41' 50.15"E

Vernacular.— Kut hom baiyoi (กูดหอมใบช้อย) (Northern); Kut thong (กูดทอง) (North-eastern); Nakkharat tua mia (นาคราชตัวเมีย) (Southern-eastern).

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 26,457,421; T. Boonkerd, Y. Sirichamorn and C. Sanguansab 203; T. Boonkerd 131; Y. Yuyen 77 [BCU]; M. Tagawa, K. Iwatsuki, H. Koyama, N. Fukuoka, A. Nalampoon & A. Chintayungkun T 9318 [BKF].

OLEANDRACEAE

Ching ex Pic.Serm., *Webbia* 20(2): 745. 1965; Devol & Kuo, *Fl. Taiwan* vol. 1. 2nd ed.: 320. 1980.

Rhizome scandent, or long-creeping scaly, fronds distant, articulate to phyllopodia; or the caudex short, erect, sending out a mass of fibrous roots and long, slender stolons. Stipes tufted, stout, non-articulated. Fronds simple or pinnate, pinnate, pinnae articulate on rachis, often caducous; venation free, once or twice forked. Sori round, dorsal or submarginal, borne on the end of a veinlet; indusia round or reniform, sinus usually narrow.

KEY TO THE GENERA

1. Fronds pinnate to bipinnate, stipe not articulated..... **1. Nephrolepis**
 1. Fronds simple, stipe articulated..... **2. Oleandra**

1. NEPHROLEPIS

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

Rhizome usually short, erect or suberect, scaly, bearing a tuft of fronds, wiry roots, and slender stolons; scales peltate, appressed, small, bicoloured with pale edge; stolons spreading, usually forming buds; roots sometimes tubers containing water. Lamina usually lanceolate or narrower in outline, pinnate, lower pinnae usually reducing downwards; pinnae sessile, articulated to rachis, usually unequal at base, more or less auricled at acroscopic base, subentire or slightly crenate; veins all free. Ending in distinct hydathodes within margin. Sori terminal on anterior branches of vein-group, one for each crenate, arranged in one row, or continuous along margin; indusia round-reniform, or continuous along margin.

KEY TO THE SPECIES

1. Sori on small marginal lobes, one to each lobe..... **2. N. davallioides**
1. Sori not maginal lobes, arranged in one row on each side of costa
2. Pinnae not having acuminate at apex with cuneate at margin
.....**1. N. biserrata**
2. Pinnae having long acuminate at apex with serrate at margin..... **3. N. sp.**

1. Nephrolepis biserrata (Sw.) Schott, Gen. Fil. ad t. 3. 1834; E. Smith, J. Siam Soc. Nat. Suppl. 8: 6. 1929; C. Chr., contr., U. S. Nat. Herb. 26: 331.1931; Holttum, Rev. Fl. Malaya 2: 380. f. 217. 1955; Seidenf., Nat., Hist. Bull. Siam Soc. 19: 86. 1958; Tagawa & K. Iwats. Fl. Thailand 3(2): 175. 1985. — *Aspidium biserratum* Sw., Schrad. J. Bot. 1800(2): 32. 1801. — *Nephrolepis acuta* (Schkuhr) Presl, Tent. Pterid.: 79. 1836; Tardieu & C. Chr. In Fl. Gén. I. -C. 7(2): 291. 1941. **Fig. 5.20 G-H.**

Rhizome ascending or suberect, bearing a few fronds drooping at apex, numerous wiry roots, and stolons; scales gradually narrowing from base towards tailed apex 5-7 mm long, 0.6-0.8 mm broad, brown, with hairy or irregular margin, thin and usually ferruginous. **Stipe** up to 43 cm long, stramineous, densely scaly with narrower scales, **Lamina** large, usually 75.5-150 by 30-43 cm or more long, lanceolate, narrowing towards both apex and base, pinnate; lateral pinnae up to 18 pairs or more pairs; middle ones *c.* 3 cm apart, larger, patent or slightly falcate at posterior end, lanceolate, acuminate at apex, cuneate at base, sessile, serrate at margin of posterior part, up to 21 by 2.1 cm, thin but stiff; veins forked near costa, posterior branches sometimes forked again at middle part, minutely scaly on costa and even on laminar surface. **Sori** round, in one row at 1/3 way from margin to costa; indusia reniform, round, *c.* 1.5-2 mm diameter.

Thailand.— NORTHTERN: Chiang Rai, Chiang Mai (Doi Suthep, Ban Du); CENTRAL: Krungthep; SOUTH-EASTERN: Chon Buri (Si Racha), Trat (Koh Chang, Ban Saphan Hin, Khlong Yai); PENINSULAR: Surat Thani (Kho Tao), NaKhon Si Thammarat (Khao Luang), Songkhla (Rattaphum), Narathiwat (Waeng), Phangnga (Takua Thung), Trang (Khao Chong), Satun, Yala (Bannang Sata).

Distribution.— Pantropic (type from America).

Ecology.— Terrestrial on dry mountain slopes in tropical evergreen forest at 330-800 m altitudes.

GPS Location.— 08° 51' 29.27"N 99° 42' 44.44"E, 08° 52' 16.47"N 99° 42' 17.91"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 478; T. Boonkerd, Y. Sirichamorn and C. Sanguansab 131; O. Rattana 15; T. Boonkerd 337; Yuyen 108 [BCU]; K. Iwatsuki, H. Koyama, N. Hutoh & A. Chintayngkun T 14484; E. Hennipman 3823 [BKF].

2. *Nephrolepis davallioides* (Sw.) Kunze, Bot. Zeit. 1846: 460; Bedd., Handb. Suppl.: 81. 1892; Holttum, Rev. Fl. Malaya ed. 2. 2.: 634. 1968. —*Aspidium davallioides* Sw., Schrad. J. Bot. 1800(2): 33. 1801. —*Nephrolepis acuminata* (Holttum) Kuhn, Ann. Lugd. Bat. 4: 286. 1869, non Presl 1836: Holttum, Rev. Fl. Malaya 2: 378. f. 220. 1955; Tagawa & K. Iwats., Fl. Thailand 3(2). 172. 1985. **Fig. 5.21** A-B.

Rhizome short-creeping, c. 1 mm in diameter, bearing close fronds, densely scaly; scales gradually narrowing from round base to tailed apex, up to 2.5 by 1 mm, dark with brown ferruginous margin. **Stipe** stramineous, c. 25-30 cm long, minutely appressed-scaly, grooved on upper surface. **Lamina** narrowly lanceolate, up to 94 cm or more long, 31.3 cm wide, pinnate; lateral pinnae 37-50 pairs, basal ones shorted, lower ones sterile, up to 15 by 2 cm, entire, falcate at tip, upper ones fertile, 8.5-13 by 1.4 cm, lobed at margin, papyraceous; vein forked near costa visible, all free. **Sori** one to each lobe a margin of fertile pinnae, terminal on anterior branch of veins, round; indusia usually round, c. 1.5 mm broad.

Thailand.—PENINSULAR: Surat Thani (Khao Nong), Nakhon Si Thammarat (Khao Luang), Yala (Khao Kalakhiri).

Distribution.— Sumatra, Malaya to Celebes (type from Java).

Ecology.— On fallen tree-trunks in hill evergreen forest at 1,000-1,250 m altitudes.

GPS Location.— 08° 52' 36.19"N 99° 42' 13.85"E, 08° 52' 51.02"N 99° 42' 01.86"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 435; T. Boonkerd, Y. Sirichamorn and C. Sanguansab 188; T. Boonkerd 318 [BCU].

3. *Nephrolepis* sp. Fig. 5.21 C-D.

Rhizome ascending or suberect, scaly and stolons, scales gradually round from base with acuminate at apex up to 2 mm long, 1 mm broad, brown, with hairy or irregular margin pale brown, thin and usually shining brown. **Stipe** up to 24.7 cm long, stramineous, densely scaly with narrower scales, **Lamina** large, usually 84.5 by 20 cm, lanceolate, falcate, narrowing towards both apex and base, pinnae up to 45 pairs; middle ones *c.* 9.6 cm apart, patent or slightly falcate at posterior end, shortly stalked, cuneate at base, long-acuminate at apex, serrate at margin of posterior part, up to 9.6 by 1.8 cm. thin; texture coriaceous; veins forked once or twice near the costa and often once again. Apart at the ends near the margin; conspicuous hydathode at each vein-ending, often marked with a white spot, on the upper surface, minutely scaly on costa and even on laminar surface. **Sori** one to each lobe; the indusium with a broad base, *c.* 1.5 mm diameter.

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

Ecology.— Terrestrial on dry mountain slopes in hill evergreen forest at 1,033 m altitudes.

GPS Location.— 08° 52' 36.31"N 99° 42' 13.85"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 165 [BCU].

Note.— *Nephrolepis* sp. is a lithophyte found near stream in tropical evergreen forest. It is closely related to a Malaysian sword fern, *Nephrolepis dicksonioides* H. Christ (Parris and Latiff, 1997), but differed in having long acuminate apex, pinnae having serrate margin rather than shallowly lobed as was found in *Nephrolepis dicksonioides* (Piggott, 1988).

2. OLEANDRA

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

Rhizome long-creeping, covered with peltate scales, bearing fronds widely spaced or in a tuft. Stipes with distinct articulation, leaving phyllopede of various heights. Lamina simple, entire, linear-lanceolate; veins usually once or twice forked near midribs, parallel and all free, close, ending in distinct hydrathode. Sori dorsal on anterior branches of veins, close to midribs; indusia reniform.

Oleandra neriiformis Cav.: Bedd., Handb.: 285. f. 146. 1833; Tardieu & C. Chr. in Fl. Gén. I.-C. 7(2): 283; 1940. — *Oleandra pistillaris* (Sw.) C. Chr., Ind. Fil. Suppl. III: 132. 1934; Holttum, Rev. Fl. Malaya 2: 386. f. 224. 1955; Tagawa & K. Iwats. Acta Phytotax. Geobot. 1800(2): 30; 1801; Tagawa & K. Iwats. Fl. Thailand 3(2): 182. 1985. **Fig. 5.21** E-F.

Rhizome thick, 0.61-1 cm in diameter, stiff, erect or suberect, branching, forming bushes, bearing several fronds in groups, the groups separated remotely; scales appressed, imbricate, oblong, round to moderately cuneate at both edges, 3.5-5 by 1.5 mm, dark brown, younger ones bearing pale and hairy tails. **Stipe** short on phyllopede up to 6 mm high, scaly. **Lamina** simple, oblanceolate, 19-40 by 3.5 cm, long-acuminate, gradually narrowing towards base, the margin subentire or a little wavy; midrib raised below, hairy and scaly or glabrescent; laminar surface hairy all over to glabrous, papyraceous, stiff, deep green. **Sori** in one irregular row usually close to midrib; indusia up to 2 mm broad.

Thailand.— SOUTH-WERSTERN: Prachuap Khiri Khan (Khao Luang); PENINSULAR: Songkhla (Khao Khieo), Trang (Khao Soi Dao), Yala (Betong).

Distribution.— Malaysia Peninsula and Java.

Ecology.— On tree-trunks in hill evergreen forest at 1,000 m altitudes.

GPS Location.— 08° 52' 36.19"N 99° 42' 13.85"E

Vernacular.— Nakkharat (นาคทราบ) (Northern, Peninsular), Wan nakkharat (ว่านนาคทราบ) (North-eastern, Peninsular); Phaya ngu (พญาญู) (North-eastern) Nacho (นาจอ) (Malay Peninsula)

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 172 [BCU]; P. Puudjaa 233 [BKF].

DIPTERIDACEAE

Reinw., Sylloge Pl. 2: 3. 1824; Tagawa & K. Iwats Fl. Thailand 3(4): 481. 1989.

Rhizome creeping, stout, densely cover with hairs; hairs multicellular, sometimes consisting in several rows of cells, bristle-like. Stipes erect, smooth glabrous. Fronds completely divided into two halves, each half divided into several unequal segments; main veins branched several times dichotomously, smaller veins anastomosing with free included veinlets in the areoles; texture coriaceous. Sori small, usually round, naked, scattered irregularly on the whole under surface of fronds, usually at junction of the smaller veins.

Dipteris conjugata Reinw., Syll. Pl. 2: 3. 1824; Holttum, Rev. Fl. Malaya 2: 135. f. 55. 1955. Tagawa & K. Iwats. Fl. Thailand 3(4): 481. f. 49. 1-2. 1989. **Fig. 5.27** D-E.

Rhizome wide-creeping on clayey ground, c. 1.2 cm in diameter, bearing fronds remotely, densely covered with hairs; hairs 5-8 by 0.5 mm, sometimes the basal portion consisting in a few rows of cells, stiff, dark brown shining. **Stipe** c. 1 m or more long, densely hairy at base, glabrous above, brown. **Lamina** up to 40 cm, 70-80 cm wide, bilobed almost to the base, the lobes spreading fan-shaped, divided more than halfway to the base into four unequal segments narrowly subtriangular, gradually narrowing towards caudately acuminate apex, irregularly waved at margin; main veins dichotomously branched several times, 2-4 main veins entering into ultimate segments, venation copiously anastomosing with included veinlets; coriaceous, green on upper surface, glaucous beneath. **Sori** small, numerous, irregularly scattered all over the lower surface of fronds, without indusia, mixed with club-shaped paraphyses.

Thailand.—PENINSULAR: Surat Thani (Koh Phangan), Nakhon Si Thammarat (Khao Luang), Phangnga (Khao Phota Luang Kaeo), Yala (Gunong Ina).

Distribution.— Vietnam and Cambodia, throughout Malesia to Polynesia and Australia, northwards to Taiwan and South Ryukyus.

Ecology.— Usually terrestrial on slopes or at edge of hill evergreen forests at 1,000-1,380 m altitudes.

GPS Location.— 08° 52' 36.19"N 99° 42' 13.85"E

Vernacular.— Bua chaek (บัวแฉก) (Peninsular).

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 405 ; T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 287 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T- 4809; E. Hennipman 3869 [BKF].

POLYPODIACEAE

Beercht. & J. Presl, Prir. Rostlin 272. 1820; Devol & Kuo, Fl. Taiwan vol. 1. 2nd ed.: 165. 1980.

Usually epiphyte, growing on tree trunks, or mossy rocks, some terrestrial. Rhizome dictyostelic, usually creeping; scales peltate, often clathrate. Fronds often simple, pinnate or rarely digitately lobed; stipes usually articulate to rhizome; veins anastomosing with included veinlets. Sori usually round, oval or linear, and in some genera acrostichoid; exindusiate; peltate, clathrate paraphyses often present.

KET TO THE GENERA

1. Fronds pinnate with pinnae jointed to rachis..... **5. Goniophlebium**
1. Fronds simple or pinnate with pinnae not jointed to rachis
 2. Nest leaves present, foliage leave pinnate..... **4. Drynaria**
 2. Nest leaves lacking
 3. Fronds covered when young with stellate hairs..... **11. Pyrrosia**
 3. Fronds not having stellate hairs
 4. Fronds simple
 5. Fronds bearing peltate scales on surface or in sori
 6. Sori round or nearly so along the margin of fronds
..... **6. Lepisorus**
 6. Sori acrostichoid on fronds much narrower than the sterile one..... **2. Belvisia**

5. Fronds not bearing any peltate scale
7. Frond dimorphic and sporangia acrostichoid
 **7. Leptochilus**
7. Frond monomorphic, not acrostichoid
8. Sori round
9. Sori not sunk in cavity..... **9. Microsorium**
9. Sori sunk in cavity..... **10. Phymatosorus**
8. Sori forming continuous or broken lines oblique
 to the midrib of the frond
10. Fronds thick, coriaceous..... **12. Selligiea**
10. Frond thin
11. Stipes articulate to rhizome,
 papyraceous..... **3. Colysis**
11. Stipe not articulate to rhizome,
 chartaceous..... **8. Loxogramme**
4. Fronds pinnate or pinnately lobed
12. Frond very large, sessile, basal portion like nest leaves
 **1. Aglaomorpha**
12. Frond with stipe, basal portion not as above
 **5. Goniophlebium**

1. AGLAOMORPHA

Schott, Gen. Fil.: ad pl. 20. 1834; Tagawa & K. Iwats., Fl. Thailand (4): 551. 1989.

Rhizome long-creeping, thick, scaly. Lamina in one form, partially dimorphic; upper part like foliage leaves, pinnatifid, lower part like nest-leaves, very broad at base. Sori small, round or variously spreading and united.

Aglaomorpha coronans (Wall. ex Mett.) Copel., Univ. Calif Publ. Bot. 16: 117. 1929; Tardieu & C. Chr. in Fl. Gén. I. -C. 7(2) : 488. f. 57, 3-4. 1941; Tagawa & K. Iwats., Fl. Thailand 3(4): 551. f. 55. 4-5. 1989. — *Polypodium coronans* Wall. ex Mett., Abh. Senck. Naturf. Ges. 2: 121. t. 3. f. 40-41. 1857. **Fig. 5.21 G.**

Rhizome creeping, thick, densely scaly throughout; scales brown, linear, about 7 by 0.5 mm, sharply toothed at margin. **Lamina** simple-pinnatifid, sessile, up to 120 by 31 cm; deeply lobed closed to rachis; costa wing less than 1 cm broad; base broadly round to cordate, up to cordate, to 15 cm broad, subentire or shallowly lobed, brown, like nest leaves of *Drynaria*; lobes of upper part of fronds ascending, c. 18-20 pairs, linear-subtriangular, attenuately acuminate at apex, entire to subentire at margin, up to 25 by 3 cm, lobes articulated to rachis; rachis raised on lower surface, grooved above, sparsely brown hairs covering throughout on rachis and costa; veins raised on both surface, venation drynaroids, or with complicatedly reticulate, main areoles quadrangular, smaller areoles with free included veinlets; texture coriaceous, green, glabrous. **Sori** one row between main veins, slightly elongated, or sometimes uniting longitudinally, but rarely continuous beyond cross veins.

Thailand.— NORTHERN: Chiang Rai (Doi Tung), Chiang Mai (Doi Hua Mot, Doi Suthep, Huai Tong, Doi Inthanon), Lampang (Mae Tia), Phrae (Mae Sai), Tak (Huai Krasa, Doi Musoe), Phitsanulok (Thung Salaeng Luang); EASTERN: Chaiyaphum (Thung Kamang, Nam Phrom); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng), Prachin Buri (Khao Yai); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); SOUTH-WESTERN: Kanchanaburi (Song Tho); 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. Khao Chong in Trang Province is the southernmost station of this species, so far.

Ecology.— On rather dry or mossy rocks or on tree-trunks or rarely terrestrial in light shade in tropical evergreen forest and hill evergreen forest at 600-1,385 m altitudes.

GPS Location.— 08° 52' 05.08"N 99° 42' 21.70"E, 08° 52' 36.19"N 99° 42' 13.85"E, 08° 52' 58.08"N 99° 41' 50.15"E

Vernacular.— Bai kut om (ใบกุศอ้อม) (Northern).

Specimens examined.— Y. Yuyen 54 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T 6817, 387; E. Hennipman 3838 [BKF].

2. BELVISIA

Mirb., Hist. Nat. Veg. 5: 111. 1803; Tagawa & K. Iwats Fl. Thailand 3(4): 519. 1989.

Rhizome short-creeping, bearing stipes usually close together, densely scaly; scales peltate, usually dark, ovate to lanceolate. Fronds jointed to rhizome, with short indistinct stipes, simple, entire, papyraceous to coriaceous, peltate scaly or glabrescent; veins copiously anastomosing, visible or hardly so; fertile portion on narrow apical part of fronds, usually wholly covered by sporangia on the lower surface, sometimes separated from the vegetative part by construction. Sporangia mixed with stalked peltate paraphyses and protected also by the narrow reflexed edge of fronds.

Belvisia spicata (L. f.) Mirble ex Copel., Gen Fil. 192. 1947; Hovenkamp & Franken, Blumea 37. 524; f. 1a, b, 2e, 3f. 1993. — *Acrostichum spicatum* L. f. Suppl. Pl. 444. 1781. — *Hymenolepis revoluta* Blume, enum. Pl. Jav. 201. 1828; Tardieu & C. Chr. in Fl. Gén. I.-C. 7(2): 451. 1941. — *Belvisia revoluta* Copel., Gen Fil. 192. 1947; Holttum, Rev. Fl. Malaya 2. 155, f. 67. 1955; Tagawa & K. Iwats. Fl. Thailand 3(4): 521. 1989. **Fig. 5.22** A-B.

Rhizome short-creeping, internodes not elongate, 3.1 mm thick, rhizome scales ovate-lanceolate or narrowly triangular, 2.5 by 1 mm, apex acute, dull with dark brown, often recurved; margin usually entire, rarely dentate; central cells with thickened wall, membranaceous zone with thin walls. **Stipes** 4 cm long, 1 mm thick. **Lamina** linear-lanceolate to linear, 26 by 1.3 cm. **Sori** covering the lamina when ripe, situated close to the midrib; paraphyses with irregularly branched and lobed blades, cells with thick walls.

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

Distribution.— Throughout Malesia; outside Malesia: tropical Africa, Sri Lanka. Indochina, Australia (Queensland), New Caledonia, Fiji, Tahiti.

Ecology.— Epiphytic on tree-trunks in tropical evergreen forest at 480-1,300 m altitudes.

GPS Location.— 08° 51' 23.67"N 99° 41' 48.28"E, 08° 52' 36.19"N 99° 42' 13.85"E, 08° 52' 37.01"N 99° 41' 31.74"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 197, 228; T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 499, 509; O. Vannasri 42 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T 4248 [BKF].

3. COLYSIS

Presl, Epim. Bot.: 145. 1849; Holttum, Rev. Fl. Malaya 2: 159. 1954.

Rhizome creeping, or climbing, sometimes rather long, the stipes jointed to it; scales rather small, dull, the cell-walls clathrate. Stipe often winged nearly to the base. Fronds simple or pinnately lobed, thin in texture, the veins usually conspicuous; main veins rather irregular but usually distinct, at a broad angle to the midrib, with two regular rows of areoles between them, the areoles containing a varying number of free veinlets, Sori in single lines between adjacent main veins, continuous or more or less broken, all the way from midrib to edge, not sunk, no umbrella-paraphyses.

KEY TO THE SPECIES

1. Fronds glossy, dark green; vein indistinct..... **2. C. wui**
 1. Fronds not glossy; veins distinct **1. C. pedunculata**

1. Colysis pedunculata (Hook. & Grev.) Ching, Bull. Fan Mem. Inst. Biol. 4: 321. 1933; Tardieu & C. Chr. In Fl. Gén. I.-C. 7(2). 494. 1941; Holttum, Rev. Fl. Malaya 2: 160. f. 71. 1955; Tagawa & K. Iwats. Fl. Thailand 3(4): 538. 1989. — *Ceterach pedunculatum* Hook. & Grev., Ic. Fil.: t. 5. 1827. **Fig. 5.22 C.**

Rhizome long-creeping or climbing, bearing fronds *c.* 3 mm, apart 3 mm in diameter; scale dark brown, clathrate, narrow acuminate apex, *c.* 2.5 by 0.5 mm, toothed at margin. **Fronds** dimorphic. **Sterile fronds:** stipes *c.* 18 cm long, narrowly winged nearly to the base; laminae oblong, usually gradually narrowing towards acute to acuminate apex, round to cuneate at base, *c.* 8.5 mm or more long by *c.* 6.7 cm; main lateral veins distinct, with included free veinlets; herbaceous. **Fertile fronds:** stipes up to 25.5 cm long, stramineous, wingless; laminae broadly oblong, broadest at middle portion, narrowing towards acute apex, round at base, up to 15 by 5.56 cm

broad. **Sori** up to 2 mm broad, extending almost all the lower surface except on midrib and lateral main veins.

