TAXONOMY OF FERNS AND FERN ALLIES AT PHUHIN BONGKLA NATIONAL PARK, PHITSANULOK PROVINCE

Miss Wilawan Rattanathirakul

A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Science in Botany
Department of Botany
Faculty of Science
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โครงการพัฒนาองค์ความรู้และศึกษานโยบายการจัดการทรัพยากรชีวภาพในประเทศไทย
c/o ศูนย์พันธุวิศวกรรมและเทคโนโลยีชีวภาพแห่งชาติ
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นางสาววิลาวัณย์ รัตนถิรกุล

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต
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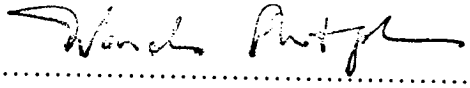

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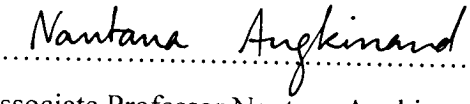

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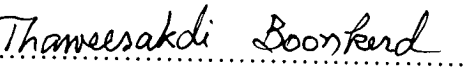

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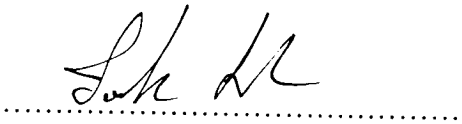

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วิลาวัณย์ รัตนถิรกุล: อนุกรมวิธานของเฟิร์นและพืชใกล้เคียงเฟิร์น บริเวณอุทยานแห่งชาติภูหินร่องกล้า จังหวัดพิษณุโลก (TAXONOMY OF FERNS AND FERN ALLIES AT PHUHIN RONGKLA NATIONAL PARK, PHITSANULOK PROVINCE) อาจารย์ที่ปรึกษา: รองศาสตราจารย์ ดร. ทวีศักดิ์ บุญเกิด 177 หน้า. ISBN 974-17-1916-7.

จากการศึกษาอนุกรมวิธานของเฟิร์นและพืชใกล้เคียงเฟิร์น บริเวณอุทยานแห่งชาติภูหินร่องกล้า จังหวัดพิษณุโลก ระหว่างเดือนมีนาคม 2544 ถึงเดือนกรกฎาคม 2545 เก็บตัวอย่างได้จำนวน 217 ตัวอย่าง นำมาศึกษาและตรวจหาชื่อวิทยาศาสตร์ ได้จำนวนทั้งสิ้น 23 วงศ์ 55 สกุล 112 ชนิด 2 พันธุ์ แบ่งออกเป็นเฟิร์นจำนวน 21 วงศ์ 53 สกุล 108 ชนิด 2 พันธุ์ พืชใกล้เคียงเฟิร์นจำนวน 2 วงศ์ 2 สกุล 4 ชนิด และวงศ์ที่พบมากที่สุดคือวงศ์ Polypodiaceae จำนวน 26 ชนิด รองลงมาคือวงศ์ Aspleniaceae จำนวน 15 ชนิด และ Dryopteridaceae จำนวน 9 ชนิด สามารถแบ่งพืชกลุ่มนี้ตามถิ่นอาศัยได้ 3 แบบ คือ ขึ้นบนดินจำนวน 44 ชนิด 1 พันธุ์ พืชอิงอาศัยจำนวน 34 ชนิด 1 พันธุ์ ขึ้นบนหินจำนวน 16 ชนิด และพบพืชที่มีถิ่นอาศัยตั้งแต่ 1 แบบขึ้นไปจำนวน 18 ชนิด และพบว่ามีเฟิร์นจำนวน 2 ชนิด ที่จัดเป็นพรรณไม้ถิ่นเดียวของประเทศไทยคือ *Diplazium siamense* C. Chr. และ *Christella siamensis* Tagawa & K. Iwats. จากการสำรวจบริเวณน้ำตกหมันแดง ซึ่งมีความสูงจากระดับน้ำทะเลประมาณ 1,200-1,600 เมตร และมีสภาพเป็นป่าดิบเขาที่ยังอุดมสมบูรณ์แห่งหนึ่ง ได้พบเฟิร์นที่มีรายงานว่าพบเป็นครั้งแรกในประเทศไทย และพบที่น้ำตกหมันแดงเพียงแห่งเดียวเท่านั้น คือ *Acrorumohra diffracta* (Baker) H. Itô ในการศึกษาครั้งนี้ได้จัดทำคำบรรยายลักษณะของพรรณไม้แต่ละชนิด รูปวิธานจำแนกวงศ์ สกุล และชนิด พร้อมทั้งศึกษาข้อมูลเกี่ยวกับการใช้ประโยชน์ ข้อมูลทางนิเวศวิทยา การกระจายพันธุ์ ชื่อพื้นเมือง พร้อมทั้งมีภาพประกอบ ตัวอย่างพรรณไม้แห้งที่เก็บได้นำไปเก็บไว้ที่พิพิธภัณฑ์พืชศาสตราจารย์กสิน สุวตะพันธุ์ ภาควิชาพฤกษศาสตร์ คณะวิทยาศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย และหอพรรณไม้ กรมป่าไม้

ภาควิชา พฤกษศาสตร์ ลายมือชื่อนิสิต วิลาวัณย์ รัตนถิรกุล

สาขาวิชา พฤกษศาสตร์ ลายมือชื่ออาจารย์ที่ปรึกษา ทวีศักดิ์ บุญเกิด

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KEY WORD: TAXONOMY / FERNS / FERN ALLIES / PHUHIN RONGKLA / PHITSANULOK
WILAWAN RATTANATHIRAKUL: TAXONOMY OF FERNS AND FERN ALLIES AT PHUHIN RONGKLA NATIONAL PARK, PHITSANULOK PROVINCE. THESIS ADVISOR: ASSOC. PROF. THAWEESAKDI BOONKERD, Ph. D. 177 pp. ISBN 974-17-1916-7.

Taxonomy of ferns and fern allies at Phu Hin Rong Kla National Park, Phitsanulok Province, was conducted from March 2001 to July 2002. Two hundreds and seventeen specimens were collected. A total of 23 families, 55 genera, 112 species and 2 varieties were identified. Among these 21 families, 53 genera, 108 species and 2 varieties are ferns, while 2 families, 2 genera and 4 species are fern allies. Three families of ferns, namely Polypodiaceae, Aspleniaceae and Dryopteridaceae are among the common families. Polypodiaceae included 26 species, while Aspleniaceae and Dryopteridaceae included 15 and 9 species, respectively. According to habitat, it is found that there are 44 species and 1 variety of terrestrial plants, 34 species and 1 variety of epiphytes, and 16 species of lithophytes. In addition, 18 species of ferns and fern allies could be found in more than one habitat. It can be concluded that two endemic species of Thailand occur in the study area, i.e. *Diplazium siamense* C. Chr. and *Christella siamensis* Tagawa & K. Iwats. It is also found that *Acrorumohra diffracta* (Baker) H. Itô is a new recorded species for Thailand. It is rather rare and can be found only in small populations along the forest trail to Man Daeng Waterfall. Key to the genera and the species were constructed. Full description, together with ecological data, distribution, vernacular name and utilization of each species were prepared. In addition, photographs of the collected species were also provided. The voucher specimens are deposited at the Professor Kasin Suvatabhandhu Herbarium, Department of botany, Faculty of Science, Chulalongkorn University and the Forest Herbarium, Royal Forest Department.

Department Botany
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Advisor's signature Thaweesakdi Boonkerd

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Thanks to the chief and staff of Phu Hin Rong Kla National Park for accommodation and cooperation during specimen collection within the National Park. My sincere thanks to the curator and staff of BKF for their kindly permission to study of pteridophyte specimens. In addition, I would like to thank the officers of the Meteorological Department for providing climatological data.

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Finally, I would like to special thank to my parent and my brothers for their loves and supports.

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CHAPTER 1

INTRODUCTION

Thailand is located in the center of the Indochinese Peninsula which is a part of Southeast Asia. The kingdom shares boundaries with Myanmar (Burma) on the west and northwest, Laos on the east and northeast, Cambodia (Kampuchea) on the southeast, and Malaysia on the south. Thailand covers a land area of 513,115 square kilometers, from North 5° 30′ to 21° and from East 97° 30′ to 105° 30′ , and extends about 2,500 kilometers from north to south and 1,250 kilometers from east to west, with a coastline of approximately 1,840 kilometers on the gulf of Thailand and 865 kilometers along the Indian Ocean (ราชบัณฑิตสถาน, 2545). Because of the special geographical situation, complex topography and landforms, as well as the diverse climate, give rise to one of the tropical country which is rich in biodiversity (ธวัชชัย สันติสุข, 2532).

However, Thailand has no unique floristic elements. Primarily, indigenous plant species from each floristic region usually shares species in common with those neighboring countries. As a result, Thailand is considered as a collective center of botanical diversity from three major regional elements, viz. Indo-Burmese, Indo-Chinese and Malesian (biodiversity (ธวัชชัย สันติสุข, 2532). According to Smitinand (1958), Thailand can be divided into seven floristic regions, i.e. The Northern (N), Northeastern (NE), Eastern (E), Central (C), Southeastern (SE), Southwestern (SW) and Peninsular (PEN).

Biodiversity is a complex system consisting of plants, animals, microorganisms and human beings. Biological resources feed and clothe us and provide housing, medicines and spiritual nourishment. Due to human population growth and economic pressure, there has been a high rate of biological resource destruction worldwide, especially in developing country like Thailand. The country has carried out many activities in support of the conservation and sustained utilization of biological resources. There have been several laws and regulations established since early 1900s, but there is still a steady decline in forest areas. So far, the country has about 172, 049.99 km^2 of forest areas (about 33.40% of forest area), fortunately most of them are national parks and wildlife sectaries (Royal Forest Department, 2001). It is generally accepted that botanical inventories are important information for conservation of natural resources. There have been intensive studied of plant diversity in upper northern Thailand, especially in Chiang Mai, Chiang Rai and Lampang

Provinces. But however, many protected areas in lower northern Thailand were never been explored, for example, Phu Hin Rong Kla National Park.

Phu Hin Rong Kla National Park is located in Phitsanulok Province, which is the mountainous area of lower northern floristic region. Due to the past activity of the Thai-Communist party in the area there was scanty plant explorations and collections and most collected plants are flowering plants. However, there were some pteridophyte collections in the other protected areas of Phitsanulok and neighboring provinces which included 118 species from Phitsanulok, 218 species from Loei, and 46 species from Phetchabun. It was more than 50% of the previous record in Flora of Thailand (Tagawa and Iwatsuki, 1979, 1985, 1988, 1989). It seems likely that these mountainous provinces are rich in pteridophyte diversity despite lacking information from Phu Hin Rong Kla National Park.

It can be seen that botanical enumeration of ferns and fern allies at Phu Hin Rong Kla National Park is scare and it is necessary to fulfil biodiversity knowledge, especially pteridophytes diversity of lower northern Thailand. The data of pteridophytes obtain from this study can be useful in biodiversity conservation in the near future.

Aim of this thesis

To conduct a botanical inventory of ferns and fern allies at Phu Hin Rong Kla National Park, Phitsanulok Province.

CHAPTER 2

LITERATURE REVIEW

In the past, the taxonomic study of plants is mainly focused on flowering plants. While ferns and fern allies have received a little attention of botanists. The followings are examples of previous botanical works.

During 1900-1916 Johasnes Schmidt, a Danish botanist collected plant specimen from Koh Chang, eastern Thailand. He collected specimens of ferns and fern allies which included 67 species within 35 genera (Schmidt, 1901). In 1911, C.C. Hosseus and B. Reichenhall, german botanists, collected plant specimens from northern and northeastern Thailand. Their collected specimens included 34 species and 19 genera of ferns and fern allies (Hosseus and Reichenhall, 1911). In 1922, Eryl Smith an English physician visited peninsular Thailand, she collected 1,948 specimens, and many of them were ferns. These specimens were deposited at Kew Herbarium (K), British Museum (BM), Singapore Herbarium (SING) and The Forest Herbarium (BKF) (Smith, cited in ก่องกานดา ชยามฤต, 2539).

During 1957-1960, there was a jointed project by Thailand and Denmark entitled "Studies in the Flora of Thailand". R.E. Holttum of Kew studied the previous pteridophyte collections, he enumerated 157 species of ferns, many of them reported for the first time, and new species were found. It was the first time that fern collections from various parts of Thailand were studied together (Bruun, 1961). R.E. Holttum was an author of "*The Ferns of Malaya*" which comprised 108 genera, and 468 species of ferns (Holttum, 1954). There were many species discovered in Southern Thailand and were served as a basis for taxonomic study of ferns in Thailand.

In 1968, T. Smitinand, the curator of the BKF studied the vegetation of Khao Yai. He reported 20 genera and 25 species of ferns and fern allies from this area (Smitinand, 1968). Then, in 1969, J. O. Sawyer and C. Chermsirivatana collected plants from Doi Suthep and Doi Pui in Chiang Mai. They enumerated 21 genera and 33 species of ferns (Sawyer and Chermsirivatana, 1969).

During 1979-1989 M. Tagawa and K. Iwatsuki, Japanese botanists from Kyoto University studied the existing herbarium specimens of pteridophytes from Thailand and a collection from their own field trips. They enumerated 34 families, 121 genera and 630 species. Their contributions to Thai pteridophytes were published in Flora of Thailand, Vol. III, part 1-4 (Tagawa and Iwatsuki, 1979, 1985, 1988, 1989).

In 1980, T. Boonkerd reported the survey and collection of ferns and fern allies at Sakaerat Environmental Research Station, Nakhon Ratshasima Province during 1974-1979. He listed 19 families, 32 genera, 66 species and 2 varieties, of these 3 species were new records for Thailand. Next, he made a collection of 49 species of pteridophytes, which offered for sale in the markets, additional collection from their natural habitat from all regions of Thailand also made. The diagnostic characters, utilization, distribution and ecology of each species were noted (Boonkerd; 1980).

In 1986, Sutheera Arkarakraisri studied spore morphology, rhizome, leaf and hair of 16 species, 2 subspecies and a variety of fern in the family Dennstaedtiaceae from specimens collected in Thailand (สุธีรา อรรคไกรสีห์, 2529). Then, K. Sridith collected non flowering plants on rock platform at Phu Hin Rongkla National Park during July 1987 to Febuary 1988, he found 27 species which included 12 species of Bryophytes, 14 species of pteridophytes and 1 species of pine (กิติเชษฐ์ ศรีดิษฐ์, 2530).

During 1992-1993, T. Boonkerd et al. surveyed plant community at Phrachomklao Science Park at Wa Kor, Prachuap Khiri Khan Province. A total of 184 species, 162 genera and 81 families of vascular plants were enumerated, but only 2 species of ferns were reported (ทวีศักดิ์ บุญเกิด และคณะ, 2536).

C. Phengkai et al. made a preliminary survey of plants diversity at Doi Inthanon National Park, Chiang Mai Province. A total of 161 families, 589 genera and 1,274 species were enumerated. Of these, 121 species in 71 genera from 25 families were pteridophytes (จำลอง เพ็งคล้าย และคณะ, 2539). Next, a taxonomic study of ferns and fern allies at Khunkorn Forest Park, Chiang Rai Province was conducted from October 1997 until October 1999. This is the first report for the area, which includes 154 species and 11 infraspecific taxa in 24 families and 64 genera. *Selaginella ciliaris* (Retz.) Spring (Selaginellaceae) and *Dicranopteris linearis* (Burm.f.) Underw. var. *montana* Holttum (Gleicheniaceae) are newly recorded for Thailand. Of these, 16 species in 3 genera from 3 families were fern allies (Boonkerd and Ratchata, 2002).

A taxonomic study of ferns and fern allies at Huaiyang Waterfall National Park, Prachuap Khiri Khan Province was also carried out. The enumeration of 128 species, 63 genera and 26 families was made. Of these, 11 species in 4 genera from 3 families were fern allies (Yuyen and Boonkerd, 2002). Boonkerd and Pollawatn (2000) compiled data from various sources as well as from their own field trips to produce a checklist of ferns and fern allies in Thailand. A total of 671 species, 4 subspecies, and 28 varieties belonging to 139 genera and 35 families were enumerated. This checklist included 27 new records for Thailand.

From the aforementioned information, it can be seen that botanical surveys of pteridophytes at Phu Hin Rong Kla National Park have been scarce despite its rich in plant diversity. More site-specific plant collections are needed to determine the distribution of the pteridophyte flora.

CHAPTER 3

STUDY SITE

3.1 Location and History

Phu Hin Rong Kla National Park covers an area of 307 square kilometers. It is located in Phetchabun mountain range. It is bounded on the north by Chaiburi District, Laos PDR and extended south to Lom Sak District in Phetchabun Province. The park is also a natural border between Nakhon Thai District in Phitsanulok Province and Dan Sai District in Loei Province. It is marked out approximately by the geographical coordinates of 16° 53′ to 17° 07′ north latitude and 100° 56′ to 101° 06′ east longitude (Figure 3.1).

In the past, Phu Hin Rong Kla used to be a battlefield between Thai soldiers and the guerrillas, member of the Thai communist party who had different principal. During 1968-1972, Phu Hin Rong Kla was a major base for the communists, who threatened the political stability of the nation. In 1972, government forces began the military operations at Phu Kwang, then at Phu Hin Rong Kla in an attempt to expel the communist insurgents. Primarily, the government forces were unsuccessful, because of the strong natural forte of Phu Hin Rong Kla, which set high up in the mountains amidst dense forests. The army changed its battle plan after initial setbacks and eventually defeated the communists with less bloodshed (การท่องเที่ยวแห่งประเทศไทย, 2543).

The general topography of the park is steep mountains in the south, the east and the west. Whilst mountain is gradually inclined to the north. The mountain range includes the important peaks of Phu Miang, Phu Paeng Ma, Phu Lomlo, Phu Khi Thao, and Phu Hin Rong Kla. It reaches its highest peak at 1,800 metres above mean sea level at Phu Mahn Khao. The park is the water source of many streams, including Huay Nam Sai, Huay Nam Kamuen, Huay Awm Singh and Huay Luang Yai (การท่องเที่ยวแห่งประเทศไทย, 2543).

Phu Hin Rong Kla is noted for its natural beauty, especially its magnificent waterfalls. It is covered by greenery all year round, probably nurtured by hidden waterfalls in the deep forest where the climate is always cool. Two of the famous waterfalls are the Rom Klao-Paradon (Fig. 5.7) and Man Daeng (Fig. 5.4, 5.6). The former is about 600 meters from the relic political school and the Hin Nam Cave. It is surrounded by colorful wild flowers, which reflect the fertility of the forest. Man Daeng waterfall has 32 distinctive tiers surrounded by a variety of wild orchids and

ferns. It is also a natural site of maple tree, which change their leaves color in November and December, adding a dash of red and yellow to the lush greenery. The waterfall is located at altitude ranging from 1,200 to 1,600 m above mean sea level.and about 18 km on a road from the park headquarter to Lom Kao District and need to walk 3.5 km further along a forest trail through the hill evergreen forest (Fig. 5.2, 5.3, 5.5).

Due to its outstanding geological features of rock platforms and a place of the very beautiful scenery of the fertile forests, which has made Phu Hin Rong Kla became a tourist attraction. Then the park was established in 1984, becoming Thailand's 48th National Park (Fig. 5.1).

3.2 Geology and Edaphic structure

In general, Rocky mountains in the park belong to rock of the Korat group such as the Phu Phan formation. The rocks are similar to those of Phu Phan range in Sakol Nakhon Province. The soil is originated from residuum and colluvium, parent rocks include sandstone, limestone, shale, quartzite. It is rather varied from site to site due to slopes of each site and types of rock. Mainly, soil is a slope complex, deriving from erosion of parent rocks. It is generally found in the mountains and steep areas. Hang Chat and Satuk soils are two common soil units of the park (กรมป่าไม้, 2541).

3.3 Climate

The climate of the area is a tropical climate, with average high temperatures year round and a distinct dry season. Three seasons were observed, i.e. the summer season during March-April, the rainy season during May-October, and the winter season during November-February (Meteorological Department, 2002).The Lom Sak Climatic Station in Phetchabun Province is the nearest station. It is marked out approximately by the geographical coordinates of 16° 46′ north latitude and 101° 15′ east longitude.

The climatological data during 1972-2002 (Figure 3.2) shows the average annual relative humidity was about 73%, while the average maximum relative humidity was 89% and the average minimum relative humidity was 51%. The average annual temperature of 26.8 °C. The average maximum temperature was 36.4 °C in April and the average minimum temperature was 16.8 °C in December. The average annual rainfall was 1051.1 mm. The highest average annual rainfall, of approximately 197.2 mm, was observed in August. The lowest annual rainfall, of about 4.5 mm in January, and a few rainy days were observed in December, which is the driest month.

3.4 Vegetation

The vegetation of Phu Hin Rong Kla National Park includes mixed deciduous forest, dry dipterocarp forest, dry evergreen forest, and hill evergreen forest (กรมป่าไม้, 2541).

3.4.1 Dry dipterocarp forest can be found on mountain slopes at an elevation of 600 m or below. Small trees and stunted trees are commonly found in this forest type. Characteristic trees include *Dipterocarpus tuberculatus*, *Dipterocarpus obtusifolius*, *Pterocarpus macrocarpus*, *Shorea obtusa*, *Shorea siamensis*, *Albizia odoratissima* and *Phyllanthus emblica*, etc (กรมป่าไม้, 2541).

3.4.2 Mixed deciduous forest can be found in strips next to dry evergreen forest. This type of forest has been severely deforested. Some residual trees include *Pterocarpus macrocarpus*, *Xylia xylocarpa*, *Morinda pubescens*, *Milletia brandisiana*, *Bauhinia malabarica*, *Careya spherica*, *Terminalia chebula*, etc (กรมป่าไม้, 2541).

3.4.3 Dry Evergreen Forest used to be found at altitudes ranging from 300 to 800 m. but this forest type was completely cleared at present. The remnants include *Lagerstroemia macrocarpa*, *Irvingia malayana*, *Mangifera coloneura*, *Anisoptera costata*, *Alstonia scholaris*, etc (กรมป่าไม้, 2541).

3.4.4 Hill Evergreen Forest is found above 1,000 m altitude. It is rather fertile as compared with the other forest types. Characteristic tree species include *Calophyllum polyanthum*, *Knema globularis*, *Elaeocarpus sphaericus*, *Cinnamomum iners*, *Cinnamomum tamala*, *Toona ciliata*, *Michelia baillonii*, *Castanopsis acuminatissima*, *Castanopsis echinocarpus*, *Lithocarpus elegans*, *Quercus kingiana*, etc. In some fire prone areas where the forest is rather open, *Pinus merkusii* and *Pinus kesiya* are usually found mixed with some members of the oak family, Fagaceae (กรมป่าไม้, 2541).

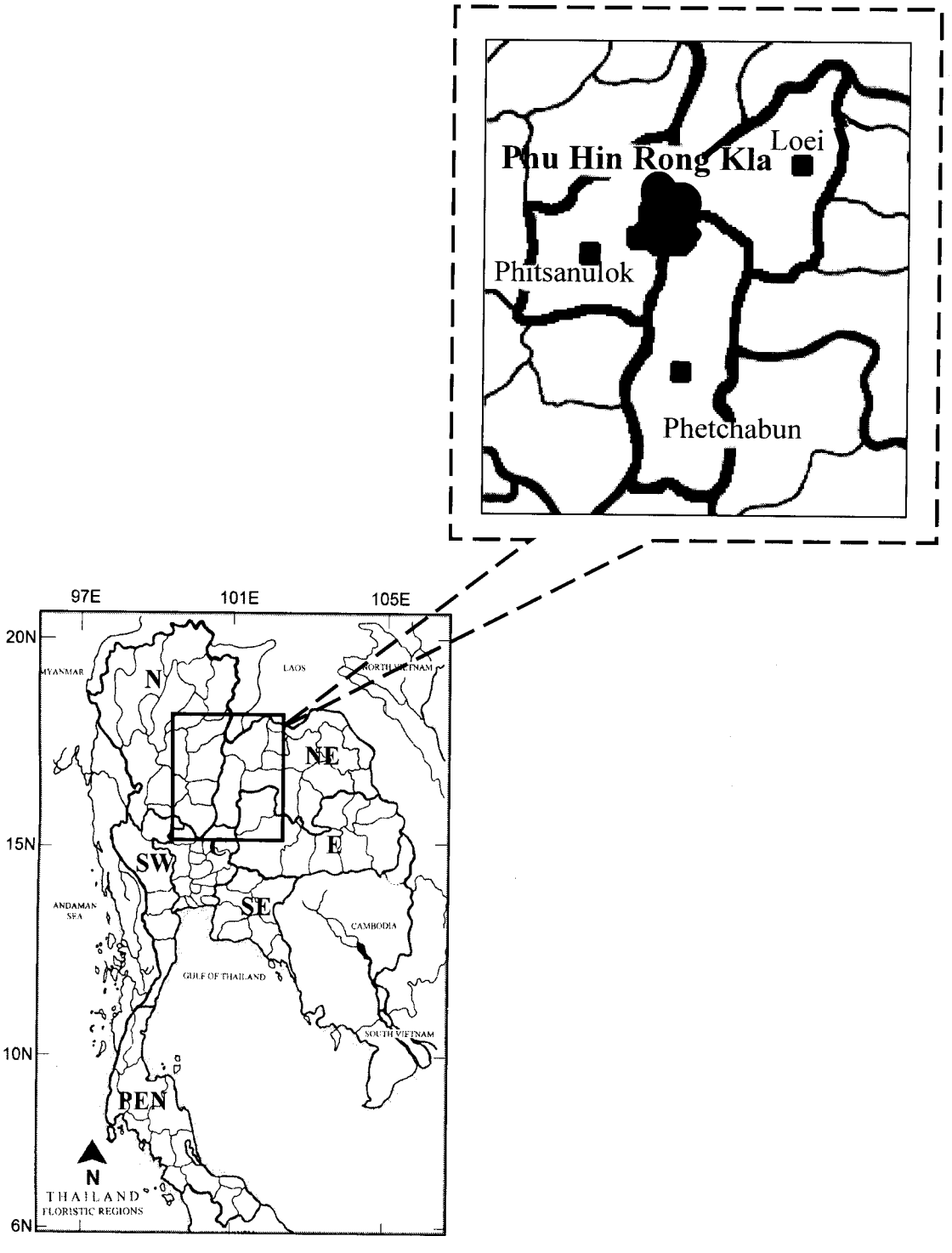

Figure 3.1 Location of Phu Hin Rong Kla National Park.