Thailand.— NORTHERN: Chiang Mai (Dao Chiang Dao); SOUTH-EASTERN: Chon Buri (Si Racha), Chantaburi (Khao Soi Dao); PENINSULAR: Surat Thani (Koh Samui, Ban Don), Krabi (Khai Phanom Bencha), Nakhon Si Thammarat (Chawang), Trang (Khao Chong, Koh Talibong).

Distribution.— SE. Himalayas (type), Sw. China (Yunnan), Vitenam to Malaysia.

Ecology.— On moist or damp rocks in stream-beds in deep shade or tropical evergreen forests at 350-600 m altitudes.

GPS Location.— 08° 51' 29.06"N 99° 42' 45.21"E, 08° 52' 04.31"N 99° 42' 18.59"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 181, 313; T. Boonkerd 681; Y. Yuyen 184 [BCU]; E. Hennipman 3881; M. Tagawa, K. Iwatsuki & N. Fukuoka 6702 [BKF].

2. *Colysis wui* (C. Chr) Ching, Bull. Fan Mem. Inst. Biol. 4: 332. 1933; Tardieu & C. Chr. In Fl. Gén. I.-C. 7(2). 494. 1941; Tagawa & K. Iwats. Fl. Thailand 3(4): 539. 1989. — *Polypodium wui* C. Chr., Bull. Dept. Biol. Sun Yatsen Univ. 13: 17. 1933. **Fig. 5.22** D-E.

Rhizome long-creeping, very dark, bearing fronds usually 2.54 mm apart, scaly; scales narrowly subtriangular, gradually narrowing from base towards taperly acuminate apex, 2.5 by 0.6 mm, greyish-brown, subentire at margin. **Fronds** monomorphic, stipes up to 20.5 cm long, stramineous, wingless; laminae not so contracted, acuminate at apex, round to cuneate at base, up to 22.2 by c. 4.2 cm; main lateral veins distinct, the veins forming areoles with included veinlets; herbaceous, green. **Sori** up to 8.5 cm narrow, up to 2.8 mm broad.

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

Distribution.— China (Kwangtung and Kwangsi, type).

Ecology.— On muddy rocks in tropical evergreen forest and hill evergreen forest at 800-1,250 m altitudes.

GPS Location.— 08° 52' 20.86"N 99° 42' 17.63"E, 08° 52' 51.40"N 99° 42' 02.14"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 492 [BCU].

4. DRYNARIA

(Bory) J. Sm., J. Bot. 4: 60. 1841; Tagawa & K. Iwats., Fl. Thailand 3(4): 543. 1989.

Rhizome creeping, scaly. Leaves in two kinds: nest-leaves (or scaly leaves) sessile. Sterile, small, usually placed to cover the rhizome, becoming brown but persistent, usually humus-collecting; foliage-leaves pinnatifid to pinnate, stipes not distinctly jointed to rhizome but all pinnae jointed to rachis, in pinnatifid leaves abscission distinct at base and each side of lobes, veins anastomosing to form drynarioid venation. Sori round or elongate.

Drynaria rigidula (Sw.) Bedd., Ferns Brit. India: t. 314. 1869; Tradieu & C. Chr. in Fl. Gén. I. –C. 7(2): 512. 1939; Holttum, Rev. Fl. Malaya 2: 183. f. 90. 1954; Tagawa & K. Iwats., Fl. Thailand 3(4): 550. 1989. — *Polypodium rigidulum* Sw., Schrad. J. Bot. 1800 (2): 26. 1801.

Rhizome creeping, about 4 mm in diameter, densely scaly throughout; scales gradually narrowing from peltate round base to apex, pale brown with dark basal point, up to 9 by 1 mm, sparsely hairs at margin with pale long downy hairs. **Nest-leaves** sessile, narrowly oblong-subdeltoid, round at base, acute at apex, up to 17 by 6 cm, lobed to 1/3 way towards midribs; lobes subtriangular, round at apex, entire, up to 2 by 0.6 cm. **Foliage-leaves:** stipes pale castaneous to purple, more or less densely downy hairy, usually very short, often bearing undeveloped pinnae at both side of stipes. **Lamina** pinnate, oblong-lanceolate, up to 35 by 17 cm; rachis pale purple, downy-hairy; lateral pinnae c. 25 pairs, linear-lanceolate, up to 11 by 1 cm, sessile, subentire or serrate at margin, caudately acuminate at apex, unequally cuneate at base; costae pale stramineous, jointed to rachis; veins raised on both surfaces, anastomosing. **Sori** round, close to costa, one row along each side of costa, one between main veins, raised on upper surface.

Thailand.— NORTHERN: Chiang Rai (Mae Kok), Chiang Mai (Mae Ho, Kong Kat, Ping Khong, Doi Suthep, Sop Aep, Doi Inthanon, Bo Luang), Phitsanulok (Thung Salaeng Luang), Tak; NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi (Khao Sabap); SOUTH-WEATERN: Kanchanaburi (Wangka, Thung Kang Yang); PENINSULAR: Krabi (Ao Luek), Surat Thani (Ban Don), Yala (Betong).

Distribution.— Indochina, Malesia, Polynesia and tropical Australia, also in Myanmar.

Ecology.— Epiphyte on tree-trunks in some open places in tropic evergreen forest at 700-800 m altitudes.

GPS Location.— 08° 52' 11.04"N 99° 42' 20.90"E, 08° 52' 20.86"N 99° 42' 17.63"E

Vernacular.— Kra prok lek (กระปรอกเล็ก), Kra prok hua hin (กระปรอกหัวหิน), Kut thang (กูดถั่ง), Kut fuei (กูดเฟื้อย), Kut mai (กูดไม้), Kutom (กูดอ้อม), Kut hang ma (กูดหางม้า) (Northern).

Specimens examined.— T. Boonkerd 19, 515 [BCU]; K. Bunchuai 1771, K. Larsen, T. Santisuk & E. Warncke 1997; M. Tagawa, K. Iwatsuki & N. Fukuoka 2433 [BKF].

5. GONIOPHLEBIUM

C. Presl, Tent. Pterid. 185. pl. 7. f. 13-14. 1836; Hovenkamp et al. in Fl. Males., Ser. II. 3: 44. f. 7, 8. 1988.

Epiphytes or epilithic, occasionally terrestrial. Rhizome long-creeping; scales mostly clathrate, appressed to erect, margin dentate, apex acuminate to filiform, often with superficial hairs. Fronds pinnate to pinnatifid, margin crenate to serrate; venation with 1-several rows of areoles, each with 1 included, excurrent, free veinlet; marginal row of excurrent veinlets present. Sori round, 1-3 rows between pinna-midrib and margin superficial to deeply sunken.

KEY TO THE SPECIES

1. Marginal of pinnae absent hairs and scales..... **G. sp.1**
 1. Marginal of pinnae present sparsely hairs and scales..... **G. sp.2**

1. *Goniophlebium* sp.1 Fig. 5.22 F-G.

Rhizome creeping, 2 mm in diameter, dark brown, phylloids 3 mm distant, densely scaly; scales peltate, round-ovate with tails, up to 1.5 by 2 mm broad at base, brown, entire. **Stipe** stramineous or brownish in upper part, 8.5-26.5 cm long, glabrescent, articulate. **Fron**d pinnate with distinct terminal pinnae, lanceolate, 13-25 cm long, up to 17 cm broad; lateral pinnae up to 5 pairs, ascending less falcate, lower to middle ones larger, distinctly stalked, lanceolate, cuneate at base, caudately acuminate at apex, up to 11.2 by 1.5-1.7 cm, serrate at margin, upper pinnae gradually becoming smaller upwards; terminal pinna up to 10.2 cm long; veins anastomosing to form 3 rows of areoles. **Sori** round, in a single row at each side of costa, medial or costular, up to 1.5 mm diameter.

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

Ecology.— On mossy tree-trunks in light shade in hill evergreen forest at 1,000-1,380 m altitudes.

GPS Location.— 08° 52' 36.19"N 99° 42' 13.85"E, 08° 52' 49.05"N 99° 41' 42.21"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 156, 162; T. Boonkerd, S S. Chantanaorapint, W. Khwaiphan 477 [BCU].

Note.— *Goniophlebium* sp.1 is an epiphytic plant on tree trunks or on tree fern in hill evergreen forest. It is similar to *Goniophlebium verrucosum* (Hook.) J. Sm. However, *Goniophlebium* sp.1 differed in having smaller size, thinner texture and shallower pit of lamina than it related species. But, however having darker colour of frond when dried. In addition, the pinnae having more serrate tip than *G. verrucosum*.

3. *Goniophlebium* sp.2 Fig. 5.23 A-B.

Rhizome creeping, 2.3 mm in diameter thick, dark brown, phylloids 3 mm distant, densely scaly; scales ovate with long tails, up to 2 mm long including tails, 1 mm broad at base, brown, dentate or toothed. **Stipe** stramineous or brownish in upper part, 6.5 cm long. **Fronde** imparipinnate, lanceolate, up to 12.6 by 8.8 cm; lateral pinnae 1 pairs, indistinctly stalked or sessile, linear-lanceolate, cuneate at base, caudately acuminate at apex, up to 6.5 by c. 1.4 cm, serrate at margin with hair, upper pinnae gradually becoming smaller upwards; terminal pinna up to 11.8 cm long; veins anastomosing to form 2 rows of areoles. **Sori** not seen.

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

Ecology.— On mossy tree-trunks in light shade in hill evergreen forest at 1,000-1,380 m altitudes.

GPS Location.— 08° 52' 36.19"N 99° 42' 13.85"E, 08° 52' 49.05"N 99° 41' 42.21"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 321[BCU].

Note.— *Goniophlebium* sp.2 is an epiphytic plant on tree trunks or on tree fern in hill evergreen forest. Only sterile plant was collected. This plant is also similar to *Goniophlebium verrucosum* (Hook.) J. Sm. but differed in having smaller size of fronds than *G. verrucosum* and *Goniophlebium* sp.1. Lamina colour is lighter when dried as compare with *Goniophlebium* sp.1 and *Goniophlebium verrucosum*. Margin is serrate and retaining hairs at most teeth.

6. LEPISORUS

(J. Sm.) Ching, Bull. Fan Mem. Inst. Biol. 4: 47. 1933; Tagawa & K. Iwats., Fl. Thailand 3(4) 507. 1989.

Rhizome creeping, bearing fronds closely, scaly; scales peltate, more or less clathrate. Stipes articulate to rhizome, sometimes indistinct from laminae, scaly at least at base. Fronds simple, entire, usually leatherly, bearing peltate scales or glabrescent; veins usually invisible, copiously anastomosing with included free

veinlets in areoles. Sori usually at junction of veins, round or rarely elongate, in some species fusing to form linear submarginal lines, superficial or sunk in cavities, exindusiate but covered when young with umbrella-shaped peltate paraphyses.

Lepisorus longifolius (Blume) Holttum, Rev. Fl. Malaya 2: 151. f. 65. 1955; Tagawa & K. Iwats Fl. Thailand 3(4): 508. 1989. — *Paragramma longifolia* (Blume) Moore. Ind.: xxxii. 1857; Copel., Gén. Fil.: 190. 1947.

Rhizome short-creeping, bearing fronds closely, glaucous on surface, scaly; scales oblong-ovate with attenuate apex, up to 2.5 by 0.8 mm, light brown, more or less clathrate, sharply toothed at margin. **Stipes** indistinct, scaly at base, stramineous, winged nearly to the very base, **Fronds** linear, up to 50 by 3.5 cm, broadest at usually about ¼ way from base, gradually narrowing towards both ends, attenuate towards but round or pointed at the very apex attenuate towards base; midrib raised on both surfaces; coriaceous, veins invisible on both surfaces, copiously anastomosing with included free veinlets. **Sori** oblong or longitudinally elongate along margin, more or less immersed in cavities, up to 2 mm broad, sometimes, up to 1 cm in length.

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.— NE. India, Myanmar, West Malesia to the Philippines and Java (type), New Guinea and Polynesia.

Ecology.— On tree-trunks in tropical evergreen forests or along streams in light shade, common at 330-400 m altitudes.

GPS Location.— 08° 51' 29.27"N 99° 42' 44.44"E, 08° 51' 37.24"N 99° 42' 40.52"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiaphan 250, 253; T. Boonkerd 366 [BCU]; Kyoji Yoda 658; M. Tagawa, K. Iwatsuki & N. Fukuoka 5403; K. Iwatsuki, H. Koyama, M. Hutoh & A. Chintayunakun, 14512 [BKF].

7. LEPTOCHILUS

Kaulf., Enum.: 147. pl. 1. f. 10. 1824. Tagawa & K. Iwats., Fl. Thailand 3(4): 54. 1989.

Terrestrial or tree-trunks; rhizome long-creeping, scaly; scales dark, peltate, more or less clathrate. Fronds biseriate, articulate to rhizome, distinctly dimorphic. Sterile laminae simple to lacinate, herbaceous to subcoriaceous, glabrous, with copiously reticulate venation, usually blackish when dried. Fertile fronds prominently contracted, linear. Sori covering the whole under surface of linear fertile laminae except on midrib and at margin, without peltate paraphyses.

Leptochilus decurrens Blume, En. Pl. Jav. : 206. 1828 ; Tradieu & C. Chr. in Fl. Gén. I.-C. 7(2) : 502. 1941; Holttum, Rev. Fl. Malaya 2: 164. f. 74. 1955; Tagawa & K. Iwats., Fl. Thailand 3(4): 542. f. 54. 7. 1989. — *Acrostichum variabile* Hook., sp. Fil. 5: 277. 1864.

Rhizome long-creeping or climbing a little above ground, up to 3-4 mm diameter, bearing fronds more than 1 cm apart, densely scaly at apex; scales narrowly-subtriangular, gradually narrowing from base towards long tail at apex, up to 3 by 0.5 mm, distinctly clathrate, dark brown. **Fronds** dimorphic. **Sterile fronds:** simple; stipes up to 10 cm long, more or less winged at least on the upper part, sparsely scaly or glabrescent at lower portion, stramineous to brown, lamina oblong to oblong-lanceolate, broadest near base, broadly cuneate at base and decurrent downwards to form wings of stipes, gradually narrowing upwards and then caudately acuminate at apex, up to 25 cm long, 6 cm wide, entire or irregularly undulate at margin; midrib raised on both surface; main lateral veins distinct, the other veins visible, forming copious areoles with forked or branched included free veinlets; dark green. **Fertile fronds:** stipes up to 15-30 cm long, stramineous to brown, wingless, glabrous; lamina linear, up to 13-20 by 0.2-0.4 cm, covered entirely covered, edges of fronds reflexed.

Thailand.— NORTHERN: Chiang Rai (Doi Phacho), Chiang Mai (Doi Chiang Dao, Tin Tok, Doi Suthep, Doi Inthanon), Lamphun (Doi Khun Tan), Mae Hong Son (Doi Loi Bian, Ban Pasui), Phrae (Huai Hom Noi), Lampang (Mae Tha):

NORTH-EASTERN: Phetchabun (Phu Miang); SOUTH-WESTERN: Uthai Thani (Noen Pradu), Kanchanaburi (Kha Thalai); PENINSULAR: Nakhon Si Thammarat (Khao Luang).

Distribution.— South India, Himalayas to South China and Taiwan, Indochina, Malesia (Type from Java) and Polynesia throughout.

Ecology.— Terrestrial on moist rocks or on basal tree trunks usually in tropical evergreen forest at 500-600 m altitudes.

GPS Location.— 08° 51' 58.06"N 99° 42' 30.55"E, 08° 51' 32.55"N 99° 41' 32.76"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 79, 259; T. Boonkerd 632; Y. Yuyen 50 [BCU]; M. Tagawa, K. Iwatsuki, H. Koyama, N. Fukuoka, A. Nalampon & A. Chintayungkun T 9331.

8. LOXOGRAMME

(Blume) C. Presl, Tent Pterid.: 214. pl. 9. f. 8. 1836.; Tagawa & K. Iwats., Fl. Thailand 3(4): 575. 1989.

Rhizome short or long-creeping, scaly; scales entire, thin, concolorous, clathrate. Frond not distinctly articulate, monomorphic to dimorphic, simple and entire, usually oblanceolate in outline, coriaceous to fleshy, glabrous; main veins hardly distinct, veins all invisible, reticulate to form areoles without, or slightly immersed, naked.

Loxogrammae avenia (Blume) Presl, Tent. Pterid.: 215. 1836; Tardieu & C. Chr. in Fl. Gén I. –C. 7(2): 465. 1941. Holttum, Rev. Fl. Malaya 2: 167. f. 76. 1955. Tagawa & K. Iwats. Fl. Thailand 3(4): 576. 1989. — *Grammitis avenia* Blume, En. Pl. Jav.: 117. 1828. **Fig. 5.23** B-C.

Rhizome short-creeping, 3.5 mm diameter, bearing fronds closely, densely covered with scales near apex; scales dark brown, hardly clathrate, linear-lanceolate, narrowing towards hair-pointed apex, c. 6 by 0.5 mm, entire. **Stipes** indistinct, dark castaneous, densely scaly at base. **Laminae** lanceolate, acuminate at apex, broadest at middle to upper 1/3 portion, gradually narrowing downwards and decurrent at base to form wings, 50 by 6 cm, edges entire or a little recurved, green on upper surface, paler

beneath; midrib distinctly raised on upper surface, hardly so beneath, pale green to brown; veins hardly visible on both surfaces, forming copious anastomosis; thick, leathery, fleshy. **Sori** linear, oblique, continuous from near midrib to the margin of fronds, forming angles of 35° to midribs, up to 5.2 cm by c. 1.5 mm, a little immersed.

Thailand.— CENTRAL: Nakhon Nayok (Nang Rong Falls); SOUTH-EASTERN: Chanthaburi (Khao Sabap), Trat (Koh Chang); PENINSULAR: Chumphon (Ban Kraye), Phangaga (Takua Pa, Khao Katha Khwam), Trang (Khao Chong), Satun, Narathiwat (Waeng), Yala (Ban Chana).

Distribution.— West Malesia (type from Java) and Indochina; also in Myanmar (Moulmein).

Ecology.— On muddy rocks in tropical evergreen forest usually near stream at 330-650 m altitudes.

GPS Location.— 08° 51' 29.27"N 99° 42' 44.44"E, 08° 52' 04.31"N 99° 42' 18.59"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 134, 187 [BCU]; D. J. Middleton, S. Suddee, S. J. Davies & C. Hernrat 1089 [BKF].

9. MICROSORUM

Link, Hort. Berol. 2: 110. 1833; Tagawa & K. Iwats., Fl. Thailand 3(4): 523. 1989.

Rhizome creeping, densely scaly in apical portion; scales peltate, usually thin, brown to darker, distinctly clathrate. Stipes articulates to rhizome, sometimes indistinct from the attenuate base of fronds. Fronds simple and entire, lobed, hastate, or pinnate, the margin of fronds or lobes not toothed; venation copiously anastomosing with free included veinlets in areoles. Sori round to oblong, usually smalls and scattered, rarely fused, without peltate paraphyses.

KEY TO THE SPECIES

1. Fronds simple
 2. Sori round one row between midrib..... **2. M. pteropus**
 2. Sori round scattered on the whole under surface of fronds
..... **3. M. punctatum**

1. Fronds deeply lobed; sori irregularly scattered on the lower surface of fronds

..... **1. M. insigne**

1. *Microsorium insigne* (Blume) Copel., Univ. Calif. Publ. Bot., 16(2): 112. 1929. —
— *Polypodium insigne* Blume, En. Pl. Javae. 127. 1828.— *Microsorium dilatatum*
(Bedd.) Sledge, Bull. Brit. Mus. (Nat. Hist.) Bot. 2: 143. 1960; Tagawa & K. Iwats.
Fl. Thailand 3(4): 530. 1989. **Fig. 5.23** D-E.

Rhizome creeping, thick, *c.* 4 mm diameter, dark, bearing fronds closely, scaly; scales oblong-subtriangular, gradually narrowing towards acuminate apex, round at base up to 2 by 1 mm, brown, clathrate, decaying from outside, oblong-ovate on older rhizome. **Stipes** up to 19.5 cm long, distinctly winged nearly to the base, scaly at base. **Lamina** simple to pinnatifid with a few lobes and winged rachis, *c.* 21 by 17 cm, the lower lateral pinnae or lobes adnate at base, oblong to narrowly oblong-lanceolate, caudate at apex, entire, up to 10.4 by 2.6 cm, the upper ones gradually becoming smaller, the terminal lobes oblong, gradually narrowing towards apex, undulate at margin, those of pinnae large fronds smaller; rachis and midrib raised, main lateral veins distinct, the other veins visible, copiously anastomosing; papyraceous, light green. **Sori** round, smaller, irregularly scattered on the lower surface, *c.* 2 mm diameter at maturity.

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

Distribution.— Himalayas to Indochina, Taiwan, Japan, Sumatra, Peninsular Malaysia, Java, Lesser Sunda Islands (Flores), Borneo, Philippines.

Ecology.— On muddy rocks usually near streams in deep shade in forest at 500-1,200 m altitudes.

GPS Location.— 08° 51' 25.45"N 99° 41' 47.36"E, 08° 52' 51.40"N 99° 42' 02.14"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 235; T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 258, 336; T. Boonkerd 1345; Y. Yuyen 45 [BCU]; E. Hennipman 3834 [BKF].

2. *Microsorium pteropus* (Blume) Copel., Univ. Calif. Publ. Bot. 16: 112. 1929; Tardieu & C. Chr. in Fl. Gén. I. –C. 7(2): 484. 1939; Holttum, Rev. Fl. Malaya 2: 172. f. 80. 1954; Tagawa & K. Iwats., Fl. Thailand 3(4): 529. 1989. — *Polypodium pteropus* Blume, En. Pl. Jav. 2: ad. 3. 1828; Fl. Jav. Fil.: 168. t. 76. 1829. **Fig. 5.23 F.**

Rhizome long-creeping, c. 2.8 mm in diameter bearing fronds rather closely, densely scaly; scales oblong-lanceolate, gradually narrowing toward apex, round at base, brown, clathrate, the margin entire, up to 2.5 by 1 mm. **Stipes** up to 4 cm long, stramineous, with the scales like those on rhizome but smaller in size, winged on upper portion. **Fronds** simple, broadest lower 1/3 portion, narrowing towards attenuately base, decurrent downwards as wings of stipes, narrowing towards attenuately very long-acuminate apex, entire, up to 7.7 by 2.1 cm, midrib raised on both surface, less minutely scaly; lateral main vein distinct beneath, the other veins hardly visible, anastomosing with a row of main areoles along both side of midrib and many smaller areoles in irregular arrangement; thinly papyraceous, dark green to blackish in colour. **Sori** round to elongate, many, one row between midrib.