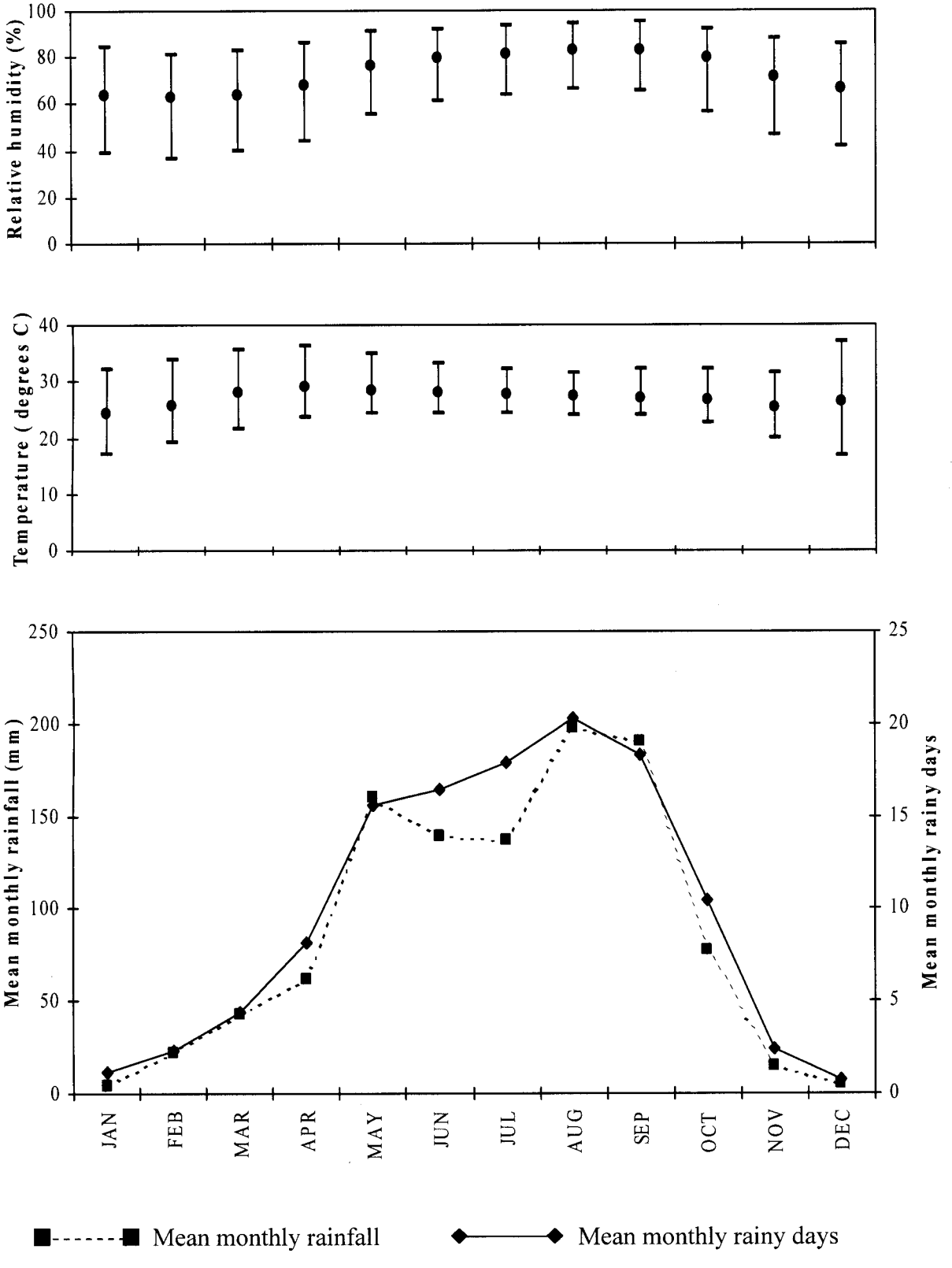

Figure 3.2 Climatological data during the period, 1972-2002, from Lom Sak Station (Data from the Department of Meteorology, Bangkok, Thailand).

CHAPTER 4

MATERIAL AND METHODS

4.1 Materials

4.1.1 Specimen collecting equipments

-a plant press, 30 cm x 45 cm
-sheets of newspapers
-corrugated cardboard
-hand pruner
-spade
-plastic bags
-hand lens
-field note
-camera
-films (colour print and transparency slide)
-altimeter
-tags

4.1.2 Herbarium specimen preparing equipments

-Deep freezer (-40 °C)
-Hot air oven
-mounting paper, 30 cm x 42 cm
-species covers, 30 cm x 42 cm
-genus covers, 30 cm x 42 cm
-latex mixed with synthetic glue in ratio 1:1
-label pad, about 10.5 cm x 13.5 cm
-needle and thread
-sand bags

4.1.3 Identification equipments

-dissecting microscope
-dissecting needles
-razor blades
-Petri dishes

-Flora of Thailand, Vol. 3 and related taxonomic literatures (Tagawa and Iwatsuki, 1979, 1985, 1988, 1989).

4.2 Methods

4.2.1. Literature review

The related taxonomic literatures were assembled from the libraries at the Professor Kasin Suvathabhandu Herbarium, Department of Botany, Chulalongkorn University (BCU) and the Forest Herbarium, Royal Forest Department (BKF). The general information of the studied site such as location, area, boundary, topography, climate, vegetation, and transportation was studied from the park's brochure; prior field trip will be made.

4.2.2. Exploration and collection

Field collections of ferns and fern allies were conducted monthly from March 2001 to July 2002 at Phu Hin Rong Kla National Park. Three duplicates of specimens were collected and photographs were taken for each species. Specimens were gathered along the existing forest trails, extending about 5 m from both sides. Some specific moist areas were selected for repeating visits, such as Man Daeng Waterfall, Rom Klao-Paradorn Waterfall and nearby sites. Field note viz. ecological data, habit, habitat and some diagnostic characters of each species were recorded.

4.2.3. Laboratory study

Laboratory study was conducted at Plant of Thailand Research Unit, Department of Botany, Faculty of Science, Chulalongkorn University. Dry herbarium specimens were prepared as described in Boonkerd et al. (ทวีศักดิ์ บุญเกิด และคณะ, 2530) and deposited at BCU and BKF. Internal and external morphological characters of each specimen were studied. Pteridophyte specimens were identified using keys and descriptions from taxonomic literatures, such as Flora, manual, monograph, as well as research paper, etc. Botanical names of each specimen were verified by comparison to the voucher herbarium specimens deposited at BCU and BKF. Author of scientific names and abbreviations used in this thesis are in accordance with the author of plant *names (Brummitt and Powell, 1992). Classification system of pteridophytes in this* thesis was followed that of Boonkerd and Pollawatn (2000). Dichotomous keys to genera and species were constructed for determining each taxon in the studied area.

Description of each species was prepared and base solely on specimens collected from Phu Hin Rong Kla National Park.

In addition, ecological data, geographical distribution, vernacular name and uses of each species were prepared.

CHAPTER 5

RESULTS

Two hundreds and seventeen specimens were collected from March 2001 to July 2002. A total of 23 families, 55 genera, 112 species and 2 varieties were identified Among these 21 families, 53 genera, 108 species and 2 varieties are ferns, while 2 families, 2 genera and 4 species are fern allies. (Table 5.1). The following are descriptions and keys to taxa found from this study.

Table 5.1 List of the ferns and fern allies at Phu Hin Rong Kla National Park.

Habitat: T= terrestrial, E= epiphytic , L= lithophytic
Abundance: R= rarely found UC= uncommon C= common A= abundant

Taxon	Habitat	Abundance
FERN ALLIES		
Class Lycopodiopsida		
Order Lycopodiales		
Family Lycopodiaceae		
Huperzia hamiltonii (Spreng.) Trevis.	E	C
Huperzia phlegmaria L.	E	R
Class Selaginellopsida		
Order Selaginellales		
Family Selaginellaceae		
Selaginella biformis A. Braun ex Kuhn	L	A
Selaginella siamensis Hieron.	L, T	C
FERNS		
Class Polypodiopsida		
Order Marattiales		
Family Marattiaceae		
Angiopteris evecta (G. Forst.) Hoffm.	T	A

Taxon	Habitat	Abundance
Order Ophioglossales		
Family Ophioglossaceae		
Ophioglossum petiolatum Hook.	T	C
Order Hymenophyllales		
Family Hymenophyllaceae		
Crepidomanes bipunctatum (Poir.) Copel.	E, L	C
Crepidomanes birmanicum (Bedd.) K. Iwats.	E, L	C
Crepidomanes minutum (Blume) K. Iwats.	E	R
Hymenophyllum badium Hook. & Grev.	E	C
Hymenophyllum barbatum (Bosch) Baker	E	C
Hymenophyllum exsertum Wall. ex Hook.	E	C
Hymenophyllum polyanthos (SW..) SW..	E, L	C
Order Gleicheniales		
Fam ily Gleicheniaceae		
Dicranopteris linearis (Burm. f.) Underw. var. *linearis*	T	C
Order Dicksoniales		
Family Dennstaedtiaceae		
Microlepia calvescens (Wall. ex Hook.) C. Presl	T	C
Microlepia herbacea Ching & C. Chr. ex C. Chr. & Tardieu	T	C
Microlepia hookeriana (Wall. ex Hook.) C. Presl	T	UC
Microlepia platyphylla (D. Don) J. Sm.	T	UC
Microlepia puberula v. A. v. R.	T	C
Microlepia strigosa (Thunb.) C. Presl	T	C
Pteridium aquilinum var. wightianum (J. Agardh) R.M. Tryon	T	A
Family Dicksoniaceae		
Cibotium barometz J. Sm.	T	R
Family Lindsaeaceae		
Lindsaea ensifolia SW..	T	UC

Taxon	Habitat	Abundance
Order Cyatheales		
Family Cyatheaceae		
Cyathea gigantea (Wall. ex Hook.) Holttum	T	C
Cyathea latebrosa (Wall. ex Hook.) Copel.	T	C
Order Pteridales		
Family Adiantaceae		
Adiantum philippense L.	L	UC
Coniogramme petelotii Tardieu	T	C
Family Pteridaceae		
Pteris bella Tagawa	T	C
Pteris longipinnula Wall. ex J. Agardh	T	UC
Pteris tokioi Masam.	T	A
Pteris vittata L.	T	UC
Family Vittariaceae		
Antrophyum callifolium Blume	E	R
Vittaria angustifolia Blume	E	C
Vittaria amboinensis Fee	E	C
Vittaria flexuosa Fee	E, L	C
Vittaria sikkimensis Kuhn	L	C
Order Blechnales		
Family Aspleniaceae		
Asplenium cheilosorum Kunze ex Mett.	L	C
Asplenium confusum Tardieu & Ching	E	C
Asplenium ensiforme Wall. ex Hook. & Grev.	E	A
Asplenium exisum C.Presl	L	C
Asplenium nidus L. var. *nidus*	E, L	A
Asplenium normale D.Don	T	C
Asplenium obscurum Blume	L	C
Asplenium paradoxum Blume	L	C
Asplenium pellucidum Lam.	E, L	UC
Asplenium perakense B. Mathew & H. Christ	E	C
Asplenium phyllitidis D.Don subsp. *phillitidis*	E, L	C
Asplenium scortechinii Bedd.	E	A

Taxon	Habitat	Abundance
Asplenium yoshinagae Makino	E	UC
Asplenium sp.1	E	R
Asplenium sp.2	L	UC
Family Blechnaceae		
Blechnum orientale L.	T	UC
Family Dryopteridaceae		
Acrorumohra diffracta (Baker) H. Itô	T	R
Arachniodes spectabilis (Ching) Ching	T	C
Didymochlaena truncatula (SW..) J. Sm.	T	A
Dryopteris hirtipes (Blume) Kuntze	T	UC
Dryopteris polita Rosenst.	T	C
Dryopteris sparsa (D. Don) Kuntze	T	C
Polystichum biaristatum (Blume) T. Moore	T	C
Tectaria impressa (Fee) Holttum	T	C
Tectaria simonsii (Baker) Ching	T	C
Family Lomariopsidaceae		
Bolbitis heteroclita (C. Presl) Ching	L, T	C
Bolbitis sinensis (Baker) K. Iwats. var. *costulata* (Hook.) Tagawa & K. Iwats.	T	C
Bolbitis sinensis (Baker) K. Iwats. var. *sinensis*	L, T	A
Bolbitis virens (Wall. ex Hook. & Grev.) Schott var. *virens*	T	UC
Elaphoglossum malayense Holttum	E	UC
Elaphoglossum stelligerum (Wall. ex Baker in Hook. & Baker) T. Moore ex Alston & Bonner	L	UC
Family Thelypteridaceae	T	
Amphineuron terminans (J. Sm.) Holttum	T	UC
Christella dentata (Forssk.) Holttum	T	
Christella siamensis Tagawa & K. Iwats.	T	A
Christella subpubescens (Blume) Holttum	T	C
Pneumatopteris truncata (Poir.) Holttum	T	UC
Pronephrium nudatum (Roxb.) Holttum	T	UC
Trigonospora ciliata (Wall. ex Benth.) Holttum	T	A

Taxon	Habitat	Abundance
Family Woodsiaceae		
Athyrium mackinnonii (Hope) C. Chr.	T	C
Diplazium siamense C. Chr.	T	A
Diplazium simplicivenium Holttum	T	A
Diplazium sp.	T	C
Order Davalliales		
Family Davalliaceae		
Davallia trichomanoides Blume var. *lorrainii* (Hance) Holttum	E, L	C
Davallia trichomanoides Blume var. *trichomanoides*	E	C
Gymnogrammitis dareiformis (Hook.) Ching ex Tardieu & C. Chr.	E	C
Humata *repens* (L. f.) J. Small ex Diels	E	C
Leucostegia immersa C. Presl	T	C
Family Oleandraceae		
Nephrolepis cordifolia (L.) C. Presl	E, L	C
Oleandra *musifolia* (Blume) C. Presl	E	C
Oleandra *undulata* (Willd.) Ching	L	C
Order Polypodiales		
Family Polypodiaceae		
Aglaomorpha *coronans* (Wall. ex Mett.) Copel.	E, L	UC
Belvisia henryi (Hieron. Ex C. Chr.) Raymond	E	C
Belvisia revoluta (Blume) Copel.	E	R
Colysis hemionitidea (C. Presl) C. Presl	L	A
Colysis pentaphylla (Baker) Ching	T	A
Colysis pothifolia (Buch.-Ham. ex D. Don) C. Presl	T	A
Crypsinus oxylobus (Wall. ex Kunze) Sledge	E, L	C
Crypsinus rhynchophyllus (Hook.) Copel.	E	A
Goniophlebium argutum J. Sm. Ex Hook.	E	C
Goniophlebium microrhizoma (C.B. Clarke ex Baker) Clarke ex Bedd.	E, L	C
Goniophlebium subauriculatum (Blume) C. Presl	L	C

Taxon	Habitat	Abundance
Lemmaphyllum carnosum (J. Sm. ex Hook.) C. Presl	E	C
Lepisorus contortus (H. Christ) Ching	E	UC
Lepisorus heterolepis (Rosenst.) Ching	E	C
Lepisorus subconfluens Ching	E	C
Lepisorus scolopendrium (Buch.-Ham. ex D. Don) Mehra & Bir	E	C
Leptochilus axillaris (Cav.) Kaulf.	E	R
Leptochilus decurrens Blume	L, T	A
Loxogramme chinensis Ching	E	UC
Microsorum dilatatum (Bedd.) Sledge	L	C
Microsorum membranaceum (D. Don) Ching	L	C
Microsorum pteropus (Blume) Copel.	L	C
Microsorum superficiale (Blume) Ching	E	A
Neocheiropteris normalis (D. Don) Tagawa	E	A
Polypodium manmeiense H. Christ	L	C
Pyrrosia lingua var. *heteractis* (Mett. ex Kuhn) Hovenkamp	E, L	A
Family Grammitidaceae		
Ctenopteris subfalcata (Blume) Kunze	E	R
Prosaptia khasyana (Hook.) C. Chr. & Tardieu	E	R

FERNS ALLIES

CLASS LYCOPODIOPSIDA

Vascular plants rooting at the base, or the rhizomes and stolons bearing adventitious roots. **Stems** erect, creeping, scandent or corm-like; microphyllus leaves with a single central vein. **Sporophylls** arranges in compact strobili or loosely spaced on the stem, sporangia borne in axils of sporophylls or on the base of sporophylls; homosporous or heterosporous.

ORDER LYCOPODIALES

LYCOPODIACEAE

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

Terrestrial or epiphytes. **Leaves** simple, with one simple vein, arranged in spiral or irregular whorls, or decussate. **Sporophylls** like the foliage leaves or aggregate into distinct strobili; sporangia solitary at base of the upper surface of sporophyll; cones distinct or not.

HUPERZIA

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

Sporophytes differentiated into roots, stems, and leaves. **Stem** elongate, dichotomous or sympodial. **Leaves** microphyllous, each with a single vein, without ligules, arranged in spirals or in whorls. **Sporangia** solitary at base of the upper surface of sporophyll; cones distinct or not; spore isosporous, tetrahedral.

Key to the species

1. Strobilus not distinct; sporophylls hardly smaller than the sterile leaves
1. H. hamiltonii
1. Strobilus distinct; sporophylls much smaller than the trophophylls
2. H. phlegmaria

1. *Huperzia hamiltonii* (Spreng.) Trevis., Atti Soc. Ital. Sci. Nat. 17: 248. 1874. - *Lycopodium hamiltonii* Spreng., Syst. Veg. 5: 429. 1828; Tagawa & K. Iwats., Fl. Thailand 3(1): 9. 1979; Devol, Fl. Taiwan Vol. 1. 2nd ed.: 33. 1980.

Stems usually pendulous, 15-22 cm long, dichotomously branching, 1-1.5 mm in diameter near base. **Leaves** ascending or subadnate, lanceolate, acute to acuminate at apex, narrowing toward sessile or very shortly stalked base, those on middle or lower part the largest, about 10 mm long, 2 mm broad, entire; veins more or less distinct beneath; texture softly chartaceous to thicker, green to yellowish green. **Sporophylls** usually smaller than the tropophylls, to 7 mm long, 1-2 mm broad,

usually gathered in apical portion, forming no distinct strobilus, up to 2-4 cm long (Figure 5.9, 5.10).

Thailand.- NORTHERN: Chiang Mai (Doi Chiang Dao, Khun Mae Lan, Khun Kong San, Doi Suthep, Doi Inthanon), Mae Hong Son (Doi Khun Huay Pong), Phitsanulok (Phu Miang); NORTH-EASTERN: Loei (Phu Luang); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTREN: Chanthaburi (Khao Soi Dao); SOUTH-WESTERN: Kanchanaburi (Sisawat); PENINSULAR: Nakhon Si Thammarat (Khao Luang).

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

Ecology.- On mossy tree-trunks in hill evergreen forest at 1600 m alt.

Specimens examined.- *W. Rattanathirakul* 157; *T. Boonkerd* 53, 1255 (BCU).

2. *Huperzia phlegmaria* (L.) Rothm., Feddes Repert. Spec. Nov. Regni Veg. 54: 62. 1944. *Lycopodium phlegmaria* L., Sp. Pl.: 1101. 1753; Tagawa & K. Iwats., Fl. Thailand 3(1): 10. 1979.

Stem pendulous, dichotomously branching in irregular intervals, to more than 100 cm long, 2-5 mm in diameter near the base. **Leaves** patent, oblong-lanceolate to ovate-subdeltoid, acuminate at apex, round to roundly trunacte at base, subsessile or very shortly stalked, 1 cm long, 4 mm broad, entire; vein more or less visible; texture coriaceous, green to yellowish green. **Strobilus** distinct, located at apex of sterile branches, dichotomously branching a few times, slender, 1-2 mm in diameter, 4-5 cm long; sporophylls ovate subdeltoid, adpressed, about 1 mm long (Figure 5.11).

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), Chanthaburi (Khao Soi Dao); PENISULAR: Chumphon (Tha San), Surat Thani (Song Phi Nong), Phangnga (Khao Thong Lang), Krabi (Ko Pu, Nai Sa, Nai Chong), Phuket (airport), Nakhon Si Thammarat (Khao Luang), Phatthalung (Khao Soi Dao, Khao Pok), Satun (Thung Nui, Tarutao), Yala (Betong).

Distribution.- Old World tropics (type from Ceylon), north to S. Japan.

Ecology.- On mossy-tree trunks in hill evergreen forest at 1300 m alt.

Vernacular.- Chong nang khli (ช้องนางคลี่) (South-western); Klet nakkharat (เกล็ดนาคราช)(Nortn-eastern); Raya (ระย้า) (Peninsular); Yom doi (ยมโดย) (Central).

Specimens examined.- *W. Rattanathirakul* 116; *T. Boonkerd* 77, 1369 (BCU).

CLASS SELAGINELLOPSIDA

Stems slender, creeping, rooting at the intervals or erect, usually without branches on lower part, rooting near base. **Leaves** small, simple, with a single vein, always bearing an in conspicuous 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 the other leaves. **Sporophylls** borne in compact strobili; microsporophylls with a single microsporangium, contains a large number of microspores.

ORDER SELAGINELLALES

SELAGINELLACEAE

Willk., Anleit. Stud. Bot. 2: 163. 1854; Devol, Fl. Taiwan Vol. 1. 2nd ed.: 42. 1980.

Stems elongate, creeping, bearing leaves and rhizophores, branching dichotomously or pinnately. **Leaves** microphyllous, monomorphic and spirally arranged, or dimorphic arranged in four rows, the ventral two patent or ascending, larger, the dorsal two smaller, adpressed to stems, directed distally. **Sporophylls** uniform and arranged spirally forming cylindrical spikes, uniform and arranged in four rows forming squarroid spikes, or dimorphic and arrangement in four rows, the dorsal and ventral rows unequal.

SELAGINELLA

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

Stems elongate, bearing leaves and rhizophores, branching dichotomously or pinnately. **Leaves** microphyllous, monomorphic and spirally arranged, or dimorphic arranged in four rows, the ventral two patent or ascending, larger, the dorsal two smaller, adpressed to stems, directed distally. **Sporophylls** unifrom and arranged spirally forming cylindrical spikes, or dimorphic and arranged in four rows, the dorsal and ventral rows unequal, heterosporous, with tetrahedral spores.

Key to the species

1. Branches pubescent, stem not growing indefinitely **1. S. biformis**
1. Branches glabrous, stem growing indefinitely, dorsal leaves nearly as large as the ventral leaves **2. S. siamensis**

1. *Selaginella biformis* A. Braun ex Kuhn, Forsch. Gaz. 4. Bot. 6: 17, 19. 1889; Tagawa & K. Iwats., Fl. Thailand 3(1): 14. f. 2: 6-8. 1979.

Stem erect or decumbent, rooting only at base for the erect plants, plant about 30 cm tall; main stem about 1.2 mm in diamiter near base, sparsely leaves, pubescent on lower surface or glabrescent in lower portion; lateral branches bipinnate to tripinnate, densely pubescent below; ultimate branches about 3 mm in breadth. **Leaves** on basal portion of erect stem unifrom, sparse and not imbricate; ventral leaves ascending, oblong subdeltoid, gradually narrowing and falcate towards acute apex, cordate at base, 2.5 mm long, 1.8 mm broad; edges dentate or ciliate near base, texture herbaceous to softly papyraceous, green; dorsal leaves asymmetrically oblong, mucronate at apex, dentate or ciliate at margin. **Spike** about 1 mm in diameter. Sporophylls unifrom, ovate subtriangular with long mucronate apex, about 1.5 cm long, 1 mm broad (Figure 5.12, 5.13).

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

Distribution.- Assam, Myanmar, S. China, Indochina and Malesia throughout (type from the Philippines).

Ecology.- On humus rich rocks in light shade or open areas in hill evergreen forest at 1250 m alt.

Specimens examined.- *W. Rattanathirakul* 55, 93; *T. Boonkerd* 25 (BCU): *K. Iwatsuki* and *N. Fukuoka* T 7402; *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 2031 (BKF).

2. *Selaginella siamensis* Hieron., Bot. Tidsskr. 24: 113. 1901; Tagawa & K. Iwats., Fl. Thailand 3(1): 18. 1979.

Stem long, growing indefinitely, climbing up bushes or procumbent, irregularly rooting to form new plants at apex, 1.2 mm in diameter, rather closely bearing brownish monomorphic leaves, glabrous; rhizophores stout, to more than 0.5 mm in diameter; lateral branches tripinnate, ovate to oblong subtriangular in outline; ultimate branches 3 mm wide. **Ventral leaves** ascending, ovate-oblong, acute to mucronate with long aristae at apex, cordate at base, to 3 mm long, 1.8 mm broad; edges ciliate throughout with white setae of about 0.1 mm in length, texture softly papyraceous, green, or sometimes reddish; dorsal leaves nearly the same as or smaller than ventral ones in size, asymmetrically oblong to suborbicular with long pale tails at apex, ciliate at margin. **Spike** usually 6 mm long, about 1.2 mm in diameter; sporophylls uniform, ovate-subtriangular with long tail (Figure 5.14, 5.15).

Thailand.- NORTHERN: Chiang Rai (Doi Phacho), Chiang Mai (Khun Khong), Lampang, Phutsanulok (Thung Salaeng Luang, Phu Miang); NORTH-EASTERN: Loei (Phu Luang, Phu Kradung); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Trat (Ko Chang-type); SOUTH-WESTERN: Kanchanaburi (Thung Kang Yang Hills); PENINSULAR: Satun (Rawai).

Distribution.- Indochina and Malaya

Ecology.- Terrestrial on rather dry ground or on rocks in light shade or in open areas in hill evergreen forest at 1300 m alt.

Specimens examined.- *W. Rattanathirakul* 120, 191 (BCU): *M. Tagawa, K. Iwatsuki and N. Fukuoka* T 628, T 636 (BKF).

FERNS

CLASS POLYPODIOPSIDA

Vascular plants ranging from minute epiphytes, small aquatics, common woodland fern to tropical tree ferns; the stem have a wide range of stele types; the leaves differ in size, shape, texture, venation and dermal appendages; the sporangia differ in from and location, usually being borne on the margin or back of ordinary frond, but are sometime borne on separate fertile fronds; indusia may be present or absent, and if present, of many different shapes; spores occur in a tremendous number of forms, nearly all are homosporous, but a few aquatics are heterosporous.

ORDER MARATTIALES

MARATTIACEAE

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

Eusporangiate, terrestrial ferns. **Stem** short, globose, erect; or rhizome fleshy, dorsiventral, creeping to suberect. **Lamina** pinnately compound, often very large, circinate when young, base of stipe with 2 large leathery persistent stipules; pulvinus at or near base of stipe and pulvini at bases of rachillae. **Sporangia** arranged 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 a tuft. **Stipe** fleshy, green, SW.ollen at base, with scattered whitish streaks at both side. **Lamina** bipinnate; pinnae and pinnules SW.ollen at base; veins all free. **Sori** with two close rows of sporangia; sporangia dehiscing along slits on the side facing the veins.

Angiopteris evecta (G. Forst.) Hoffm., Com. Reg. Gott. 12: 29. t. 5. 1796; Holttum, Rev. Fl. Malaya 2: 44. f. 3. 1955; Bebb., Handb.: 460. f. 285.1969; Tagawa & K. Iwats., Fl. Thailand 3(1): 41. 1979.-*Polypodium evectum* Forst., Fl. Ins. Austr. Prod.: 81. 1786.- *Angiopteris crassipes* Wall. ex Presl, Suppl. Tent. Pterid.: 23. 1845.- *Angiopteris helferiana* Presl, Suppl. Tent. Pterid.: 22. 1845.- *Angiopteris* sp.; C. Chr., Contr. U.S. Natn. Herb. 26: 329.1931.

Rhizome short, massive, bearing several large fronds in a tuft. **Stipe** fleshy, green, SW.ollen at base, with scattered whitish streaks at both side, more than 120 cm or more long. **Lamina** bipinnate; pinnae and pinnules SW.ollen at base; various in size; about 220 cm long, 180 cm wide; rachis green, fleshy, glabrous; pinnae to 100 cm or more long, bearing pinnules 3 cm apart; pinnules about 15 by 2 cm, oblong-lanceolate, acuminate apex, each with short SW.ollen 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; texture subcoriaceous, green, pale below, glabrous; veins

all free, simple or forked. **Sori** with two close rows of sporangia; sporangia dehiscing along slits on the side facing the veins, about 1 mm from edge (Figure 5.16, 5.17).

Thailand.- This species is common throughout Thailand usually in shade.

Distribution.- Malesia and Indonesia.

Ecology.- Terrestrial along stream in hill evergreen forest at 1350 m alt.

Vernacular.- Wan kip ma (ว่านกีบม้า), Wan kip raet (ว่านกีบแรต) (Central); Kip ma lom (กีบม้าลม), Kip raet (กีบแรต) (Northern); Duku (ดูกู) (Malay/Peninsular).

Uses.- Rhizome used in local medicine.

Specimens examined.- *W. Rattanathirakul* 54; *T. Boonkerd* 190, 194(BCU): *M. Tagawa* and *N. Fukuoka* T 2101; *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 1287 (BKF).

ORDER OPHIOGLOSSALES

OPHIOGLOSSACEAE

(R. Brown) C. Agardh, Aphor. Bot. 8: 113. 1822; Devol, Fl. Taiwan Vol. 1. 2nd ed.: 64. 1980.

Succulent herbs, terrestrial or epiphyte. **Stem** fleshy, short or rhizome fleshy, creeping; root long, fleshy. **Lamina** pinnate or ternate, not circinate; fertile segment branching from sterile frond. **Sporangia** born in a simple or compound spike.

OPHIOGLOSSUM

L., Sp. Pl.: 1062.1753; Tagawa & K. Iwats., Fl. Thailand 3(1): 35. 1979

Rhizome short, erect; tropophyll simple or forked a few times near the apex; venation reticulate; spikes simple, with two rows of sporangia which are joined together almost completely, each opening by a transverse slit.

Ophioglossum petiolatum Hook., Exot. Fl. 1: 56, t. 56. 1823; Tagawa & K. Iwats., Fl. Thailand 3(1): 37. 1979. Devol, Fl. Taiwan Vol. 1. 2nd ed.: 70. pl. 19. 1980.- *Ophioglossum reticulatum* auct. non L.: Bedd., Handb.: 465. f. 290.1883.

Rhizome cylindrical, 2-4 mm in diameter, to 8 mm long, bearing many roots. **Lamina** simple, 8 cm long, 1 or 2 on a rhizome; phyllomophore to 4 cm long;

trophophyll variable in size and form, ovate to oblong, round to moderately acute at apex, deeply cordate at base, 3 cm long, 2.5 cm broad; costae not differentiated; veins reticulate, areoles visible, many, free included veinlets often present, simple or branched; texture softy herbaceous, rather fleshy, greenish in living and yellowish in dried specimen, glabrous; sporophyll simple, with stalks of 10-14 cm in length. **Spikes** 2-4 cm long, sporangia up to 1 mm in diameter (Figure 5.18).

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

Distribution.- Pantropic

Ecology.- Terrestrial on mountain slopes in light shade in hill evergreen forest at 1450 m alt.

Specimens examined.- *W. Rattanathirakul* 73; *T. Boonkerd* 1017, 1212 (BCU).

ORDER HYMENOPHYLLALES

HYMENOPHYLLACEAE

Link, Handbuch 3: 36. 1883; Holttum, Rev. Fl. Malaya 2: 72. 1955.

Rhizome usually slender and long creeping with distant fronds, young parts covered with hairs, sometime rootless. **Lamina** variable in shape and size; texture membranous except at vein. **Sori** terminal on the ultimate one-veined lobes, or marginal at vein-ending on leaflets with many veins; receptacle columnar, more or less elongate, the apical part of the indusium more or less dilated, often more or less deeply divided in to two lips.

Key to the genera

1. Involucres tubular; receptacle long extruded or included; rhizome creeping with dense dark brownish hairs; false veinlets present or not.

1. Crepidomanes

1. Involucres bilabiate; receptacle included; rhizome long creeping, nearly glabrous or sparsely with brownish hairs; false veinlets absent.

2. Hymenophyllum

1. CREPIDOMANES

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

Rhizome long-creeping, filiform, hairy. **Lamina** tiny and digitate to medium sized and pinnately compound, the ultimate segments or lobes entire at margin; false veinlets present or absent; involucre obconic to campanulate, winged, with bilabiate mouth; receptacles extruded.

Key to the species

1. False veinlets present, involucre tubular with bilabiate mouth, frond tripinnatifid **1. C. bipunctatum**
1. False veinlets wanting
   2. Fronds oblong to oblong ovate, tripinnate or more compound **2. C. birmanicum**
   2. Fronds flabellate to pinnate, glabrous at margin **3. C. minutum**

1. *Crepidomanes bipunctatum* (Poir.) Copel., Philipp. J. Sci. 67(1): 59. 1938; Tagawa & K. Iwats., Fl. Thailand 3(1): 90. 1979.- *Trichomanes bipunctatum* Poir. in Lamk., Enc. 8: 69. 1808; Holttum, Rev. Fl. Malaya 2: 99. f. 35. 1955; Bedd., Handb.: 41. 1969: *Trichomanes pyxidiferum* auct. Non Linn.: Christ, Bot. Tidsskr. 24: 103. 1901.- *Trichomanes filicula* auct. Non Bory: Christ, Bot. Tidsskr. 24: 103. 1901.

Rhizome long-creeping, about 1 mm diam., covered with dark brownish hairs. **Stipe** about 2-3 cm long, winged almost to the base, bearing short hairs; rachis winged throughout. **Lamina** variable in shape and size, ovate to oblong, round to acute at apex, tripinnatifid, usually 4-6 cm long, 3-5 cm wide, pinnae 6-8 pairs, the larger ones 2-3 cm long, 1 cm wide, shortly stalked or sessile in the upper ones; pinnules oblong to subdeltoid, with about 6-9 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; texture herbaceous, light green, glabrous. **Sori** on the apice of short axillary lobes; involucre tubular, 2 mm long, winged, the mouth bilabiate, the lips round to acute, as wide as long (Figure 5.22).

Thailand.- NORTH-EASTERN: Loei (Phu Kradung); CENTRAL: Nakhon Nayok (Khao Yai); EASTERN: Nakhon Ratchasima (Pak Thong Chai, Kathok, Ban Thakum); SOUTH-EASTERN: Chanthaburi (Taruang, Khao Sabap, Makham, Phriu

watewfall), Trat (Ko Chang, Dan Chumpon, Ko Kut); SOUTH-WESTERN: Kanchanaburi (Khlong Wa); PENINSULAR: Krabi (Phanom Bencha), Chumphon (Tha Ngo, Tha San, Langsuan), Ranong (La-un, Khao Phota Chongdong), Surat Thani (Khlong Nam Wing, Ban Kop Kaep, Ko Tao, Ban Don), Nakhon Si Thammarat (Klong Luang, Ao Luk), Phuket (Ko Talibong, Thalang), Phatthalung (Khlong 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 in hill evergreen forest at 1600 m alt.

Specimens examined.- *W. Rattanathirakul* 10, 13 (BCU): *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 5580, T 6701 (BKF).

2. *Crepidomanes birmanicum* (Bedd.) K. Iwats., J. Fac. Sci. U. Tokyo III. 13: 530. 1985.- *Trichomanes birmanicum* Bedd. Suppl. Ferns Brit. Ind. 3, t. 349. 1876; Tagawa & K. Iwats., Fl. Thailand 3(1): 84. f. 5: 7. 1979.- *Vandenboschia birmanica* (Bedd.) Ching. Acta Phytotax. Sin. 8(2): 135. 1959.-*Trichomanes radicans* auct. non SW..: Bedd., Handb.: 43. 1883; Holttum, Rev. Fl. Malaya 2: 107. 1955

Rhizome long-creeping, more than 1 mm diam., densely covered with dark brownish hairs. **Stipe** more than 1 cm apart, distinctly winged almost to the base, hairy when young, 2.5-5 cm long. **Lamina** oblong-lanceolate, acute at apex, round to cordate at base, 15 cm long, 4 cm wide, tripinnatifid; rachis winged throughout, the wings more than 0.5 mm broad on each side, entire and flat; pinnae subdeltoid to ovate, moderately acute at apex, broadly cuneate to subtruncate at base, stalks shortly winged, in larger ones about 2 cm long and wide; ultimate segments narrow, about 0.3 mm broad, acute at apex; not so deeply dissected, wings of various axes usually broader than the ultimate lobes; dark green in color. **Sori** on short axial segments, usually on basal acroscopic portions of pinnules or on secondary pinnules; involucre tubular with little-dilated mouth and short stalk, about 1.5 mm long, 0.7 mm diam. (Figure 5.19).

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

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

Ecology.- On mossy tree-trunks in hill evergreen forest at 1600 m alt.

Specimens examined.- *W. Rattanathirakul* 14 (BCU); *E. Hennipman* 3437, *K. Iwatsuki* and *N. Fukuoka* T 3684 (BKF).

3. *Crepidomanes minutum* (Blume) K. Iwats., J. Fac. Sci. U. Tokyo III. 13: 524. 1985.- *Trichomanes minutum* Blume, Enum. Pl. Javae. 2: 223. 1828; Holltum, Rev. Fl. Malaya 2: 96. 1955.- *Gonocormus saxifragoides* (C. Presl) Bosch, Hymen. Jav.: 9. 1861; Tagawa & K. Iwats., Fl. Thailand 3(1): 80. 1979.- *Trichomanes saxifragoides* Presl, Hymen.: 16, 39. 1843.- *Trichomanes parvulum* Blume, En. Pl. Jav.: 223. 1828; Bedd., Handb.: 39. f. 18. 1969.- *Gonocormus minutus* auct. non (Blume) Bosch: Copel., Phil. J. Sci. 67: 57. 1938.- *Gonocormus prolifer* (Blume) Prantl, Hymen.: 51. 1875; Tagawa & K. Iwats., Fl. Thailand 3(1): 81. 1979.- *Gonocormus siamensis* Tagawa & K. Iwats., Acta Phytotax. Geobot. 22: 99. f. 3. 1967; Tagawa & K. Iwats., Fl. Thailand 3(1): 81. 1979.

Rhizome long-creeping, very slender, covered with dark brownish hairs. Stipe slender, wingless, about 0.5-1 cm long. **Lamina** seemingly flabellate to bipinatifid, irregularly branching dichotomously or with short main axis, about 1 cm long, often wider than long, not proliferous; ultimate segments with a single veinlet, round to moderately acute at apex, the margin entire, thickened and somewhat curved inwardly. **Sori** at apices of ultimate segments; involucre tubular, windeg, the mouth conspicuously dilated.

Thailand.- NORTH-EASTERN: Loei (Phu Luang, Phu Kradung); EASTERN: Nakhon Ratchasima (Khao Lotung); SOUTH-EASTERN: Prachin Buri (Khap Yai), Trat (Ko Kut); SOUTH-WESTERH: Prachuap Khiri Khan (Khao Luang); PENINSULAR: Krabi (Ko Pu), Nakhon Si Thammarat (Khao Luang), Ranong (Khao Phota Chongdong), Surat Thani (Ko Tao), Trung (Khao Sung, Khao Chong), Phangnga (khao Katha Khwam), Phuket (Khao Phra), Narathiwat (Bacho Falls), Yala (Khao Kalakhiri, Betong).

Distribution.- Old world tropics (type from Luzon), east to Polynesia and north to Japan, Malaysia and Sumatra.

Ecology.- On mossy tree-trunks in hill evergreen forest at 1600 m alt.

Specimens examined.- *W. Rattanathirakul* 6 (BCU); *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 1833, T 1838, T 2015 (BKF).

2. HYMENOPHYLLUM

J. E. Smith, Mém. Acad. Turin. 5. 418. 1793; Tagawa & K. Iwats., Fl. Thailand 3(1): 74. 1979.

Rhizome filamentous, general not distinctly different from stipe and rachis, **Lamina** small, flabellate or pinnate; false veinlets absent; invulocre elongate, mouth dilated, entire; receptacles extruded or included.

Key to the species

1. All axis glabrous
   2. Involucre distinctly wider than long **1. H. badium**
   2. Involucre triangular to subdeltoid, longer than wide **4. H. polyanthos**
1. Stipe, rachis, and pinna-rachis persistently hairly
   3. Margin of lobes toothed **2. H. barbatum**
   3. Margin of lobes entire **3. H. exsertum**

1. *Hymenophyllum badium* Hook. & Grev., Icon. Filic. 1(4): t. 76. 1828; Holttum, Rev. Fl. Malaya 2: 83. f. 25. 1955.- *Hymenophyllum javanicum* var. *badium* (Hook. & Grev.) C.B. Clarke, Trans. Linn. Soc. London, Bot. 1(7): 438. 1880; Bedd., Handb.: 33. 1883.- *Mecodium badium* (Hook. & Grev) Copel., Philipp. J. Sci. 67: 23. 1938; Tagawa & K. Iwats., Fl. Thailand 3(1): 72. 1979; Devol, Fl. Taiwan Vol. 1.2nd ed.: 124. 1980.

Rhizome wiry, the rootlets densely hairly, 0.8 mm diam. **Stipe** hard, naked, up to 1 mm diam., less than 10 cm long, winged except the basal portion, the wings entire, more or less crisped or almost flat, gradually narrowing downwards. **Lamina** variable to some extent in size and from, usually oblong, occasionally broader or narrower, acute at apex, tripinnate to quadripinnatifid, 10-12 cm long, 4-6 cm wide; rachis like the upper part of stipes, winged throughout, wings up to 1.2 mm broad, entire, near flat, waved or crisped, pinnae to 10 in pairs, the larger ones oblong to oblong-lanceolate, acute or moderately acute at apex, upper ones gradually smaller; ultimate segments narrowly oblong or somewhat elongate, round to obtuse at apex, entire and flat at margin, 1 mm or broader, the wings of costae and the higher axes not crisped. **Sori** many on a frond; involucre orbicular-renifrom, divided to the very base, 1.5-2.5 mm long, somewhat broader; lips round, entire but occasionally undulate; receptacle capitate, included.

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

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

Ecology.- On mossy tree-trunks in hill evergreen forest at 1600 m alt.

Specimens examined.- *W. Rattanathirakul* 3; *T. Boonkerd* 94 (BCU): *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 2672, T 4842 (BKF).

2. *Hymenophyllum barbatum* (Bosch) Baker, Syn. Fil.: 68. 1867; Tagawa & K. Iwats., Fl. Thailand 3(1): 74. 1979; Devol, Fl. Taiwan Vol. 1. 2nd ed.: 120. 1980.- *Leptocionium barbatum* Bosch, Ned. Kruidk. Arch. 5(2): 146. 1863.

Rhizome about 0.2 mm diam., covered with stiff brownish hairs when young. **Stipe** 1 cm apart, narrowing winged in the upper parts, rather densely hairy, 1.0 cm long. **Lamina** bipinnatifid to tripinnatifid, oblong to oblong-lanceolate, moderately acute at apex, gradually narrowing or broadly cuneate to base, 2.5 cm long, 2 cm wide; rachis distinctly winged, rather densely hairy on the underside; pinnae linear-subdeltoid, acute at apex, unequally cuneate at base, 1 cm long and 0.5 cm wide; ultimate segments linear-oblong, usually about 1.5 mm wide, distinctly toothed and flat or crisped at margin like the wings of the rachis; every axis rather distinct, hairy on the underside. **Sori** in the apices of short segments; involucre bilabiate almost to the base, the lips round to acute, serrate at margin; receptacles clavate, included.

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

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

Ecology.- On mossy tree-trunks in hill evergreen forest at 1600 m alt.

Specimens examined.- *W. Rattanathirakul* 126 (BCU): *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 1502, T 2673 (BKF).

3. *Hymenophyllum exsertum* Wall. ex Hook., Sp. Fil. 1: 109, pl. 38A, 1844; Holttum, Rev. Fl. Malaya 2: 86. f. 28. 1955; Bedd., Handb.: 30. f. 16. 1969.- *Mecodium exsertum* (Wall. ex Hook.) Copel., Philipp. J. Sci. 67: 23. 1938; Tagawa & K. Iwats., Fl. Thailand 3(1): 73. 1979.

Rhizome wiry, sparsely brown hair throughtout, laxly branched about 0.3 mm diam. **Stipe** remote, hairy on adaxial side, about 1-1.5 cm long, winged on the upper part; **Lamina** variable in shape and size, oblong-ovate, to oblong-lanceolate, round to acute at apex, bipinnatifid, up to 4 by 2 cm, rachis like the upper part of Stipe, hairy throughout, more densely on abaxial side, winged of the upper part broader, pinnae 8-10 pairs, oblong to oblong-lanceolate slightly falcate, round to moderately acute at apex, 1 cm long, 0.5 cm wide, with a few to several segments; ultimate segments to 1.5 mm long, 1 mm broad, entire and flat; hairs on every axis, rather sparse on upper axis, brown; texture herbaceous. **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; receptacles clavate, includes (Figure 5.20, 5.21).

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 Kradung); 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 (Klong Luang), Trang (Khao Sung, Khao Chong).

Distribution.- N. India (type from Nepal), S. China, Upper Myanmar, Indochina, south of Malaya.

Ecology.- On mossy tree-trunks in hill evergreen forest at 1600 m alt.

Specimens examined.- *W. Rattanathirakul* 4 (BCU): *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 2883, T 2669 (BKF).

4. *Hymenophyllum polyanthos* (SW..) SW.., Schrad. J. Bot., 1800 (2): 102. 1801; Holttum, Rev. Fl. Malaya 2: 81. f. 23. 1955; Bedd., Handb.: 30. 1969.- *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.

Rhizome slander, less than 0.2 mm diam., with hairy rootlets. **Stipe** 1.5-2 cm long, wingless except the uppermost part, sparesely hairy especially in the younger parts, the rootlets densely hairy, the hair brown, up to 1 mm long. **Lamina** variable both in size and form, lanceolate, oblong-lanceolate, oblong or subdeltoid, acute to acuminate at apex, 5-9 cm long, 2-2.5 cm wide, usually tripinnatifid, herbaceous; rachis wings throughout, wings very narrow, entire, flat; pinnae less than 10 in pairs, the largest one in the middle of the frond, 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 about 0.8 mm broad. **Sori** scattered usually on the upper parts of fronds; involucre subdeltoid or rarely renifrom, about 1 mm in length, 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 Kradung, 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.- Tropic or subtropics throughout the world (type frpm Jamaica), north to central Japan.

Ecology.- On mossy tree-trunks in hill evergreen forest at 1600 m alt.

Specimens examined.- *W. Rattanathirakul* 64; *T. Boonkerd* 47, 1052 (BCU): *M. Tagawa* and *K. Iwatsuki* T 1040; *K. Iwatsuki* T 6262 (BKF).

ORDER GLEICHENIALES

GLEICHENIACEAE

(J. Presl) C. Presl, Reliq. Haenk. 1: 70. 1825; Holttum, Rev. Fl. Malaya 2: 61. 1955.

Rhizome long-creeping, the apical part covered with stiff hairs or with scales. **Lamina** usually long, scrambling or climbing; main rachis bearing opposite pairs of lateral branches, the apical bud protected by hairs or scales and often also by stipule like leaflets; leaflets lobed almost to the costa; veins forked, all free. **Sori** on vein, terminal or not, sporangia few, rather large, without indusium.

DICRANOPTERIS

Bernh., 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 linearis (Burm. f.) Underw. var. ***linearis***, Bull. Tor. Bot. Club 34: 249. 1907; Holttum, in Fl. Mal. II. 1: 33. f. 12. 14 f-i. 1959; Holttum, Rev. Fl. Malaya 2: 68. f. 16. 1955; Bedd., Handb.: 4. f. 1.1969; Tagawa & K. Iwats., Fl. Thailand 3(1): 55. 1979; Devol, Fl. Taiwan Vol. 1. 2nd ed.: 43. 1980.- *Polypodium linearis* Burm. f., Fl. Ind.: 235. t. 67. f. 2. 1768.- *Gleichenia linearis* (Burm. f.) Clarke, Tr. L. Soc. II. Bot. 1: 428. 1880.

Rhizome widely creeping, slender, hairy. Stipe erect, stramineous or brown, glabrescent. **Lamina** primary rachis-branches usually twice or thrice forked, the two branches at each fork nearly equal; ultimate branches 15-30 cm long, 5-7 cm wide; ultimate segments linear, entire, round at apex, up to 3 cm broad; texture firm, lower serface slightly glaucous, glabrescent, veins more or less prominent on lower surface and hairy. **Sori** in a single row at each side of costules.

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

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

Ecology.- In clearing at edge of hill evergreen forest in open places at 1600 m alt.

Vernacular.- Kiku kachoei (กี๊กุกะเจ้ย) (Karen/Northern); Kut pit (กูดปิ้ด), Kut Muk (กูดหมึก) (Northern); Kut taem (กูดแต้ม), Chon lek (โจ้นเหล็ก), Chon (โชน) (Peninsular); Kuekae (กือแก), Ruesae (รือแซ) (Malay/Peninsular).

Specimens examined.- *W. Rattanathirakul* 104; *T. Boonkerd* 1180, 1469 (BCU).

ORDER DICKSONIALES

DENNSTAEDTIACEAE

Lotsy, Vortr. Bot. Stammesgesch. 2: 655. 1909; Holttum, Rev. Fl. Malaya 2: 302. 1955.

Rhizome creeping, covered with hairs. **Lamina** medium to large and much divided; ultimate leaflets more or less unequal at base; veins all free; texture thin or firm, never fleshy or leathery. **Sori** terminal on veins and either (a) marginal and enclosed in a cup, or (b) near the margin and more or less protected by a small reflexed lobe of the margin, or (c) near the margin and protected by pouch-shaped indusium attached below and at side of the receptacle.

Key to the genera

1. Sori submarginal or dorsal; indusia thin, cup-shaped, attached by base and side **1. Microlepia**
1. Sori elongate along margin of lobes, protected by thin reflexed edge of lobes **2. Pteridium**

1. MICROLEPIA

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

Rhizome creeping, covered with short hairs. **Stipe** rather close, hairy; Lamina pinnate to pinnately decompound, the ultimate pinnules usually obliquely incised in most cases hairy; axes grooved, veins 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 simply pinnate
   2. Pinnae less than 20 pairs, lobed more than 1/3 way towards costa **1. M. calvescent**
   2. Pinnae more than 25 pairs, serrate at margin **4. M. hookeriana**
1. Frounds bipinnate or more compound
   3. Lamina 40-70 cm long, pinnules to 3 cm long
      4. Texture herbaceous; veins not so distinct on lower surface of lobes **2. M. herbacea**
      4. Texture subcoriaceous; veins on lower surface of lobes distinctly raised, paler than the lamina **6. M. strigosa**
   3. Lamina 80-130 cm long, larger pinnules more than 5 cm long
      5. Lower surface of lamina not or hardly hairy, sori terminal on veinlets, each in marginal dentation **4. M. platyphylla**
      5. Lower surface of lamina densely hairy, sori at or a little within the margin of lobes **5. M. puberula**

1. ***Microlepia calvescens*** (Wall. ex Hook.) C. Presl, Epim.: 95. 1849; Tagawa & K. Iwats., Fl. Thailand 3(1): 114. f. 7: 3. 1979; Shieh, Fl. Taiwan Vol. 1. 2nd ed.: 247. 1980.- *Davallia calvescens* Wall. ex Hook., Sp. Fil. 1: 172. t. 48 B. 1846.- *Microlepia marginalis* var. *calvescens* (Wall. ex Hook.) Bedd., Handb.: 64. 1883.- *Microlepia marginata* var. *calvescens* (Wall. ex Hook.) C. Chr., Ind. Fil.: 208. 1905.- *Microlepia marginata* auct. non (Houtt.) C. Chr.: Holtt., Dansk Bot. Aek 23: 233. 1965.

Rhizome long-creeping, about 4 mm diam.; densely covered with bright blackish-brown hairs, 2 mm long. **Stipe** 2-5 cm apart, stramineous, hairs at base like those on rhizome, minutely pubescent upwards, grooved on upper surface, 75 cm long. **Lamina** oblong-lanceolate, acuminate at apex, 60 cm long, up to 25 cm wide, pinnate to bipinnatifid; rachis grooved on upper surface, densely pubescent throughout, stramineous or darker beneath; lateral pinnae more than 12 pairs, the upper ones gradually reducing in size to from an indistinct apical pinna, the latger ones straight, more or less ascending, linear-lanceolate, gradually narrowing towards long caudate-acuminate apex, distinctly stalked, cuneate anterior and very narowly cuneate posteriorly at base, lobed about halfway or almost completely to costa; costa densely pubesent; lobes oblong, oblique, subfalcate, acute at apex, obscurely waved at margin, up to 1 cm long, 0.6 cm broad; papyraceous, green, glabrous above, veins pinnate, main veins usually zig-zag. **Sori** terminal on veinlets, 1-1.5 mm from the margin of lobes; indusia cup-shaped, hairy (Figure 5.23).

Thailand.- NORTHERN: Chiang Rai, Chiang Mai (Doi Suthep, Mae Raem), Lampang, Phitsanulok (Thung Salaeng Luang, Salaeng Haeng); NORTH-EASTERN: Phetchabun (Phu Miang, Lom Kao), Loei (Phu Luang, Phu Kradung); SOUTH-WESTERN: Kanchanaburi (Klang Dong); PENINSULAR: Phangnga (Khao Bangto).

Distribution.- E. Himalaya (type), Upper Myanmar, China (Yunnan & Kwangsi), Taiwan and Vietnam; also recorded from Indonesia.

Ecology.- Terrestrial on rather dry slopes in hill evergreen forest at 1600 m alt.

Specimens examined.- *W. Rattanathirakul* 59; *T. Boonkerd* 247, 1116 (BCU): *M. Tagawa* T 3941; *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 629 (BKF).

2. *Microlepia herbacea* Ching & C. Chr. ex C. Chr. & Tardieu, Not. Syst. 6: 6. pl. 1. f. 1-2. 1937; Tagawa & K. Iwats., Fl. Thailand 3(1): 115. f. 8: 1. 1979.- *Microlepia trichosora* Ching, Fl. Reip. Pop. Sin. 2: 358. 1959.- *Microlepia herbacea* var. *trichosora* (Ching) Serizawa, J. Jap. Bot. 47: 46. 1972.