Thailand.— NORTHERN: Chiang Rai (Mae Lap), Chiang Mai (Doi Chiang Dao, Doi Saket), Lampang (Mae Long), Tak, Phitsanulok (Thung Salaeng Luang); NORTH-EASTERN: Loei (Phu Luang); EASTERN: Buri Rum (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 (Koh Samui, Ban Don), Nakhon Si Thammarat (Khao Luang, Thap Chang, Khiriwong), Trang (Khao Chong), Satun (Bukit Racha, Wang), Yala (Bannang Sta)

Distribution.— India to Malesia (type from Java), north to South China and the Ryukyus.

Ecology. —Lithophytes on wet and muddy rocks by stream in tropical evergreen forest at 400-600 m altitudes.

GPS Location.— 08° 51' 37.24"N 99° 42' 40.52"E, 08° 51' 32.55"N 99° 41' 32.76"E

Vernacular.— Kut hang noh kaling (กูดหางนกกะลิง) (Peninsular)

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 501, 502; T. Boonkerd 560; Y. Yuyen 99 [BCU]; T. Smitinand 948: M. Tagawa, K. Iwatsuki & N. Fukuoka 1090 [BKF].

3. *Microsorium punctatum* (L.) Copel., Univ. Calif. Publ. Bot. 16: 111. 1929; Tardieu & C. Chr. in Fl. Gén. I. –C. 7(2): 484. 1939; Holttum, Rev. Fl. Malaya 2: 179. 1955. — *Acrostichum punctatum* L., Sp. Pl. ed. 2: 1524. 1763. — *Pleopeltis punctata* (L.) Bedd., Ferns Brit. Ind. Suppl.: 22. 1876. — *Polypodium punctatum* (L.) Sw., Schrad. J. Bot. 1800(2): 21. 1801. **Fig. 5.23 G.**

Rhizome short-creeping, 4-5 mm in diameter, dark or glaucous on surface, bearing fronds closely, scaly; scales narrowly oblong-subtriangular, gradually narrowing from ovate basal portion towards long-attenuate apex, concolously dark greyish-brown, clathrate, margin distinctly toothed, up to 2 by 1.5 mm. **Stipes** not distinct from fronds. **Lamina** narrowly oblong to lanceolate, gradually narrowing towards acute apex or moderately acute with not pointed apex, narrowing towards attenuate base, 33-50 cm long including stipes, 4-5 mm broad; midrib raised on both surfaces, other veins obscure, finely anastomosing to form copious areoles; subcoriaceous, the margin of fronds sometime revolute. **Sori** small round, many, scattered on the whole under surface of fronds.

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 Musea), Phitsanulok (Salaeng Haeng, Thung Salaeng Luang); 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, Koh Chang, Koh Kut); SOUTH-WESTERN: Kanchanaburi (Khao Ri Yi, Wangka, Sai Yok), Prachuap Khiri Khan (Bang Saphan); PENINSULAR: Ranong (Kra Buri, Klong Nakha), Surat Thani (Ban Don), Phangnga (Klong Nang Yon), Phuket, Nakhon Si Thammarat (Khao Luang, Thung Song), Trang (Khao Chong), Yala (Khao Khalakhiri, Bannang Sta).

Distribution.— Throughout the tropics of the world, West Africa to Tahiti.

Ecology.— Epiphyte tree-trunks usually in dry open place or in light shade in tropical evergreen forest and hill evergreen forest at 400-1,200 m altitudes.

GPS Location.— 08° 51' 37.24"N 99° 42' 40.52"E, 08° 52' 20.86"N 99° 42' 17.63"E, 08° 52' 51.02"N 99° 42' 01.86"E

Vernacular.— Kraprok hang sing (กระปรอกหางสิงห์) (South-eastern); Prue mai (ปรือไม้) (South-western); Lin phi mai (ลีนฝีมื่อไม้), Hang nok wa (หางนกหว้า) (Peninsular); Ai-ka bu-kong ka-waeng (ไอกานุกงกะแวง) (Malay/Peninsular); Crested Fern.

Specimens examined.— O. Ratana 49; T. Boonkerd 159; Y. Yuyen 7 [BCU]; K. Iwatsuki 6854; M. Tagawa & I. Yamada T-140 [BKF].

10. PHYMATOSORUS

Pic.Serm., *Webbia* 28(2): 457. 1973; B. Øllg., *Fami Gen. Vasc. Pl. I.* 221. 1990.

Rhizome usually long-creeping, bearing fronds jointed to the apices of short erect base; scales peltate, at least the middle part clathrate, with raised and thickened lateral cell walls, clathrate. Fronds glabrous, simple or deeply pinnatifid, thinly leathery, the veins clearly visible or not the edge slightly thickened but not notched; veins forming irregular areoles between the main lateral veins, each areole with included free veinlet pointing in all directions. Sori rather large, sunk in distinct cavities which appear as prominences on the upper surface, in one row on each side of the midrib of the fronds or of its lobes, a very distinct acroscopic veinlet always passing from the base (or near the base) of a main lateral vein to the sorus; paraphyses sometimes with enlarged apices, no peltate paraphyses.

KEY TO THE SPECIES

1. Fronds large; lobes to about 10 pairs..... **1. P. nigrescens**
1. Fronds medium; lobes about 2-3 pairs **2. P. sp.**

Phymatosorus nigrescens (Blume) Pic.Serm., *Webbia* 28 (2): 459. 1973. — *Phymatodes nigrescens* (Blume) J. Sm., *Ferns Br. For.*: 94. 1866; Tradieu & C. Chr. in *Fl. Gén. I. -C.* 7(2): 473. 1941; Holttum, *Rev. Fl. Malaya* 2: 193. f. 95. 1954; Seidenf., *Nat. Hist. Bull. Siam Soc.* 19 86. 1958. — *Polypodium nigrescens* Blume, *Enum. Pl. Jav.* 126. 1828. *Fl. Jav. Fil. t.* 70. — *Microsorium nigrescens* (Blume) Copel. *Occ. Pap. B.P. Bishop Mus.* 14: 74. 1938; Tagawa & K. Iwats., *Fl. Thailand* 3(4): 532. 1989.

Rhizome creeping, tick, *c.* 5 mm in diameter scaly; scales circular to oblong, round to moderately acute at apex, round at base, attached near the center, minutely hairy at margin, *c.* 2.5 mm in both directions, brown, less clathrate with thick internal cell-walls and transparent surface walls, the internal wall gradually becoming thinner outwards. **Stipes** up to 40 cm long, stramineous to pale castaneous. **Fronde**s oblong-ovate to subdeltoid, pinnatifid with broadly winged rachis, up to 73 by 54 cm; lateral pinnae up to 9 pairs, the basal ones the largest, up to 27 by 4.5 cm in fertile, gradually narrowing towards apex, entire at margin, the upper ones gradually becoming smaller, the wings of rachis *c.* the same as the pinnae in breadth; costae raised on both surfaces, veins hardly visible, anastomosing, with many included veinlets ending in raised point; coriaceous. **Sori** in two rather irregular rows at each side of midribs, round or elongate in deep hollows *c.* 2 mm in breadth, raised on upper surface.

Thailand.— EASTERN: Chaiyaphum (Nam Phrom, Phu Khieo), Nakhon Ratchasima (Pak Thong Chai); SOUTH-EASTERN: Prachin Buri (Khao Yai), Chantaburi (Takhaomao Falls, Khao Sabap, Khao Soi Dao), Trat (Koh Chang); SOUTH-WESTERN: Uthai Thani (Ban Rai), Kanchanaburi (Khao Ri Yai, Ban Ti Li), Prachuap Khiri Khan (Ban Huai Ta, Ban Sai Khao); PENINSULAR: Chumphon (Tha Ngo), Phangnga (Khao Katha Khwam, Khao Phra Mi), Nakhon Si Thammarat (Chawang, Khao Luang, Khiriwong), Trang (Khao Chong), Satun, Pattani, Narathiwat (Waeng, Bacho, Sungai Padi, Bacho Falls), Yala (Bannang Sta).

Distribution.— Sri Lanka, South India, Vietnam, Cambodia, throughout Malesia (type from Java) and Polynesia.

Ecology.— On rather dry rocks in tropical evergreen forests at 700-800 m altitudes.

GPS Location.— 08° 51' 44.32"N 99° 41' 32.98"E, 08° 52' 20.86"N 99° 42' 17.63"E

Vernacular.— Ka-lo ra-wa (กาโลระวา) (Malay/Peninsular).

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 467; T. Boonkerd 637; O. Neamsuwan 69 [BCU]; K. Iwatsuki & N. Fukuoka 7319; M. Tagawa, K. Iwatsuki and N. Fukuoka 5293 [BKF].

2. *Phymatosorus* sp. Fig. 5.23 H.

Rhizome creeping, thick, *c.* 2.61 mm diameter, dark, bearing fronds closely; scales circular to oblong, round to moderately acute at apex, round at base, up to 2 by 1 mm, brown, decaying from outside. **Stipes** up to 7 cm long, stramineous, with winged on upper portion. **Laminae** simple to pinnatifid with a few lobes and winged rachis, *c.* 14 by 13 cm, the lower lateral pinnae or lobes adnate at base, oblong to narrowly oblong-lanceolate, entire, acute at apex; rachis and midrib raised, veins anastomosing; papyraceous, light green. **Sori** in two rather irregular rows at each side of midribs, round *c.* 1.5 mm in breadth, raised on upper surface.

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

Distribution.— -

Ecology.— On trunks or branches in tropical evergreen at 700 m altitudes.

GPS Location.— 08° 51' 44.32"N 99° 41' 32.98"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint, W. Khwaiphan 466 [BCU].

Note.— *Phymatosorus* sp. is an epiphytic plant growing on tree fern in hill evergreen forest. It is similar to *Phymatosorus nigrescens* (Blume) Pic. Serm. but differed in having much smaller size and thinner texture of frond.

11. PYRROSIA

Mirbel, Hist. Nat. Veg. 5: 91.1803; Tagawa & K. Iwats., Fl. Thailand 3(4): 491. 1989.

Rhizome long-creeping, usually slender, scaly; scales peltate, fringed with hairs or entire, not clatrate. Fronds simple to palmately lobed, entire, fleshy, rarely dimorphic; venation anastomosing, completely hidden; surface. Sori round, larger, in a single row or more commonly in several close rows at each side of midribs, sometimes looking like the acrostichoid condition, naked, but protected by stellate hairs.

KEY TO THE SPECIES

1. Fronds not dimorphic or hardly dimorphic
 2. Fronds less than 3 cm broad, densely hairy beneath
 3. Sori not sunken, rhizome scale entire..... **2. P. albicans**
 3. Sori sunken, rhizome scale ciliate..... **3. P. lanceolata**
 2. Fronds more than 3 cm broad, lamina oblong-lanceolate with acuminate at apex..... **4. P. lingua var. heteractis**
1. Fronds dimorphic with long slender fertile fronds
 4. Sterile frond always much longer than wide, hairs beneath sparse not thickly woolly..... **1. P. adnascens**
 4. Sterile frond nearly circular to broadly ovate, thickly covered beneath with loose woolly hairs
 5. Sterile frond to about 1.5-3 cm..... **5. P. nummularifolia**
 5. Sterile frond to about 1 cm..... **6. P. piloselloides**

1. *Pyrrosia adnascens* (Sw.) Ching, Bull. Chin. Bot. Soc. 1: 45. 1935; Tardieu & C. Chr. In Fl. Gén. I. –C. 7(2): 505. 1941; Holttum, Rev. Fl. Malaya 2: 144. f. 60. 1955; Seidenf., Nat. Hist. Bull. Siam Soc. 19: 86. 1959; Tagawa & K. Iwats., Fl. Thailand 3(4): 496. 1989. — *Polypodium adnascens* Sw., Syn. Fil: 25. 222. pl. 2. f. 2. 1806. — *Cyclophrus adnascens* (Sw.) Desv., Berl. Mag. 5: 300. 1811. — *Pyrrosia lanceolata* (L.) Farw.; Hovenkamp, Leid. Bot. Ser. 9: 191. 1986, p.p.

Rhizome long-creeping, 1-2 mm diameter, bearing fronds 1-3 cm apart, dark brown, densely scaly throughout; scales oblong-subdeltoid, round at base, attenuate at apex, up to 3 by 0.6 mm, dark brown in central portion, gradually paler outwards to pale margin, hairy at margin, appressed, imbricate. **Fronds** typically dimorphic. **Sterile fronds:** stipes *c.* 1 cm long, scaly at base, stellate hair dark brown or paler upwards; laminae lanceolate, round at apex, gradually narrowing towards base, usually up to 6 by 1.7 cm. but sometimes up to 15 cm long, and up to 1.8 cm broad; midrib grooved on upper surface, raised beneath, pale green, veins completely hidden, anastomosing; thick and fleshy, upper surface stellate-hairy or glabrescent, lower surface densely hairy with appressed stellate hair with brown centre. **Fertile fronds** longer, up to 20 by 1 cm, with stipes of up to 4 cm in length, moderately acute at apex. **Sporangia** covering the whole lower surface of apical half, becoming narrow in soriferous portion; sori close, naked, covered with dense stellate hairs when young, curved back in dried condition.

Thailand.— NOTHERN: 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 Thuenk); CENTRAL: Saraburi (Muak Lek), Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chon Buri (Si Racha, Koh Sichang), Chanthaburi (Makhm, Khlung, Laem Sing, Khao Sabap), Trat (Ban Saphan Hin, Koh Chang, Koh Rang Yai); SOUTH-WESTERN: Kanchanaburi (Erawan), Prachuap Khiri Khan (Huai Yang, Bang Saphan) PENINSULAR: Ranong (Khao Sai Daeng), Surat Thani (Koh Tao, Koh Kut, Ban Don), Phangnga (Takua Thung, Koh Kho Khao, Thung Maphrao, Koh Similan), Phuket (Koh Phu), Nakhon Si Thammarat (Khiriwong, Chawang, Khao Luang), Trang (Khao Chong), Phatthalung, Narathiwat (Bacho Falls), Yala (Bannang Sata).

Distribution.— Very widely known in the tropics of Asia, India to South China, Indochina, Taiwan and the Ryukyus, Malesia throughout to Polynesia.

Ecology.— Epiphytic on dry tree-trunks or on rocks in open places or in light shade in tropical evergreen forests at 400-900 m altitudes.

GPS Location.— 08° 51' 37.24"N 99° 42' 40.52"E, 08° 52' 28.14"N 99° 42' 15.02"E

Vernacular.— Phak pik kai (ผักปิกไค) (Northern).

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 75, 150; O. Rattana 47; T. Boonkerd 1127; Y. Yuyen 20 [BCU]; M. Tagawa, T. Shimizu, M. Hutoh, H. Koyama & A. Nalampoon 9770 [BKF].

2. *Pyrrosia albicans* (Blume) Ching., Bull. Chin. Bot. Soc. 1: 72. 1935; Hovenkamp, Leid, Bot. Ser. 9: 153. 1986, p.p. Fig 50. 4-5. — *Niphobolus albicans* C. Presl, Epim. Bot. 131. 1851. — *Pyrrosia floccigera* (Blume) Ching, Bull. Chin, Bot. Soc. 1: 71. 1935; Holttum, Rev. Fl. Malaya 2: 147. 1955; Tagawa & K. Iwats. Fl. Thailand 3(4): 500. 1989. **Fig. 24.** A-B.

Rhizome long-creeping, not grooved ventrally 1.2 mm thick, phyllopodia 2.2 cm apart, lateral buds situated halfway down the internodia Scales peltate; 4 by 0.6 mm; entire, shining brown. **Fronde** monomorphic, stipitate; stipe 7 cm, as long as the lamina; lamina index 13 cm; widest *c.* the middle, base cuneate, apex obtuse to acute. Venation: secondary veins distinct, with the tertiary vein forming regular areoles; included veins simple or occasionally forked, free, excurrent. Hydrathode absent. Indument dimorphic, a dense mat, persistent, whitish to brown; upper layer composed of hairs 1 mm in diameter, with erecto-patent, acicular rays, mixed with a lower layer composed of hairs with mainly woolly rays. **Sori** apical, closely packed, in a sharply defined patch, superficial; in a row in each soliferous areole, 1 mm in diameter; when old individually distinct, exerted from the indument, paraphyses present, mixed with the sporangia, with long, curly rays.

Thailand.— NORTHERN: Tak (Ban Musoe); SOUTH-WESTERN: Kanchanaburi (Si Sawat); PENINSULAR: Nakhon Si Thammarat (Khao Nan), Trang (Khao Chong).

Distribution.— West Malesia (Sumatra and Malay to the Philippines and Java, type)

Ecology.— On rocks in tropical evergreen forests at 600-700 m altitudes.

GPS Location.— 08° 51' 32.55"N 99° 41' 32.76"E, 08° 51' 44.32"N 99° 41' 32.98"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 471; T. Boonkerd, Y. Sirichamorn and C. Sanguansab 204; A. Sathapattayanon 74 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T 5283; E. Hennipman 3014[BKF].

3. *Pyrrosia lanceolata* (L.) Farwell., Amer. Midl. Nat. 12. 245. 1931; Hovenkamp, Leid. Bot. Ser. 9: 191. f.25. 1986, p.p. Holttum, Rev. Fl. Malaya 2: 144. f. 6. 1955; Tagawa & K. Iwats. Fl. Thailand 3(4): 499. 1989. — *Acrostichum lanceolatum* L., Sp.Pl. 2. 1067. 1753. Fig. 5.24 E-F.

Rhizome long-creeping, narrowly grooved ventrally, 1 mm thick, phyllopodia 2.2 cm apart, lateral buds situated. Scale peltate, 0.65 by 1 mm; base ciliate; acumen light brown, often with a distinct hyaline margin, ciliate; short, orbicular scales usually present. **Fronde**s moderately to distinctly dimorphic, distinctly to indistinctly stipitate. **Fertile fronds:** stipes up to 1.8 cm; lamina up to 16.7 cm; widest below or c. the middle, 1.35 cm, base cuneate to narrowly cuneate, apex obtuse to acute. **Sterile fronds:** stipes to 1.2 cm; lamina 12.5 cm; widest below, c. or above the middle, 2.3 cm base attenuate, cuneate or narrowly cuneate, apex rounded, obtuse or acute. Venation: secondary veins indistinct, with the tertiary veins forming more or less regular areoles; included veins simple, occasionally forked or more copiously branched, mainly free; free veins excurrent. Hydrathodes absent, rarely present, few and indistinct, scattered over the lamina. Indument monomorphic, sparsely thin, persistent to fugacious, whitish to brown; hairs 0.05 mm with erecto-patent to appressed, acicular rays. **Sori** apical to all over the lamina, closely packed in a more or less sharply defined patch, distinctly sunken; not confluent; 1 mm in diameter; developing from the apex downwards, when old individually distinct, exerted from the indument, sporangia with paraphyses.

Thailand.— NORTHERN: Chiang Rai (Mae Lao), Chiang Mai (Chiang Dao, Mae Klang, Mae Hoi), Mae Hong Son; South-WESTERN: Chantaburi (Khao Sa bab), Trat (Koh Chang); PENINSULAR: Nakhon Si Thammarat (Khao Nan).

Distribution.— Himalayas to Myanmar, Southwest China (Yunnan) and Indochina, South India and Sri Lanka (type); also reported from Polynesia.

Ecology.— Epiphytic on dry tree trunks or on rock in light shade in tropical evergreen forest at 600-700 m altitudes.

GPS Location.— 08° 51' 32.55"N 99° 41' 32.76"E, 08° 51' 44.32"N 99° 41' 32.98"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn, C. Sanguansab 149, 150; T. Boonkerd 1223, 1175 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T 5285; Kai Larsen, Supee S. Larsen, I. Nielsen & T. Santisuk 34100 [BKF].

4. *Pyrrosia lingua* (Thunb.) Farw., Amer. Midl Naturalist 12(8): 302. 1931. **var. heteractis** (Mett. ex Khun) Hovenkamp, Blumea 30: 208. 1984. — *Acrostichum lingua* Thunb., Fl. Jap. 330, pl 33, 1784. — *Pyrrosia eberhardtii* (Christ) Ching, Bull. Chin. Bot. Soc. 1: 59. 1935; Tagawa & K. Iwats., Fl. Thailand 3(4): 505. f. 50. 9-10. 1989. — *Pyrrosia heteractis* (Mett. ex Kuhn) Ching, Bull. Chin Bot. Soc. 1: 57. 1935; Tagawa & K. Iwats., Fl. Thailand 3(4): 506. 1989. **Fig. 5.24 C-D.**

Rhizome long-creeping, 2.3 mm in diameter, bearing fronds 4 cm apart, scaly throughout; scales appressed or patent at least in the upper part especially in younger portion, narrowly subtriangular, gradually narrowing from broadest peltate portion towards attenuate apex, up to 7.5 by 2 mm, usually bi-coloured with nearly black basal portion and brown marginal portions, entire at margin, bearing long downy hairs at margin of apical portion. **Stipe** up to 10 cm long, scaly at base with those like rhizome-scales, densely hairy throughout, brown. **Fron**d oblong-lanceolate, acute to acuminate at apex, caudate or very shortly decurrent at base, 14.3 by 3.2 cm, sterile fronds usually shorter and broader; midrib and main veins distinct, raised beneath, veins hardly visible, anastomosing; rigidly coriaceous, upper surface dense mat of stellate hairs greyish in colour. **Sori** round, distinct, scattered on all the lower surface or in upper part of it, embedded in stellate hairs, not confluent.

Thailand.— NORTHERN: Chiang Rai (Doi Tung), Chiang Mai (Doi Pha Hom Pok, Doi Chiang Dao, Doi Inthanon, Doi Suthep, Pha Mon). Phitsanulok (Phu Miang, Thung Salaeng Luang); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng, Phu Paek); PENINSULAR: Nakhon Si Thammarat (Khao Luang, Khao Phra Mi), Phangnga (Khao Phota Luang Kaeo), Trang (Khao Chong).

Distribution.— South China (Hainan) and Vietnam (type).

Ecology.— Terrestrial or epiphyte on tree-trunks in light shade in hill evergreen forest at 800-1,100 m altitudes.

GPS Location.— 08° 52' 20.86"N 99° 42' 17.63"E, 08° 52' 41.34"N 99° 42' 08.14"E

Vernacular.— Lin Kuram (ลีนกูรัม) (Eastern).

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 495; T. Boonkerd 1264; Y. Yuyen 139 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T 4779 [BKF].

5. *Pyrrosia nummularifolia* (Sw.) Ching, Bull. Chin. Bot. Soc. 1. 52: 1935; Holttum, Fl. Malaya 2: 144. f. 59: 1954. Hovenkamp, Leid. Bot. Ser. 9: 214. f. 23. 1986; Tagawa & K. Iwats. Fl. Thailand 3(4): 494. 1989. — *Acrostichum nummularifolium* Sw., Syn. Fil. 191,419. 1806.