Rhizome long-creeping, densely covered with stiff blackish brown hairs, about 4 mm diam. **Stipe** stramineous, densely hairy at base, glabrescent or minutely pobescent above, up to 50 cm long. **Lamina** oblong-lanceolate, gradually narrowing towards attenuately acuminate apex, round or cuneate at base, bipinnate, about 60 cm long, 40 cm wide; rachis stramineous, distinctly grooved on the upper surface, densely hirsute throughout; lateral pinnae usually more than 10 in pairs, upper ones gradually reducing in size not forming a distinct apical pinna, larger ones distinctly stalked, straight or subfalcate, ascending, pinnate, lanceolate, gradually narrowing towards caudately acuminate apex, broadly cuneate at base, up to 28 long, 4 cm wide; costa grooved, densely pubescent; pinnules oblong or roundly quadrangular, round or moderately acute at apex, cuneate at sessile base, lobed to 1/3 way to costule, the larger ones 2.5 cm long, 1 cm wide; ultimate lobes quadrangular. Round or obtuse at apex, with a few distinct teeth at margin, sinus very narrow; herbaceous, green, glabrous except the underside of veins. **Sori** terminal on basal acroscopic veinlets, at bottom of sinus between lobes, small; indusia cup-shaped, hairy (Figure 5.24).

Thailand.- NORTHERN: Chiang Rai (Doi Tung), Chiang Mai (Doi Inthanon); NORTH-EASTERN: Phetchabun (Phu Miang), Loei (Phu Luang, Phu Kradung); SOUTH-WESTERN: Kanchanaburi (Klang Dong); CENTRAL: Nakhon Nayok (Khao Yai).

Distribution.- Vietnam (type); Ching notes that this probably grows in Kwangsi and Hainan.

Ecology.- Terrestrial on rather dry slopes with humus in hill evergreen forest *at 1500 m alt.*

Specimens examined.- *W. Rattanathirakul* 20; *T. Boonkerd* 450, 649 (BCU): *K. Iwatsuki* and *N. Fukuoka* T 7409; *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 591 (BKF).

3. *Microlepia hookeriana* (Wall. ex Hook.) C. Presl, Epim.: 95. 1849; Tagawa & K. Iwats., Fl. Thailand 3(1): 113. f. 7: 1-2. 1979; Shieh, Fl. Taiwan Vol. 1. 2nd ed.: 248. 1980.- *Davallia hookeriana* Wall. ex Hook., Sp. Fil. 1: 172. t. 47 B. 1846; *Scyphularia hookeriana* (Wall. ex Hook.) J. Smith, Hist. Fil.: 261. 1875.

Rhizome long-creeping, densely covered with setose bright brown hairs, about 2 mm long, 3-5 mm in diam. **Stipe** 2-5 cm apart erect, 20-35 long, stramineous or darker, densely covered with hairs like those on rhizome but shorter, more or less grooved on the upper surface. **Lamina** pinnate, gradually narrowing towards acuminate apex, narrowly oblong, up to 40 cm long, 15 cm wide; rachis like the upper parts of stipes, distinctly grooved on the upper surface and densely hairy throughout; lateral pinnae usually more than 25 pairs, close except for a few lower ones which are somewhat shorter, remote and deflexed, all sessile, linear, slightly falcate, gradually narrowing towards acute apex, serrate at margin, broadly cuneate posteriorly and auricled anteriorly at base, 8 cm long, 1.2 cm broad; terminal pinnae distinct, gradually narrowing upwards, up to 15 cm long; herbaceous, deep green, veins once forked, hairy on veins beneath and on both surfaces of costa. **Sori** terminal on veinlets, at margin of pinnae; indusia cup-shaped, less than 1 mm broad, 0.5 mm long, glabrous.

Thailand.- NORTHERN: Chiang Rai (Doi Phacho); NORTH-EASTERN: Loei (Phu Luang, Phu Kradung); EASTERN: Nakhon Ratchasima (Khao Laem); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); PENINSULAR: Phangnga (Khao Bangto), Nakhon Si Thammarat (Klong Luang).

Distribution.- E. Himalaya (type) and Upper Myanmar to S. China, Tonkin, Taiwan and Ryukyus, southwards to Borneo, Sumatra and Indonesia.

Ecology.- Terrestrial on rather dry ground in shade in hill evergreen forest at 1300 m alt.

Specimens examined.- *W. Rattanathirakul* 140; *T. Boonkerd* 1112 (BCU): *E. Hennipman* 3933; *K. Iwatsuki* and *N. Fukuoka* T 3693, *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 610 (BKF).

4. ***Microlepia platyphylla*** (D. Don) J. Sm., Lond. J. Bot. 1: 472. 1842; Tagawa & K. Iwats., Fl. Thailand 3(1): 121. f. 8: 5. 1979; Shieh, Fl. Taiwan Vol. 1. 2nd ed.: 250. 1980.- *Davallia platyphylla* Don, Prod. Fl. Nepal.: 10. 1825.

Rhizome creeping, very sthick, the apex densely covered with hairs. **Stipe** thick, stramineous, glabrous throughout, up to 1 m long. **Lamina** very large, bipinnate, subtriangular in outline, 100-130 cm long; rachis like the upper part of stipe, glabrous; lateral pinnae remote from each other, the upper ones gradually reducing in size, the larger ones distinctly stalked, oblong-subtriangular, caudate-acuminate at apex, up to 40 cm long, 30 cm wide; costae grooved on the upper surface, hairy in grooves; larger pinnules linear-subtriangular, gradually narrowing towards long-caudate apex, the base unequally cuneate and with the stalk more than 1.5 cm in length, more than 18 cm long, 2-4 cm wide; costules distinct and naked on the underside, indistinct on lower surface, both surfaces of segments glabrous, green, chartaceous. **Sori** terminal on veinlets, each in a marginal dentation, a little inside the margin; indusia shallowly cup-shaped, glabrous.

Thailand.- NORTHERN: Chiang Mai (Kong San, Doi Chiang Dao, Doi Suthep), Lamphun (Doi Khun Tan).

Distribution.- Ceylon, Himalaya (type) to SW.. China, Taiwan, Indochina and Philippines.

Ecology.- Terrestrial on rather dry slopes in hill evergreen forest at 1300 m alt.

Vernacular.- Hora khao nua (โหราเขาเนื้อ), Hora phak kut (โหราผักกูด) (Central); Hora hkao krabu (โหราเขากระบือ) (South-western).

Specimens examined.- *W. Rattanathirakul* 190; *T. Boonkerd* 722, 1357 (BCU): *E. Hennipman* 3240; *K. Iwatsuki* and *N. Fukuoka* T 4492 (BKF).

5. ***Microlepia puberula*** v. A. v. R., Jard. Bot. Buit, II. 11: 17. 1913; Holttum, Rev. Fl. Malaya 2: 312. f. 179. 1955; Tagawa & K. Iwats., Fl. Thailand 3(1): 120. f. 8: 3. 1979.

Rhizome creeping, thick, densely hairy at apex, glabrescent in the other part. **Stipe** stramineous, up to 100 cm long, almost glabrous throughout. **Lamina** bipinnate-tripinnatisect, oblong-subtriangular or oblong with moderately acute apex, up to 100 cm long 50 cm wide; rachis stramineous or brown, grooved on the upper surface, rather densely pubescent on the upper portion; lateral pinnae less than 10 pairs, upper ones gradually reduced in size, the basal largest ones oblong-

subtriangular, gradually narrowing towards caudately acuminate apex, distinctly stalked at base, up to 45 cm long, 15 cm wide; costae like the upper parts of rachis, densely hairy throughout; larger pinnules oblong-subtriangular, long caudate at apex, unequally cuneate at base, basal acroscopic lobes large, basiscopic ones smaller than the next anterior ones, pinnatisect, stalked at base 7 by 2 cm; costules densely hairy on both surfaces; ultimate lobes oblong, oblique or spatulate in larger ones, entire or obscurely undulate at margin, round at apex; veins rather distinct and hairy below, less so above, green, papyraceous to chartaceous, hairy on the under surface of laminar parts. **Sori** at or a little within the margin of lobes; indusia shallowly cup-shaped, hairy (Figure 5.25)

Thailand.- NORTHERN: Chiang Mai (Doi Suthep); SOUTH-WASTERN: Kanchanaburi (Song Tho); PENINSULAR: Yala (Betong).

Distribution.- W. Malesia.

Ecology.- Terrestrial on rather dry slopes in hill evergreen forest at 1600 m alt.

Specimens examined.- *W. Rattanathirakul* 48; *Y. Yuyen* 154 (BCU): *J.F. Maxwell* 87-939, 95-939 (BKF).

6. *Microlepia strigosa* (Thunb.) C. Presl, Epim.: 95. 1849; Holttum, Rev. Fl. Malaya 2: 310. f. 177. 1955; Bedd., Handb.: 67.1969; Tagawa & K. Iwats., Fl. Thailand 3(1): 116. f. 8: 2. 1979; Shieh, Fl. Taiwan Vol. 1. 2nd ed.: 251. 1980.- *Trichomanes strigosum* Thunb., Fl. Jap.: 339. 1784.

Rhizome wide creeping, about 5 mm diam.; densely covered with yellow brown setose hairs, about 2 mm long. **Stipe** stramineous or brownish, densely pubsecent, especially in the grooves on upper surface or glabrescent in older ones, up to 50 cm long. **Lamina** bipinnate, or tripinnatifid in larger frond, 75 cm long, 25 cm wide, ovate-oblong to oblong-lanceolate, acuminate at apex; rachis like the upper part of stipe, distinctly grooved on upperside, the grove not jointed to that of pinna-rachis, densely pubescent below; lateral pinnae sometimes more than 20 pairs, few lower ones a little reduced or not, the upper ones gradually reducing in size, the largest ones straight, ascending, distinctly stalked, linear-subtriangular, gradually narrowing toward long-caudate acuminate apex, cuneate at base, up to 28 cm long, 4 cm wide; the largest pinnuals oblong to oblong-subdeltoid; oblique, moderately acute at apex, subtruncate anteriorly and very narrowly cuneate posteriorly at base, deeply lobed to pinnatisect, up to 2.5 cm long, 1 cm wide, sessile or petiolulate; ultimate lobes round to spatuliform, obscurely undulate at margin; veins pinnate, veinlets forked, distinct on undersurface of lobes, paler, hairy, softly chartaceous; deep green above, glabrous

except on veins. **Sori** between the crenae of lobes, submarginal; indusia rather broadly cup-shaped, small, less than 1 mm broad, hairy.

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

Distribution.-Himalaya to Ceylon and Polynesia, northwards to Japan (type).

Ecology.- Terrestrial on mountain slopes usually in hill evergreen forest at 1600 m alt.

Specimens examined.- *W. Rattanathirakul* 15; *T. Boonkerd* 693, 710 (BCU): *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 3013 (BKF).

2. PTERIDIUM

Gled. ex Scopoli, Fl. Carn. ed. 1.: 169. 1760; Tagawa & K. Iwats., Fl. Thailand 3(1): 125. 1979.

Rhizome long-creeping, deep in earth, hairy. **Lamina** tripinnate to quadripinnatifid at base, the apex growing for a considerable period; axes grooved, the grooves decurrent to those in the next higher order; veins all free except for the soral commissure. **Sori** submarginal, linear; indusia formed in two parts, the thin reflexed edge of the leaflets and thin membrane attached just below the receptacle.

Pteridium aquilinum var. ***wightianum*** (J. Agardh) R.M. Tryon, Rhodosa 43: 22. pl. 650. f. 1& pl. 651. f. 3. Map 2. 1941; Tagawa & K. Iwats., Fl. Thailand 3(1): 125. f. 9: 5, 7. 1979.- *Pteris recurvata* Wall. ex J. Agardh var. *wightiana* J. Agardh, Rec. Pterid.: 50. 1839.- *Pteridium aquilinum* (L.) Kuhn in Deck., Reis. Ost.-Afr. 3(3): 11. 1879; Holttum, Rev. Fl. Malaya 2: 389. f. 225. 1955.

Rhizome long-creeping, covered with fine pale brown hairs. **Stipe** more than 1 m long, thick, dark brown to black in hypogeal parts, stramineous upwards, densely covered with pale brown hairs. **Lamina** tripinnate to quadripinnatifid at base, the apex growing for a considerable period, up to 1 m or more both in length and width; rachis, costae and costules grooved on upper surface, the grooves decurrent to those in the next higher order; basal pair of pinnae larger, almost comparable with rest of lamina in size, up to 90 cm long, 45 cm wide, or rather narrower; ultimate leaflets small and narrow, subcoriaceous, usually covered with pale brown hairs, veins free, forked, raised beneath, hairy. **Sori** linear, submarginal, the apices of veins jointed by vascular commissure, thus froming long continuous receptacle; indusia formed in two parts,

one consisting of the thin reflexed edge of the leaflets, the other thin, almost transparent membrane attached just below the receptacles (Figure 5.26).

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

Distribution.- Himalaya to Malesia and Taiwan.

Ecology.- Usually growing in open areas in hill evergreen forest at 1500 m alt.

Vernacular.- Kut kia (กูดเกี๊ยะ) (Northern); Chon (โชน) Chon Yai (โชนใหญ่) (Peninsular); Lue-san (ลือซัน) (Malay/Peninsular).

Specimens examined.- *W. Rattanathirakul* 174; *T. Boonkerd* 463, 1362 (BCU).

DICKSONIACEAE

(C. Presl) Bower, Origin Land Fl. 591-595. 1908; Devol, Fl. Taiwan Vol. 1. 2nd ed.: 131. 1980.

Tree ferns with tall stout trunks or prostrate rhizomes, covered with a mass of hair, **Stipe** not articulate to rhizome. **Lamina** large, tripinnatifid; veins free. **Sori** marginal or submarginal, terminal on veinlet; indusia 2 lobed, outer lobe a continuation of the leaf margin and bent at about right angles to leaf surface.

CIBOTIUM

Kaulf., Enum.: 229. 1824; Tagawa & K. Iwats., Fl. Thailand 3(1): 109. 1979.

Rhizome massive, densely covered with golden yellow long hairs. **Stipe** stout, not jointed to rhizome, densely hairy at base; **Lamina** very large, more than 3 m tall including stipe, pinnately decompound; ultimate segments acute at apex; veins forked forked, all free. **Sori** terminal on veins submarginal, protected by two indusia.

Cibotium barometz J. Sm., Lond. J. Bot. 1: 437. 1842; Holttum, Rev. Fl. Malaya 2: 114. f. 45. 1955; in Fl. Mal. II. 1(2): 165. f. 33. a-c. 1963; Bedd., Handb.: 24. f. 8. 1969; Tagawa & K. Iwats., Fl. Thailand 3(1): 109. f. 6: 8-10. 1979; Devol, Fl. Taiwan Vol. 1.2nd ed.: 131. 1980.- *Polypodium barometz* L., Sp. Pl.: 1092. 1753.

Rhizome massive, prostrate, very densely covered with golden yellow hairs. **Stipe** thick, sometimes attaining to 2 cm diam., more than 1.5 m long in larger ones, densely covered with shining, golden yellow, long (more than 4 cm long in some largee ones), slender or warty hairs at base, the hairs on upper parts not so dense, brown to darker, setose, gradually becoming shorter upwards. **Lamina** large, up to 130 cm long, more than 1 m in wide, bipinnate; pinnae many, the largest ones up to 70 cm long, 25 cm wide, with numerous pinnules; pinnules deeply pinnatifid throughout, very short stalked or subsessile at posterior parts of pinnae, linear-lanceolate, gradually narrowing towards acuminate apex, broadly cuneate to subtruncate at base, 15 cm long, 2.5 cm wide; ultimate segment oblong, oblique to subfalcate, acute at apex, shallowly but distinctly dentate at margin, glaucous in lower surface, 0.8-1.5 cm long, about 3 mm broad, with intervals of 5 mm between the adjacent costules; costae and costules covered with pale, entangled, flaccid, appressed hairs below; veins distinct, once (or twice in larger lobes) forked, sparsely hairy below. **Sori** terminal on usually unbranched lower veins, parallel to edge of lobes, protected by two indusia; outer indusia round, inner ones elongate at maturity, oblong (Figure 5.27).

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

Distribution.- Himalaya to S. China and Taiwan, south to W. Malesia, north to the Ryukyus.

Ecology.- On open hill slope and stream banks in hill evergreen forest at 1350 m alt.

Vernacular.- Kut phipa (กูดผีป่า), Kut phan (กูดพาน) (Northern); Khon kai noi (ขนไก่น้อย) (Northern-eastern); Hatsadaeng (หัสแดง) (Eastern); La-ong faifa (ละอองไฟฟ้า), Wan kai noi (ว่านไก่น้อย) (Central); Kut sua (กูดเสือ), Pho si (โพสี), Ninla phosi (นิลโพสี) (Peninsular).

Uses.- Locally used for medicine, especially silky hairs on buds used as stypties.

Specimens examined.- *W. Rattanathirakul* 175; *T. Boonkerd* 53, 67, 1300 (BCU).

LINDSAEACEAE

Pic. Serm., Webbia 24(2): 707-708. 1970; Shieh, Fl. Taiwan Vol. 1.2nd ed.: 249. 1980.

Terrestrial or climbing. **Rhizome** creeping, clothed with narrow scales or with hairs. **Lamina** 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 or joined to form a fusion-sori (coensori) of varying lengths, indusium always present, attached on the basal side of the sorus and opening toward the margin.

LINDSAEA

Dryand., Trans. L. Soc. 3: 39. 1797; Tagawa & K. Iwats., Fl. Thailand 3(1): 129. 1979.-*Isoloma* J. Smith, J. Bot. 3: 414. 1841.

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

Lindsaea ensifolia SW.., Schard. J. Bot. 1800(2): 77. 1801; Tagawa & K. Iwats., Fl. Thailand 3(1): 131. 1979.- *Schizoloma ensifolium* (SW..) J. Smith, J. Bot. 3: 414. 1841; Holttum, Rev. Fl. Malaya 2: 346. f. 200. 1955; Bedd., Handb.: 80. f. 41. 1969.- *Lindsaea griffithianum* Hook., Sp. Fil. 1: 219. t. 68B. 1846.- *Schizoloma griffithianum* (Hook.) Fée, Gen. Fil.: 108. 1852.- *Diplazium bantamense* auct. non Blume.: Christ, Bot. Tidsskr. 24: 108. 1901.

Rhizome creeping, bearing fronds close together or up to 2 cm part, brown to darker, scaly at least apically; scales linear, up to 2.5 mm long, 0.3 mm broad, brown, slightly shining. Stipe stramineous or castaneous at least at base, 24 cm long. **Lamina** simply pinnate, ovate to oblong-lanceolate in outline, lateral pinnae 3-6 pairs, linear-lanceolate, caudately acuminate at apex, cuneate, rounded or subtruncate at base, very shortly stalked, entire at margin, up to 17 cm long, 2 cm broad, rather variable, smaller ones about 5 mm broad; terminal pinnae like lateral ones, subcoriaceous; veins anastomosing forming 2-4 rows of areoles at each side of costa, distinct beneath. **Sori** continuos along margin; indusia firm, nearly reaching the edges (Figure 5.28).

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

Distribution.- Old World tropics from W. Africa (type from Mauritus) to Australia and Polynesia, north to the Ryukyus.

Ecology.- Terrestrial on rather dry slopes, usually in open areas or in light shade in hill evergreen forest at 1300 m alt.

Vernacular.- Hang nok kaling (หางนกกระลิง) (Central).

Specimens examined.- *W. Rattanathirakul* 200, *T. Boonkerd* 116, 1261, 1304 (BCU).

ORDER CYATHEALES

CYATHEACEAE

Kaulf., Wesen Farrenkr. 119. 1827; Holttum, Rev. Fl. Malaya 2: 115. 1955.

Terrestrial tree frens; stem erect, forming a massive trunk in most species, when old cover with a mat of interlacing roots; apex of trunk and base of stipe more or less densely with scale. **Stipe** scaly at least nears the base. **Lamina** large, usually bipinnate and more or less deeply bipinnatifid; costules of pinnulate-lobes nearly at right angles to the costae; veins strictly pinnate, simple or forked. **Sori** one 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.

CYATHEA

J. E. Smith, Mém. Acad. Turin. 5. 416. 1793; Tagawa & K. Iwats., Fl. Thailand 3(1): 101. 1979.- *Gymnosphaera* Bl., En. Pl. Jav.: 242. 1828.- *Sphaeropteris* Bernh., Schrad. J. Bot. 1800(2): 122. 1801.- *Alsophila* R. Br., Prod.: 158. 1810.

Terrestrial tree ferns; stem erect, tall, to 10 m or more in height, scaly, bearing rosette of fronds at apex; fronds usually larger, bearing both scales and hairs, pinnately compound, vein usually free; sori round, dorsal on veinlets, on distinct receptacle; indusia distinct or wanting.

Key to the species

1. Sori without indusia, stipe not warty and covered throughout by copious spreading scales, stipe and rachis brownish **1. C. gigantea**
1. Sori with indusia, stipe warty and short spiny at base, upper part of stipe and rachis pale or stramineous **2. C. latebrosa**

1. *Cyathea gigantea* (Wall. ex Hook.) Holttum, Gard. Bull. S. S. 8: 318. 1935; Holttum, Rev. Fl. Malaya 2: 128. f. 53. 1955; Fl. Mal. II 1: 124.1963; Tagawa & K. Iwats., Fl. Thailand 3(1): 105. 1979.-*Alsophila gigantea* Wall. ex Hook., Sp. Fil. 1: 53. 1844.- *Alsophila glabra* auct. non. (Bl.) Copel.: Bedd., Handb.: 14. 1883.

Trunk up to 2 m or more tall. **Stipe** up to 50 cm or more long, nearly black or deep castaneous, polished, densely covered with spreading scales; scales up to 2 cm long, 3 mm broad, dark brown to nearly black, shining, stiff, edges ferrugineous, rather broad, pale; pneumathodes small, in a single row, distinct. **Lamina** main rachis castaneous to nearly black, minutely scaly, smooth; pinnae up to 70 cm or more long, 25 cm wide, acuminate at apex; pinna-rachis hairy on upper surface, sparsely warty or scaly beneath, dark at base, paler towards apex; pinnules about 2.5 cm apart, patent or ascending, straight or slightly falcate lanceolate, caudate-acuminate at apex, cordate at base, very shortly stalked, up to 12 cm long, 2 cm wide, lobed to more than 1/3 way towards costae; round at apex, oblique, falcate, serrate at margin, up to 4 mm broad, with narrow sinus; texture thin, papyraceous, green, veins pinnate, veinlets simple, all free. **Sori** close to costule or medial, naked (Figure 5.30, 5.31).

Thailand.- NORTHERN: Chiang Rai (Doi Tung), Chiang Mai (Kang Kaet, Doi Suthep, Doi Inthanon, Fang), Tak (Doi Musoe); NORTH-EASTERN: Loei (Phu Luang); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao, Khao Sabap), Trat (Ko Chang, Ko Kut); SOUTH-WESTERN: Kanchanaburi (Wangka); PENINSULAR: Ranong (Muang Laen, Khao Nom Sao), Surat Thani (Ban Don, Khao Nong, Klong Ton), Phangnga (Takua Pa), Nakhon Si Thammarat (Klong Luang, Chawang Nok Nang), Satun, Yala (Ban Chana).

Distribution.- E. Himalaya (type), S. India, Ceylon, Myanmar, S. China, Indochina, Malaya, Sumatra and W. Indonesia.

Ecology.- On mountain slopes or stream banks in hill evergreen forest at 1350 m alt.

Vernacular.- Maha sadum (มหาสะดำ) (South-eastern); Maha sadaeng (มหาสะแดง) (Peninsular); Kut ngong (กูดโง่ง), Kut yong (กูดโย่ง), Kut hang nok yung (กูดหางนกยูง) (Northern); Khasudo (คาซูโด) (Karen/Northern).

Uses.- Fibrous trunk used for orchid media.

Specimens examined.- *W. Rattanathirakul* 176 (BCU): *E. Hennipman* 3006; *M. Tagawa* T 3844; *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 2432 (BKF).

2. *Cyathea latebrosa* (Wall. ex Hook.) Copel., Philipp. J. Sci. 4: 52. 1909; Holttum, Rev. Fl. Malaya 2: 120. f. 48. 1955; Fl. Mal. II. 1: 115.1963; Tagawa & K. Iwats., Fl. Thailand 3(1): 104. 1979.-*Alsophila latebrosa* Wall. ex Hook., Sp. Fil. 1: 37. 1844; Bedd., Handb.: 11. 1969.

Trunk up to 2-3 m or more tall. **Stipe** up to 40 cm or more long, with very short spines, yellowish brown to darker, scaly at base; scales linear, to 2 cm long, 1.3 mm broad, dark brown, shining, stiff, the edges paler, ferrugineous, soon abraded; pheumathodes in a single row, separated or continuous, smooth, glabrescent or hairy on upper surface. **Lamina** lower pinnae reduced to 10 cm long, irregular in form, rather distant, larger pinnae about 40 cm by 15 cm wide, narrower oblong, caudately acuminate at apex; pinna-rachis warty beneath, hairy and sparsely scaly on upper surface; pinnules more than 25 pairs, larger ones about 2 cm apart, oblong-lanceolate, gradually narrowing towards acuminate apex, subtruncate at base, sessile, up to 10 cm long, 2 cm wide, lobed nearly to costa; lobes oblique, falcate, round at apex, entire or slightly serrate at margin, up to 1 cm long, 3 mm broad; costae hairy on upper surface, costae and costules scale 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 ones simple. **Sori** close to costules; indusia entirely covered by base of sorus; paraphyses longer than sporangia; scales at costular side of receptacles (Figure 5.29).

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

Distribution.- Cambodia, Hainan, Malaya (type), Sumatra and Borneo.

Ecology.- On mountain slopes or stream banks in hill evergreen forest at 1350 m alt.

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

Uses.- Fibrous trunk used for orchid media.

Specimens examined.- *W. Rattanathirakul* 177 (BCU): *M. Tagawa*, *K. Iwatsuki* and *N. Fukuoka* T 4804, T 6814 (BKF).

ORDER PTERIDALES

ADIANTACEAE

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

Terrestrial ferns. **Rhizome** erect, oblique or creeping, clothed with either hairs or narrow brownish scales. **Lamina** unifrom or rarely subdimorphic, 1-4 pinnate or pedate, rarely simple, not articulate to rhizome; veins free or rarely anastomosing without in cluded free veinlets, **Sori** superficial, linear, following the course of veins, exindusiate or close to the margin, protected by reflexed leaf-margin and opening introsely; sporangia developing in mixed sequence.

Key to the genera

1. Sori protected by and borne on reflexed margin of leaflets **1. Adiantum**
1. Sori exindusiate, superficial, following the course of veins **2. Coniogramme**

1. ADIANTUM

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

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

Adiantum philippense L., Sp. Pl. 2: 1094. 1753; Holttum, Rev. Fl. Malaya 2: 598. f. 350. 1955; Bedd., Handb.: 82. f. 43. 1969; Shieh, Fl. Taiwan Vol. 1. 2nd ed.: 306. pl. 106. 1980; Tagawa & K. Iwats., Fl. Thailand 3(2): 211. 1985.- *Adiantum lunulatum* Burm. f., Fl. Ind.: 253. 1768.

Rhizome short, suberect, the apex covered with scales; scales linear, a little broader at base, entire, up to 3 mm long, bicoloured. **Stipe** bright castaneous to black, glabrous or sparsely scaly at basal portion, about 10 cm long; scale on stipe like those on rhizome except in being concolorous brown. **Lamina** linear-lanceolate to oblong, pinnate, up to 10 cm long, 3 cm wide, rachis perfectly glabrous, occasionally prolonged, leafless on upper part, and rooting at tip, more commonly bearing an apical pinna like lateral ones; lateral pinnae large at base, slightly reduced in size upwards, distinctly stalked; stalks usually 1-2 mm long, with an angle of about 60° to rachis; leaflet crescent-shaped, about 1-1.5 by 0.5 cm, in the upper leaflets the lower two edges meeting at stalks to form cuneate base; thin, softly herbaceous, glabrous on both surface; veins a little raised, outer edge of leaflets subentire, crisped or lobed to about 1/4 of breadth of leaflets, sinus narrow, lobes round to subquadrangular, round to truncate at subentire or toothed apex. **Sori** at margin of leaflets, reflexed soral flaps elongate, usually 5 mm long (Figure 5.34).

Thailand.- NORTHERN: Chiang Rai (Doi Tung), Chiang Mai (Fang, Doi Chiang Dao, Mae Klang, Doi Inthanon, Wang Tao, Doi Saket), Mae Hong Son (Mae La Noi, Bo Luang), Lampang (Huai Thak) Lamphun (Doi Khun Tan), Phitsanulok (Thung Salaeng Luang, Kaeng So Pha), Tak (Lan Sang, Ban Musoe, Wang Chao); NORTH-EASTERN: Phetchabun (Phu Miang), Loei (Phu Luang, Phu Kradung); CENTRAL: Nakhon Nayok, Krungthep; SOUTH-EASTERN: Prachin Buri, Chon Buri (Si Racha), Chanthaburi (Khao Sabap); SOUTH-WESTERN: Kanchanaburi (Sai Yok, Wangka, Bang Kasi, Thung Kang Yang Hills, Tha Po); PENINSULAR: Nakhon Si Thammarat (Thung Song).

Distribution.- Throughout the tropics of the Old World (type from Philippines).

Ecology.- On rather dry or muddy crevices of rocks in light shade in hill evergreen forest at 1300 m alt.

Vernacular.- Kut hu khwak (กูดหูดวาก), Hua khwak (หัวขวาก), Ya Khwak (หญ้าขวาก), Phak kachot nu (ผักกระฉอดหนู) (South-eastern); Hang chingcha (หางชิงช้า) (Peninsular).

Specimens examined.- *W. Rattanathirakul* 185; *T. Boonkerd* 441, 1020 (BCU): *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 2366; *M. Tagawa, K. Iwatsuki, H. Koyama* and *A. Chintayungkun* T 8588 (BKF).

2. CONIOGRAMME

Fée, Gen. Fil.: 167. 1852; Tagawa & K. Iwats., Fl. Thailand 3(2): 188. 1985.

Rhizome creeping, scaly; scales basally attached, thin, concolorous, entire. **Stipe** thick, pales green, glabrous. **Lamina** usually large, pinnate to tripinnate; leaflets subentire or serrulate, usually large, herbaceous to softly papyraceous, glabrous or pubescent; veins free, or anastomosing to form areoles without included free veinlets, ending in hydathodes. **Sori** elongate along veins, without indusia.

Coniogramme petelotii Tardieu, Bull. Mus. Paris II. 5: 334. 1933; Tagawa & K. Iwats., Fl. Thailand 3(2): 189. 1985.

Rhizome creeping, up to 8 mm in diam., the apex covered with scales; scales linear, with long tails, 8 mm long, entire, glabrous, concolorously brown. **Stipe** stramineous, a little SW.ollen at scaly base, minutely scaly upwards, 50-65 cm long, grooved on adaxial surface of the upper portion. **Lamina** oblong-oval, to 45 by 25 cm, simply imparipinnate with a few lateral pinnae; rachis scaly, grooved on upper surface; lateral pinnae 2 or 3 pairs, shortly stalked, oblong-lanceolate, falcate, acuminate at apex, cuneate to round at base, entire at margin, up to 23 by 7 cm; apical pinna like the lateral ones, a little larger, cuneate at base; costa distinctly raised on lower surface, shallowly grooved on upper surface, with minute scales; veins parallel, once or twice forked, very rarely reticulate, more or less distinct on upper surface, hydathodes about 1 mm from cartilagineous margin; herbaceous to a little fleshy, green on upper surface, paler beneath, glabrous. **Sori** along veins, from costa to 3/4 to 5/6 way to margin, without indusia (Figure 5.32, 5.33).

Thailand.- NORTHERN: Chiang Mai (Doi Inthanon, Doi Khun Huai Pong).

Distribution.- Yunnan and Tonkin (type).

Ecology.- On wet sandy ground by streams in hill evergreen forest at 1280 m alt.

Specimens examined.- *W. Rattanathirakul* 88 (BCU): *E. Hennipman* 3426; *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 3024 (BKF).

PTERIDACEAE

E.D.M. Kirchn., Schul-Bot. 109. 1831; Shieh, Fl. Taiwan Vol. 1. 2nd ed.: 281. 1980.

Terrestrial ferns. **Rhizome** erect or creeping, clothed with scales. **Lamina** unifrom or subdimorphic, 1-3-pinnate or variously divided, not articulate to rhizome; veins free or anastomousing without included free veinlets. **Sori** round or oblong, borne on distal ends or on the apical parts of veins, or forming continous coenosori borne on the vascular commissure connecting the vein-ends, without true indusium, but protected by the modified and sharply reflexed leaf-margin and opening introrsely.

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 bicoloured with pale ferrugineous edges. **Stipe** rachis and costa distinctly grooved on upper surface, the edges distinct, usually spinose on costa, the grooves decurrent into those in the next Order. **Lamina** in most cases bipinnatisect in opposite pairs, or in some cases simple, pinnate, tripartite, each basal pinna or branch with a pinnatisect or bipinnate branch; pinnatisect pinnae or pinnules usually bearing terminal lobes like the lateral ones or longer; veins pinnate in plan, in some species with costal and costular areoles, the others free except for the soral commissure, basal branch sometimes arising directly from costa. **Sori** continuous along margin of ultimate segments, indusiate; indusia formed by reflexed margin of lobes, usually transparent, glabrous.

Key to the species

1. Pinnae deeply lobed, or each of the lowest pinnae with one or a few branch near base
   2. Stipe shining, castaneous or deeply purplish at least in lowest part
      3. Lateral pinnae 2.5 cm wide, scale concolorously brown, entire **1. P. bella**
      3. Lateral pinnae 4-6 cm wide, with broadly winged stalks **3. P. tokioi**
   2. Stipes stramineous, slightly castaneous to purplish near base **2. P. longipinnula**
1. Pinnae all simple, basal pinnae not branched, lower ones gradually much reduced **4. P. vittata**

1. *Pteris bella* Tagawa, Acta Phytotax. Geobot. 8: 166. 1939; Shieh, Fl. Taiwan Vol. 1. 2nd ed.: 293. 1980; Tagawa & K. Iwats., Fl. Thailand 3(2): 250. f. 19. 3. 1985.

Rhizome erect or ascending, bearing a tufe of frounds at apex, densely scaly; scale up to 6.5 by 0.5 mm, concolorously brown, entire. **Stipe** deep purplish, shining, scaly at base, glabrescent upwards, 50 cm long. **Lamina** oblong with acute apex, deeply bipinnatisect, 30 by 20 cm; rachis shining purple, glabrescent; lateral pinnae 5-6 pairs, opposite, lanceolate, caudately acuminate at apex, slightly narrowing towards subtruncate sessile base, up to 15 by 2.5 cm; costa stramineous, glabrescent; pinnules oblique, round at apex, entire at margin, adnate at base and decurrent to the costa with wings less than 0.5 mm broad, up to 12 by 4 mm, softly papyraceous, green; veins forked, raised beneath. **Sori** marginal, usually less than 7 mm long; indusia pale brown, thin (Figure 5.37).

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

Distribution.- Taiwan (type)

Ecology.- Terrestrial on mountain slopes in hill evergreen forest at 1600 m alt.

Specimens examined.- *W. Rattanathirakul* 21, 41 (BCU): *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 1491, T 4799, T 1281 (BKF).

2. *Pteris longipinnula* Wall. ex J. Agardh., Rec. Pterid.: 19. 1839; Holttum, Rev. Fl. Malaya 2: 404. 1955; Bedd., Handb.: 112. 1969.

Rhizome short, suberect, scaly; scales narrowly elliptic, distinctly bicolored, the central portion dark brown, stiff, up to 4.7 by 0.4 mm, marginal portion pale brown, thin, composed of quadrangular cells and decaying from margin, 0.1 mm broad on each side. Stipe stramineous, slightly castaneous to purplish near base, 70 cm long, slightly grooved above and terete below, glabrous. **Lamina** oblong-ovate to ovate, acute at apex, about 55 by 30 cm, bipinnatisect; rachis hairy in grooves; lateral pinnae 3 pairs, all nearly equal in size and from, ascending, with short stalks 3-10 mm long, elliptic or narrowly so, round to broadly cuneate at base, the base decurrent to stalks, caudate at apex with apical segments up to 25 by 5 mm, up to 25 by 4.5 cm at middle portions; costa green, stramineous in dried specimens, grooved, bearing sparse slender spines; ultimate segments 20-25 pairs, narrowly elliptic, falcate, rounded at apex, up to 50 by 8 mm, the lower basal ones usually longer than upper ones, edges entire or undulate, thickened; veins simple or more commonly forked, basal posterior

ones springing directly from costa. **Sori** linear, along margin of ultimate segments; indusia up to 0.7 mm broad, thin but firm, entire (Figure 5.38).

Thailand.- PENINSULAR: Surat Thani (Ban Don), Yala (Bannang Sata).

Distribution.- S. India, Malesia (type from Malaya). The circumscription and the range of this species are as yet not certain.

Ecology.- On humus-rich mountain slopes in hill evergreen forest at 1300 m alt.

Specimens examined.- *W. Rattanathirakul* 193 (BCU): *K. Iwatsuki, N. Fukuoka, M. Hutoh* and *D. chaiglom* T 10914 (BKF).

3. *Pteris tokioi* Masam., Trans. Nat. Hist. Soc. Formosa 25: 13. 1935; Shieh, Fl. Taiwan Vol. 1. 2nd ed.: 300. 1980; Tagawa & K. Iwats., Fl. Thailand 3(2): 238. f. 19. 2. 1985.- *Pteris excelsa* auct. non Gaud.: Tard. & C. Chr. In Fl. Gen. I.-C. 7(2): 154. 1940.

Rhizome short-creeping, thick, bearing fronds closely, densely scaly at apex; scales shining-brown, concolorous, linear, up to by 0.5 mm, entire. **Stipe** shining, deep castaceous to dark purple, 85 cm long, sparsely hirsute or glabrescent. **Lamina** oblong-ovate, bipinnatifid, 50-60 by 30-40 cm; lateral pinnae 4-6 pairs, opposite, oblong-lanceolate, rounded at base, the base with broadly winged stalked, cordately acuminate at apex, up to 24 by 6 cm, basal ones the largest, each bearing a large deeply lobed basal basiscopic branch just like upper lateral pinnae; ultimate segments narrowly oblong, falcate, rounded at apex, serrate at margin, up to 25 by 10 mm, papyraceous, dark green; vein forked, free except in soral commissure, visible on both surface. **Sori** continuous along margin of segments from base towards apex; indusia pale, thin, entire (Figure 5.35, 5.36).

Thailand.- NORTHERN: Phetchabun (Phu Miang); NORTH-EASTERN: Loei (Phu Luang); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao).

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

Ecology.- On humus-rich mountain slopes in hill evergreen forest at 1600 m alt.

Specimens examined.- *W. Rattanathirakul* 6, 152 (BCU): *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 1324; *K. Iwatsuki* and *N. Fukuoka* T 7190 (BKF).

4. *Pteris vittata* L, Sp. Pl.: 1074. 1753; Holttum, Rev. Fl. Malaya 2: 396. f. 230. 1955; Bedd., Handb.: 4. f. 1.1969; Devol, Fl. Taiwan Vol. 1. 2nd ed.: 300. 1980; Tagawa & K. Iwats., Fl. Thailand 3(2): 233. 1985.- *Pteris longifilia* auct. non Retz.: Bedd., Handb.: 106. f. 55. 1883.

Rhizome short, ascending, bearing a tuft of fronds, scaly; scales light brown, narrow, up to 5 mm long. **Stipe** up to 10 cm long, densely scaly on lower part, stramineous. **Lamina** imparipinnate, oblanceolate, widest at upper 1/6 portion; pinnae simple, lower ones gradually becoming smaller downwards to mere auricles, middle or upper ones linear, nearly straight, up to 12 cm by 0.7 cm, lower ones gradually much reduced, sessile and cordate at base, caudately long-acuminate at apex, serrate at non-soriferous margin; terminal pinnae usually much longer, up to 20 cm or more long, about 1 cm broad; rachis grooved on upper surface, minutely scaly; veins forked, free except when connected by soral commissure. **Sori** marginal, continuous along margin of pinnae; indusia thin, pale (Figure 5.39).

Thailand.- NORTHERN: Chiang Rai (Doi Tung), Chiang Mai (Doi Chiang Dao, Kaeng Ka, Mae Klang), Mae Hong Son (Mae Sariang), Lampang, Tak (Lan Sang, Mae Sot, Doi Musoe); NORTH-EASTERN: Loei (Ban Nong Noen Thong); CENTRAL: Saraburi (Muak Lek); SOUTH-EASTERN: Chanthaburi, Trat (Ko Chang); SOUTH-WESTERN: Kanchanaburi (Sai Yok, Erawan Falls, Song Tho, Chedi Sam Ong); PENINSULAR: Surat Thani (Ban Don), Phatthalung, Nakhon Si Thammarat (Ron Phibun), Phangnga (Thap Put), Songkhla, Trang, Satun, Yala (Bannang Sata).

Distribution.- Tropics and subtropics of the old world (type from China), north to S. Japan.

Ecology.- On rather wet sandy ground in hill evergreen forest at 1300 m alt.

Vernacular.- Kaching duphae (กะจิงดูแพะ) (Karen/Northern); Kut tat (กูดตาด), Kut mak (กูดหมาก) (Northern).

Specimens examined.- *W. Rattanathirakul* 197 (BCU): *M. Tagawa, K. Iwatsuki, H. Koyama* and *A. Chintayungkun* T 8573; *M. Tagawa* and *A.I. Yamada* T 94 (BKF).

VITTARIACEAE

(C. Presl) Ching, Sunyatsenia 5(4): 210, 232. 1940; Devol, Fl. Taiwan Vol. 1. 2nd ed.: 231. 1980.

Small ferns growing suberect or pendent on rocks or tree trunks. **Rhizome** creeping, short; roots covered with a mass of brown hairs; scales clathrate; stipitate or sessile. **Lamina** simple, tufted or approximate, simple, entire, veins anastomosing, forming elongated areoles without included veinlets. **Sori** elongate along margin, or dichotomously forking veins, superficial or more often in soral grooved, paraphyses, filifrom or cub-shaped, simple or branched.

Key to the genera

1. Fronds broadly lanceolate or broader, costa absent, sori usually in more than two rows, elongate along veins, often reticulate **1. Antrophyum**
1. Fronds linear, costa distinct or hardly visible, coenosori borne in two rows being either marginal, submarginal **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. **Lamina** broadly lanceolate or broader, rarely forked at apex; costa wanting or rarely partial; veins forming large elongate areoles without included veinlets. **Sori** elongate along veins, sometimes reticulate.

Antrophyum callifolium Blume, En. Pl, Jav.: 111. 1828; Holttum, Rev. Fl. Malaya 2: 605. f. 356. 1955; Tagawa & K. Iwats., Fl. Thailand 3(2): 221. 1985.- *Antrophyum reticulatum* auct. non (Forst.) Kaulf.: Bedd., Handb.: 401. f. 235. 1883.- *Antrophyum semicostatum* auct. non Bl.: Bonap., Not. Pterid. 14: 63. 1923.- *Antrophyllum* sp.: Holttum, Dansk Bot. Ark. 20: 34. 1961.

Rhizome short-creeping, bearing a few to several fronds in a tuft, scaly; scales narrowly subtriangular, gradually narrowing from base toward long-tailed apex, up to 5 by 0.8 mm, dark brown to blackish, sharply toothed at margin. **Stipe** short, indistinctly merging with the basal portion of frond, scaly. **Lamina** oblong-lanceolate to broadly oblanceolate, gradually narrowing toward acuminate apex, gradually

narrowing downwards, up to 30 by 4 cm, texture papyraceous; pale green; costa distinct only near the base, veins more or less distinct, evenly anastomosing without included veinlets. **Sori** linear, anastomosing along veins, uaually on the whole undersurface except for the lowest middle portion, paraphyses filamentous, long, numerous (Figure 5.40, 5.41).

Thailand.- NORTHERN: Chiang Mai (Doi Suthep, Chiang Mai, Mae Taeng, Lamoo), Tak (Huai Krasa); NORTH-EASTERN: Nong Khai, Loei (Phu Luang, Phu Kradung, Khao Huai Khae); CENTRAL: Nakhon Nayok (Khao Yai, Nang Rong falls); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao, Khao Sabap), Trat (Ko Chang); SOUTH-WESTERN: Kanchanaburi (Khao Sakan, Song Tho); PENINSULAR: Chumphon (Tha Ngo, Langsuan, Tako, Sapli), Surat Thani (Ko Tao, Ban Don, Ko Phangan), Nakhon Si Thammarat (Khiriwong, Khao Luang, Thung Song), Narathiwat (Sg. Padi), Phangnga (Thap Put), Phuket, Trang (Khao Chong), Yala (Bannang Sata).

Distribution.- Widely known from the tropics of the Old World (type from Indonesia), although the exact boundary is not clear.

Ecology.- On mossy tree-trunks in hill evergreen forest at 1250 m alt.

Specimens examined.- *W. Rattanathirakul* 174 (BCU): *E. Hennipman* 3738; *J.F. Maxwell* 86-1012 (BKF).

1. VITTARIA

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

Rhizome short-creeping, densely covered with clathrate scales. **Lamina** linear, simple, entire; 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, dosal or in marginal flaps; paraphyses usually abundant.

Key to the species

1. Sori intramarginal, superficial **1. V. amboinensis**
1. Sori marginal or nearly marginal
   2. Costa more or less distinct on lower surface
      3. Fronds up to 25 cm long, 0.5-0.7 cm broad **2. V. angustifolia**
      3. Fronds up to 30-40 cm long, 1.5 cm broad **3. V. flexuosa**
   2. Costa hardly visible on both surface; sori immersed in grooves **4. V. sikkimensis**

1. ***Vittaria amboinensis*** Fée, 3^{me} Mém.: 14. t. 1. f. 1. 1852; Bedd., Handb.: 407. 1969; Tagawa & K. Iwats., Fl. Thailand 3(2): 226. f. 17. 6. 1985.-*Vittaria scolopendrina* auct. non (Bory) Thwait.: Holttum, Dansk Bot. Ark. 20: 34. 1961.

Rhizome short, about 3 mm diam., bearing a mass of roots, densely scaly throughout; scales subulate at apex, up to 5 by 0.4 mm, dark brown to blackish, clathrate, minutely toothed at margin. **Stipe** distinct, up to 10 cm or longer, dark castaneous on the lower portion, very narrowly winged almost to the very base. **Lamina** liner-lanceolate, gradually narrowing towards acuminate apex, gradually narrowing downwards into wings of stipe, up to 55 cm long including stipe, up to 2 cm or more broad, the margin flat or slightly recurved, coriaceous or thicker; costa distinctly raised on lower surface, distinct on upper surface: veins hidden. **Sori** superficial, submarginal, the submarginal laminar portion less than 1 mm wide, almost throughout the margin of frond except for the apex and lowermost portion (Figure 5.44).

Thailand.- NORTHERN: Chiang Mai (Doi Suthep), Tak (Ban Musoe); NORTH-EASTERN: Loei (Phu Luang, Phu Kradung); EASTERN: Nakhon Ratchasima (Khao Khieo); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); PENINSULAR: Krabi (Phanom Bencha), Trang (Khao Chong).

Distribution.- Sikkim, Myanmar, Indochina, Amboina (type) and Indonesia.

Ecology.- On tree-trunks usually in hill evergreen forest at 1450 m alt.

Specimens examined.- *W. Rattanathirakul* 30 (BCU): *E. Hennipman* 3854; *M. Tagawa, K. Iwatsuki and N. Fukuoka* T 639, T 945, T 1286 (BKF).

2. ***Vittaria angustifolia*** Blume, En. Pl. Jav.: 199. 1828; Holttum, Rev. Fl. Malaya 2: 610. 1955; Tagawa & K. Iwats., Fl. Thailand 3(2): 225. 1985.- *Vittaria ensiformis* auct. non SW..: Tagawa & K. Iwats., Southest As. St. 5: 111. 1967.

Rhizome creeping, usually about 1.5 mm diam., bearing fronds rather sparsely, densely scaly throughout; scales narrow, gradually narrowing from base towards hair-pointed apex, up to 5 by 0.3 cm, fuscous, clathrate, minutely toothed at margin. **Stipe** short, green or dark at the very base. **Lamina** linear, 20-27 cm long, up to 0.7 mm, usually curved and pendulous, acute at apex, gradually narrowing downwards and merging into very narrow wings of stipe, leathery; costa more or less distinct on lower surface, the margin flat or inrolled. **Sori** immersed in deep groove almost at margin of fronds, usually limited to the upper half (Figure 5.42, 5.43).

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 Indonesia), east to New Caledonia.

Ecology.- On mossy tree-trunks in hill evergreen forest at 1600 m alt.

Specimens examined.- *W. Rattanathirakul* 11; *P. Ratchata* 183; *T. Boonkerd* 1091 (BCU).

3. *Vittaria flexuosa* Fée, 3^{me} Mém.: 16. 1852; Rev. Fl. Malaya 2: 611. 1955; Devol, Fl. Taiwan Vol. 1. 2nd ed.: 237. pl. 84. 1980; Tagawa & K. Iwats., Fl. Thailand 3(2): 225. 1985.- *Vittaria lineata* auct. non SW..: Bedd., Handb.: 407. 1883.

Rhizome short, up to 4 mm diam., bearing close fronds, densely scaly; scales linear, gradually narrowing towards hair-pointed apex, up to 5 by 0.5 mm, brown to dark brown, clathrate, minutely toothed at margin. **Stipe** narrowly winged throughout, dark at very base. **Lamina** linear, usually inrolled at margin in dried condition, 30 by 1.5 cm, gradually narrowing towards long-tailed apex, gradually narrowly downwards into the narrow wings of stipe; costa strongly raised to the apex on lower surface, indistinct on upper surface, pale. **Sori** in submarginal grooves usually at usually at 1/5-1/4 way from margin to midrib, sometimes not wholly immersed, usually on upper half of frond except the very apex (Figure 5.47).

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

Distribution.- E. Himalaya (type) to SW.. and S. China and Indochina, north to Japan, south to Malaya.

Ecology.- On tree-trunks or moist rocks usually in hill evergreen forest at 1250 m alt.

Specimens examined.- *W. Rattanathirakul* 164; *T. Boonkerd* 1143, 1408 (BCU): *K. Iwatsuki* and *N. Fukuoka* T 3190; *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 1494 (BKF).

4. *Vittaria sikkimensis* Kuhn, Linnaea 36: 66. 1869; Bedd., Handb.: 406. f. 239. 1969; Tagawa & K. Iwats., Fl. Thailand 3(2): 224. f. 17. 5. 1985.

Rhizome short-creeping, slender, bearing many fronds successively, densely scaly throughout; scales linear, gradually narrowing towards hair-pointed apex, up to 3 by 0.2 mm, greyish-brown, clathrate, toothed at margin. **Stipe** indistinct, green to darker, winged throughout. **Lamina** simple, very narrow, broadest in upper part, gradually narrowing towards acute apex, narrowing downwards, up to 12 cm long, up to 1.3 mm broad, thinly coriaceous; costa indistinct, the margin flat or a little inrolled; veins anastomosing to from narrow areoles. **Sori** immersed in distinct groove near the margin of fronds, occupying almost the whole margin except very top and lowest portion (Figure 5.45, 5.46).

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

Distribution.- Sikkim (type), Yunnan and Tonkin.

Ecology.- On moist rocks in hill evergreen forest at 1500 m alt.

Specimens examined.- *W. Rattanathirakul* 33 (BCU): *T. Shimizu*, *M. Hutohi* and *D. Chaiglom* T 8947; *T. Shimizu*, *K. Iwatsuki*, *N. Fukuoka*, *M. Hutoh*, *D. Chaiglom* and *A. Nalampoon* T 11440 (BKF).

ORDER BLECHNALES

ASPLENIACEAE

Newman, Hist. Brit. Ferns 6. 1840; Devol and Kuo, Fl. Taiwan Vol. 1. 2nd ed.: 476. 1980.

Terrestrial, lithophyte or epiphytic. **Rhizome** creeping or erect; scale usually clathrate, narrowly lanceolate, dark brown to black. **Lamina** simple, pinnate to decompound. **Stipe** not articulate to rhizome, with two vascular strands at base of stipes; venation free and forking. **Sori** linear, borne on side of a veinlet; indusia linear, narrow.

ASPLENIUM

L., Sp. Pl.: 1078. 1753; Tagawa & K. Iwats., Fl. Thailand 3(3): 261. 1988.

Rhizome short, erect or long-creeping; scales clathrate, glabrous. **Lamina** 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.

Key to the species

1. Frond simple
   2. Veins all free
      3. Midrib distinctly raised on both surfaces, veins with angles of less than 30° to midrib, undersurface of lamina without scales **3. A. ensiforme**
      3. Midrib raised below, flat above, veins with angles of 70-80° to midrib, undersurface of lamina covered with small scales
         4. Frond linear, up to 2 cm broad, with shallow serration at margin at least in upper part or subentire, midrib raised on under surface, flat above, veins with angles of 70-80° to midrib **12. A. scortechinii**
         4. Frond lanceolate, up to 3 cm broad, with undulate at margin, midrib raised on upper surface, flat below, veins with angles of 40-50° to midrib **13. A. sp. 1**
   2. Veins anastomosing at margin, joining the apices of veinlets
      5. Frond up to 20 cm or more broad, sori extending from near midrib half-way to margin **5. A. nidus**
      5. Frond up to 7 cm broad, sori reaching more than half-way to margin **11. A. phyllitidis**
1. Frond pinnate or more compound
   6. Rhizome long-creeping, pinnae subdimidiate at acroscopic base
      7. Stipe and rachis dull grey-green, not polished. Sori short, usually up to 3 mm long **7. A. obscurum**
      7. Stipe and rachis purple, polished
         8. Sori up to 2 mm long, confined to lobes **1. A. cheilosorum**
         8. Sori more than 2.5 mm long, on middle or basal part of veins **4. A. excisum**
   6. Rhizome short, creeping, ascending or erect
      9. Frond pinnate
         10. Midrib of pinna not grooved above but usually raised **6. A. normale**
         10. Midrib of pinna grooved above

11. Lower pinnae extremely reduced, less than half as long as middle ones **9. A. pellucidum**
11. Lower pinnae not or only slightly reduced
    12. Pinnae less than 15 pairs, pinnae entire or slightly undulate; rachis proliferous **8. A. paradoxum**
    12. Pinnae up to 30 pairs, rachis not proliferous
        13. Pinnae shortly stalked, toothed at margin **15. A. sp. 2**
        13. Pinnae stalked, lobed usually to half-way
            14. Stipe and rachis dark green to brownish, not polished; scales entire, narrow, subulate **13. A. yoshinagae**
            14. Stipe and rachis nearly black, polished or paler; scales gradually narrowing from base towards hair-pointed apex **10. A. perakense**
9. Frond tripinnatifid, Stipe purplish to nearly black, shining; not gemmiferous **2. A. confusum**

1. *Asplenium cheilosorum* Kunze ex Mett., Abhandl. Senckenb. Naturf. Ges. 3: 177. t. 5. f. 12-13. 1859; Holttum, Rev. Fl. Malaya 2: 435. f. 253. 1955; Bedd., Handb.: 153. f. 77. 1969; Devol and Kuo, Fl. Taiwan Vol. 1. 2nd ed.: 481. 1980; Tagawa & K. Iwats., Fl. Thailand 3(2): 279. f. 22. 2. 1985.- *Asplenium heterocarpum* Wall. ex Hook., Sp. Fil. 3: 132. t. 175. 1860.