Rhizome long-creeping, narrowly grooved ventrally, thick, 1 mm in diameter, phyllopodia, sometimes opposite the phyllopodia. Scales peltate, 1 by 0.5 mm; base entire to ciliate; acumen light brown, ciliate; short, round to ovate scales regularly present. **Fron**d strongly dimorphic, distinctly to indistinctly stipitate. **Sterile fronds:** sessile with stipes to 1.5 mm; lamina 1.7 cm; base cordate to rounded or occasionally forked, occasionally anastomosing; free veins many, mainly excurrent but some recurrent. Hydrathodes absent. Indument dimorphic, a dense mat, persistent, brown, the lower layer mostly whitish; upper layer composed of hairs less than 0.5 mm in diameter, with erecto-patent, acicular rays, usually distinctly raised above a lower layer composed of hairs with mainly wooly rays. **Sori** not seen.

Thailand.— SOUTH-WESTERN: Kanchanaburi (Wangka); PENINSULAR: Nakhon Si Thammarat (Khao Luang, Khiriwong, Thung Song), Trang (Khao Chong, Khao Khao), Satun (Khuan Kalong, Khlong Tan, Pulang Kapong), Yala (Bannang Sata)

Distribution.— India, Myanmar, West Malesia (type from Java) east to the Philippines, Celebes and Lesser Sunda Islands.

Ecology.— Epiphytic on tree-trunks in light shade in tropical evergreen forest at 330-500 m altitudes.

GPS Location.— 08° 51' 29.27"N 99° 42' 44.44"E, 08° 51' 25.45"N 99° 41' 47.36"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 97, 280; T. Boonkerd 68, 159 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T 4513 [BKF].

6. *Pyrrosia piloselloides* (L.) M. G. Price, *Kalikasan* 3: 176. 1974. — *Pteris piloselloides* L., *Sp. Pl.* 2, ed. 2. 1763. — *Pteris piloselloides* L., *Spec. Pl. Ed. II* 1530. 1763. — *Taenitis piloselloides* R. Br., *Prodr. Fl. Nov. Holl.* 154. 1810. — *Notholaena piloselloides* Kaulf., *Enum.* 133. 1824. — *Pteropsis piloselloides* Desv., *Mém. Soc. Linn. Paris* 6. 218 1827. — *Drymoglossum piloselloides* C. Presl. *Tent. Pterid.* 227. pl. 10, f. 5-6. 1873; Holttum, *Rev. Fl. Malaya* 2: 149. f. 64. 1955.

Rhizome long-creeping, *c.* 1 mm, scaly throughout; scales small, almost round to ovate, peltate, centre dark, paler edges with relatively long hairs. **FronDs** distinct dimorphic. **Sterile fronds** nearly circular, and *c.* 1 cm across, sometimes broadly to the base, apex broadly rounded, coriaceous, surface smooth, bearing scattered appressed stellate hairs, midrib visible in basal half only, veins not distinct in the mesh of anastomosing veinlets, free veinlets simple. **Fertile fronds** 3-12 cm long, 5-8 mm wide, narrowed gradually to the base, apex broadly rounded texture and hairs as sterile fronds, sorus forming a broad marginal band to about 2.5 mm wide when mature, passing round the apex of the frond and almost to the base on either side.

Thailand.—NORTH-EASTERN: Nong Khai (Ban Bang); EASTERN: Chaiyaphum (Thung Kamang, Tat Ton); CENTRAL: Nakhon Nayok (Khao Yai), Krung Thep (Bangkok); SOUTH-EASTERN: Chon Buri (Si Racha), Chanthaburi (Khao Sabap, Ban Takhian Thong, Makham), Trat (Khao Saming); SOUTH-WESTERN: Kanchanaburi (Wangka, Phomphi); PENINSULAR: Chumphon, Krabi, Ranong (Koh Chang), Surat Thani (Ban Na San, Koh Tao, Khun Thale Lake), Phangnga (Yan Yao), Nakhon Si Thammarat (Khiri Wong, Khao Luang, Chawang), Trang, Songkhla, Satun, Narathiwat (Bacho Falls), Yala (Bannang Sata).

Distribution.— North-East India and Indo-China, Sumatra to New Guinea.

Ecology.— Epiphytic on dry tree trunks or on rock in light shade in tropical evergreen forest at 400-900 m altitudes.

GPS Location.— 08° 51' 37.24"N 99° 42' 40.52"E, 08° 52' 28.14"N 99° 42' 15.02"E

Vernacular.— Klet nakkarat (เกล็ดนาคราช) (Central); Kip ma lom (กีบม้าลม) (Northern); man hia (มันเหี้ย) (Southern).

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphon 4, 55; O. Rattana 46; T. Boonkerd 99 [BCU]; K. Iwatsuki, H. Koyama, M. Hutoh, A. Chintayungkun T 14490 [BKF].

12. SELLIGUEA

Bory, Dict. Class. D' Hist. Nat. 6: 587. 1824; 17: 41. 1839; Tagawa & K. Iwats., Fl. Thailand 3(4): 562. 1989.

Rhizome long-creeping, rather thick, scaly throughout; scales usually hair-pointed, peltate, thin but firm. Not clathrate, hardly bi-coloured. Fronds simple and entire, distinctly stipitate with stipes jointed to rhizome, coriaceous, rigid, brown or reddish visible, anastomosing to form copious networks with include free veinlets in areoles. Sori more or less sunk, usually linear, or interrupted, in a single row between adjacent main veins.

KEY TO THE SPECIES

1. Fronds monomorphic, rhizome scales chestnut-brown..... **1. S. laciniata**
 1. Fronds distinctly dimorphic, rhizome scales pale brown edge with center dark brown..... **2. S. triloba**

1. Selliguela laciniata (C. Presl) Hovenkamp, Blumea 43. 47. 1998. — *Pleopeltis laciniata* Bedd., Suppl. Ferns Brit. India. 97. 1892. — *Crypsinus laciniatus* Holttum, Rev. Fl. Malaya 2: 198. 1954; Tagawa & K. Iwats. Fl. Thailand 3(4): 562. 1989. **Fig. 5.24 G-H.**

Rhizome 3 mm thick scales pseudopeltate to peltate, spreading 8 by 1 mm, acute, brown, evenly coloured or with a lighter margin, strongly dentate with teeth close, very long. **Fronds** pinnatifid, rarely pinnae 9 pairs, width of connecting stipe

up to 21.5 cm; base cordate; largest pinna is 2nd-6th from base, 28 by 23.5 cm wide, widest at 24 cm, with a cuspidate, basal pinnae narrowed on basiscopic base or cut away to costa; hydrathodes frequent, margin cartilaginous, thickened; notches sporadically to regularly present (mostly); venation: main veins on upper surface raised, connecting veins distinct or veinlets also distinct; veinlets free and anastomosing, free veinlets excurrent and recurrent. **Sori** round, singly between adjacent veins, in one row between costa and margin, at 1.5 mm from costa, 2.5 mm wide, slightly to deeply sunken.

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

Distribution.— Malesia: Sumatra, Peninsular Malaysia (extending into South Thailand), Java, Lesser Sunda Islands, Moluccas.

Ecology.— Epiphytic, On trunks or branches, on rocks in hill evergreen at 1,000-1,380 m altitudes.

GPS Location.— 08° 52' 36.19"N 99° 42' 13.85"E, 08° 52' 58.08"N 99° 41' 50.15"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 463; T. Boonkerd, Y. Sirichamorn and C. Sanguansab 196; T. Boonkerd 1434 [BCU]; K. Iwatsuki, H. Koyama, M. Hutoh & A. Chintayungkun T 14568 [BKF].

2. *Selliguea triloba* (Holttum) M. G. Price, Contr. Univ. Michigan Herb. 17. 276. 1990; Hovenkamp, Blumea 43. 57. 1998. — *Polypodium trilobum* Houtt., Nat. Hist. 148. 1783. — *Crysinus trilobus* Copel., Gen. Fli. 206. 1947. Holttum, Rev. Malaya 2: 196. 1954; Tagawa & K. Iwats. Fl. Thailand 3(4): 558. 1989. — *Phymatodes triphylla* (Jacq.) C. Chr. & Tardieu, Not. Syst. 2: 284. t. 22. 1941; in Fl. Gén. I. –C. 7(2): 470. f. 55, 4-5. 1941. **Fig. 5.25** A-B

Rhizome long creeping, 2.83 mm in diameter; not so densely scaly throughout, scales ovate, more or less imbricate, acuminate but not tailed at apex, round at base, appressed, 2.5 by 2 mm, pale brown, membraneous, subentire at margin. **Fronde** distinctly dimorphic. **Sterile fronds** stipes 12.5 cm long stramenous, laminae usually tri-lobed, gradually narrowing towards moderately acute apex, up to 14.5 by 16.5 cm. apical lobed like simple laminae, laterl lobed oblong-lanceolate,

ascending, caudately acuminate at apex, slightly narrowing at base in large one; rachis and costae distinctly raised beneath, main vein distinct on both surface, other veins hardly visible, anastomosing, coriaceous light green. **Fertile fronds** taller: stipe 34 cm long, lamina pinnatifid, with up to 4 pairs of lateral lobes, rachis narrowly winged wing up to 3 mm in breadth; lobe linear, acuminate at apex, entire, 17.5 by 0.6 cm basal one the largest, smaller upwards. **Sori** in a single row at each side of costa, deeply sunken, round up to 4 mm diameter on upper surface.

Thailand.— PENINSULAR: Nakhon Si Thammarat (Khao Luang, Khao Nan) Yala (Khao Khalakhiri).

Distribution.— Indochina, Hainan. Sumatra, Peninsular Malaysia, Java, Broneo, Philippines.

Ecology.— Epiphytic, on trunks or branches, on rocks in hill evergreen at 1,000-1,380 m altitudes.

GPS Location.— 08° 52' 36.19"N 99° 42' 13.85"E, 08° 52' 58.08"N 99° 41' 50.15"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 445; T. Boonkerd, Y. Sirichamorn and C. Sanguansab 196 [BCU].

GRAMMITIDACEAE

Newman, *Hist. Brit. Ferns* 7. 1-5 Feb 1-5 Feb 1840; *Devol, Fl. Taiwan* vol. 1. 2nd ed.: 216. 1980.

Mostly small epiphytes growing on mossy tree trunks or on rocks; rhizome short-creeping or suberect; scales usually opaque or sometimes clathrate. Stipes tufted, usually not articulate to rhizome. Fronds simple, pinnate or rarely bipinnate, veins free; patent hairs usually borne on stipes, rachis and one or both surfaces of frond. Sori round, oval or linear, dorsal or marginal, superficial or immersed; sporangia often setose.

KEY TO THE GENERA

1. Sori round
 2. Fertile lobes or pinnae flat
 3. Sori superficial, or almost so
 4. Fronds simple, entire..... **4. Oreogrammitis**
 4. Fronds lobed more than halfway to midrib, each lobe or pinna with a simple or forked vein..... **3. Ctenopterella**
 3. Sori immersed in soral cavities..... **5. Prosaptia**
 2. Fertile lobes or pinnae folded
 5. Basiscopic part of fertile lobes folded over sori..... **2. Calymmodon**
 5. Both upper and lower margins of distal part of fertile lobes folded and meet above sori..... **1. Acrosorus**
1. Sori elongate..... **6. Scleroglossum**

1. ACROSORUS

Copel., Phil. J. Sci. 1. Suppl.: 158. 1906; Tagawa & K. Iwats., Fl. Thailand 3(4): 597. 1989.

Rhizome short, bearing a rosette of fronds at apex, scaly. Frond narrow, deeply lobed, each lobe with a single vein; texture leathery or fleshy; stipes and midrib short hairy; fertile lobes on upper parts of fronds. Sori solitary, protected when young by the two edges of the distal half of lobe being reflexed and meeting over it.

Acrosorus friderici-et-pauli (Christ) Copel. Phil. J. Sci. 1. Suppl. II. 159. 1906. — *Polypodium friderici-et-pauli* Christ. Ann. Tard. Buit. II. 4. 37. 1904. — *Acrosorus triangularis* (Scort. ex Bedd.) Copel., Phil., Phil. J. Sci. 3 C: 347. 1909; Holttum, Rev. Malaya 2: 222. f. 122. 1955. Tagawa & K. Iwats. Fl. Thailand 3(4): 597. 1989. f. 59. 4-5. **Fig. 5.25** C-D.

Rhizome short, suberect, bearing fronds in tuft, usually also with old fronds, scaly; scales linear, up to 3 by 0.3 mm, brown or bright brown, entire. **Stipes** indistinct, green to brown, winged to the very base. **Laminae** linear, up to 17.3 cm by 5.5 mm, gradually narrowing towards both apex and base, deeply lobed almost to midrib, the basiscopic edges almost straight or slightly curved, forming *c.* 45° to

midrib, the apex moderately acute, 2 mm in both length and width; thinly leathery, glabrous or nearly so except on midrib, veins hardly visible, simple; fertile lobes at middle or apical portion of fronds, sometimes mixed with sterile ones, each bearing a sorus, both edges of the distal half reflexed and meeting over sorus and protected it when young.

Thailand.—PENINSULAR: Surat Thani (Khao Nong), Nakhon Si Thammarat (Khao Luang), Yala (Gunong Ina).

Distribution.— Malaysia (type), Borneo and the Philippines.

Ecology.— On mossy tree-trunks in hill evergreen forests on ridges at 1,000-1,380 m altitudes.

GPS Location.— 08° 52' 36.19"N 99° 42' 13.85"E, 08° 52' 58.08"N 99° 41' 50.15"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 433; C. Thorat 127 [BCU]; K. Iwatsuki, H. Koyama, M. Hutoh & A. Chintayungkun T 14580 [BKF].

2. CALYMMODON

Presl, Tent. Pterid.: 203. 1836; Tagawa & K. Iwats., Fl. Thailand 3(4): 594. 1989.

Small plant. Rhizome short, creeping or suberect, with a tuft of fronds at apex, scaly. Laminae narrow, hairy, lobed almost to midrib, each lobe with a simple vein. Sori on upper lobes, one to each lobe, folded at basiscopic portion to protect young sori.

Calymmodon cucullatus (Nees & Blume) Presl, Tent. Pterid.: 204. 1836; Holttum, Rev. Fl. Malaya 2: 220. f. 120. 1955; Tagawa & K. Iwats. Fl. Thailand 3(4): 596. 1989. — *Polypodium cuculatum* Nees & Blume, Nova Acta 1: 121. 1828. **Fig. 5.25** E-F.

Rhizome short, suberect, bearing many fronds in tuft, scaly; scales brown, not clathrate, c. 3 by 0.8 mm, narrowly oblong, rather suddenly narrowed at acuminate apex, entire at margin, glabrous. Stipes very short, dark brown, winged. Laminae linear, up to 5 cm by 6 mm, lobed almost to midrib with a wing c. 0.3 mm broad at

each side; sterile lobes oblong, round to moderately acute at apex, entire at margin, up to 3 by 1 mm; fertile lobes on upper part of fronds. Sori solitary, naked but protected by folded basiscopic half of the fertile lobes, thus the fertile lobes bilabiate in appearance.

Thailand.— PENNSULAR: Chumphon (Khao Nom Sao), Nakhon Si Thammarat (Khao Luang), Phanganga (Khao Katha Khwam), Yala (Gnong Ina).

Distribution.— Palaeotropics (type from Java), Sri Lanka and Sumatra to Australia.

Ecology.— On mossy tree-trunks in hill evergreen forests on ridges at 1,100-1,350 m altitudes.

GPS Location.— 08° 52' 41.34"N 99° 42' 08.14"E, 08° 52' 58.08"N 99° 41' 50.15"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 199; T. Boonkerd & Polawatn. [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T 5279 [BKF].

3. CTENOPTERELLA

Parris, B. S, Gard. Bull. Singapore 58(2): 243. 2007.

Rhizomes dorsiventral, stipes in two rows, sometimes articulated to rhizome, phyllopodia sometimes present. Rhizome scales pale to medium brown, not articulate, not iridescent, glabrous, dull to glossy, cells turgid or not, without cross-walls. Hairs simple and branched, whitish or pale to dark brown. Laminae deeply pinnately lobed, pinnae or bipinnately lobed; venation free, vein in pinnae usually pinnately branched, rarely dimidiately branched, ends of vein branches usually with hydrathodes on adaxial surface of lamina. Sori on pinnate, usually in two rows, rarely in one row, superficial or slightly sunken, ± circular to elliptic; sporangia glabrous.

Ctenopterella khaoluangensis (Tagawa & K. Iwats.) Parris, Gard. Bull. Singapore 58(2): 243. 2007. — *Xiphopteris khaoluangensis* Tagawa & K. Iwats., Acta Phytotax. Geobot. 23: 177. f. 14. 1969; Tagawa & K. Iwats. Fl. Thailand 3(4): 587. 1989. f. 58.6. — *Ctenopteris malayana* Parris, Kew Bull. 41: 494. 1986. **Fig. 5.25 G.**

Rhizome short, erect, bearing several fronds in tuft, scaly; scales ovate-lanceolate, acute, entire, *c.* 2.5 by 0.5 mm, membranous, light brown. **Stipes** short, green or castaneous narrowly winged to the base, glabrous. **Laminae** linear-lanceolate, widest at middle and gradually narrowing towards both ends, moderately acute at apex, 8.1 cm by 5 mm, deeply pinnatisect; rachis green or castaneous below, round and green above, minutely acute to acuminate, usually *c.* 0.3 mm in both length, laminae entirely lobed to rachis, lobes erect-patent, oblong, moderately acute to acuminate falcate, slightly curved and entire at lower edged, with a distinct lobule near acroscopic base, *c.* 4 by 1.5 mm; lobes subtriangular, acute to acuminate, usually *c.* 1 mm in both length and width; veins once forked, long basisopic branch in lobe and short acroscopic branch of veins, usually at base lobes of lobules, round, *c.* 1.3 mm diameter.

Thailand.— PENINSULAR: Nakhon Si Thammarat (Khao Luang, type), Yala (Gunong Ina).

Distribution.— Endemic.

Ecology.— On tree-trunks in hill evergreen forests at 1,000-1,380 m altitudes; locally common.

GPS Location.— 08° 52' 41.34"N 99° 42' 08.14"E, 08° 52' 58.08"N 99° 41' 50.15"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 223 [BCU]; K. Iwatsuki, H. Koyama, M. Hutch & A. Chintayungkun T 14594 [BKF].

4. OREOGRAMMITIS

Parris, B. S, Gard. Bull. Singapore 58(2): 253. 2007.

Rhizome dorsiventral, stipes in two rows, sometimes articulated to rhizome, sometimes with prominent phyllopodia. Rhizome scales pale to dark brown or backish, usually not clathrate, rarely clathrate, usually not iridescent, rarely iridescent, usually subglossy, rarely dull or glossy, glabrous, cell usually not turgid, rarely subturgid or turgid, without cross-walls. Hair usually simple, rarely branched. Laminae usually simple, rarely pinnatifid or pinnate; venation usually free, rarely with occasional anastomoses, vein usually dichotomously one-two (-four)-branched, rarely

pinnately branched, end of vein branched sometimes with hydrathodes on adaxial surface of lamina. Sori in two (to six or more) rows on \pm simple laminae, one (to three or more) on each side of the mid-vein, in two rows, one on each side of pinna mid-vein when pinnate, superficial or slightly sunken in broad shallow depressions, rarely deeply sunken in steep-side pits, on abaxial surface of lamina, \pm circular to narrowly elliptic; first-developed sporangia of each sorus characteristically with one to nine simple glandular hairs clustered at apex of sporangium adjacent to annulus; later-developed sporangia of each sorus glabrous.

Oreogrammitis adpersa (Blume) Parris, Gard. Bull. Singapore 58(2): 255. 2007. — *Grammitis adpersa* Blume, Fl. Jav. Fil.: 115. t. 48. f. 2. 1828; Holttum, Rev. Fl. Malaya 2: 214. f. 111. 1955; Tagawa & K. Iwats. Fl. Thailand 3(4): 586. 1989. — *Grammitis subevenosa* (Baker) C. Chr & Tardieu., Not. Syst. 8: 179. 1939; in Fl. Gén. I. –C. 7(2): 523. 1941. f. 58. 3-5. **Fig. 5.26** A-B.

Rhizome short, creeping, or ascending, bearing fronds in tuft, scaly; scales narrow, gradually narrowing toward apex, 3 by 0.5 mm, plae brown, thin. **Stipes** up to 0.5 cm long, densely short pubescent with caduceus pubescences. **Fronde**s linear, round or moderately acute at apex, gradually narrowing downwards and decurrent into wings of stipes, entire; veins forked, the ends not reaching the margin, ending in hydrathodes on upper surface, thin but firm, glabrous or sparsely short-hairy. **Sori** in distinct cavities along midrib, rounded to oblong.

Thailand.— PENINSULAR: Phangnga (Khao Katha Khwan).

Distribution.— Malaya to the Philippines and Java (type).

Ecology.— On tree-trunks in hill evergreen forests at 1,000-1,385 m altitudes.

GPS Location.— 08° 52' 36.19"N 99° 42' 13.85"E, 08° 52' 58.08"N 99° 41' 50.15"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint, and W. Khwaiphan 456: T. Boonkerd, Y. Sirichamorn and C. Sanguansab 210 [BCU].

5. PROSAPTIA

C. Presl, Tent. Pterid.: 165. 1836; Tagawa & K. Iwats., Fl. Thailand 3(4): 591. 1989.

Rhizome short-creeping or ascending, scaly. Fronds in tuft, pinnatifid with free venation. Sori round to elliptic, more or less sunk in cavities at margin or on lower surface of fronds.

KEY TO THE SPECIES

1. Mouth of soral cavities not opening towards the margin of lobes, with raised edges
..... **3. P. obliquata**
1. Mouth of soral cavities opening towards the margin of lobes
 2. Sori marginal. Fronds lobed almost to midrib..... **2. P. contigua**
 2. Mouth of soral cavities within the marginal lobes, Fronds deeply lobed
with a wing **1. P. alata**

1. Prosaptia alata (Blume) Christ, Ann. Jard. Bot. Buit. II. 5: 127. 1905. — *Davallia alata* Blume, En. Pl. Jav.: 230. 1828. — *Ctenopteris alata* (Blume) Holttum, Rev. Fl. Malaya 2: 232. f. 131. 1955. Tagawa & K. Iwats. Fl. Thailand 3(4): 593. 1989. f. 59. 1-3. **Fig. 5.26** C-D.

Rhizome short, subsascending to suberect, bearing a few fronds in tuft, scaly; scales narrow, up to 4 by 0.5 mm gradually narrowing towards attenuate apex, subclathrate with darker internal walls, setose hairy at margin, pale brown. Stipes very short, castaneous or darker, hairy. Frond narrowly lanceolate, gradually narrowing toward both ends, moderately acute to acuminate at apex, deeply lobed to midrib with a wing 1.5 mm in breadth at each side of midrib, up to 13.3 by 2.2 cm; middle lobes subpatent to slightly ascending, round to moderately acute at apex, entire, up to 1 cm by 3 mm; thinly, sparsely hairy at margin, veins simple hidden. Sori terminal on veinlets, 1 on a lobe usually on apical position, submarginal, cup-shaped with the mouth opening towards margin.

Thailand.— PENINSULAR: Chumphon (Khao Nom Sao), Surat Thani (Koh Phangan), Trang (Khao Chong), Yala (Khao Khalakhiri).

Distribution.— Tropics of Asia, Sri Lanka to Polynesia (type from Java)

Ecology.— On tree-trunks in tropical evergreen forests at 700 m altitudes.

GPS Location.— 08° 51' 32.55"N 99° 41' 32.76"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 482 ; T. Boonkerd 1508 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T 6825 [BKF].

2. *Prosaptia contigua* (Forst.) Presl. Tent. Pterid.: 166. 1936. — *Trichomanes contiguum* Forst., Prodr.: 84. 1786. — *Ctenopteris contigua* (Forst.) Holttum, Rev. Malaya 2: 230. f. 130. 1955. Tagawa & K. Iwats. Fl. Thailand 3(4): 593. 1989. **Fig. 5.26** E-F.

Rhizome short-creeping, bearing, fronds closely, densely scaly; scales subtriangular, attenuate at apex, c. 4 by 1 mm. thin, more or less clathrate, hairy at margin with dark brown, short setose hairs, **Stipes** short, dark brown, rather densely setose hairy. **Laminae** linear-lanceolate, gradually narrowing towards both ends, up to 26.6 by 2.8 cm, deeply lobed slightly ascending, narrowly subtriangular, straight or slight or falcate, entire, up to 1.5 cm by 3 mm; thinly leathery, veins simple, sparsely hairy at margin. **Sori** in cup-shaped cavities at margin of apical portion of lobes, opening towards margin, c. 1 mm diameter.

Thailand.— PENINSULAR: Chumphon (Khao Nom Sao), Surat Thani (Khao Nong), Nakhon Si Thammarat (Khao Luang), Yala (Gunong Ina).

Distribution.— Tropics of Asia, Sri Lanka, South India, Sumatra to Polynesia

Ecology.— On tree-trunks in hill evergreen forests at 1,100-1,385 m altitudes.

GPS Location.— 08° 52' 41.34"N 99° 42' 08.14"E, 08° 52' 58.08"N 99° 41' 50.15"E

Specimens examined.— T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 450; T. Boonkerd, Y. Sirichamorn and C. Sanguansab 219; T. Boonkerd & R. Polawatn. 26; T. Boonkerd 1507 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T 14573, T 4825 [BKF].

3. *Prosaptia obliquata* (Blume) Mett., Reise Oest. Freg. Nov. Bot. 1: 214. 1870; Tagawa & K. Iwats. Fl. Thailand 3(4): 592. 1989. — *Polypodium obliquatum* Blume, En. Pl. Jav. : 128. 1828. — *Ctenopteris obliquata* (Blume) Copel. Phil. J. Sci. 81: 111. 1953; Holttum, Rev. Fl. Malaya 2: 221. f. 129. 1955. **Fig. 26. G - Fig. 5.27 A.**

Rhizome short, creeping to ascending, bearing fronds in tuft, scaly; scales narrowly subtriangular, up to 4.5 by 1 mm, long-acuminate at apex, clathrate with thick internal walls and transparent surface, densely hairy at margin with setose dark brown hairs, thinly leathery. **Stipes** up to 3 cm long, pale brown, densely hairy. **Laminae** linear-lanceolate, gradually narrowing from base towards acuminate apex, up to 28 by 5.2 cm, the lower ones gradually shorter and the upper ones becoming smaller upwards; thinly leathery to papyraceous; veins simple, hairy at margin of lobes with short, setose brown hairs. **Sori** terminal at veins, oblong, oblique, medial or submarginal, immersed with distinctly raised deges.

Thailand.— PENINSULAR: Krabi (Phanom Bencha), Phangnga (Khao Phota Luang Kaeo), Nakhon Si Thammarat (Khao Luang).

Distribution.— Tropics of Asia, from South India and Sri Lanka to New Guinea (type from Java).

Ecology.— On tree-trunks in hill evergreen forests at 1,100-1,385 m altitudes.

GPS Location.— 08° 52' 41.34"N 99° 42' 08.14"E, 08° 52' 58.08"N 99° 41' 50.15"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 194, 220; T. Boonkerd 37 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T 4822 [BKF].

6. SCLEROGLOSSUM

v. A. v. Ros., Bull. Jard. Bot. Buil. II. 7: 37. 1912; Tagawa & K. Iwats., Fl. Thailand 3(4): 598. 1989.

Rhizome short, bearing a rosette of fronds, scaly. Fronds, scaly. Fronds simple, narrow, entire, glabrous or setose hairy, leathery in texture; veins hardly visible, usually once forked. Sori sunk in marginal or sub marginal grooves, naked.

Scleroglossum pusillum (Blume) v.A.v. Ros., Bull. Jard. Bot. Buit. II. 7: 39. pl. 5. f. 1-2. 1912; Tardieu & C. Chr. in Fl. Gén. I. –C. 7(2):. 524. f. 39, 4-5. 1941; Holttum, Rev. Fl. Malaya 2: 234. f. 135. 1955; Tagawa & K. Iwats. Fl. Thailand 3(4): 598. 1989. f. 59. 8-9. — *Vittaria pusilla* Blume, En. Pl. Jav.: 199. 1828. **Fig. 5.27** B-C.

Rhizome short, suberect, bearing a tuft of fronds at apex, scaly; scales narrow, gradually narrowing from base towards acuminate apex, up to 3.5 by 0.5 mm, pale brown, entire, moderately acute at apex, up to 13 cm by 3 mm; leathery, glabrous. **Soral** grooves submarginal, opening towards margin, in apical to middle portion.

Thailand.— NORTHERN: Chiang Mai (Doi Suthep); SOUTH-EASTERN: Trat (Khao Kuap, Tha Kum); PENINSULAR: Nakhoa Si Thammarat (Khao Luang), Yala (Gunong Ina).

Distribution.— Malesia throughout (type from Java).

Ecology.— On mossy tree-trunks in hill evergreen forests on ridges at 1,100-1,385 m altitudes.

GPS Location.— 08° 52' 41.34"N 99° 42' 08.14"E, 08° 52' 58.08"N 99° 41' 50.15"E

Specimens examined.— T. Boonkerd, Y. Sirichamorn and C. Sanguansab 201; T. Boonkerd, S. Chantanaorapint and W. Khwaiphan 453; H. B. G. Garrett 1081 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T 4827 [BKF].

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Figure 5.1 A-B: *Huperzia coralia* (Spring) J. Holub; A. habitat; B. sporophyll. C. *Huperzia hippuris* (Christ) J. Holub; sporophyll. D. *Huperzia nummulariifolia* (Blume) T. Chambers; sporophyll. E-F: *Huperzia phlegmaria* (L.) Rothm; E. habitat; F. sporophyll. G-H: *Huperzia pinifolia* Trevis.; G. habitat; H. sporophyll.

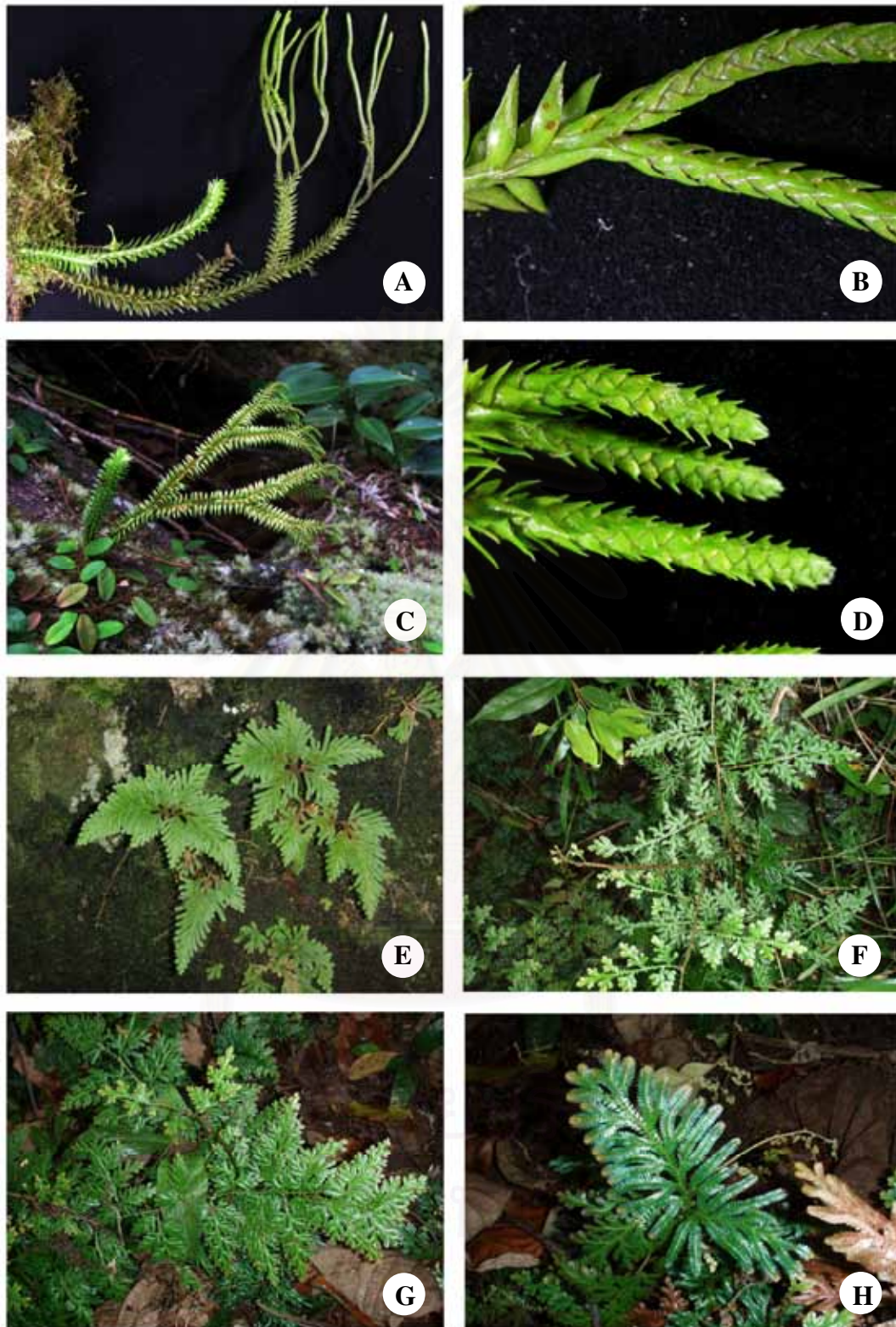


Figure 5.2 A-B: *Huperzia* sp.1; A. habitat; B. sporophyll. C-D: *Huperzia* sp.2; C. habitat; D. sporophyll. E. *Selaginella argentea* (Wall. ex Hook. & Grev.) Spring; habitat. F. *Selaginella helferi* Warb.; habitat. G-H: *Selaginella willdenowii* (Desv. ex Poir.) Baker; G. habitat; H. character iridescent blue colour.



Figure 5.3 A. *Helminthostachys zeylanica* (L.) Hook.; habitat. B. *Angiopteris evecta* (G. Forst.) Hoffm.; habitat. C-D: *Cephalomanes obscurum* (Blume) K. Iwats.; C. habitat; D sori. E. *Crepidomanes auriculatum* (Blume) K. Iwats.; habitat. F-G: *Crepidomanes bipunctatum* (Poir.) Copel.; F. habitat; G. sori. H. *Crepidomanes latemarginale* (Eaton) Copel.



Figure 5.4 A. *Crepidomanes latemarginale* (Eaton) Copel.; sori. B-C: *Crepidomanes maximum* (Blume) K. Iwats. B. habitat; C. sori. D-E: *Crepidomanes pallidum* (Blume) K. Iwats.; D. habitat; E. sori. F. *Hymenophyllum acanthoides* (Bosch) Rosenst.; habitat. G-H: *Hymenophyllum exsertum* Wall. ex Hook.; G. habitat; H. sori.



Figure 5.5 A-B: *Hymenophyllum javanicum* Spreng.; A. habitat; B. sori. C. *Hymenophyllum polyanthos* (Sw.) Sw.; D-E: *Hymenophyllum treubii* Racib; D. habitat; E. sori. F. *Trichomanes bimarginatum* Bosch; frond and sori. G-H: *Dicranopteris splendida* (Hand-Mazz.) Tagawa; G. habitat; H. sori.

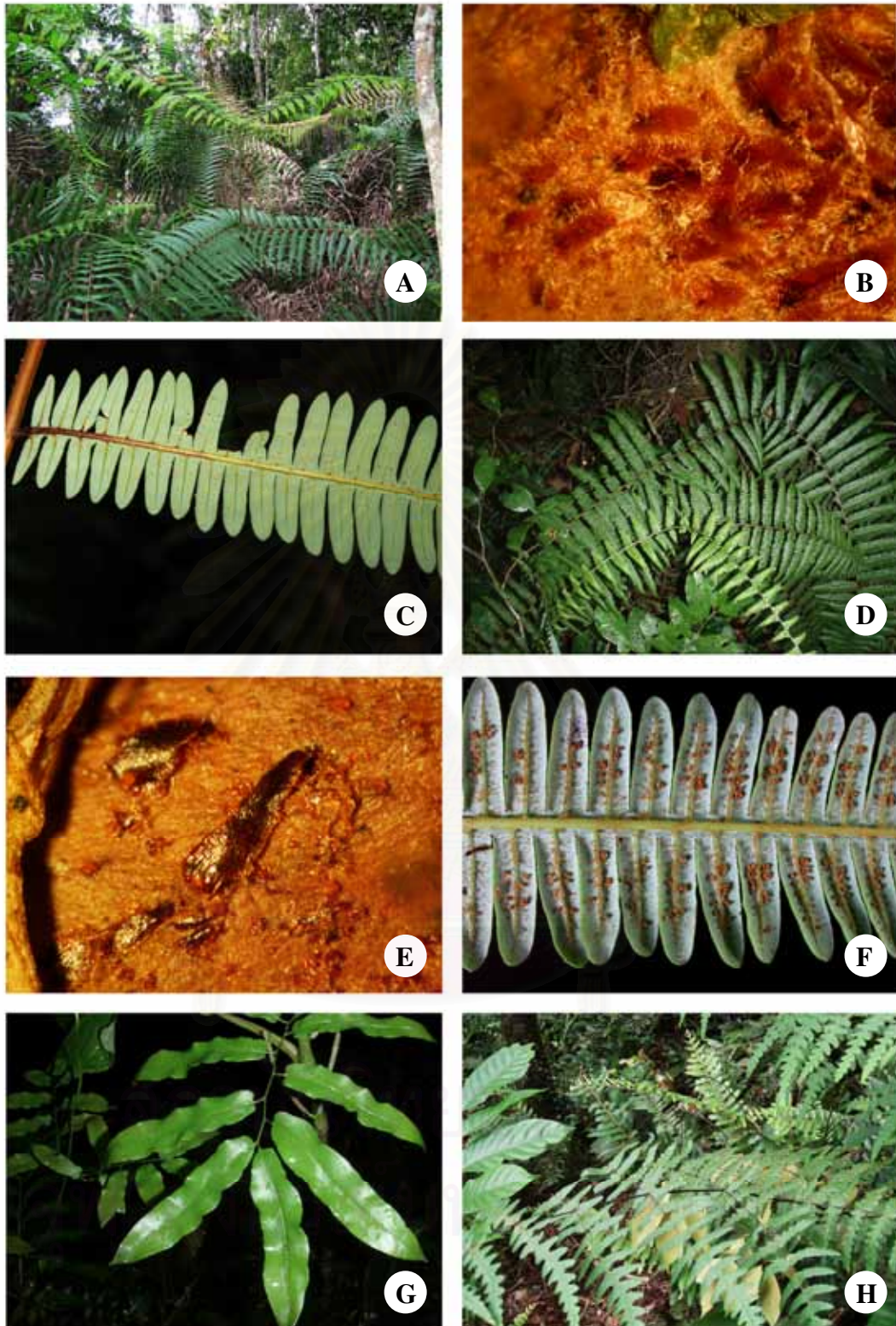


Figure 5.6 A-C: *Gleichenia longissima* Blume; A. habitat; B. scales; C sori. D-F: *Gleichenia norrisii* Mett. ex Kuhn; D. habitat; E. scales; F. sori. G. *Lygodium salicifolium* C. Presl; frond H. *Histiopteris incisa* (Thunb.) J. Sm., habitat.



Figure 5.7 A. *Histiopteris incisa* (Thunb.) J. Sm.; sori. B-C: *Microlepidia speluncae* (L.) T. Moore; B. habitat; C. sori. D-E: *Microlepidia strigosa* (Thunb.) C. Presl; D. habitat; E. sori. F-G: *Lindsaea doryphora* Kramer; F. habitat; G. sori. H. *Lindsaea lucida* Blume; habitat.



Figure 5.8 A. *Lindsaea lucida* Blume; sori. B-C. *Lindsaea oblanceolata* v. A. v. Ros.; B habitat; C. sori. D. *Lindsaea repens* (Bory) Thwaites var. *pectinata* (Blume) Mett. ex Kuhn; habitat. E-F: *Cyathea glabra* (Blume) Copel.; E. habitat; F. sori.



Figure 5.9 A-B: *Cyathea hymenoides* Mett.; A. habitat; B. sori. C-D: *Cyathea latebrosa* (Wall. ex Hook) Copel.; C. habitat; D. sori. E. *Adiantum latifolium* Lam.; habitat. F. *Taeneticus blechnoides* (Willd.) Sw.; habitat. G *Pteris biaurita* L.; frond.

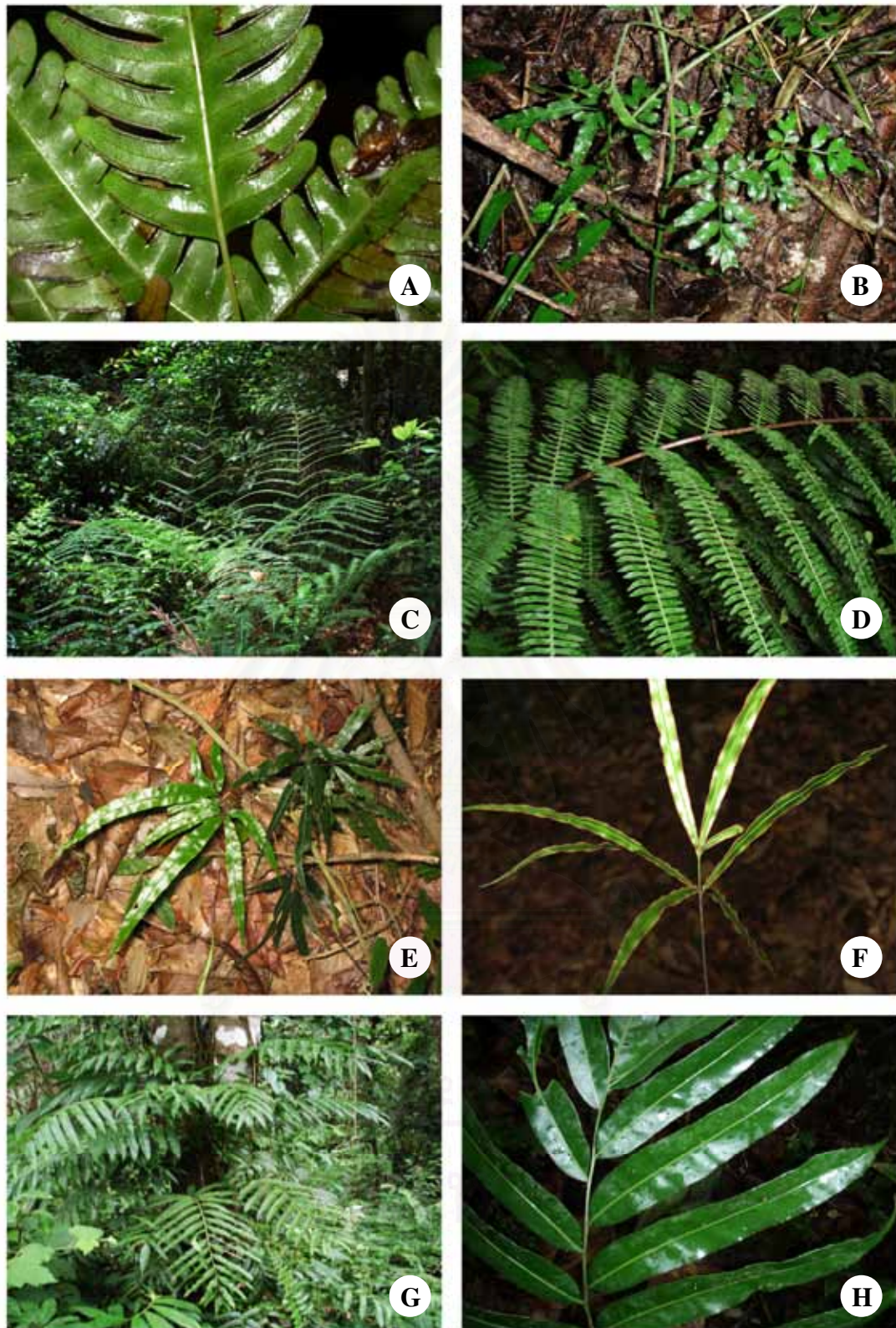


Figure 5.10 A. *Pteris biaurita* L.; sori. B. *Pteris ensiformis* Burm. f.; habitat. C-D : *Pteris mertensioides* Willd.; C. habitat; D. frond. E-F: *Pteris scabripes* Wall. ex J. Agardh; E. habitat; F. sori. G-H: *Stenochlaena palustris* (Burm. f.) Bedd.; G. habitat; H. sori.