Rhizome long-creeping, bearing two rows of alternate fronds closely on dosal surface, scaly near apex; scales gradually narrowing from base towards long, hairy apex, up to 3 by 0.3 mm, clathrate, sometimes the cell-walls very thick. **Stipe** 24 cm long, purple, polished but dirty on the lower portion, more or less warty on upper portion; rachis similarly colored, glabrous, grooved above. **Lamina** pinnate, narrowly lanceolate in outline, subtruncate at base, attenuately acuminate at apex, up to 50 by up to 4.5 cm; pinnae up to 40 or more pairs, subquadrangular, dimidiate, the lower half very narrow, thus the midrib close to entire lower margin, round at apex, trincate at acroscopic base, lobed to 1/5 way on upper margin, lobes rounded or forked at apex, about 1 mm broad, usually a lobe placed on each apical portion of lower margin, up to 25 by 8 mm, a few lower pairs slightly reduced or reflexed, shortly stalked, thin, pale green; veins distinct, all free. **Sori** confined to lobes, one or rarely two on each lobe, 1.5-2 mm long; indusia thin, opening outwardly (Figure 5.48).

Thailand.- NORTHERN: Chiang Rai (Doi Phacho), Chiang Mai (Doi Suthep, Doi Inthanon, Doi Hua Mot), Mae Hong Son (Mae La Noi), Phetchabun (Phu Miang);

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

Distribution.- Ceylon (type), S. India, E. Himalaya, S. China, Myanmar, Indochina, Malaya, Borneo, Philippines, Taiwan and north to southern edge of Japan.

Ecology.- On moist muddy rocks or terrestrial on wet sandy slopes usually along streams in hill evergreen forest at 1550 m alt.

Specimens examined.- *W. Rattanathirakul* 70 (BCU): *E. Hennipman* 3433, *M. Tagawa*, *K. Iwatsuki* and *N. Fukuoka* T 2667; *K. Iwatsuki* and *N. Fukuoka* T 3690 (BKF).

2. *Asplenium confusum* Tardieu & Ching, Not. Syst. 5: 148. pl. 4. f. 3. pl. 7. 1936; Tagawa & K. Iwats., Fl. Thailand 3(2): 289. 1985.- *Asplenium laserpitiiforme* auct. non Lamk.: Christ, Bot. Tidsskr. 24: 107. 1901.

Rhizome short, ascending, densely scaly; scales narrow, gradually narrowing towards hair-pointed apex, about 14 by 0.8 mm, entire, greyish to dark brown, crisped. **Stipe** about 35 cm long, dark stramineous to polished dark purple or nearly black, grooved above. **Lamina** tripinnate, elliptic to oblong- subtriangular, acuminate, 30-40 by 10-18 cm; rachis glabrous, grooved; lower pinnae 2-5 cm from the next ones, ascending, oblong-subtriangular, cuneate to subtruncate at base, gradually narrowing and bending up towards caudately acuminate apex, stalked, 10-12 by up to 4 cm; larger pinnules stalked, oblong- subtriangular, acute at apex, cuneate at base, pinnatifid to pinnate, up to 3 by 1.5 cm; ultimate segments (or secondary pinnules) spathulate, rounded and tooth at apex, cuneate and sessile at base, up to 10 by 5 mm, sometimes lobed to half-way, papyraceous to coriaceous; veins raised on both surfaces. **Sori** up to 6 mm long, usually nearly to midrib, close together but rarely confuent; indusia thin but firm, persistent (Figure 5.49).

Thailand.- NORTHERN: Phitsanulok (Thung Salaeng Luang), Tak (Mae Sot, Huai Krasa); NORTH-EASTERN: Loei (Phu Luang, Phu Kradung); CENTRAL: 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: Chumphon (Ban Krayae), Surat Thani (Ko Tao, Khlong Bakatae, Ko Samui, Ban Don), Phangnga (Pulao Tiban).

Distribution.- Indochina (type).

Ecology.- On mossy tree-trunks or often on root mass of *Asplenium nidus* in hill evergreen forest at 1400 m alt.

Vernacular.- Kraprok hang maeo (กะปรอกหางแมว) (South-eastern).

Specimens examined.- *W. Rattanathirakul* 103 (BCU): *E. Hennipman* 3974, 3684, *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 604 (BKF).

3. *Asplenium ensiforme* Wall. ex Hook. & Grev., Ic. Fil.: t. 71. 1829; Bedd., Handb.: 141. f. 71. 1969; Devol and Kuo, Fl. Taiwan Vol. 1. 2nd ed.: 482. pl. 168. 1980; Tagawa & K. Iwats., Fl. Thailand 3(2): 266. 1985.

Rhizome short, suberect, bearing fronds in a tuft, scaly at apex; scales gradually narrowing from base towards apex, dark brown, paler near margin, about 7.5 by 1.2 mm at base, entire, more or less clathrate. **Stipe** dark, indistinct from lamina, narrowly winged nearly to the base. **Lamina** simple, entire or rarely irregularly waved at margin, spathulate, broadest in upper quarter, narrowing towards caudately acuminate apex, gradually narrowing and attenuate at base, about 40 by 2.5 cm, subcoriaceous, glabrous; midrib distinctly raised on both surfaces, grooved on upper surface; lateral veins ascending, forming angles of about 20° to midrib, forked near base, visible on lower surface, hardly so above. **Sori** oblique, elongate along acroscopic branches of veins, up to 1.4 cm long; indusia thin but firm (Figure 5.51, 5.52).

Thailand.- NORTHERN: Chiang Mai (Doi Khun Huai Pong, Doi Chiang Dao, Doi Suthep, Doi Inthanon); NORTH-EASTERN: Loei (Phu Luang).

Distribution.- Ceylon, India (type), SW.. China and Indochina, extending north to southern edge of Japan.

Ecology.- On tree-trunks usually in hill evergreen forest at 1600 m alt.

Specimens examined.- *W. Rattanathirakul* 23, 57 (BCU): *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 2886, T 1489 (BKF).

4. *Asplenium exisum* C. Presl, Epim.: 74. 1819; Holttum, Rev. Fl. Malaya 2: 439. f. 256. 1955; Devol and Kuo, Fl. Taiwan Vol. 1. 2nd ed.: 484. 1980; Tagawa & K. Iwats., Fl. Thailand 3(2): 278. 1985.-*Asplenium unilaterale* f. *majus* C. Chr., B. P. Bishop Mus. Bull. 177: 67. 1943.- *Asplenium unilaterale* var. *majus* (C. Chr.) Sledge, Bull. Brit. Mus. (Nat. Hist.) Bot. 3: 246. 1965.- *Asplenium unilaterale* auct. non Lank.: Tard. C. Chr. in Fl. Gen. I.-C. 7(2): 224. 1940.

Rhizome long-creeping, bearing many roots on ventral and two rows of fronds on dorsal surface, scaly; scales gradually narrowing from base toward hair-pointed apex, up to 4 by 0.3 mm, dark brown to nigrescent, clathrate. **Stipe** close or up to 1 cm apart, castaneous to purplish, polished, scaly near at base, 15 cm long. **Lamina** pinnate, lanceolate, broadest at basal 1/5-1/8 portion, almost parallel or slightly

narrowing upwards and then rather suddenly narrowing to caudate apex, 35-40 long, about 8-10 cm wide; rachis terete throughtout; pinnae usually 20-30 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, acuminate at apex, up to 5 by 1 cm, the largest ones shortly stalked, a little falcate, thin, herbaceous, light green; veins visible. **Sori** about 5.5 mm long; indusia herbaceous, pale, opening towards anterior side (Figure 5.50).

Thailand.- NORTHERN: Chiang Mai (Mae Ho, Doi Suthep), Lampang, Tak (Mae Sot, Ban Musoe), Phitsanulok (Thung Salaeng Luang, Huai Ya); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao, Pong Nam Ron).

Distribution.- Tropical Africa, Ceylon, S. India, Himalaya, Malesia throughout to Polynesia (type from Samoa) and Hawaii, north to Tonkin, S. China, Taiwan and Ryukyus.

Ecology.- On wet muddy rocks usually along streams in hill evergreen forest at 1250 m alt.

Specimens examined.- *W. Rattanathirakul* 36 (BCU): *M. Tagawa* and *N. Fukuoka* T 2104; *K. Iwatsuki* and *N. Fukuoka* T 3964, T 7163 (BKF).

5. *Asplenium nidus* L. var. ***nidus***, L., Sp. Pl.: 1079. 1753; Holttum, Rev. Fl. Malaya 2: 419. 1955; Bedd., Handb.: 137. 1969; Devol and Kuo, Fl. Taiwan Vol. 1. 2nd ed.: 485. 1980; Tagawa & K. Iwats., Fl. Thailand 3(2): 266. 1985.- *Thamnopteris ninus* (L.) C. Presl, Epim.: 68. 1849.

Rhizome short, erect or ascending, stout, bearing a rosette of fronds, usually with a mass roots on which are growing various epiphytes, scaly; scales brown to darker, clathrate, up to 1.5 cm long 3 mm broad. **Stipe** stramineous to dark, 2-5 cm long, scaly at base. **Lamina** simple, up to 1 m or more long, 9-12 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 from submarginal veins about 0.5 mm inside leaf margin. **Sori** elongate along veins, extending from near midrib half-way to the margin, usually on every vein; indusia about 0.5 mm broad, with a space of 0.5 mm or wider between (Figure 5.53, 5.54).

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

Distribution.- Throughout the Old World tropics (type from Indonesia).

Ecology.- On mossy tree-trunks in hill evergreen forest at 1600 m alt.

Vernacular.- Katae tai hin (กะแตไต่หิน) (North-eastern); Kaprok hua long (กะปรอกหัวลง), Kaprok hang sing (กะปรอกหางสิงห์) (South-eastern).

Specimens examined.- *W. Rattanathirakul* 32 (BCU); *T. Boonkerd* 1094: *M. Tagawa*, *K. Iwatsuki* and *N. Fukuoka* T 386, T 1895 (BKF).

6. *Asplenium normale* D. Don, Prod. Fl. Nepal.: 7. 1825; Holttum, Rev. Fl. Malaya 2: 436. f. 254. 1955; Bedd., Handb.: 144. 1969; Devol and Kuo, Fl. Taiwan Vol. 1. 2nd ed.: 486. 1980; Tagawa & K. Iwats., Fl. Thailand 3(2): 280. 1985.

Rhizome short, erect, scaly; scales gradually narrowing from base towards hair-pointed apex, up to 4 by 0.7 mm, bicoloured, the central portion black, with longitudinal cells, the edges brown to dark brown. **Stipe** very deep castaceous to nearly black, more or less polished, up to 15 cm long, grooved with two low but distinct ridges on adaxial surface. **Lamina** pinnate, lanceolate to narrower, slightly narrowing at base, gradually narrowing upwards, caudately acuminate at apex, up to 30 cm by 4 cm; rachis wingless throughout, viviparous; lateral pinnae up to 40 pairs, sessile, patent or slightly reflexed, oblong, rounded at apex, lobed to 1/5 way on both margins, narrowly cuneate at basiscopic base, auricled and truncate at acroscopic base, about 20 by 6 mm; midrib rarely viviparous; veinlets simple or forked, not running to the very top of lobes. **Sori** up to 3 mm long; indusia thin (Figure 5.55, 5.56).

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

Distribution.- Old world tropics throughout, north to Himalaya (type) and Japan

Ecology.- Terrestrial on rather dry slopes or humus-rich groundin hill evergreen forest at 1600 m alt.

Specimens examined.- *W. Rattanathirakul* 17, 25 (BCU): *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 602, T 617 (BKF).

7. *Asplenium obscurum* Blume, En. Pl. Jav.: 181. 1828; Devol and Kuo, Fl. Taiwan Vol. 1. 2nd ed.: 486. 1980; Tagawa & K. Iwats., Fl. Thailand 3(2): 279. f. 22. 1. 1985.

Rhizome creeping, bearing many roots on ventral and two rows of fronds on dorsal surface, scaly scales gradually narrowing from base towards hair-pointed apex, up to 6.5 by 2 mm, dark brown, clathrate. **Stipe** close or up to 1 cm apart, often green and fleshy; stipe and rachis green or brownish never polished. **Lamina** pinnate, lanceolate, almost parallel or slightly narrowing upwards and then rather suddenly narrowing to caudate apex, 36 cm long, 9 cm wide; pinnae usually 20-30 pairs, roundly quadrangular, posterior half of lower portion dimidiate, truncate and slightly auricles at acroscopic base, rounded at apex, lobed to 1/5 way at upper and anterior half of lower margin, lobed rounded, oblique, moderately acute to rounded at apex, 20 by 6 mm, lateral pinnae patent, little falcate, less widely spaced. **Sori** short, usually up to 3 mm long, or in more or less sausage-form.

Thailand.- NORTHERN: Chiang Rai (Doi Tung, Doi Phacho), Chiang Mai (Doi Suthep, Doi Inthanon,), Lamphun (Doi Khun Tan).

Distribution.- Madagascar, Ceylon, S. India and E. Himalaya, Myanmar, Indochina, S. China, Taiwan and throughout Malesia (type from Indonesia)

Ecology.- On moist muddy rocks or wet sandy ground in hill evergreen forest at 1500 m alt.

Specimens examined.- *W. Rattanathirakul* 111 (BCU): *K. Iwatsuki* T 4463; *R. Pooma* T 560 (BKF).

8. *Asplenium paradoxum* Blume, En. Pl. Jav.: 179. 1828; Holttum, Rev. Fl. Malaya 2: 430. 1955; Bedd., Handb.: 151. F 76. 1969; Tagawa & K. Iwats., Fl. Thailand 3(2): 282. 1985.

Rhizome short, ascending, 5-7 mm diam., densely scaly throughout; scales gradually narrowing towards acuminate apex, entire, up to 8 by 1.3 mm, dark brown, the margin a little paler. **Stipe** stramineous or darker, purplish at basal portion, sparsely scaly, up to 25 cm long. **Lamina** pinnate, broadly lanceolate, acute at apex, round at base, up to 40 by 14 cm; rachis stramineous, darker below, minutely scaly or glabrescent, gemmiferous at upper portion; pinnae about 10 pairs, ascending, stalked, lower ones with stalks of 0.5-1 cm, falcate, gradually narrowing from base towards

apex, caudately acuminate at apex, broadly cuneate and roundly auricled at acroscopic base and cuneate at basiscopic base, minutely toothed at margin, up to 10 by 2.5 cm, softly chartaceous to papyraceous, light green; costa grooved above with ridges, raised below, glabrous, the other veins hardly visible. **Sori** long, up to 2.5 cm long, occupying almost the whole length of veins, 1-3 for each vein group, open to posterior side (Figure 5.57, 5.58).

Thailand.- NORTH-EASTERN: Loei (Phu Luang); PENINSULAR: Patthani (Ban Sai Khao).

Distribution.- W. Malesia (type from Indonesia).

Ecology.- On moist muddy rock in hill evergreen forest at 1350 m alt.

Specimens examined.- *W. Rattanathirakul* 53 (BCU): *E. Hennipman* 3555; *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 1523, T 1252 (BKF).

9. *Asplenium pellucidum* Lam., Enc. 2: 305. 1786; Holttum, Rev. Fl. Malaya 2: 428. f. 246. 1955; Bedd., Handb.: 149. 1969; Tagawa & K. Iwats., Fl. Thailand 3(2): 282. 1985.- *Asplenium hirtum* Kaulf., Enum.: 169. 1824.

Rhizome short, erect, up to 1 cm diam., densely scaly; scales gradually narrowing from base towards long-tailed apex, up to 10 by 0.8 mm, dark brown to black, bright, with very thick internal cell-wall. **Stipe** dark purple, up to 10 cm or more long, or reduced pinnae auricle-like placed just above the rhizome. **Lamina** pinnate, lanceolate in outline, broadest at middle, gradually narrowing towards both apex and base, up to 50 cm or more long, 10 cm wide; rachis covered with linear scales; lateral pinnae many, up tp 50 pairs, the middle ones the largest, patent, sessile, gradually narrowing towards round to acute apex, broadly cuneate to truncate at roundly auricled acroscipic base, narrowly cuneate at basiscopic base, lobed to 2/5 at margin, up to 5 by 2.5 mm, rounded at slightly waved apex, including 4 or 5 veinlets branched from a single lateral vein, papyraceous to thinly chartaceous; veins more or less visible. **Sori** elongate along posterior veinlets of vein groups, up to 7 mm long, more or less curved, not reaching the lobes (Figure 5.65).

Thailand.- NORTHERN: Tak (Ban Musoe); CENTRAL: Nakhon Nayok (Khao Yai, Nang Rong Falls); EASTERN: Nakhon Ratchasima (Kathok); SOUTH-EASTERN: Chanthaburi (Khao Sabap); SOUTH-WESTERN: Kanchanaburi (Klang Dong); PENINSULAR: Nakhon Si Thammarat (Thung Song), Trang (Khao Chong), Satun, Yala (Betong).

Distribution.- Old world tropics, from E. Africa (type) to New Guinea, north of Sikkim.

Ecology.- On moist muddy rocks in hill evergreen forest at 1300 m alt.

Specimens examined.- *W. Rattanathirakul* 144 (BCU): *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 6700; *M. Tagawa, K. Iwatsuki, H. Koyama* and *A. Chintayungkun* T 8602 (BKF).

10. *Asplenium perakense* B. Mathew & H. Christ, J. L. Soc. Bot. 39: 214. 1909; Holttum, Rev. Fl. Malaya 2: 429. f. 248. 1955; Tagawa & K. Iwats., Fl. Thailand 3(2): 286. 1985

Rhizome short, suberect, bearing a tuft of fronds, densely scaly; scales gradually narrowing from base towards hair-pointed apex, entire, or with a few long projections near base, up to 10 by 1.5 mm at base, brown. **Stipe** polished black to dark brownish-purple, scaly throughout, 15-20 cm long. **Lamina** pinnate, narrowly oblong, acute at apex, a little reduced downwards, up to 30-40 by 15 cm; rachis like the upper part of side, scaly with narrow scales; pinnae 15-20 pairs, stalked, middle ones the largest, ascending, narrowly subtriangular, caudately acuminate at apex, auricled at acroscopic and cuneate at basiscopic bases, lobed nearly to costa, up to 8 by 2.5 cm; lobes oblong or quadrangular, oblique, dentate at apex, usually 5-7 mm wide; softly chartaceous to chartaceous, veins visible. **Sori** long, crescent-shaped, 1-4 for each lobe; indusia herbaceous (Figure 5.67, 5.68).

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

Distribution.- Malaya (type).

Ecology.- On tree-trunks in hill evergreen forest at 1450 m alt.

Specimens examined.- *W. Rattanathirakul* 112 (BCU): *E. Hennipman* 3848; *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 4785; *K. Iwatsuki, H. Koyama* and *A. Chintayungkun* T 8396 (BKF).

11. *Asplenium phyllitidis* D.Don subsp. ***phillitidis***, Prod. Fl. Nepal.: 7. 1825; Holttum, Rev. Fl. Malaya 2: 420. 1955; Tagawa & K. Iwats., Fl. Thailand 3(2): 268. f. 21. 3. 1985.- *Asplenium nidus* var. *phyllitidis* (D. Don) v.A.v.Ros., Handb. Suppl.: 282. 1917.- *Thamnopteris nidus* var. *phyllitidis* (D. Don) Bedd., Handb.: 139. 1883.

Rhizome short, erect or ascending, stout, bearing a rosette of fronds, usually with a mass roots on which are growing various epiphytes, scaly; scales brown, broader up to 1 cm long 2.5 mm broad, clathrate,. **Stipe** stramineous to dark, 2-5 cm long, scaly at base. **Lamina** simple, up to 65 by 6 cm, broadest at middle, gradually narrowing towards both apex and base, coriaceous, grass-green when living, paler below; midrib raised below, veins once or rarely twice forked, the first forking near

midrib and then running parallel, uniting at apex to from submarginal veins about 0.5 mm in leaf margin. **Sori** elongate along veins, reaching more than half-way to margin, often occupying ¾ of the length of veins; indusia about 0.5 mm broad (Figure 5.59, 5.60).

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

Distribution.- Himalaya (type).

Ecology.- On mossy tree-trunks in hill evergreen forest at 1600 m alt.

Specimens examined.- *W. Rattanathirakul* 109 (BCU): *K. Iwatsuki* and *N. Fukuoka* T 7424; *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 6812 (BKF).

12. *Asplenium scortechinii* Bedd., J. Bot. 322. 1887. Holttum, Rev. Fl. Malaya 2: 420. 1955; Tagawa & K. Iwats., Fl. Thailand 3(2): 271. 1985.- *Asplenium annamense* Christ, J. Bot. 21: 232, 264. 1908.

Rhizome short, suberect, bearing a few to several fronds in a tuft, scaly near apex; scales oblong-lanceolate, gradually narrowing towards acute apex, about 6 by 2 mm, dark brown centrally, paler at edges, sometimes bearing irregular projections at margin, clathrate. **Stipe** not distinct from lamina, winged, stramineous or brownish. **Lamina** simple, linear, up to 40 by 2 cm, broadest at middle, narrowing towards caudately long-acuminate apex, attenuate towards base, with shallow serration at margin at least in upper part or subentire; chartaceous, minutely scaly on midrib; midrib raised below, flat above, rather thick; lateral veins forming angles of 70-80° to midrib, simple or forked. **Sori** elongate along simple veins or acroscopic branches of forked ones, from near midrib to about 2/3 way towards edge of frond; indusia up to 1.1 mm broad, firm (Figure 5.61, 5.69).

Thailand.- NORTH-EASTERN: Loei (Phu Luang, Phu Kradung); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); PENINSULAR: Nakhon Si Thammarat (Khao Luang), Trang (Khao Chong, Khao Sung).

Distribution.- Indochina and Malaya (type).

Ecology.- On mossy tree-trunks in hill evergreen forest at 1600 m alt.

Specimens examined.- *W. Rattanathirakul* 115 (BCU); *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 4775, T 6834 (BKF).

13. ***Asplenium yoshinagae*** Makino, Phan. Pterid. Jap. Ic. 111. 1. pl. 64. 1900; Devol and Kuo, Fl. Taiwan Vol. 1. 2nd ed.: 487. 1980; Tagawa & K. Iwats., Fl. Thailand 3(2): 285. f. 23. 1. 1985.- *Asplenium planicaule* Wall. ex Mett., Abhandl. Senckenb. Naturf. Ges. 3: 201. 1859.- *Asplenium indicum* Sledge, Bul. Brit. Mus. (Nat. Hist.) Bot. 3: 264. 1965.

Rhizome short, erect, scaly; scales dark brown to nearly black, narrow, subulate, entire, up to 7 by 0.7 mm. **Stipe** usually up to 9 long, dark green to brownish, not polished, sparsely scaly. **Lamina** pinnate, narrowly lanceolate, commonly about 16 by 6 cm, acute to acuminate at apex; rachis like the upper part of stipe, rarely gemmiferous; pinnae 12-15 pairs, stalked, dimidiate, rhomboid, acute at apex, broadly cuneate and auricled at acroscopic base, narrowly cuneate and entire at basiscopic base, margin irregularly lobed with dentate margin, 3 by 1 cm, chartaceous, deep green, brownish in dried specimens. **Sori** elongate, many near the costa (Figure 5.66).

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

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

Ecology.- On mossy tree-trunks in hill evergreen forest at 1200 m alt.

Specimens examined.- *W. Rattanathirakul* 117 (BCU); *E. Hennipman* 3267; *T. Shimizu, K. Iwatsuki, N. Fukuoka, M. Hutoh* and *D. Chaiglom* T 11601 (BKF).

14. ***Asplenium*** **sp. 1**

Rhizome short, suberect, bearing a few to several fronds in a tuft, scaly near apex; scales narrow, subulate, gradually narrowing towards acuminate apex, about 5 by 0.6 mm, dark brown centrally, paler at edges, bearing irregular projections at margin, clathrate. **Stipe** not distinct from lamina, winged, stramineous. **Lamina** simple, lanceolate, up to 27 by 3 cm, broadest at middle, acuminate at apex, attenuate towards base, with undulate at margin; chartaceous, minutely scaly on midrib; midrib raised on upper surface, flat below; lateral veins forming angles of 40-50° to midrib, simple or forked. **Sori** elongate along simple veins or acroscopic branches of forked ones, from near midrib to more than 2/3 way towards edge of frond; indusia up to 0.7 mm broad, firm (Figure 5.62, 5.63).

Thailand.- NORTHERN: Phitsanulok (Phu Hin Rong Kla).

Distribution.- N/A

Ecology.- On tree-trunks in hill evergreen forest at 1500 m alt.

Vernacular.- N/A

Specimens examined.- (BCU) *W. Rattanathirakul* 119.

Note.- *Asplenium* sp.1 is an epiphyte on mossy tree-trunks in hill evergreen forest at 1,600 m alt. It is similar to *Asplenium scortechinii* Bedd., but their details of fronds, such as, shape and size of lamina and venation are different.

15. *Asplenium* sp.2

Rhizome short, ascending, densely scaly throughout; scales gradually narrowing from base towards hairy pointed apex, entire, up to13 by 1.3 mm, brown to dark brown. **Stipe** brown to dark brown, not polished, bearing narrow scales throughout, up to 22 cm long. **Lamina** pinnate, lanceolate, acuminat at apex, up to 60 by 20 cm; rachis brown to dark brown, with very narrow hair-like scales; leteral pinnae about 25-30 pairs, shortly stalked, gradually narrowing from base towards apex, caudately acuminate at apex, broadly cuneate and roundly auricled at acroscopic base and cuneate at basiscopic base, toothed at margin, up to 9 by 1.5-2 cm, chartaceous, deep green. **Sori** long, up to 1.5 cm long, opening towards posterior (Figure 5.64).

Thailand.- NORTHERN: Phitsanulok (Phu Hin Rong Kla).

Distribution.- N/A

Ecology.- On moist muddy rock in hill evergreen forest at 1300 m alt.

Vernacular.- N/A

Specimens examined.- (BCU) *W. Rattanathirakul* 196.

Note.- *Asplenium* sp.2 is a lithophyte on moist muddy rock in hill evergreen forest at 1300 m alt. It looks like *Asplenium pellucidum* Lam. This *Asplenium* species has short pinnae stalks, toothed leaf margin, lower pinnae not reduced, brownish to dark brown stipes, and bearing narrow scales throughout. These characters are different from *Asplenium pellucidum* Lam.