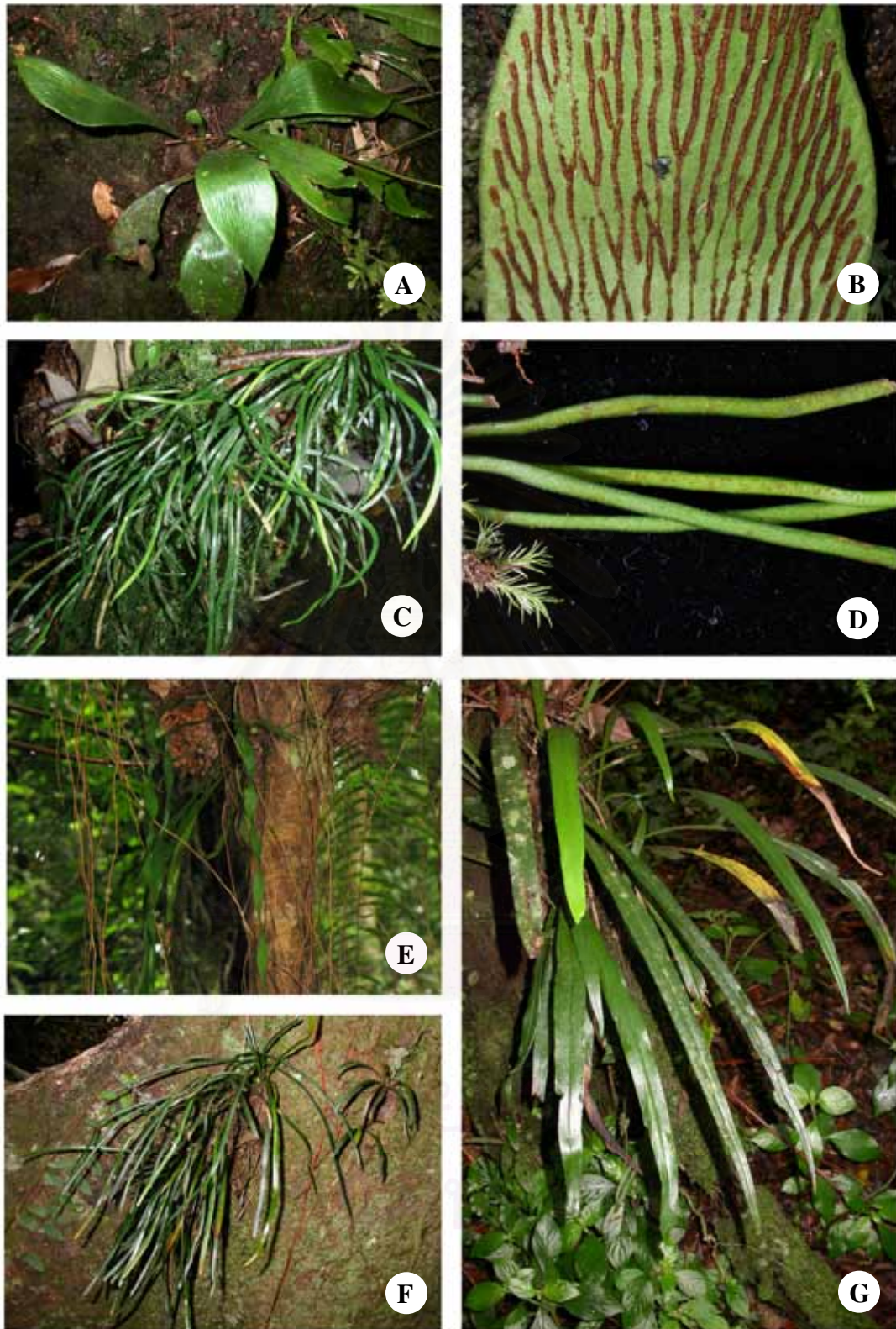


Figure 5.11 A-B: *Anthrophium callifolium* Blume; A. habitat; B. sori. C-D: *Vittaria angustifolia* Blume; C. habitat; D. sori. E. *Vittaria elongata* Sw.; habitat. F. *Vittaria ensiformis* Sw.; habitat. G. *Vittaria scolopendrina* (Bory) Schkuhrex ex Thwaites; habitat.

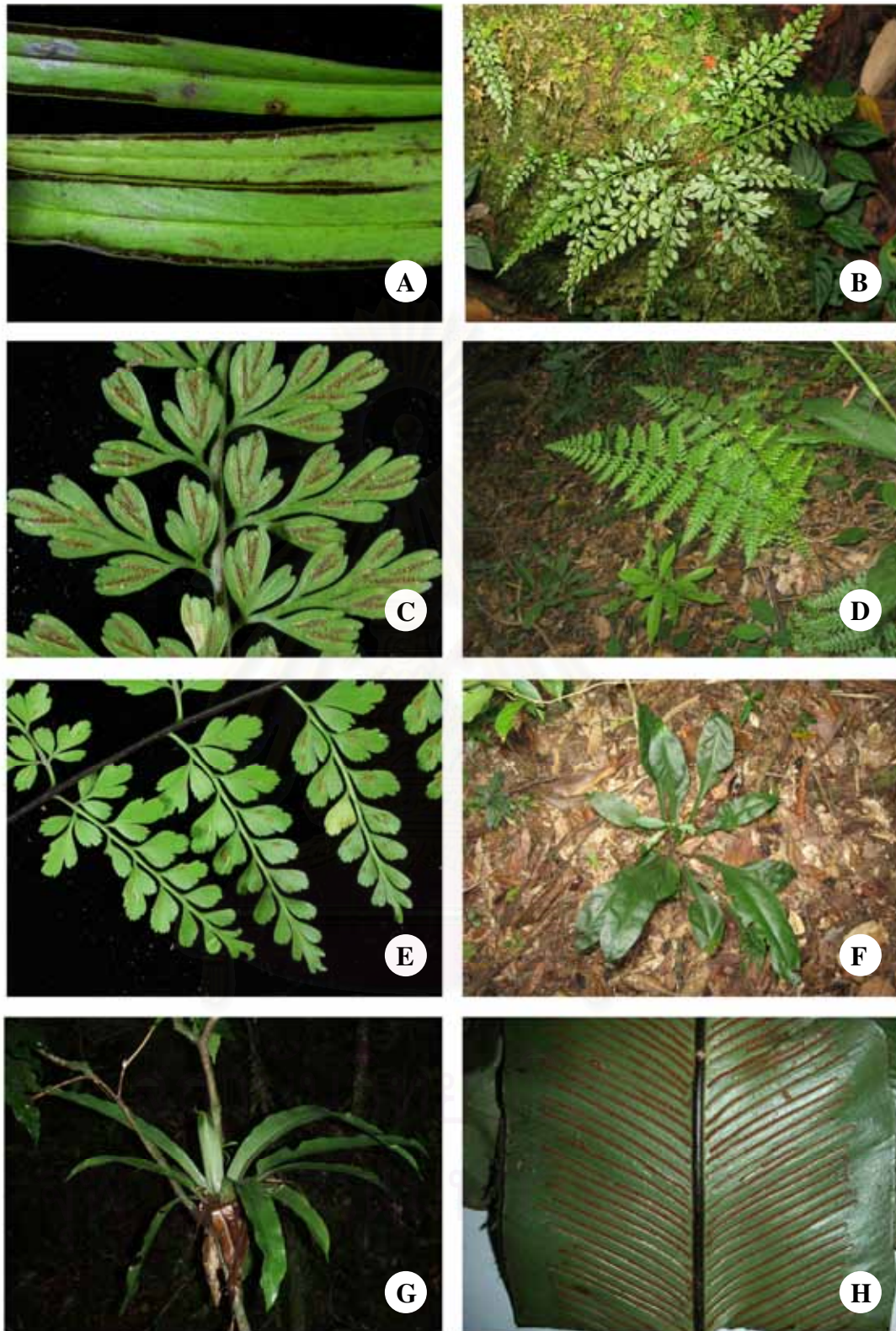


Figure 5.12 A. *Vittaria flexuosa* Fée; habitat. B-C *Asplenium affine* Sw.; B. habitat; C. sori. D-E: *Asplenium confusum* Tardieu & Ching; D. habitat; E. sori. F. *Asplenium grevillei* Wall. ex Hook. & Grev.; G-H: *Asplenium nidus* L. var. *nidus*; G. habitat; H. sori.



Figure 5.13 A. *Asplenium normale* D. Don; habitat. B-C: *Asplenium perakense* Matthew & Christ; B. habitat; C. sori. D. *Asplenium salignum* Blume; E-F: *Asplenium tenerum* G. Forst.; E. habitat; F. sori. G. *Hymenasplenium apogamum* (N. Murak. & Hatan.) Nakaike; habitat.

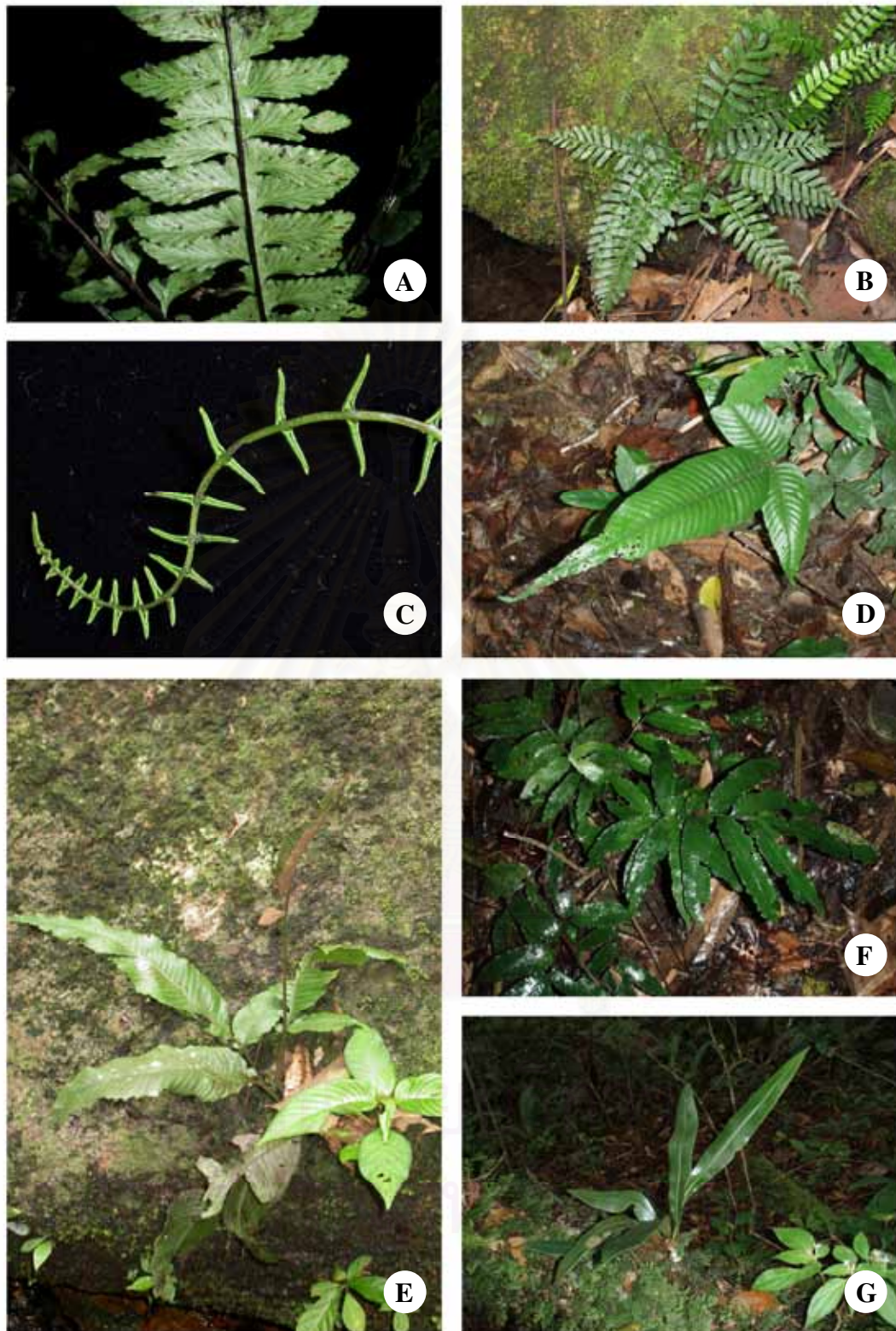


Figure 5.14 A. *Hymenasplenium apogamum* (N. Murak. & Hatan.) Nakaïke; sori. B-C: *Bolbitis appendiculata* (Willd.) K. Iwats.; B. habitat; C. sori. D. *Bolbitis heteroclita* (C. Presl) Ching; habitat. E. *Bolbitis sinuata* (C. Presl) Hennisman; habitat. F. *Bolbitis virens* (Wall. ex Hook. & Grev.) Schott; habitat. G. *Elaphoglossum malayense* Holttum; habitat.



Figure 5.15 A. *Elaphoglossum malayense* Holttum; sori. B-C: *Didymochlaena truncatula* (Sw.) J. Sm.; B. habitat; C. sori. D-E: *Heterogonium sagenioides* (Mett.) Holttum; D. habitat; E. sori. F-G: *Pleocnemia irregularis* (C. Presl) Holttum; F. habitat; G sori.

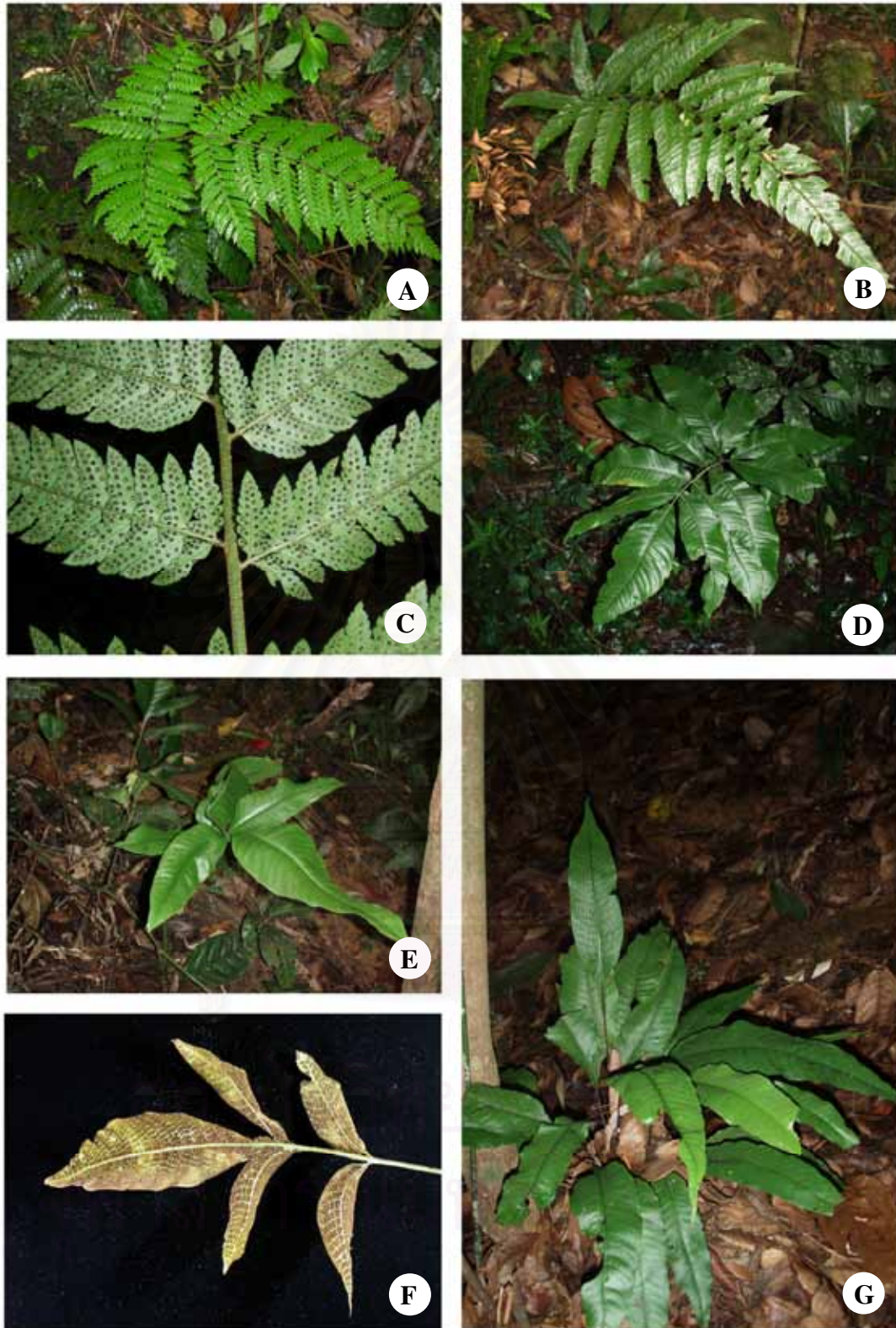


Figure 5.16 A. *Pleocnemia* sp.; habitat. B-C: *Polystichum prolificans* v. A. v. Ros.; B. habitat; C. sori. D. *Tectaria polymorpha* (Wall. ex Hook.) Copel.; habitat. E-F: *Tectaria semipinnata* (Roxb.) Morton; E. habitat; F. sori. G. *Tectaria singaporeana* (Wall. ex Hook & Grev.) Ching; habitat.



Figure 5.17 A. *Tectaria singaporeana* (Wall. ex Hook & Grev.) Ching; sori. B. *Christella dentata* (Forssk.) Holttum; habitat. C-D: *Christella papilio* (C. Hope) Holttum; C. habitat; D. sori. E-F: *Mesophlebion crassifolium* (Blume) Holttum; E. habitat; F. sori. G-H: *Pronephrium repandum* (Fée) Holttum; G. habitat; H. sori.



Figure 5.18 A-B: *Diplazium bantamense* Blume; A. habitat; B. sori. C-D: *Diplazium cordifolium* Blume; C. habitat; D. sori. E-F: *Diplazium crenatoserratum* (Blume) T. Moore; E. habitat; F. sori. G-H: *Diplazium dilatatum* Blume; G. habitat; H. sori.



Figure 5.19 A-B: *Diplazium donianum* (Mett.) Tardieu; A. habitat; B. sori. C-D: *Diplazium simplicivenium* Holttum; C. habitat; D. sori. E-F: *Diplazium sorzogonense* (C. Presl) C. Presl; E. habitat F. sori. G. *Diplazium tomentosum* Blume; habitat. H. *Diplazium xiphophyllum* (Bak.) C. Chr.; habitat.



Figure 5.20 A. *Diplazium xiphophyllum* (Bak.) C. Chr.; sori. B-C: *Davallia corniculata* Moor; B. habitat; C. sori. D. *Davallia embolostegia* Copel.; habitat. E-F: *Davallia repens* (L. f.) Kuhn; E. habitat; F. sori. G-H: *Nephrolepis biserrata* (Sw.) Schott; G. habitat; H. sori.



Figure 5.21 A-B: *Nephrolepis davalliodes* (Sw.) Kunze; A. habitat; B. sori. C-D: *Nephrolepis* sp.; C. habitat; D. sori. E-F: *Oleandra neriiiformis* Cav.; E. habitat; F. sori. G. *Aglaomorpha coronans* (Wall. ex Mett.) Copel.; habitat.

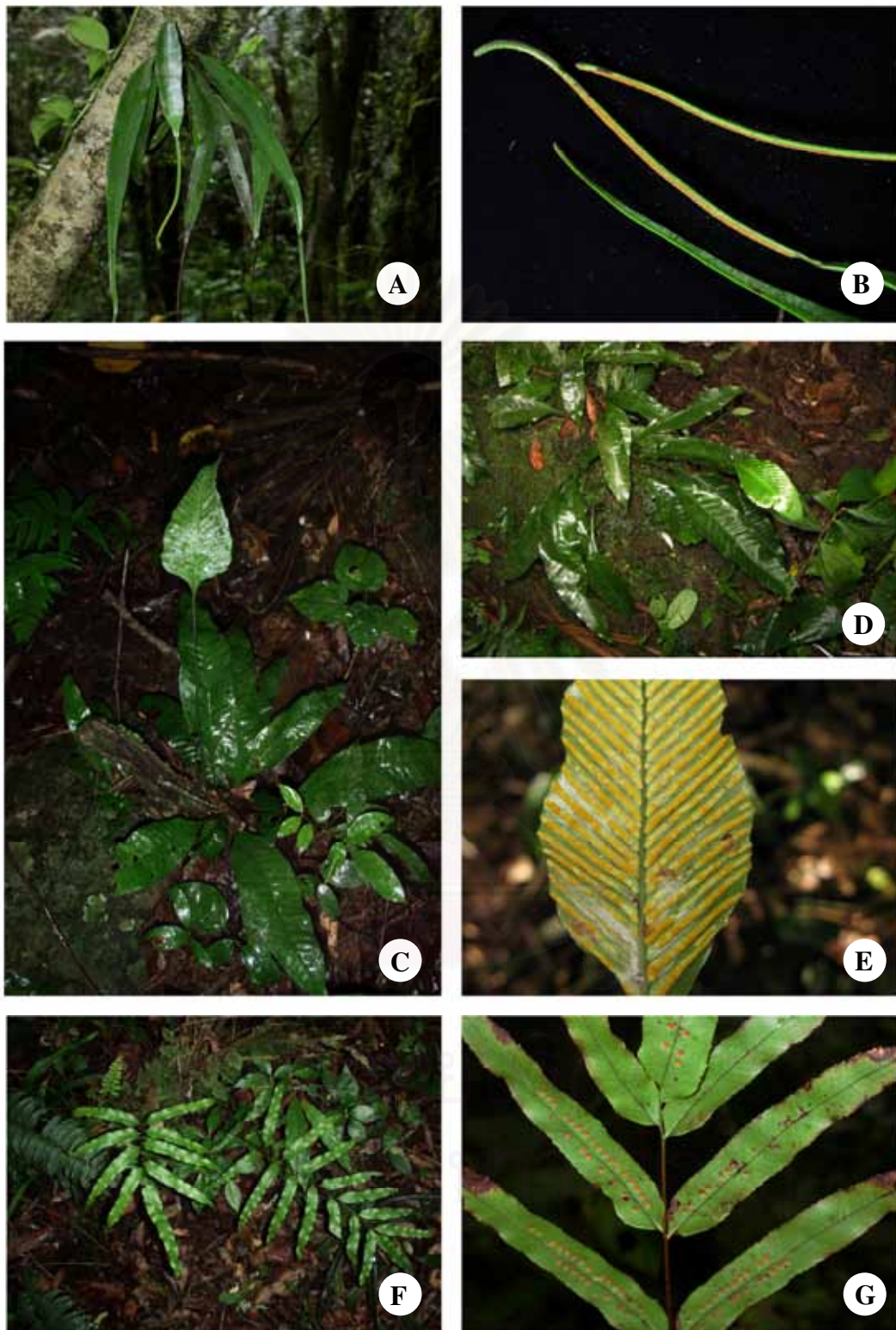


Figure 5.22 A-B: *Belvisia spicata* (L. f.) Mirbel ex Copel.; A. habitat; B. sori. C. *Colysis pedunculata* (Hook. & Grev.) Ching; habitat. D-E: *Colysis wui* (C. Chr.) Ching; D. habitat; E. sori. F-G: *Goniophlebium* sp.1; F. habitat; G. sori.



Figure 5.23 A-B: *Goniophlebium* sp.2; habitat. B-C: *Loxogramme avenia* (Blume) C. Presl; B. habitat; C. sori. D-E: *Microsorium insigne* (Blume) Copel.; D; habitat; E; sori. F. *Microsorium pteropus* (Blume) Copel. G; *Microsorium punctatum* (L.) Copel.; habitat. H. *Phymatosorus* sp.; sori.