BLECHNACEAE

(C. Presl) Copel., Ann. Cryptog. Phytopathol. 5: 155. 1947; Devol, Fl. Taiwan Vol. 1. 2nd ed.: 149. 1980.

Rhizome creeping, erect, stout or scandent. Fronds monomorphic or dimorphic, usually pinnate or pinnatifid, rarely bipinnate; stipes scaly at base, not articulate to rhizome; venation usually free, or with a costa row of areoles. Sori costal, discrete or in a coensori; usually with an indusium opening towards costa, rarely exindusiate.

BLECHNUM

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

Rhizome stout, erect, bearing fronds in a tuft, scaly; scale narrow, entire, usually with pale cartilaginous margin. **Lamina** pinnate with apical pinna, usually not thin, glabrous; lateral pinnae usually entire, narrow, fertile ones contracted or not; costal grooves not confluent with groove of rachis; veins free, usually once or a few times forks. **Sori** linear, parallel and close to costa, sometimes forming costal areoles of veins (soral veins); indusia 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.: 151. 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, 2 cm or more long, up to 2 mm broad, tailed at apex, dark brown with pale cartilaginous edges which sometimes becoming uneven. **Stipe** stout, stramineous, or sometimes purplish when young, up to 60 cm long, densely scaly at base, bearing small auricle (reduced pinnae) throughout. **Lamina** pinnate, up to 85 by 34 cm, lateral pinnae many in number, close, 2-3 cm apart from each other, ascending, linear, gradually towards tong-tailed apex, round or subtruncate at sessile base, or decurrent at posterior base and adnate in the upper ones, entire, 30 by 1.2-2 cm; veins simple or forked usually near costa, distinct on both surface, very close up to 0.5 mm apart; coriaceous, green, glabrous throughout. **Sori** narrow, long-continuous along costa; indusia narrow, usually broken before maturity (Figure 5.70).

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

Distribution.- Tropic of Asia, Australia and the Pacific, India to Polynesia, northern edge of Japan (Yakushima)

Ecology.- On rather dry open slopes in hill evergreen forest at 1200 m alt.

Vernacular.- Kut khang fan (กูดข้างฟาน) (Nothern); Kut doi (กูดดอย) (Central); Mahasadam (มหาสะดำ) (South-eastern).

Specimens examined.- *W. Rattanathirakul* 89; T. Boonkerd 1031, 1114 (BCU): ; *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 600, T 4678 (BKF).

DRYOPTERIDACEAE

Herter, Revista Sudamer. Bot. 9:15. 1949; Devol and Kuo, Fl. Taiwan Vol. 1. 2nd ed.: 359. 1980.

Medium sized terrestrial ferns. **Rhizome** usually short erect or creeping. **Stipe** with a ring of several vascular bundles, usually tufted, scaly at least at base; scales opaque and quite diverse in size, shape, texture and color; venation free; rachis deeply grooved on upper side and usually open to receive rachillae grooves. **Sori** round, dorsal or terminal on veins; indusia round or round-reniform, paltate and centrally attached or attached by a deep sinus, rarely absent.

Key to the genera

1. Veins all free
   2. Sori elongate, pinnule articulate to rachis, subdimidiate **3. Didymochlaena**
   2. Sori round, pinnule not articulated
      3. Rachis usually zigzag **1. Acrorumohra**
      3. Rachis not zigzag
      4. Indusia round, peltate, pinnules often with stiff aristate margins **5. Polystichum**

4. Indusia round-reniform, attached at sinus.
    5. Axes not decurrent, anadromic, or the first secondary pinnule directed towards the apex of frond. **2. Arachniodes**
    5. Axes in the higher order decurrent to major ones; catadromic, or the first secondary pinnule of a medial primary pinna directed towards the base of frond **4. Dryopteris**
1. Veins anastomosing, basalpinnal unlobed, or when lobed the basal basiscopic lobes or pinnules longest **6. Tectaria**

1. ACRORUMOHRA

(H. Itô) H. Itô, Nov. Fl. Jap. 4: 101. 1939; Shieh, Fl. Taiwan Vol. 1. 2nd ed.: 360. 1980.

Rhizome short and erect, clothed with scales. **Lamina** tufted, ovate to lanceolate, bi-tripinnate, lowest pinnules or segments without aristate teeth along the margin or at the apices; veins free, vein-tip not enlarged. **Sori** terminal on the veins; indusium reniform or exindusiate.

Acrorumohra diffracta (Baker) H. Itô, Nov. Fl. Jap. 4: 101. 1939; Shieh, Fl. Taiwan Vol. 1. 2nd ed.: 360. 1980.- *Nephrodium diffracta* Baker in Kew Bull. 230. 1898.- *Dryopteris reflexipinna* Hayata, Icon. Pl. Form. 4: 174. F. 113. 1914.

Rhizome short, erect or ascending, densely clothed with dark brown scales, up to 7 by 0.7 cm. **Stipe** 45 cm long, castaneous at least towards base, stramineous above, glabrous, scaly at base. **Lamina** 30 by 30 cm, quadripinnate, deltoid or broadly ovate, glabrous, herbaceous, gradually narrowing toward acuminate at apex, up to 14 by 7 cm, pinnae about 6-8 pairs, rachis zigzag; groove open to receive rachillae grooved, petiolules reflexed about 30 degree, segments fan-shaprd, undulate to crenate. **Sori** terminal on the veins; indusium reniform or exindusiate (Figure 5.75, 5.76, 5.77).

Thailand.- NORTHERN: Phitsanulok (Phu Hin Rong Kla).

Distribution.- China, Indochina and Taiwan.

Ecology.- On humus-rich mountain slopes in hill evergreen forest at 1600 m alt.

Vernacular.- Fern zig zag (เฟิร์นซิกแซก) (Northern).

Specimens examined.- *W. Rattanathirakul* 62 (BCU).

2. ARACHNIODES

Blume, Enum. Pl. Javae: 241. 1828; Tagawa & K. Iwats., Fl. Thailand 3(3): 339. 1988.- *Rumohra* Raddi, Opusc. Sci. Bologn. 3: 290. 1819, p.p. majore excl. typum.- *Polystichopsis* (J. Sm.) C. Chr. In Verdoorn, Man. Pterid.: 543. 1938.- *Byrsopteris* Mort., Amer. Fern J. 50: 149. 1960.

Rhizome creeping, short or more long, scaly; scales usually entire and grabrous, concolorous. **Stipe** scaly or glabrescent. **Lamina** ovate with broad base, tri pinnatifid or more compound, anadromic in sequence of frond architecture or basal posterior pinnules interior to basal anterior ones; ultimate segment segments rhomboid, aristate in many species; herbaceous to chartaceous; veins all free. **Sori** dorsal or rarely terminal on veinlets; indusia reniform, or rarely wanting.

Arachniodes spectabilis (Ching) Ching, Acta Bot. Sin. 10: 259. 1962; Tagawa & K. Iwats., Fl. Thailand 3(3): 343. f. 30. 3-4. 1988.- *Rumohra spectabilis* Ching, Sinensia 5: 58. pl. 11. 1934.

Rhizome short, erect; scales dense, narrow, up to 12 by 0.5 mm, brown, entire. **Stipe** stramineous, up to 50 cm long, scaly on basal part, glabrescent upwards; scales up to 20 by 0.7 mm, dark-brown, entire. **Lamina** oblong-subtriangular, gradually narrowing towards acuminate apex, tripinnate, up to 35 by 30 cm; rachis glabrous, grooved on upper surface; lateral pinnae more than 10 pairs, the lowest the largest, with large basal acroscopic pinnules, middle pinnae distinctly stalked, slightly falcate, linear-subtriangular, widest at base, gradually narrowing towards caudate-acute apex, about 24 by 6 cm, upper ones gradually becoming smaller; pinnules oblong-subdeltoid, acute at apex, unequally cuneate at stalked base, often dimidiate at posterior base; segments sessile, oblong, oblique, round to moderately acute, lobed at margin, up to 10 by 5 mm; lobes serrate at margin, ending with moderate awns; harsh, glabrous green on upper surface. **Sori** dorsal on veinlets, near midrib; indusia round, entirely covered and enveloping the sori when young, breaking down irregularly (Figure 5.71, 5.74).

Thailand.- NORTHERN: Chiang Rai (Doi Pacho), Chiang Mai (Doi Inthanon), Mae Hong Son (Doi Khun Huai Pong), Lampang, Phitsanulok (Phu Miang); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao),); SOUTH-WESTERN: Kanchanaburi (Khao Ri Yai).

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

Ecology.- On rather dry or humus-rich mountain slopes in hill evergreen forest at 1600 m alt.

Specimens examined.- *W. Rattanathirakul* 26 (BCU): *T. Shimizu, K.* Iwatsuki, *N. Fukuoka, M. Hutoh* and *D. Chaiglom* T 11600 (BKF).

3. 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; pinnae jointed to rachis; pinnules subsessile, subdimidiate, rounded at apex, glabrescent; veins forked, all free, ending in enlarged submarginal apices. **Sori** terminal on veinlets, with elongete receptacles, slightky sunken; indusia elliptic, fixed to veinlets along medial line, rounded at distal end, cordate at base, firm, glabrous.

Didymochlaena truncatula (SW..) J. Sm., J. Bot. 4: 196. 1841; Holttum, Rev. Fl. Malaya 2: 483. f. 285. 1955; Tagawa & K. Iwats., Fl. Thailand 3(3): 331. f. 28. 8-11. 1988.- *Aspidium truncatulum* SW.., Schrad. J. Bot. 1800(2): 36. 1801.- *Didymochlaena lunulata* auct. non (Brum.) Desv.: Bedd., Handb.: 199. f. 99. 1883.

Rhizome massive, bearing a group of fronds like a small tree fern, sometimes more than 10 cm long, covered densely with scales; scale up to 30 by 3 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 70 cm long, grooved on adaxial surface. **Lamina** oblong or narrower, up to 100 by 40 cm, bipinnate; rachis densely covered with narrower scales and downy hairs; pinnae 20 or more pairs, joined to rachis, linear-lanceolate, acuminate at apex, subtruncate at base, up to 24 by 3 cm; pinna-rachis grooved, grooves not decurrent into those on rachis; leaflets jointed to rachis, uniform in size and form throughout, nearly oblong, about 1.5 by 0.6 mm, rounded at apex, entire or very slightly serrate at margin; thick, dark green but brown in dried specimens, blabrous, bearing distinct spines at base of leaflets. **Sori** terminal on anterior branch of veins, elongate, somewhat hollowed; indusia glabrous, about 2.5 mm long (Figure 5.72, 5.73).

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

Distribution.- Pantropic (type from Indonesia).

Ecology.- On humus-rich mountain slopes in hill evergreen forest at 1350 m alt.

Specimens examined.- *W. Rattanathirakul* 51; *T. Boonkerd* 322, 1494(BCU).

3. DRYOPTERIS

Adans., Fam. Pl. 2: 20, 551. 1763; Tagawa & K. Iwats., Fl. Thailand 3(3): 345. 1988.

Rhizome short, ascending to erect, stout, scaly; scales in most cases broad and entire, non-clathrate. **Stipe** usually in a tuft at apex of rhizome, scaly. **Lamina** mostly broad at base, pinnate to decompound, basal anterior pinnules interior to basal posterior ones or catadromic in sequence of frond-architecture; usually papyraceous or firm, typically glabrous; vein all free. **Sori** dorsal on veinlets, round with punctate receptacles; indusia round-renifrom, attached at the inner end of sinus, or rarely wanting.

Key to the species

1. Sori indusiate
   2. Frond pinnate, lamina lanceolate, stipe stramineous **1. D. hirtipes**
   2. Frond bipinnatifid or more compound, lamina oblong-subdeltoid, stipe castaneous at least towards base, stramineous above **3. D. sparsa**
1. Sori exindusiate, frond bipinnate **2. D. polita**

1. *Dryopteris hirtipes* (Blume) Kuntze, Rev. Gen. Pl. 2: 813. 1891; Holttum, Rev. Fl. Malaya 2: 635. 1955; Bedd., Handb.: 232. f. 120. 1969; Tagawa & K. Iwats., Fl. Thailand 3(3): 347. f. 31. 1-2. 1988.- *Aspidium hirtipes* Bl., En. Pl. Jav.: 148. 1828.- *Lastrea hirtipes* (Bl.) Moore, Ind. Fil.: 85. 1858.

Rhizome short, erect; oblong-lanceolate with long tail, up to 1.6 by 0.2 cm, brown to dark, membranous, entire. **Stipe** stramineous, densely scaly at base, moer sparsely upwards, up to 45 cm long. **Lamina** pinnate, lanceolate, caudate-acute at apex, slightly narrowing at base, up to 70 by 30 cm; rachis grooved on upper surface, densely scaly throughout with narrow, brown to nearly black scales up to 8 mm long; pinnae more than 20 pairs, lower pinnae falcate, linear-lanceolate, caudate-attenuate, truncate or subcordate at base, subsessile or very shortly stalked, up to 18 by 2 cm, lobed to quarter way towards costa, upper pinnae gradually becoming smaller upwards, decurrent at base; costa nearly at right angle to rachis, distinctly raised on lower surface, grooved above; lobes subdeltoid, oblique, round to acute at apex,

entire, up to 5 by 6 mm; chartaceous, deep green, glabrous. **Sori** in two or three indistinct rows near costa, leaving marginal half of lamina sterile, indusiate; indusia round-renifrom, small, fugacious, glabrous.

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

Distribution.- Sri Lanka, S. India, W. Malaysia, Sumatra, Indonesia (type), Borneo and the Philippines.

Ecology.- On humus-rich mountain slopes in hill evergreen forest at 1460 m alt.

Specimens examined.- *W. Rattanathirakul* 101; *T. Boonkerd* 1356 (BCU): *K. Iwatsuki and N. Fukuoka* T 3201; *T. Shimizu, K. Iwatsuki, N. Fukuoka, M. Hutoh, D. Chaiglom* and *A. Nalampoon* T 11694 (BKF).

2. *Dryopteris polita* Rosenst., in Fedde, Rep. Sp. Nov. 13: 218. 1914; Holttum, Rev. Fl. Malaya 2: 492. 1955; Devol and Kuo, Fl. Taiwan Vol. 1. 2nd ed.: 378. 1980; Tagawa & K. Iwats., Fl. Thailand 3(3): 353. f. 32. 9-11. 1988.- *Dryopteris chapensis* auct. non C. Chr. & Ching., Holttum, Dansk Bot. Ark. 20: 30. 1961.

Rhizome short, ascending or suberect, scales light brown, entore, up to 15 by 1.4 mm. **Stipe** stramineous, scaly at base with the scales similar to those on rhizome, more sparsely scaly upwards with smaller ones, up to 45 cm long. **Lamina** oblong with acuminate apex, bipinnate, up to 40 by 25 cm; 5 or 6 lower lateral pinnae nearly equal in size or slightly smaller upwards, with stalks of 2.5 cm long, narrowly sub triangular with acuminate apex, unegually broadly cuneate at base, 20 by 5 cm; upper pinnae rather suddenly shortened, very shortly stalked, sessile or adnate at base, oblong-subdeltoid with acute apex, shallowly lobed at margin; pinnules oblong-subdeltoid, round at apex, round or cuneate at base or acroscopically auricled in larger ones, up to 4 by 1 cm, serrate at margin; papyraceous, not very thick or harsh, deep green. **Sori** dosal on veinlets, medial or just beyond midway from midrib to margin of pinnule, in one row, exindusiate (Figure 5.79).

Thailand.- NORTHERN: Chiang Mai (Doi Chiang Dao), Tak (Doi Musoe-Mae Sot); NORTH-EASTERN: Loei (Phu Luang, Phu Kradung); CENTRAL: Nakhon Nayok (Khao Yai National Park); PENINSULAR: Nakhon Si Thammarat (Khao Luang), Ranong (Kapoe).

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

Ecology.- On mountain slopes in hill evergreen forest at 1500 m alt.

Specimens examined.- *W. Rattanathirakul* 204 (BCU): *E. Hennipman* 3093; *T. Shimizu, H. Toyokuni, H. Koyama, T. Yahara* and *C. Niyomdham* T 23039 (BKF).

3. *Dryopteris sparsa* (D. Don) Kuntze, Rev. Gen. Pl. 2: 813. 1891; Holttum, Rev. Fl. Malaya 2: 492. f. 292. 1955; Devol and Kuo, Fl. Taiwan Vol. 1. 2nd ed.: 380. 1980; *Nephrodium sparsum* D. Don, Prodr. Fl. Nepal.: 6. 1825.- *Lastrea sparsa* (D. Don) T. Moore, Index Fil.: 87, 104. 1858; Bedd., Handb.: 252. 1969; Tagawa & K. Iwats., Fl. Thailand 3(3): 352. 1988.

Rhizome short, erect; scales membranous, light brown or the centre dark brown, oblong-ovate, about 8.5 by 2 mm. **Stipe** castaneous at least towards base, stramineous above, densely scaly at base, sparsely so above, up to 37 cm long. **Lamina** oblong-subdeltoid, acuminate at apex, bipinnate, bipinnate or tripinnate at widest base, up to 45 by 17 cm; basal pinnae the largest, asymmetrically subtriangular, acuminate at apex, up to 20 by 12 cm; middle pinnae falcate, stalked, subtriangular-lanceolate; pinnules oblong, slightly falcate, rounded or moderately acute at apex, unequally cuneate at sessile base or decurrent at base in upper ones, up to 22 by 7 mm, lobed 1/3 way to midrib; basal acroscopic pinnule of lower pinnae large, about twice as large as the next one, pinnate; lobes oblong, oblique, rounded or moderately acute at apex, serrate at margin; papyraceous to chartaceous, deep green above, pale beneath; veins pinnate, veinlets simple, ending within margin of lobes. **Sori** costular or medial; indusia large, about 1.5 mm diam., glabrous (Figure 5.78).

Thailand.- NORTHERN: Chiang Rai (Mae Lao), Chiang Mai (Doi Chiang Dao, Doi Suthep); NORTH-EASTERN: Loei (Phu Luang, Phu Kradung); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); PENINSULAR: Nakhon Si Thammarat (Khao Luang).

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

Ecology.- On mountain slopes in hill evergreen forest at 1600 m alt.

Specimens examined.- *W. Rattanathirakul* 35, 81 (BCU): *K. Iwatsuki* and *N. Fukuoka* T 7193; *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 1260 (BKF).

4. POLYSTICHUM

Roth, Tent. Fl. Germ. 3: 31, 69. 1799; Tagawa & K. Iwats., Fl. Thailand 3(3): 333. 1988.

Rhizome short, usually ascending or erect, bearing a tuft of fronds at apex; scales urually rather broad, lacerate. **Stipe** densely scaly. **Lamina** usually oblong, narrow at base, anadromic in sequence, pinnate to bipinnate, coriaceous, with mucronate apex of ultimate lobes; veins all free, usually bearing fibroid scales. **Sori** commonly dirsal on veivs, round; indusia round, peltate, or rarely wanting.

Polystichum biaristatum (Blume) T. Moore, Index. Fil.: 86. 1858; Devol and Kuo, Fl. Taiwan Vol. 1. 2nd ed.: 388. 1980; Tagawa & K. Iwats., Fl. Thailand 3(3): 337. f. 29. 10-11. 1988.- *Aspidium biaristatum* Blume, Enum. Pl. Javae: 2: 164-165. 1828.- *Polystichum aculeatum* var. *biaristatum* (Blume) Bedd., Handb.: 209. 1883.- *Aspidium aculeatum* auct. non (L.) SW..: Hoss., Beih. Bot. Centr. 28(2): 363. 1911.- *Polystichum aculeatum* auct. non (L.) Schott: Holttum, Dansk Bot. Ark. 20: 30. 1961.

Rhizome short, suberect; scales narrowly subtriangular, attenuate at apex, entire at margin, up to 11 by 0.8 mm, bicoloured, central portion shinning black and tough, the margin brown to dark brown with ferrugineous margin. **Stipe** 36 cm long; scale at base of two kinds, one like those on rhizome, the other narrower, linear, up to 1 cm long, brown, toothed at margin, those on upper part linear, black with brown broader base. **Lamina** oblong-lanceolate, widest at middle, slightly narrowing towards base, acuminate at apex, 40 by 30 cm; rachis densely scaly throughout with linear black scales with brown broader base; pinnae more than 15 pairs, lower pinnae patent or slightly ascending, very shortly stalked, lanceolate, gradually acuminate at apex, broadly cuneate or subtruncate at base, up to 18 by 4 cm; basal acroscopic pinnules larger; pinnules rather close, oblong or gradually narrowing toward apex, falcate, acute and ending in sharp awns at apex, sessile, 23 by 7 mm, shallowly lobed at margin; veinlets a little raised on lower surface, minutely scaly; coriaceous, green. **Sori** arranged in one row at submarginal or medial part of pinnules; indusia pale brown, about 1 mm diam.

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

Distribution.- Sri Lanka, N. India, S. China, Taiwan and Indonesia (type)..

Ecology.- On humus-rich mountain slopes in hill evergreen forest at 1600 m alt.

Specimens examined.- *W. Rattanathirakul* 27 (BCU): *E. Hennipman* 3327; *K. Iwatsuki* and *N. Fukuoka* T 3433 (BKF).

5. TECTARIA

Cav., Anales Hist. Nat. 1: 115. 1799; Tagawa & K. Iwats., Fl. Thailand 3(3): 364. 1988.- *Ctenitopsis* Ching, Bull. Fan Mem. Inst. Biol. 8: 304. 1938.

Rhizome usually thick, short, erect to short-creeping, scaly at apex. **Stipe** stramineous to ebeneous. **Lamina** 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, indusiate or exindusiate, or sometimes elongate; indusia if present round-renifrom.

Key to the species

1. Sori usually terminal on included free veinlets, often in two rows between main veins, stipe pale brown to castaneous **1. T. impressa**
1. Sori on anastomosing veins, stipe dark purple to nearly black **2.T. simonsii**

1. *Tectaria impressa* (Fée) Holttum, Kew Bull. 43: 483. 1988.- *Phlebigonium impressum* Fée, Mem. Foug. 5: 314, t. 24A, f. 2. 1852.- *Tectaria variolosa* (Wall. ex Hook.) C. Chr., Contr. U.S. Nat. Herb. 26: 289. 1931; Holttum, Rev. Fl. Malaya 2: 506. f. 298. 1955; Devol and Kuo, Fl. Taiwan Vol. 1. 2nd ed.: 346. 1980; Tagawa & K. Iwats., Fl. Thailand 3(3): 368. 1988.- *Aspidium variolosum* Wall. ex Hook., Sp. Fil. 4: 51. 1862; Bedd., Handb.: 216. f. 111. 1969.- *Nephrodium variolosum* (Wall. ex Hook.) Hook. & Bak., Syn. Fil.: 298. 1867.- *Sagenia membranifolia* auct. non Christ: Hoss., Beih. Bot. Centr. 28(2): 366. 1911.

Rhizome short, creeping, ascending or erect, scales linear, hairy at margin, rather stiff, bicoloured by neraly black central portion with brown ferrugineous edges or concolorous brown, up to 7 by 0.7 mm. **Stipe** pale brown to castaneous, 20-35 cm in sterile and up to 60 cm in fertile fronds, densely pubescent on adaxial surface, glabrous beneath. **Lamina** ovate- subdeltoid or pentagonal, up to 40 by 30 cm, tripinnatifid at base; lateral pinnae 2-4 pairs, the basal pinna much the largest, stalked, asymmetrically subtriangular, acute at apex, with one or two basal basiscopic

pinnules; upper pinnae shortly stalked, deeply lobed or with a free sessile basal basiscopic pinnule; apical pinna subdeltoid, cuneate and a little decurrent at base, deeply lobed to pinnatifid; herbaceous, green, glabrous on laminar surface; rachis and pinna-rachis with dense articulate hairs above, glabrous beneath; veins forming copious anastomoses with included veinlets. **Sori** terminal on free included veinlets, round, usually in a single row at each side of midrib, more or less raised on upper surface; indusia persistent, glabrous (Figure 5.80).

Thailand.- All over the country.

Distribution.- N. India (type), SW.. China, Indochina, Taiwan, W. Malaysia to Indonesia.

Ecology.- On rather dry mountain slopes in hill evergreen forest at 1500 m alt.

Vernacular.- Kut kwang (กูดกวาง), Kut kieo (กูดเกียว), Kut sang (กูดชาง), Kut hok (กูดหก), Kut hom kha (กูดฮ่มคำ) (Northern); Chon pa (โชนปา) (Peninsular).

Specimens examined.- *W. Rattanathirakul* 156 (BCU): *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 1087, T 1897 (BKF).

2. *Tectaria simonsii* (Baker) Ching, Sinensia 2: 32. pl. 13. 1931; Devol, Fl. Taiwan Vol. 1. 2nd ed.: 345. 1980; Tagawa & K. Iwats., Fl. Thailand 3(3): 374. f. 35. 1-3. 1988.- *Nephrodium simonsii* Baker, Syn. Fil.: 504. 1874.-*Aspidium simonsii* (Baker) Bedd., Ferns Br. Ind. Suppl.: 15. t. 367. 1876; Handb.: 218. 1969.- *Aspidium longicrure* Christ, Bull. Géogr. Bot. Mans. 1909.

Rhizome short, ascending, scaly at apex; scales linear-subtriangular, up to 15 by 1.3 mm, dark brown to nearly black, stiff, entire. **Stipe** 40-60 cm long, dark purple to nearly black, polished, minutely pubescent throughout. **Lamina** subpentagonal, bipinate to tripinnatifid, 30-40 by 25-30 cm; lateral pinnae 2-4 pairs, basal pinnae pinnae up to 25 cm long and wide, stalked, with a few free pinnules like the upper pinnae, which are stalked or sessile, oblanceolate, caudate at apex, round at base, up to 20 by 5 cm, with one or two lateral lobes, subentire or irregularly crenulate, apical pinna subdeltoid-lanceolate, broadest at base, lobed in lower part; thin, deep-green; costa of lower pinnae nearly black, pubescent, of upper pinnae like main veins paler, distinctly raised beneath, other veins slightly raised on both surface, glabrescent, forming copious anastomoses with many included free veinlets. **Sori** at apex or at junction of veinlets, irregularly arranged in 2-5 rows between main veins, round or often elongate ang united to the next one, usually up to 0.8 mm diam.; indusia small, caducous (Figure 5.81).

Thailand.- NORTHERN: Chiang Rai (Mae Kok, Mae Lao), Chiang Mai (Pong Pho), Lampang, Phitsanulok (Thung Salaeng Luang); SOUTH-EASTERN: Chon Buri (Ang Chang Nam); SOUTH-WESTERN: Uthai Thani (Ban Rai).

Distribution.- Sikkim, India (Assam, type) to S. China, N. Vietnam, Taiwan and the Ryukyus.

Ecology.- On mountain slopes in hill evergreen forest at 1200 m alt.

Specimens examined.- *W. Rattanathirakul* 156 (BCU): *M. Tagawa* and *N. Fukuoka* T 2102, T 7178; *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 1276 (BKF).

LOMARIOPSIDACEAE

Alston, Taxon 5: 25. 1956; Devol and Kuo, Fl. Taiwan Vol. 1. 2nd ed.: 347. 1980.