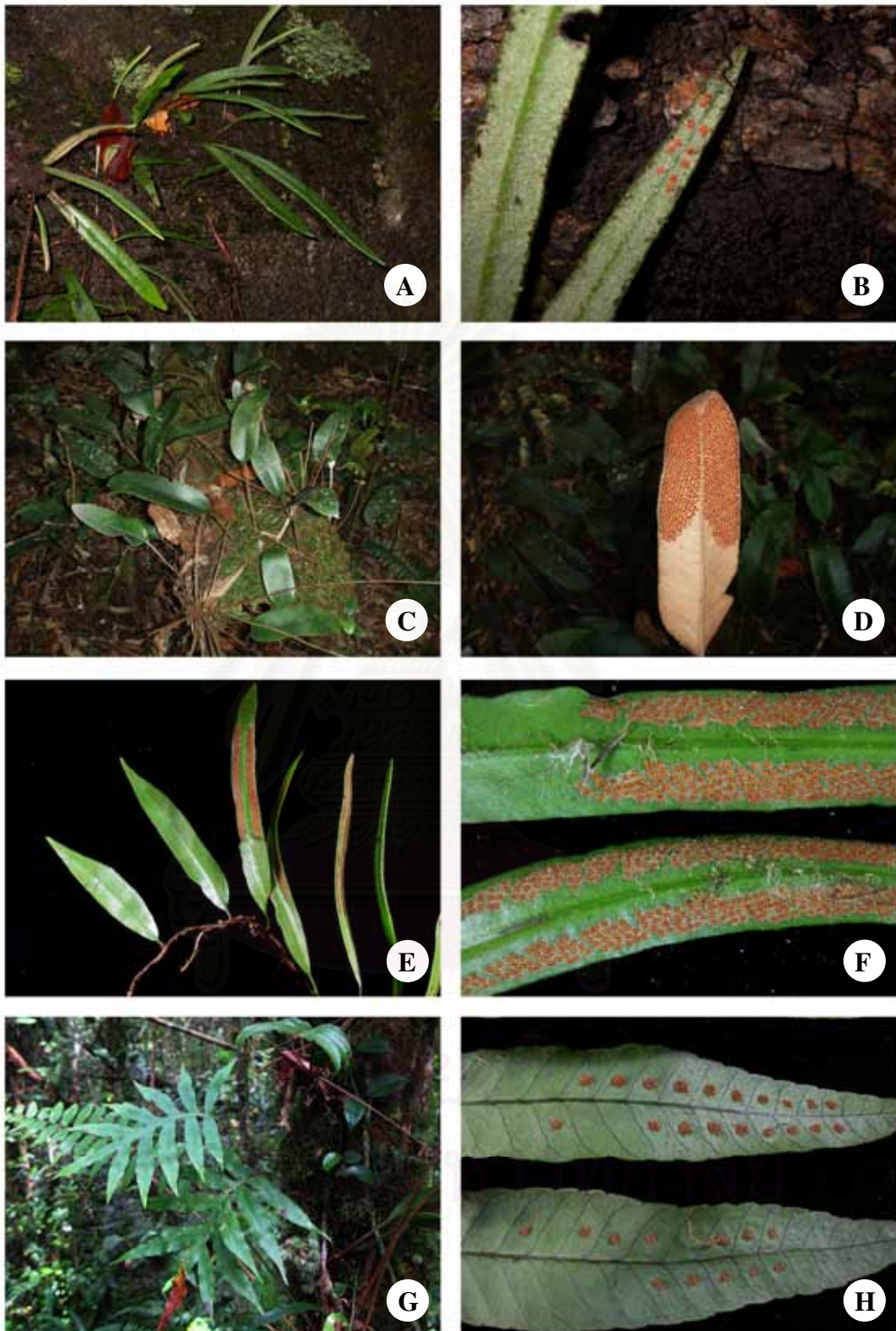


Figure 5.24 A-B: *Pyrrosia albicans* (Blume) Ching; A. habitat; B. sori. C-D: *Pyrrosia lingua* (Thunb.) Farwell var. *heteractis* (Mett. ex Kuhn) Hovenkamp; C. habitat; D. sori. E-F: *Pyrrosia lanceolata* (L.) Farwell; E. habitat; F. sori. G-H: *Selliquea laciniata* (C. Presl) Hovenkamp; G. habitat; H. sori.

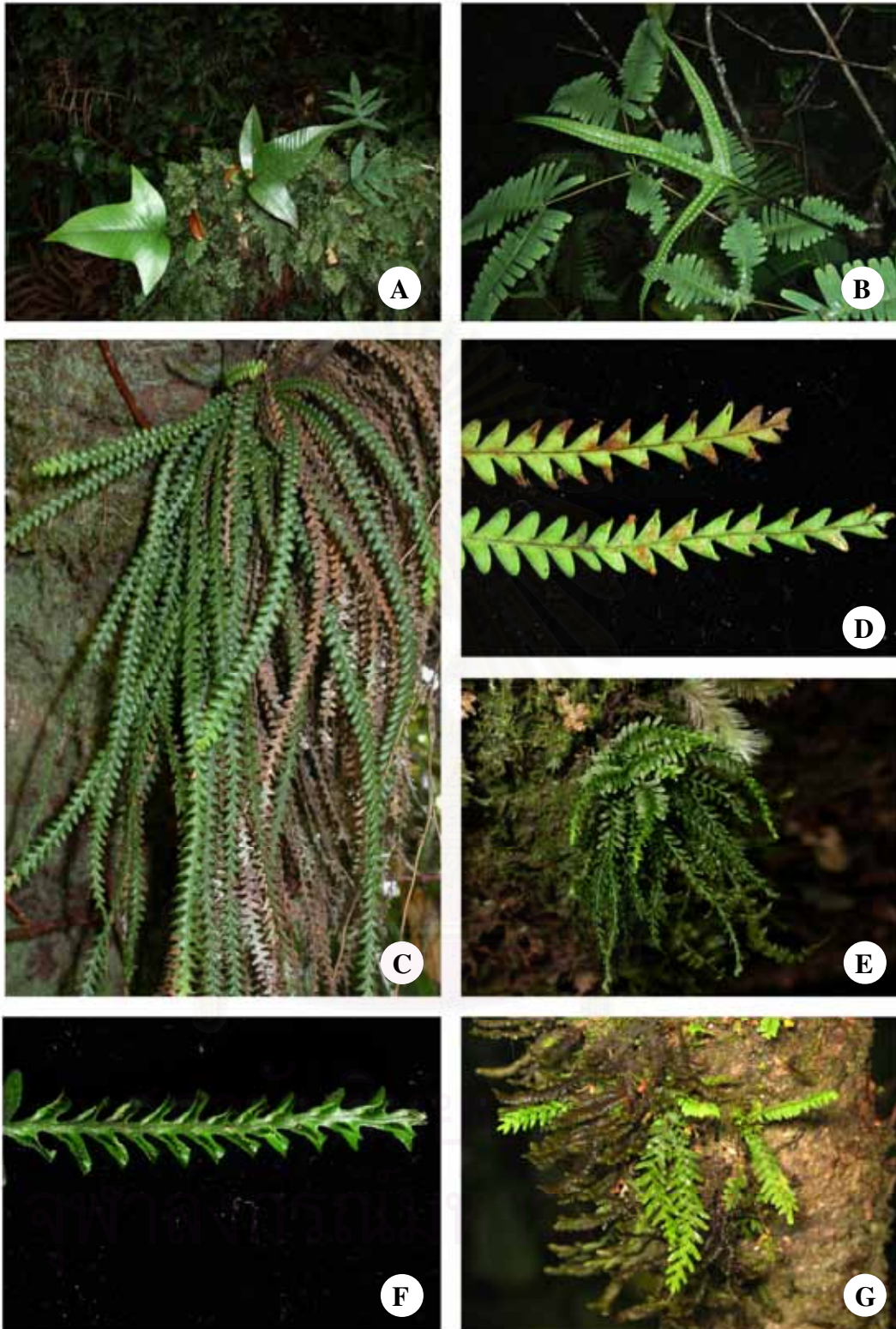


Figure 5.25 A-B: *Selliquea triloba* (Houtt.) M. G. Price; A. habitat; B. sori. C-D: *Acrosorus friderici-et-pauli* (H. Christ) Copel.; C. habitat; D. sori. E-F: *Calymmodon cucullatus* (Nees & Blume) C. Presl; E. habitat; F. sori. G. *Ctenopterella khaoluangensis* (Tagawa & K. Iwats.) Parris; habitat.



Figure 5.26 A-B: *Oreogrammitis adspersa* (Blume) Parris; A. habitat; B. sori. C-D: *Prosaptia alata* (Blume) H. Christ; C. habitat; D. sori. E-F: *Prosaptia contigua* (G. Forst.) C. Presl; E. habitat; F. sori. G. *Prosaptia obliquata* (Blume) Mett.; habitat.



Figure 5.27 A. *Prasaptia obliquata* (Blume) Mett.; sori. B-C: *Scleroglossum pusillum* (Blume) Alderw.; B. habitat; C. sori. D-E: *Dipteris conjugata* Reinw.; D. habitat; E. sori.

จุฬาลงกรณ์มหาวิทยาลัย

CHAPTER VI

DISCUSSION AND CONCLUSION

Diversity of fern and fern allies at Khao Nan Yai area in Khao Nan National Park were explored from July 2007 to April 2008. A total of 221 specimens were collected and subsequently determined into 131 species and 3 varieties, in 58 genera within 24 families. Among these, 22 families, 56 genera, 120 species and 3 varieties were ferns, while 2 families, 2 genera and 11 species were fern allies. The 22 families of ferns, namely Polypodiaceae, Hymenophyllaceae, Woodsiaceae, Aspleniaceae and Dryopteridaceae were among the common families. Polypodiaceae included 23 species in 12 genera while Hymenophyllaceae included 12 species in 4 genera and Woodsiaceae included 10 species in 1 genus. While Dryopteridaceae included 10 species in 6 genera and Aspleniaceae included 10 species in 2 genera, respectively. With regard to habitats, there were 37 species and 2 varieties of epiphytes, 45 species and 2 varieties of terrestrials, 14 species of lithophytes. However, 35 species of ferns and fern allies could be found in more than one habitat. Furthermore, it can be concluded that 68 species were found in tropical evergreen forest, while 46 species were found in hill evergreen forest.

6.1 Diversity of fern and fern allies in relation to habitat

Various habitats of ferns and fern allies at Khao Nan Yai area in Khao Nan National Park were found, such as the forest floor (terrestrial), on tree fern or tree trunks and branches (epiphyte), and on rocks (lithophytes). Furthermore, some species of ferns and fern allies can be found in more than one habitat (Fig. 6.1).

6.1.1 Terrestrials

It was found that 45 species and 1 variety of ferns were terrestrials, which includes mountain slopes as well as stream banks with shady or exposed areas. Most terrestrial ferns were observed on mountain slopes. Common terrestrial ferns were member of the families Woodsiaceae, Dryopteridaceae, Dennstaedtiaceae, Pteridaceae, Gleicheniaceae and Selaginellaceae. The common species included *Diplazium tomentosum* Blume, *Diplazium sorzogonense* (C. Presl) C. Presl, *Didymochlaena truncatula* (Sw.) J. Sm., *Pteris scabripes* Wall. ex J. Agardh, *Microlepia strigosa* (Thunb.) C. Presl. These ferns usually occupied humus-rich

mountain slopes. Some terrestrial mountain ferns, for example *Asplenium normale* D. Don, can be also found in hill evergreen forest. It usually occupied humus-rich grounds or rocks. Whereas some plant can be found near stream banks, where air and soil humidity is rather high, there exist tree ferns or big-sized ferns, such as *Cyathea latebrosa* (C. Presl) Copel., *Angiopteris evecta* (G. Forst.) Hoffm., and *Pleocnemia irregularis* (C. Presl) Holttum. Some ferns, for example *Tectaria polymorpha* (Wall. ex Hook.) Copel., and *Pteridrys australis* Ching can be observed along stream in shady places. In exposed areas of the hill evergreen forest, the common terrestrial sun-ferns can be found, i.e. *Dipteris conjugata* Reinw., *Histiopteris incisa* (Thunb.) J. Sm., *Gleichenia longissima* Blume, and *Dicranopteris splendida* (Hand-Mazz.) Tagawa. These ferns have rhizomes below the ground surface, their above ground plant-parts are still protected from strong sun-light and strong winds.

6.1.2 Epiphytes

It was found that 37 species, 2 varieties of ferns and fern allies are epiphytes (Fig. 6.1). In general, these ferns and fern allies grow on tree trunks, mossy tree trunks or branches of trees. Common families included Polypodiaceae, Hymenophyllaceae, Aspleniaceae, Grammitidaceae, Vittariaceae, Davalliaceae and Lycopodiaceae. Most ferns are observed on tree trunks, such as *Pyrrhosia lingua* (Thunb.) Farwell var. *heteractis* (Mett. ex Kuhn) Hovenkamp, *Oreogrammitis adspersa* (Blume) Parris, *Vittaria scolopendrina* (Bory) Schkuhr ex Thwaites, *Davallia embolostegia* Copel., *Elaphoglossum malayense* Holttum, and *Huperzia phlegmaria* (L.) Rothm. Some ferns, such as *Hymenophyllum polyanthos* (Sw.) Sw., *Hymenophyllum exsertum* Wall. ex Hook., *Prosaptia contigua* (G. Forst.) C. Presl. and *Scleroglossum pusillum* (Blume) Alderw., usually occur on tree bark together with bryophytes, such as mosses and leafy liverworts. In some spots where sun-light can penetrate to tree-trunk or tree branch, a large epiphyte i.e. *Aglaomorpha coronans* (Wall. ex Mett.) Copel. can be noticed. This plant has leathery and glossy fronds as well as a succulent rhizome. These characters give rise to its drought resistance during dry season. This fern species can collect humus in the same way as *Drynaria rigidula* (Sw.) Bedd. and *Asplenium nidus* L. var. *nidus* did. *A. coronans* (Wall. ex Mett.) Copel. is frequently found in both upper elevation of tropical evergreen forest and hill evergreen forest. In contrast, the small-sized ferns member of the family Grammitidaceae are usually confined to hill evergreen forest. The

uncommon epiphytic species included *Davallia corniculata* Moor, *Vittaria flexuosa* Fée, *Crepidomanes bipunctatum* (Poir.) Copel. and *Hymenophyllum treubii* Racib. (Table 5.1). They are found only in some specific sites with rather small number, for example *Hymenophyllum treubii* or locally abundant, i.e. *Crepidomanes bipunctatum*.

6.1.3 Lithophytes

It was found that 14 species of ferns and fern allies are lithophytes. These ferns and fern allies grow on muddy rocks or humus-rich rocks. They usually bear short or long creeping rhizomes attached on rock surface. Some lithophytes, for examples, *Bolbitis appendiculata* (Willd.) K. Iwats., *Bolbitis heteroclita* (C. Presl) Ching, *Bolbitis virens* (Wall. ex Hook. & Grev.) Schott, *Trichomanes bimarginatum* Bosch., *Christella papilio* (C. Hope) Holttum, *Crepidomanes maximum* (Blume) K. Iwats., *Cephalomanes obscurum* (Blume) K. Iwats., *Microsorium dilatatum* (Bedd.) Sledge and *Hymenasplenium apogamum* (N. Murak. & Hatan.) Nakaike can be found in high humidity area such as along stream banks. While *Microsorium pteropus* (Blume) Copel is usually found on muddy rocks in stream or streamlet near waterfalls. It can withstand flood for a consideration periods without any harm to the plant, such species is a member of rheophyte (Boonkerd, 1996).

6.1.4 Ferns that were found in more than one habitat

It was found that 35 species of ferns and fern allies were found in more than one habitat. These includes common species of ferns, such as *Oleandra neriiformis* Cav., *Asplenium normale* D. Don, *Lindsaea oblanceolata* v. A. v. Ros. and *Lindsaea repens* (Bory) Thwaites var. *pectinata* (Blume) Mett. ex Kuhn. They can be either terrestrials or epiphytes. While *Polystichum prolificans* v. A. v. Ros. and *Diplazium dilatatum* Blume can be terrestrials or lithophytes. Some species can be either epiphyte or lithophyte, such as *Davallia embolostegia* Copel., *Davallia repens* (L. f.) Kuhn and *Colysis wui* (C. Chr.) Ching. They usually have wide creeping rhizomes with short root system and grew rather well either on mossy trunks or on humus-rich rocks.

6.2 Diversity of fern and fern allies and vegetation

The vegetation of Khao Nan Yai area in Khao Nan National Park included 2 forest types, namely tropical evergreen forest and hill evergreen forest. Each species of ferns and fern allies may be restricted to only one forest type or in both forest types (Fig. 6.2).

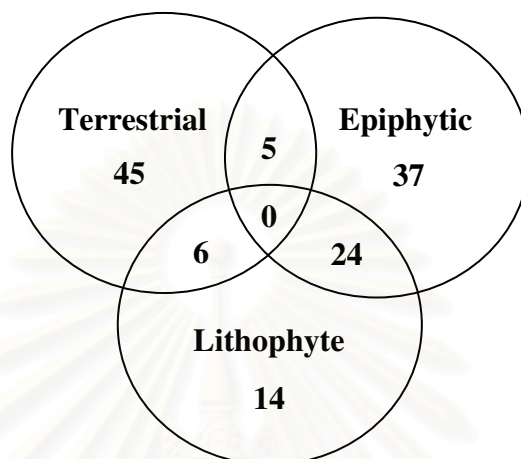


Fig. 6.1 Diversity of ferns and fern allies in each habitat.

6.2.1 Tropical Evergreen Forest

At Khao Nan Yai area, tropical evergreen forest can be found between 330-1,000 m elevations. It was found that 68 species and 2 varieties of ferns and fern allies occur in this vegetation (Fig. 6.1). This forest type has the highest number of ferns and fern allies as compared with hill evergreen forest. Higher diversity probably caused by the higher areas and possibly due in part to the favorable physical factors of this forest type such as warm temperature, and high air and soil humidity which were rather stable between day and night. Moreover, sun-light has been shaded by tree canopy permit optimum light intensity for the ground flora. So these physical environments promote growth of ferns and fern allies, especially terrestrial ferns.

The common families included Dryopteridaceae, Woodsiaceae, Pteridaceae, Thelypteridaceae, Dennstaedtiaceae, Schizaeaceae and Hymenophyllaceae. The characteristic species of this forest type included filmy ferns, such as *Trichomanes bimarginatum* Bosch and *Crepidomanes bipunctatum* (Poir.) Copel.; medium-sized ferns: *Christella papilio* (C. Hope) Holttum, *Pronephrium repandum* (Fée) Holttum, *Microlepia speluncae* (L.) T. Moore and *Pteris mertensioides* Willd; large-sized ferns: *Cyathea latebrosa* (C. Presl) Copel., *Angiopteris evecta* (G. Forst.) Hoffm. and

Pleocnemia irregularis (C. Presl) Holttum. These ferns usually grown near moist spots, e.g. stream banks. The common epiphytes comprised *Drynaria rigidula* (Sw.) Bedd., *Asplenium nidus* L. var. *nidus* and *Microsorium punctatum* (L.) Copel. They normally occur on tree trunks or branches where suitable light can be obtained.

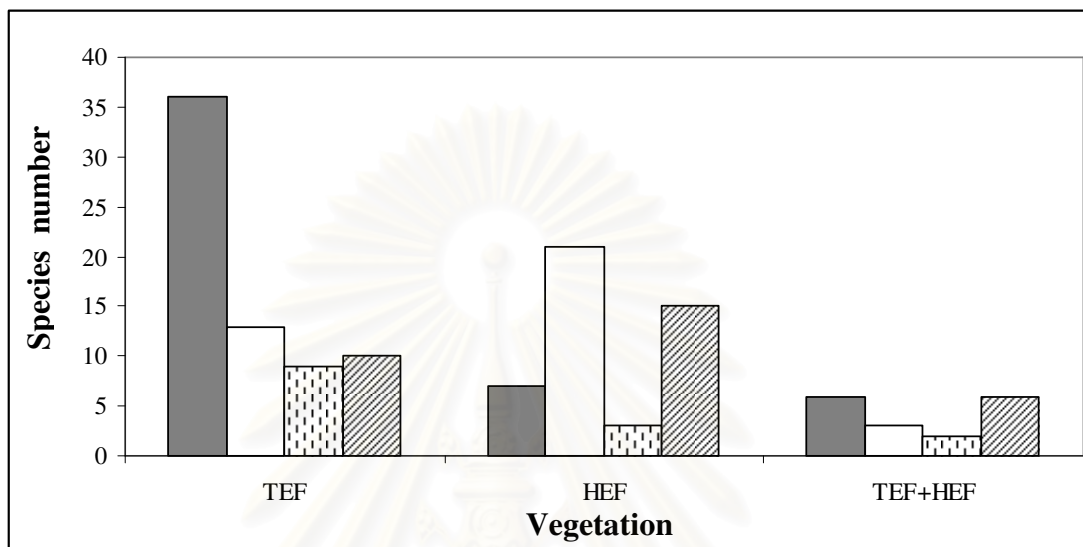


Fig. 6.2 Diversity of ferns and fern allies in Tropical Evergreen Forest (TEF) and Hill Evergreen forest (HEF), ■ Terrestrial □ Epiphyte ▤ Lithophyte ▨ More than 1 habitat

6.2.2 Hill Evergreen Forest

This forest type was found at altitude above 1,000 m to the summit (1,385 m) of Khao Nan Yai. In this study, 46 species of ferns and fern allies were found and they confined to hill evergreen forest. The Diversity of ferns and fern allies in this forest type was lower than tropical evergreen forest. Since hill evergreen forest is mainly found on mountain ridge and has rather smaller areas than the tropical evergreen forest. Only small number of terrestrial species can be found while most species are epiphytes. The high diversity of epiphytes is probably in consequence of high and stable relative air humidity in this forest which are necessary for the existing of epiphytes. Some epiphytic ferns member of the tropical evergreen forest can also be found on humus-rich and high humidity soils. The common terrestrial species included *Dipteris conjugata* Reinw., *Gleichenia longissima* Blume and *Histiopteris incisa* (Thunb.) J. Sm. While *Huperzia phlegmaria* (L.) Rothm, *Lindsaea*

oblanceolata v. A. v. Ros., *Lindsaea repens* (Bory) Thwaites var. *pectinata* (Blume) Mett. ex Kuhn, *Elaphoglossum malayense* Holttum, *Asplenium perakense* Matthew & Christ were frequently found as epiphytes on tree trunk. Moreover, the occurrence of *Selliguea laciniata* (C. Presl) Hovenkamp and *Selliguea triloba* (Houtt.) M. G. Price at Khao Nan Yai is the northernmost station of these Malaysian elements (Iwatsuki, 1973; Tagawa and Iwatsuki, 1989; Hovenkamp et al., 1998).

Seventeen species can be found in both tropical evergreen forest and hill evergreen forest such as *Selaginella intermedia* (Blume) Spring, *Asplenium nidus* L. var. *nidus*, *Davallia embolostegia* Copel., *Aglomorpha coronans* (Wall. ex Mett.) Copel., *Microlepia strigosa* (Thunb.) C. Presl., *Microsorium punctatum* (L.) Copel. However, some species, for example *Asplenium nidus* L. var. *nidus* and *Microsorium punctatum* (L.) Copel. do have a wide distribution throughout Thailand (Tagawa & Iwatsuki, 1989).

6.3 Endemic species

From the literature surveys and the results from this study it can be concluded that only an endemic species to Thailand, *Ctenopterella khaoluangensis* (Tagawa & K. Iwats) Parris, occurred in the study area (Fig. 5.25 G.). Tagawa & Iwatsuki (1989) noted the rarity of this fern species at Khao Luang National Park, Nakhon Si Thammarat Province, Thailand. However, at Khao Nan Yai area, this species usually occurs above 1,000 m altitude and is a locally abundant species on mossy tree-trunks or branches. It is easily noticed from the deeply pinnatisect frond with distinct lobules near acroscopic base.

6.4 Rare species

Some species of ferns and fern allies can be found in small number or small population in this study area, though they have a wide distribution in Thailand. For example, *Prosaptia alata* (Blume) H. Christ (Fig. 5.26 C-D.) which can be found only small population in tropical evergreen forest of Khao Nan Yai area. In addition, *Huperzia pinifolia* Trevis. (Fig. 5.1 G-H.) was found only once throughout the survey. Their rare status at Khao Nan Yai area is worth further exploring.

6.4 Alien species

Adiantum latifolium Lam. is the only alien species in this study. This plant is common among undergrowth and become weedy species elsewhere in the lowlands. This species was escaped from cultivation in Malay Peninsula and become naturalized in Malaysia and peninsular Thailand. This glaucous maiden hair fern is indigenous to Central America and Northern South America, but is not common there except as a weed in plantations (Piggott, 1988).

6.5 New Records

From this study it can be concluded that five new records of Thailand are found, i.e. *Cyathea glabra* (Blume) Copel, *Cyathea hymenodes* Mett., *Huperzia coralia* (Spring) Holub, *Huperzia hippuris* (Christ) J. Holub and *Hymenophyllum treubii* Racib. They are not included in Tagawa & Iwatsuki (1979, 1985, 1988 and 1989) and Boonkerd & Pollawatn (2000). The first species has been reported in western Malaysia while the later 3 species (excluded *Hymenophyllum treubii* Racib.) have been reported from Sumatra, Malay Peninsula and Malaysia. Its present distribution was in agreement with the distribution of the Malesian elements (Holtum, 1963). These species were a terrestrial semi-shade on humus-rich mountain slopes in hill evergreen forest at 800-1,385 m altitudes. Only one filmy fern, *Hymenophyllum treubii* Racib. which has been reported in Malaya to New Guinea, was found as a new record in this study. It was an uncommon epiphytic species on mossy tree-trunks along the forest trail in dense hill evergreen forest at 1,033 m altitudes.

6.6 Dubious species

In this study, there were seven species of ferns and fern allies cannot be determined to species level though more attempting had been made using keys from Flora of Thailand as well as keys from the other Flora. Herbarium specimens of related species from BCU, BKF, UKMB, and SING were also studied and comparison with descriptions were made, but they still could not be identified to species level. They were 2 species of *Huperzia*, 2 species of *Goniophlebium*, 1 species of *Pleocnemia*, 1 species of *Phymatosorus* sp. and 1 species of *Nephrolepis*.

1. *Huperzia* sp.1 is an epiphytic plant on tree-trunks in hill evergreen forest at 1,200 m altitudes. It is similar to *Huperzia phyllantha* (Hook. & Walker-Arnott) J. Holub but *Huperzia* sp.1 has acuminate leaf apex, revolute margin, sporophyll is rhomboid with long tail apex. These characters are different from *Huperzia phyllantha* (Hook. & Walker-Arnott) J. Holub.

2. *Huperzia* sp.2 is an epiphytic plant on tree-trunks in hill evergreen forest at 1,000 -1,200 m altitudes. It is similar to *Huperzia phlegmaria* (L.) Rothm., but their details of microphyll, sporophyll, and strobilus are different.

3. *Goniophlebium* sp.1 is an epiphytic plant on tree trunks or on tree fern in hill evergreen forest. It is similar to *Goniophlebium verrucosum* (Hook.) J. Sm. However, *Goniophlebium* sp.1 differed in having smaller size, thinner texture and shallower pit of lamina than it related species. But, however having darker colour of frond when dried. In addition, the pinnae having more serrate tip than *G. verrucosum*.

4. *Goniophlebium* sp.2 is an epiphytic plant on tree trunks or on tree fern in hill evergreen forest. Only sterile plant was collected. This plant is also similar to *Goniophlebium verrucosum* (Hook.) J. Sm. but differed in having smaller size of fronds than *G. verrucosum* and *Goniophlebium* sp.1. Lamina colour is lighter when dried as compare with *Goniophlebium* sp.1 and *Goniophlebium verrucosum*. Margin is serrate and retaining hairs at most teeth.

5. *Phymatosorus* sp. is an epiphytic plant growing on tree fern in hill evergreen forest. It is similar to *Phymatosorus nigrescens* (Blume) Pic. Serm. but differed in having much smaller size and thinner texture of frond.

6. *Nephrolepis* sp. is a lithophyte found near stream in tropical evergreen forest. It is closely related to a Malaysian sword fern, *Nephrolepis dicksonioides* H. Christ (Parris and Latiff, 1997), but differed in having long acuminate apex, pinnae having serrate margin rather than shallowly lobed as was found in *Nephrolepis dicksonioides* (Piggott, 1988).

7. *Pleocnemia* sp. was a terrestrial plant in hill evergreen forest. It is closely related to *Pleocnemia hemiteliiformis* (Racib.) Holttum, but differed in having lamina tripinnate, pinnule-segment with sparse hairs at margin.

6.7 Record of New Locality

It was found that 3 species occurred in Khao Nan Yai are worth noting for their new distribution in Thailand.

6.7.1 The Indo-Burmese element

The Indo-Burmese elements have their distribution from the eastern Himalayas and Guinghai-Tibetan plateau and the subtropics of South China, the Ganges plain, Eastern India, Bangladesh, Upper Myanmar and Thailand (Boonkerd, 1996). According to Flora of Thailand one species of fern and one species of fern allies were member of the Indo-Burmese element (Tagawa and Iwatsuki, 1979, 1985, 1988, 1989).

Selaginella helferi Warb., a terrestrial plant is found climbing on shrub or small plants in evergreen forest at 400-1,600 m altitudes in monsoon areas. It was reported from Assam, Myanmar, South China (Kweichow, Kwangsi) and Indochina. In Thailand, this plant was previously found in the north, north-east and south-east (Tagawa and Iwatsuki, 1979).

Christella papilio (C. Hope) Holttum, is found from Sri Lanka, Himalaya, Taiwan and Malaysia. It occurs in northern and south-western Thailand. This species grows on muddy rocks by streamlets in tropical evergreen forest at 600-700 m elevations of Khao Nan Yai area.

6.7.2 The Indo-Chinese element

The Indo-Chinese elements have their distribution from southern China to Indochina (Boonkerd, 1996). According to Flora of Thailand, one species of fern is a member of the Indo-Chinese elements (Tagawa and Iwatsuki, 1979, 1985, 1988, 1989).

Heterogonium sageniodes (Mett.) Holttum was found on the forest floor in tropical evergreen forest at about 200-500 m altitudes. It was previously reported from Hainan, Indochina to west Malesia and eastern Thailand (Chaiyaphum Province). This species was found in tropical evergreen forest at 460-800 m elevation from this study.

6.8 Comparison of ferns and fern allies diversity

The continuous surveys of ferns and fern allies in a specific area were rarely carried out, especially in peninsular Thailand. However, an attempt had been made to compare between some studied sites in peninsular Thailand and adjacent area; Huaiyang Waterfalls National Park, Si Phang-nga National Park, and Tarutao National Park were selected for this purpose.

Tarutao National Park

Tarutao National Park, Satun Province, in the Andaman Sea off the west coast of peninsular Thailand. It covers an area 1,500 km³ and ranges in elevations to over 600 m, the highest peak of the island is 708 m above mean sea level. The specimens were collected from the natural forest of Tarutao, mountaintops of the other nearby islands, and the forest of Rawi Island. A total of 869 species were reported. Of these 15 families, 28 genera, 47 species of ferns and 2 families, 2 genera, 2 species of fern allies were found (Congdon, 1982). It was found that 18 species of ferns and fern allies were in common with this study (Table 6.1).

Tum-nang Waterfall in Si Phang-nga National Park

Tum-nang Waterfall in Si Phang-nga National Park, Phangnga Province, is a part of peninsular Thailand. The specimens were collected from 50-350 m altitudes in the tropical rain forest. Sixteen families, 26 genera, 48 species of ferns and fern allies were reported (จรัล ลีรติวงศ์ และสาขใจ จรเอ็ชด, 2547). It was found that 24 species of ferns and fern allies were in common with the collection from Khao Nan Yai area (Table 6.1).

Huaiyang Waterfall National Park

Huaiyang Waterfall National Park, Prachup Khiri Khan Province, is a part of southwestern floristic region and the gateway to peninsular Thailand. It covered an area of approximately 161 km² and ranges in elevations from 100 to 1,250 m above mean sea level. The vegetation of this park includes mixed deciduous forest, dry evergreen forest, tropical rainforest and hill evergreen forest. The average annual relative humidity was about 78 %. The average rainfall was 1,150 mm, while the highest rainfall of about 300 mm in October and the rainfall about 28 mm in December. The average temperature of 27°C was observed, while the maximum high temperature was 33°C in April and the maximum low temperature was 20°C in December. Twenty six families, 63 genera, 128 species were reported (Yuyen and Boonkerd, 2002). It was found that 42 species of fern and fern allies were in common with the collection from Khao Nan Yai area (Table 6.1).

Regarding to table 6.1, it was found that species enumeration of ferns and fern allies in Tum-nang National Park and Tarutao National Park is less than Huaiyang National Park and Khao Nan Yai areas. This is because these two areas have no hill evergreen forest. The studies of hill evergreen forest in southern Thailand were partially carried out only in Khao Luang National Park, Nakhon Si Thammarat province and Huaiyang Waterfall National Park, Prachup Khiri Khan province.

Table 6.1 Comparison of ferns and fern allies from this study with Tarutao National Park (1), Tum-nang Waterfall, Si Phang-nga National Park (2), and Huaiyang Waterfall National Park (3). **Note** “-” denoted absence “✓” denoted presence

Taxon	1	2	3
Lycopodiaceae			
<i>Huperzia coralia</i> (Spring) J. Holub	-	-	-
<i>Huperzia hippuris</i> (Christ) J. Holub	-	-	-
<i>Huperzia nummulariifolia</i> (Blume) Chambers	-	-	-
<i>Huperzia phlegmaria</i> (L.) Rothm	-	-	-
<i>Huperzia pinifolia</i> Trevis.	-	-	-
<i>Huperzia</i> sp.1	-	-	-
<i>Huperzia</i> sp.2	-	-	-
Selaginellaceae			
<i>Selaginella argentea</i> (Wall. ex Hook. & Grev.) Spring	-	-	✓
<i>Selaginella helferi</i> Warb.	-	-	-
<i>Selaginella intermedia</i> (Blume) Spring	-	✓	-
<i>Selaginella willdenowii</i> (Desv. ex Poir.) Baker	-	✓	-
Ophioglossaceae			
<i>Helminthostachys zeylanica</i> (L.) Hook.	-	-	-
Marattiaceae			
<i>Angiopteris evecta</i> (G. Forst.) Hoffm.	✓	✓	✓
Hymenophyllaceae			
<i>Cephalomanes obscurum</i> (Blume) K. Iwats.	-	-	-
<i>Crepidomanes auriculatum</i> (Blume) K. Iwats.	-	-	-
<i>Crepidomanes bipunctatum</i> (Poir.) Copel.	-	-	-
<i>Crepidomanes latemarginale</i> (Eaton) Copel.	-	-	-
<i>Crepidomanes maximum</i> (Blume) K. Iwats.	-	✓	-
<i>Crepidomanes pallidum</i> (Blume) K. Iwats.	-	-	-

Taxon	1	2	3
Hymenophyllaceae (continued)			
<i>Hymenophyllum acanthoides</i> (Bosch) Rosenst.	-	✓	-
<i>Hymenophyllum exsertum</i> Wall. ex Hook.	-	-	✓
<i>Hymenophyllum javanicum</i> Spreng.	-	-	-
<i>Hymenophyllum polyanthos</i> (Sw.) Sw.	-	-	-
<i>Hymenophyllum treubii</i> Racib.	-	-	-
<i>Trichomanes bimarginatum</i> Bosch	-	-	-
Gleicheniaceae			
<i>Gleichenia norrisii</i> Mett. ex Kuhn	-	-	-
<i>Gleichenia longissima</i> Blume	-	-	-
<i>Dicranopteris splendida</i> (Hand- Mazz.) Tagawa	-	-	-
Schizaeaceae			
<i>Lygodium polystachyum</i> Wall. ex T. Moore	-	-	-
<i>Lygodium salicifolium</i> C. Presl	-	-	✓
Dennstaedtiaceae			
<i>Histiopteris incisa</i> (Thunb.) J. Sm.	-	-	-
<i>Microleopia strigosa</i> (Thunb.) C. Presl	-	-	✓
<i>Microleopia speluncae</i> (L.) T. Moore	✓	-	✓
Lindsaeaceae			
<i>Lindsaea doryphora</i> Kramer	-	-	-
<i>Lindsaea lucida</i> Blume	-	✓	-
<i>Lindsaea oblanceolata</i> v. A. v. Ros.	-	✓	-
<i>Lindsaea repens</i> (Bory) Thwaites var. <i>pectinata</i> (Blume) Mett. ex Kuhn	-	-	-

Taxon	1	2	3
Cyatheaceae			
<i>Cyathea glabra</i> (Blume) Copel	-	-	-
<i>Cyathea hymenodes</i> Mett.	-	-	-
<i>Cyathea latebrosa</i> (C. Presl) Copel.	-	-	✓
Adiantaceae			
<i>Adiantum latifolium</i> Lam.	-	-	-
<i>Taenitis blechnoides</i> (Willd.) Sw.	✓	✓	-
Pteridaceae			
<i>Pteris biaurita</i> L.	-	-	-
<i>Pteris ensiformis</i> Burm. f.	-	-	✓
<i>Pteris grevilleana</i> Wall. ex J. Agardh	-	-	-
<i>Pteris mertensioides</i> Willd.	-	✓	-
<i>Pteris scabripes</i> Wall. ex J. Agardh	-	-	-
<i>Stenochlaena palustris</i> (Burm. f.) Bedd.	✓	-	-
Vittariaceae			
<i>Anthrophum callifolium</i> Blume	✓	✓	✓
<i>Vittaria angustifolia</i> Blume	-	-	-
<i>Vittaria elongata</i> Sw.	✓	-	-
<i>Vittaria ensiformis</i> Sw.	✓	✓	✓
<i>Vittaria flexuosa</i> Fée	✓	-	-
<i>Vittaria scolopendrina</i> (Bory) Schkuhr ex Thwaites	-	-	-
Aspleniaceae			
<i>Asplenium affine</i> Sw.	-	-	-
<i>Asplenium confusum</i> Tardieu & Ching	-	-	✓
<i>Asplenium grevillei</i> Wall. ex Hook. & Grev.	-	-	-
<i>Asplenium nidus</i> L. var. <i>nidus</i>	-	✓	✓
<i>Asplenium normale</i> D. Don	-	✓	✓
<i>Asplenium perakense</i> Matthew & Christ	-	-	✓

Taxon	1	2	3
Aspleniaceae (continued)			
<i>Asplenium salignum</i> Blume	-	-	-
<i>Asplenium tenerum</i> G. Forst.	-	-	-
<i>Hymenasplenium apogamus</i> (N. Murak. & Hatan.) Nakaike	-	-	✓
Blechnaceae			
<i>Blechnum orientale</i> L.	✓	✓	✓
Lomariopsidaceae			
<i>Bolbitis appendiculata</i> (Willd.) K. Iwats.	✓	✓	✓
<i>Bolbitis heteroclita</i> (C. Presl) Ching	-	✓	✓
<i>Bolbitis sinuata</i> (C. Presl) Hennisman	-	-	-
<i>Bolbitis virens</i> (Wall. ex Hook. & Grev.) Schott	✓	-	✓
<i>Elaphoglossum malayense</i> Holttum	-	✓	-
Dryopteridaceae			
<i>Didymochlaena truncatula</i> (Sw.) J. Sm.	-	-	-
<i>Heterogonium sagenioides</i> (Mett.) Holttum	-	-	-
<i>Pleocnemia irregularis</i> (C. Presl) Holttum	✓	-	-
<i>Pleocnemia</i> sp.	-	-	-
<i>Polystichum prolificans</i> v. A. v. Ros.	-	-	-
<i>Pteridrys australis</i> Ching	-	-	-
<i>Tectaria polymorpha</i> (Wall. ex Hook.) Copel.	✓	✓	✓
<i>Tectaria semipinnata</i> (Roxb.) Morton	-	-	-
<i>Tectaria singaporeana</i> (Wall. ex Hook & Grev.) Ching	✓	-	-
Thelypteridaceae			
<i>Christella dentata</i> (Forssk.) Holttum	-	✓	✓
<i>Christella papilio</i> (C. Hope) Holttum	-	-	✓
<i>Mesophlebion crassifolium</i> (Blume) Holttum	-	-	-
<i>Pronephrium repandum</i> (Fée) Holttum	-	✓	-

Taxon	1	2	3
Woodsiaceae			
<i>Diplazium bantamense</i> Blume	-	-	✓
<i>Diplazium cordifolium</i> Blume	-	-	-
<i>Diplazium crenatoserratum</i> (Blume) T. Moore	-	-	✓
<i>Diplazium dilatatum</i> Blume	-	-	✓
<i>Diplazium donianum</i> (Mett.) Tardieu	-	-	✓
<i>Diplazium silvaticum</i> (Bory) Sw.	-	-	✓
<i>Diplazium simplicivenium</i> Holttum	-	-	✓
<i>Diplazium sorzogonense</i> (C. Presl) C. Presl	-	-	-
<i>Diplazium tomentosum</i> Blume	-	-	-
<i>Diplazium xiphophyllum</i> (Bak.) C. Chr.	-	-	-
Davalliaceae			
<i>Davallia corniculata</i> Moor	-	-	-
<i>Davallia embolostegia</i> Copel.	-	-	-
<i>Davallia repens</i> Kuhn	✓	-	✓
Oleandraceae			
<i>Nephrolepis biserrata</i> (Sw.) Schott	✓	-	✓
<i>Nephrolepis davalliodes</i> (Sw.) Kunze	-	-	-
<i>Nephrolepis</i> sp.	-	-	-
<i>Oleandra neriiiformis</i> Cav.	-	-	-
Dipteridaceae			
<i>Dipteris conjugata</i> Reinw.	-	-	-
Polypodiaceae			
<i>Aglaomorpha coronans</i> (Wall. ex Mett.) Copel.	-	-	✓
<i>Belvisia spicata</i> (L. f.) Mirbel ex Copel.	-	-	✓
<i>Colysis pedunculata</i> (Hook. & Grev.) Ching	-	-	✓
<i>Colysis wui</i> (C. Chr.) Ching	-	-	-
<i>Drynaria rigidula</i> (Sw.) Bedd.	✓	-	✓

Taxon	1	2	3
Polypodiaceae (continued)			
<i>Goniophlebium</i> sp.1	-	-	-
<i>Goniophlebium</i> sp.2	-	-	-
<i>Lepisorus longifolius</i> (Blume) Holttum	-	✓	-
<i>Leptochilus decurrens</i> Blume	-	-	
<i>Loxogramme avenia</i> (Blume) C. Presl	-	-	✓
<i>Microsorium insigne</i> (Blume) Copel.	-	-	✓
<i>Microsorium pteropus</i> (Blume) Copel.	-	-	✓
<i>Microsorium punctatum</i> (L.) Copel.	-	✓	✓
<i>Phymatosorus nigrescens</i> (Blume) Pic. Serm.	-	-	✓
<i>Phymatosorus</i> sp.	-	-	-
<i>Pyrrosia adnascens</i> (Sw.) Ching	✓	✓	✓
<i>Pyrrosia albicans</i> (Blume) Ching.	-	-	-
<i>Pyrrosia lingua</i> (Thunb.) Farwell var. <i>heteractis</i> (Mett. ex Kuhn) Hovenkamp	-	-	✓
<i>Pyrrosia nummularifolia</i> (Sw.) Ching	-	-	-
<i>Pyrrosia lanceolata</i> (L.) Farwell	-	-	-
<i>Pyrrosia piloselloides</i> (L.) M. G. Price	-	✓	-
<i>Selliquea laciniata</i> (C. Presl) Hovenkamp	-	-	-
<i>Selliquea triloba</i> (Houtt.) M. G. Price	-	-	-
Grammitidaceae			
<i>Acrosorus friderici-et-pauli</i> (H. Christ) Copel.	-	-	-
<i>Calymmodon cucullatus</i> (Nees & Blume) C. Presl	-	-	-
<i>Ctenopterella khaoluangensis</i> (Tagawa & K. Iwats.) Parris	-	-	-
<i>Oreogrammitis adspersa</i> (Blume) Parris	-	-	-
<i>Prosaptia alata</i> (Blume) H. Christ	-	-	-
<i>Prosaptia contigua</i> (G. Forst.) C. Presl	-	-	-
<i>Prosaptia obliquata</i> (Blume) Mett.	-	-	-
<i>Scleroglossum pusillum</i> (Blume) Alderw.	-	-	-

The result from this study indicated that Khao Nan Yai area is rather rich in pteridophytes as compared with the other protected area (Table 6.2). However, it can be seen that there are some different in vegetation among each site. Ferns and fern allies diversity at Tarutao National Park, Tum-nang Waterfall are rather low. It might be explained by insufficient diversity data of pteridophytes. Tropical evergreen forest and hill evergreen forest were the main vegetations at Khao Nan Yai and Huaiyang Waterfall Forest Park. Taking the area into account, it was found that ferns and fern allies diversity at Khao Nan Yai area was rather high similar to Huaiyang Waterfall Forest Park. Though Khao Nan Yai has some disturbed areas in tropical evergreen forest and hill evergreen forest as compares with the other protected areas.

Table 6.2 Comparison of ferns and fern allies diversity among four protected areas.

Protected area	Number of family	Number of genera	Number of species
Khao Nan Yai area in Khao Nan National Park	24	58	130
Tarutao National Park	15	28	47
Tum-nang Waterfall, Si Phang-nga National Park	16	26	48
Huaiyang Waterfall National Park	26	63	128

6.9 Problems encounter from this study

1. During rainy season it was rather difficult to collect and take a picture of the specimens. So some pictures are low quality.
2. The studied site is a mountainous area with some high and steep cliffs and was difficult to access.
3. Taxonomic references on fern allies, especially keys and descriptions are scare. So some rare species can determine with uncertain.
4. The voucher herbarium specimens at BCU, BKF, SING and UKMB are not available for some problematic species, resulted in uncertain determinations.

6.10 Benefit of this research

1. The fundamental data on species diversity of ferns and fern allies in Khao Nan National Park was obtained.
2. Total number of voucher specimens at the Professor Kasin Suvatabhanda Herbarium (BCU), Department of botany was increased by the collections from this study.
3. The information from this study can be used as a basis for conservation and tourism promotion programs.



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