Rhizome creeping, or scandent, stipes distant or tufted; scales brown, ovate of lanceolate, peltately attached near base. **Stipe** with one or two grooves on upper side. **Lamina** dimorphic, simple or pinnate; veins free, simple or once forked, or anastomosing and forming areolae without included veinlets, or free excurrent veinlets, fertile fronds usually with longer stipes and narrower lamina. **Sporangia** acrotichoid.

Key to the genera

1. Frond pinnate to decompound; stipe usually not jointed to rhizome **1. Bolbitis**
1. Frond simple, epiphytic or on cliffs; stipe usually jointed to rhizome **2. Elaphoglossum**

BOBITIS

Schott, Gen. Fil.: ad. t. 14. 1834; Tagawa & K. Iwats., Fl. Thailand 3(3): 310. 1988.- *Egenolfia* Schott, Gen. Fil.: ad t. 16. 1834.- *Campium* C. Presl, Tent. Pterid.: 238. pl. X. 22-23. 1836.

Rhizome creeping, bearing two rows of usually close fronds on dorsal surface and numerous roots on ventral surface, scaly; scales usually concolorous, hardly clathrate, glabrous. **Lamina** dimorphic, usually not jointed to rhizome, simple to bipinatifid, often viviparous near apex. **Sporangia** dispersed on the whole undersurface, or rarely restricted to marginal portion, of fertile pinnae or frond (acrostichoid).

Key to the species

1. Veins all free, fertile pinnae narrowly oblong; sterile pinnae lobed more than halfway toward costa **2. B. sinensis**
1. Veins anastomosing
   2. No included free veinlets in areoles, lamina simple or imparipinnate with one or two pairs of lateral pinnae, apex of frond paeticularly elongate, with bud **1. B. heteroclita**
   2. Many included and excurrent free veinlets in areoles, lamina pinnate,oblong-ovate to oblong, fertile pinnae linear to oblong-lanceolate **3. B. virens var. virens**

1. *Bolbitis heteroclita* (C. Presl) Ching, Ind. Fil. Suppl. III.: 48. 1934; Holttum, Rev. Fl. Malaya 2: 462. f. 271. 1955; in Fl. Mal. II. 1: 325. f. 25d, 31a-g. 1978; Devol and Kuo, Fl. Taiwan Vol. 1. 2nd ed.: 348. pl. 122. 1980; Tagawa & K. Iwats., Fl. Thailand 3(3): 320. 1988.- *Acrostichum heterocclitum* Presl, Rel. Haenk. I.: 15. pl. 2. f. 2. 1825.-*Leptochilus heteroclitus* (Presl) C. Chr., Ind. Fil.: 385. 1906.

Rhizome long-creeping, scaly; scales nearly black with narrow brown ferrugineous margin, linear up to 5.5 by 0.8 mm. **Sterile frond**; sitped 13 cm long, stramineous; lamina simple or imparipinnate with one or two pairs of lateral pinnae; lateral pinnae oblong cuneate and shortly stalked at base, caudate at apex, 15 by 3.5 cm, almost entire or irregularly shallowly waved, terminal pinnae oblong, or often very long-tailed with narrow linear tails 45-60 cm long, up to 20-25 cm long excluding the tail, 6 cm broad; rachis narrowly winged, glabrescent; costa naked, sometimes viviparous; veins distinct on both surface, finely reticulated, without included free veinlets; herbaceous or softly papyraceous, glabrous, deep green, blackish when dried. **Fertile frond** not seen in this site: stipe nearly the same as or larger than those of sterile ones; lateral pinnae up to 6 pairs, oblong, about 5 by 2.7 cm, apical pinna a little large 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 Thai, Thung Salaeng Luang); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chon Buri (Si Racha), Chanthaburi (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, S. and SW.. China, Taiwan, Ryukyu, Indochina, throughout Malesia (type from Luzon) to New Guinea.

Ecology.- On wet ground or muddy moist rocks usually near streams in hill evergreen forest at 1250 m alt.

Vernacular.- Kut pao (กูดเป๋า), Kut hang nok kaling (กูดหางนกกะลิง) (Nothern).

Specimens examined.- *W. Rattanathirakul* 187 (BCU): *M. Tagawa* and *N. Fukuoka* T 2103; *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 5289 (BKF).

2. *Bolbitis sinensis* (Baker) K. Iwats., Acta Phytotax. Geobot. 18: 49. 1959; in Fl. Mal. II. 1: 325. f. 27h. 1978. Tagawa & K. Iwats., Fl. Thailand 3(3): 318. f. 26. 1-4. 1988.-*acrostichum sinense* Bak., Kew Bull. 14. 1906.- *Egenolfia sinensis* (Bak.) Maxon, Proc. Biol. Soc. Wash. 36: 173. 1923.

Rhizome creeping, scale greyish-brown, narrowly subtriangular with long-acuminate apex, entire, up to 4 by 0.7 mm. **Sterile frond**: stipe 15-30 long, scaly at base with brown, appressed, membranous, small, broadly oblong scales; lamina up to 25-60 by 25-35 cm, lamina narrowly subtriangular, the apex attenuately long-tailed, often viviparous at apex; rachis sparsely scaly, winged in upper part; leteral pinnae up to 15 pairs, basal pinnae the longest, stalked, middle pinnae patent, lanceolate, shortly stalked, upper one ascending, oblong, moderately acute to round at apex, lobed to 4/5 way towards costa, adnate at base to from indistinct apical pinna; lobes obligue, acuminate at apex, up to 7 mm broad, close to each other; main veins raised beneath, sparsely minutely scaly, veinlets simple or forked, all free; herbaceous to papyraceous, deep green, dark brown when dried. **Fertile frond** about the same height as or lower than the sterile onr; stipe 25-40 cm long; lamina narrower, 15-25 by 5-7 cm; lower lateral pinnae oblong, gradually narrowing from base to apex, subtruncate or rounded at distinctly stalked base, rounded to moderately acute at apex, subentire or very slightly waved at margin, terminal pinna narrowly subtriangular with lobed base, about 4 cm long; veins pinnate, veinlets simple, all free, the apex ending inside the distinct cartilaginous margin; sporangia dispersed on the undersurface, naked.

Key to the varieties

1. Pinnae of sterile frond 25- 50 by 12- 15 cm, basal pinnae lobed to 4/5 way towards costa **a. B. sinensis** var. **sinensis**
1. Pinnae of sterile frond 80 by 35 cm, basal pinnae pinnatifid, a few basal anterior pinnules large, deeply lobed to half - way towards costule, plants large **b. B. sinensis** var. **costulata**

a. var. ***sinensis***

Lamina 25-40 cm; basal pinna asymmetrically oblong-subtriangular, caudately acuminate at apex, lobed to 4/5 way to wards costa, up to 12-45 cm (Figure 5.82, 5.83).

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

Distribution.- India, Myanmar, SW.. China (type) and Tonkin.

Ecology.- On humus-rich slopes, sometimes on muddy rocks in hill evergreen forest at 1500 m alt.

Vernacular.- Kut bong (กูดบ้ง) (Northern).

Specimens examined.- *W. Rattanathirakul* 46 (BCU): *K. Iwatsuki* and *N. Fukuoka* T 3427; *M. Tagawa*, *K. Iwatsuki* and *N. Fukuoka* T 2665, T 4214 (BKF).

b. var. ***costulata*** (Hook.) Tagawa & K. Iwats., Acta Phytotax. Geobot. 22: 102. 1967; Tagawa & K. Iwats., Fl. Thailand 3(3): 319. f. 26. 5. 1988.- *Acrostichum appendiculatum* var. *costulatum* Hook., Sp. Fil. 5: 252. 1864.- *Polybotrya appendiculata* var. *costulata* (Hook.) Bedd., Ferns Br. Ind.: pl. 110. 1865; Bedd., Handb.: 426. f. 257. 1969.

Different from the type variety in: plants larger, sterile lamina up to 80 by 35 cm, with about 25 pairs of lateral pinnae, basal pinna asymmetrically subtriangular, pinnatifid, a few basal anterior pinnules large, up to 7 by 1.5 cm, deeply lobed to half-way towards costule, lobes more or less serrate at margin, basal pinnae of fertile fronds lobed.

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

Distribution.- Khasia and Lower Myanmar (type).

Ecology.- On humus-rich slopes in hill evergreen forest at 1450 m alt.

Specimens examined.- *W. Rattanathirakul* 28 (BCU): *M. Tagawa* and *N. Fukuoka* T 2665, T 2106 (BKF).

3. *Bolbitis virens* (Wall. ex Hook. & Grev.) Schott var. ***virens***, Gen. Fil.: ad t. 14. 1834; Holttum, Rev. Fl. Malaya 2: 468. f. 275. 1955; Tagawa & K. Iwats., Fl. Thailand 3(3): 314. 1988.- *Acrostichum virens* Wall. ex Hook. & Grev., Ic. Fil. II: pl. 231. 1831.- *campium virens* (Hook. & Grev.) Presl, Tent. Pterid.: 239. 1836.- *Bolbitis costata* auct. non (Presl) Ching: Holttum, Dansk Bot. Ark. 20: 30. 1961.

Rhizome creeping, thick, densely scaly; scales thin but firm, dark brown, up to 7 by 1 mm. **Sterile frond**: stipe 30-40 cm long, densely scaly throughout, scales on upper portion light brown, ferrugineous, appressed, irregular in shape; lamina oblong-ovate to oblong, 35 by 25 cm; lateral pinnae 5 pairs, stalked, straight, ascending or patent in lower ones, oblong to oblong-lanceolate, caudate at apex, narrowly cuneate or unequally rounded at base, up to 18 by 1.5 cm, toothed at margin, mor or less waved; costa minutely scaly beneath, veins slightly raised on under surface, reticulate with a few included veinlets 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 45 cm long; laminar up to 25 by 12 cm; pinnae 4 pairs, linear, acuminate at apex, stalked, up to 10 by 0.5 cm; sporangia dispersed on the whole undersurface of pinnae (Figure 5.84, 5.85).

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

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

Ecology.- On mountain sloprs often near streams in hill evergreen forest at 1200 m alt.

Vernacular.- Kut ngong (กูดง้อง) (North-eastern)

Specimens examined.- *W. Rattanathirakul* 189 (BCU): *E. Hennipman* 3159; *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 372, T 1086 (BKF).

2. ELAPHOGLOSSUM

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

Rhizome creeping, bearing two rows of fronds on dorsal surface, scaly. Lamina simple, entire, usually coriaceous, dimorphic. **Stipe** SW.ollen at base, jointed to rhizome; vein simple or forked, parallel or anastomosing in some species. **Sporangia** covering the whole lower surface of fertile frond (acrostichoid).

Key to the species

1. Frond coriaceous, margin with cartilaginous membrane, surface subglabrous or covered with usually adherent scales, without long-armed stellate hair
1. E. malayense
1. Frond thick herbaceous or soft in texture, margin without distinct cartilaginous membrane, surfaces conspicuously covered with long-armed stellate hairs
2. E. stelligerum

1. *Elaphoglossum malayense* Holttum, Blumea 14: 322. 1966; in Fl. Mal. II. 1: 308. 1978; Tagawa & K. Iwats., Fl. Thailand 3(3): 308. 1988.- *Elaphoglossum callifolium* auct. Non (Blume) Moore: Tard. & C. Chr. in Fl. Gén. I.-C. 7(2): 541. 1941; Holttum, Rev. Fl. Malaya 2: 459. f. 269. 1955.

Rhizome short, densely covered with scales; scales brown, membranous, oblong-lanceolate, up to 10 by 1 mm, entire or with irregular projections at margin. **Sterile frond**: stipe up to 3 cm long, stramineous with dark base, slightly winged on upper part, scales at base dense like those on rhizome becoming more sparse upwards; lamina oblong-lanceolate to linear-lanceolate, gradually narrowing towards both ends, 20 by 2.2 cm, entire, narrowly marginate with cartilaginous membrane; midrib raised on both surface, very sparsely minutely scaly or glabrescent; coriaceous, veins visible on both surfaces, green, usually brownish in dried specimens. **Fertile frond**: stipe up to 6 cm long, gradually narrowing towards both ends, 15 cm long, about 2 cm broad (Figure 5.88, 5.89).

Thailand.- NORTH-EASTERN: Loei (Phu Kradueng); EASTERN: Nakhon Ratchasima (Khao Yai); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); SOUTH-WESTERN: Kanchanaburi (Sai Yok, Erawan Falls, Song Tho, Chedi Sam Ong);

PENINSULAR: Surat Thani (Ko Phangan), Nakhon Si Thammarat (Khao Luang), Trang (Khao Chong),Phangnga (Khao Phra Mi).

Distribution.- Annam and Malaysia (type).

Ecology.- On mossy tree-trunks in hill evergreen forest at 1250 m alt.

Specimens examined.- *W. Rattanathirakul* 100 (BCU): *E. Hennipman* 3866; *K. Iwatsuki* T 30845; *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 6829 (BKF).

2. *Elaphoglossum stelligerum* (Wall. ex Baker in Hook. & Baker) T. Moore ex Alston & Bonner, Candollea 15: 216. 1956; Holttum, Rev. Fl. Malaya 2: 455. f. 264. 1955; Tagawa & K. Iwats., Fl. Thailand 3(3): 304. 1988.- *Acrostichum stelligerum* Wall. ex Baker in Hook. & Baker, Syn. Fil. (ed. 2) 521. 1874.- *Elaphoglossum yunnanense* (Bak.) C. Chr., Contr. U.S. Nat. Herb. 26: 327, 335. 1931.- *Elaphoglossum viscosum* auct. non J. Smith: Bedd., Handb.: 420. f. 250. 1883.

Rhizome short-creeping, densely scaly throughout; scales light brown, up to 4 by 0.3 mm, persistent, subentire or with irregular teeth at margin. **Sterile frond**: stipe stramineous, 6-9 cm in length, densely scaly throughout; scales various, like those on rhizome, minute and hair-like, or stellate; lamina linear-lanceolate, gradually narrowing towards both ends, 25 by 1.3 cm; midrib raised on both surfaces, densely covered with scales; veins simple or a few times forked, parallel, the apex ending at margin of frond, hardly visible on both surfaces on distinct on lower surface in dried specimen; papyraceous, deep green, densely covered on both surfaces with brown long-armed stellate scales, upper surface of lamina often glabrescent. **Fertile frond**: lower than the sterile one; stipe like those of the sterile fronds, longer, about 11 cm; lamina linear, acute at apex, 15 by 0.5 cm, densely covered with stellate scales on upper surface (Figure 5.86, 5.87).

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

Distribution.- N. India (type), SW., China and Annam.

Ecology.- On muddy rocks by streams or mossy tree-trunks in hill evergreen forest at 1300 m alt.

Specimens examined.- Specimens examined.- *W. Rattanathirakul* 133 (BCU): *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 603, T 620 T 789 (BKF).

THELYPTERIDACEAE

Ching ex Pic. Serm., Webbia 24: 709. 1970; Holttum, in Fl. Mal. II. 1: 331. 1981; Kuo, Fl. Taiwan Vol. 1.2nd ed.: 401. 1980.

Rhizome erect, short-creeping or long-creeping; scales usually thin, not peltate. **Stipe** not articulated to stem, containing two vascular bundles at base and uniting into a U-shaped bundle in the upper part. **Lamina** usually pinnate with crenate or lobed pinnae, upper suefaces of costae grooved or not, if grooved, not open to admit grove of rachis; lowest pinnae 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 renifrom, glabrous or bearing hairs and/or glands.

Key to the genera

1. Reduced pinnae usually present at base of frond or without such pinnae mostly having broad subentire normal pinnae
   2. Areophores, SW.ollen
      3. Broad thin scales, lacking superficial hairs, on base of stipe; capitate hairs, rarely setae, or neither, on sporangia **3. Pneumatopteris**
      3. Scales on base of stipe narrow, hairy on surface; spherical glands on setae usually present on sporangia **4. Pronephrium**
   2. Areophores not rarely SW.ollen
      4. Basal large pinnae much narrowed at base; 1-2 pairs of reduced basal pinnae inconstantly present **1. Amphineuron**
      4. Basal pinnae not much narrowed at base, usually auricled; a few pairs of lower pinnae gradually reduced, lowest not very small **2. Christella**
1. No reduced pinnae at base of frond; subentire pinnae with goniopteroid or meniscioid venation rarely present **5. Trigonospora**

1. AMPHINEURON

Holttum, Blumea 19: 45. 1971; in Fl. Mal. II. 1: 544. f. 19. 1981.- *Thelypteris* Schmidel, Icon. Pl., ed. Keller 3, 45-48. 1763; Tagawa & K. Iwats., Fl. Thailand 3(3): 393. 1988.

Rhizome erect, or short- or long-creeping; scales narrow, setiferous; stipe minutely hairy, scaly at the base; lamina often very large, pinnate, veins pinnate in the pinnae-lobes, simple, basal veins either free and passins to the margin separately, or connivent at the sinus-membrane, or anastomosing to from an excurrent vein; sinus-membrane usually ending in a prominent tooth; short acicular hairs always present on some part of lower surface. Sori medial, supramedial or close to margins of lobes; indusia usually present, often with some short acicular hairs and a few small glandular hairs.

Amphineuron terminans (J. Sm.) Holttum, Amer. Fern J. 63(3): 82. 1973; in Fl. Mal. II. 1: 545. f. 19a. 1981.- *Nephrodium terminans* J. Sm., Bot. Mag. 72 (Companion): 32. 1846.- *Thelypteris terminans* (Hook.) Tagawa & K. Iwats., Acta Phytotax. Geobot. 26: 169. 1975; Tagawa & K. Iwats., Fl. Thailand 3(3): 432. 1988.- *Nephrodium terminans* Hook., Sp. Fil. 4: 73. 1862.- *Nephrodium pteroides* auct. non (Retz.) J. Smith: Bedd., Hand.: 269. 1883.- *Dryopteris pteroides* auct. non (Retz.) O. Ktze. : C. Chr., Contr. U.S. Nat. Herb. 26: 184. 1931.- *Cyclosorus interruptus* auct. non (Willd.) H. Ito: Ching, Bull. Fan Mem. Inst. Biol. 8: 184. 1938; Holttum, Rev. Fl. Malaya 2: 262. f. 149. 1955.- *Thelypteris interrupta* auct. non (Willd.) K. Iwats.: Tagawa & K. Iwats., Southeast As. St. 3(3): 79. 1965.- *Cyclosorus extensus* auct. non (Blume) Ching: Holttum, Dansk Bot. Ark. 20: 23. 1961.

Rhizome long-creeping, about 1 cm diam.; scale narrow, brown, up to 12 by 1.3 mm, hairy. Stipe up to 100 cm long, stramineous with dark scaly base, pubescebt. **Lamina** oblong-lanceolate, acute at apex, 100 cm or more long, about 60 cm wide; lateral pinnae more than 30 pairs, basal pinnae not or little reduced, patent to ascending, lower ones linear, straight, gradually narrowing towards long-acuminate apex, cuneate and shortly stalked at base, up to 33 by 2 cm, lobed to half-way to costa; segments oblong, oblique, round to moderately acute at apex, entire; papyraceous, green; veins pinnate, veinlets simple, hairy, basal 1-1.5 pairs uniting with those of the next group below sinus. **Sori** confined to upper part of segments, often hallowed; indu1sia persistent, hairy.

Thailand.- Common all over country.

Distribution.- Tropics of Asia (type from Burma) to Australia (Queensland).

Ecology.- On rather dry mountain slopes in hill evergreen forest at 1250 m alt.

Specimens examined.- *W. Rattanathirakul* 163; *T. Boonkerd* 605, 729 (BCU): *M. Tagawa,T. Shimizu, M. Hutoh, H. Koyama* and *A. Nalampoon* T 9747 (BKF).

2. CHRISTELLA

H. Lév., Fl. Kouy-Tchéou. 472. 1915; Holttum, in Fl. Mal. II. 1: 550. f. 20. 1981; Kuo, Fl. Taiwan Vol. 1. 2nd ed.: 402. 1980.- *Thelypteris* Schmidel, Icon. Pl., ed. Keller 3, 45-48. 1763; Tagawa & K. Iwats., Fl. Thailand 3(3): 393. 1988.- *Nephrodium* Schott, Gen. Fil. t. 10. 1834.- *Thelypteris* subg. *Cyclosoriopsis* K. Iwats, Mem. Coll. Sci. Univ. Kyoto B, 31. 28. 1964.

Rhizome erect, suberect or creeping; scales almost always narrow with many superficial hairs. **Lamina** bipinatifid with lobed pinnae, sinus membrane present; lower pinnae never or only gradually shortened, but not abruptly shortened; upper surface of costae grooved. Venation goniopteroid. Sporangium with a single cylindric unicellular hair on stalk.

Key to the species

1. Rhizome short or creeping
   2. Rhizome short, or shortly creeping, lower pinnae gradually becoming smaller downwards, indusia large, densely hairy **1. C. dentata**
   2. Rhizome long-creeping, lower pinnae reduced to mere auricles, indusia glabrous or sparsely hirsute **3. C. subpubescens**
1. Rhizome short, erect, basal pinnae slightly shortenrd and deflexed **2. C. siamensis**

1. *Christella dentata* (Forssk.) Holttum, J. S. African Bot 40(2): 143. 1974; Kuo, Fl. Taiwan Vol. 1.2nd ed.: 404. 1980.- *Polypodium dentatum* Forssk. Fl. Aegypt.-Arab. 185. 1775.- *Thelypteris dentata* (Forssk.) St. John, Amer. Fern J. 26: 44. 1966; Tagawa & K. Iwats., Fl. Thailand 3(3): 427. 1988.- *Cyclosorus dentatus* (Forssk.) Ching, Bull. Fan Mem. Inst. Biol. 8: 206. 1938.- *Christella dentata* (Forssk.) Brownsey & Jermy, Brit. Fern Gaz. 10: 338. 1973; in Fl. Mal. II. 1: 557. f. 1 p, 20a. 1981.- *Cyclosorus subpubescens* auct. non (Blume) Ching; Holttum, Rev. Fl. Malaya 2: 273. f. 157. 1955.

Rhizome short, erect, ascending, or shortly creeping, with a tuft of fronds; scales narrow, about 8 by 1.5 mm, pale brown, hairy. **Stipe** about 30 cm long, bearing reduced pinnae on upper portion, scaly at base, hairy throughout. **Lamina** narrowly oblong, acute at apex, gradually narrowing downwards, up to 75 by 25 cm; lateral pinnae about 20 pairs, patent to ascending, sessile, linear-lanceolate, more or less auricled at base, gradually narrowing towards long-acuminate apex, up to 14 by 2 cm, lobed 1/3 to 2/3 way costa; lower pinnae gradually becoming smaller downwards but rarely reduced to mere 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, Dansai), Khon Kaen (Pha Nok Khao); CENTRAL: Nakhon Nayok (Khao Yai), Saraburi (Muak Lek), Krung Thep (Bangkok, Khlong San); SOUTH-EASTERN: Prachin Buri (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.- On rather dry ground slopes in hill evergreen forest at 1300 m alt.

Specimens examined.- *W. Rattanathirakul* 60 (BCU): *M. Tagawa*, *K. Iwatsuki* and *N. Fukuoka* T 308, T 2036 (BKF).

2. *Christella siamensis* Tagawa & K. Iwats., Kew Bull. 31: 332. 1976; *Thelypteris siamensis* Tagawa & K. Iwats., Acta Phytotax. Geobot. 22: 101. f. 5. 1967; Tagawa & K. Iwats., Fl. Thailand 3(3): 426. f. 44. 7-9. 1988.

Rhizome erect; scales linear-lanceolate with long tails, up to 10 by 0.7 mm, sparsely hairy at margin. **Stipe** densely scaly at base, hirsute throughout, up to 35 cm long. **Lamina** oblong-lanceolate, acute at apex, up to 50 by 22 cm; a few lower pinnae slightly reduced, defiexed, auricled at acroscopic base, middle larger ones falcate, sessile, linear-lanceolate, long-acuminate at apex, broadly cuneate to truncate at base, up to 12 by 1.7 cm, lobed to 2/3 way to costa; segments oblong, oblique, rounded to moderately acute at apex, entire; papyraceous, hairy on surface; basal

veinlets uniting to from goniopteroid venation. **Sori** medial to supramedial; indusia round-renifrom, persistent, densely hirsute (Figure 5.90).

Thailand.- NORTH-EASTERN: Phetchabun (Phu Miang), Loei (Phu Luang, type).

Distribution.- Endemic.

Ecology.- On humus-rich mountain slopes in hill evergreen forest at 1450 m alt.

Specimens examined.- *W. Rattanathirakul* 47, 61 (BCU): *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 1277; *J.F. Maxwell* 97-703 (BKF).

3. *Christella subpubescens* (Blume) Holttum, Kew Bull. 31: 323. 1976; in Fl. Mal. II. 1: 558. f. 20g.1981.- *Aspidium subpubescens* Blume, Enum. Pl. Javae 2: 149-150. 1828..- *Thelypteris subpubescens* (Blume) K. Iwats., Mem. Coll. Sci. Univ. Kyoto B. 31: 173. 1965; Tagawa & K. Iwats., Fl. Thailand 3(3): 428. 1988.- *Cyclosorus subpubescens* (Blume) Ching, Bull. Fan Mem. Inst. Biol. 8: 211. 1938; Holttum, Rev. Fl. Malaya 2: 273. f. 157. 1955.- *Cyclosorus parasiticus* var. *subpubescens* (Blume) Tard & C. Chr., Notul. Syst. 7: 78. 1938.

Rhizome long-creeping, with remote stipes; scales narrow, about 8 by 1.5 mm, pale brown, hairy. **Stipe** about 24 cm long, bearing reduced pinnae on upper portion, scaly at base, hairy throughout. **Lamina** narrowly oblong, acute at apex, gradually narrowing downwards, up to 100 by 35 cm; lateral pinnae about 20 pairs, patent to ascending, sessile, linear-lanceolate, more or less auricled at base, gradually narrowing towards long-acuminate apex, up to 20 by 2 cm, lobed 1/3 to 2/3 way costa; lower pinnae reduced to mere auricles; segments oblong-subdeltoid, oblique, rounded at apex, entire; herbaceous to softly papyraceous, yellow-green to green, lower surface of frond subglabrous or rather sparsely hairy; basal veinlets and basal second anterior ones uniting below callous-membrane. **Sori** medial, round; indusia glabrous or sparsely hirsute.

Thailand.- SOUTH-EASTERN: Chanthaburi (Khao Soi Dao)

Distribution.- Tropical Asia (type from Java) to Australia (Queensland), north to S. Japan.

Ecology.- On rather dry mountain slopes in hill evergreen forest at 1500 m alt.

Specimens examined.- *W. Rattanathirakul* 49, *T. Boonkerd* 380, 395, 713 (BCU): *K. Iwatsuki* and *N. Fukuoka* T 3430, T 7106; *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 2429 (BKF).

3. PNEUMATOPTERIS

Nakai, Bot. Mag. Tokyo 47: 179. 1933; Holttum, in Fl. Mal. II. 1: 414. f. 11. 1981; Kuo, Fl. Taiwan Vol. 1.2nd ed.: 427. 1980.- *Thelypteris* Schmidel, Icon. Pl., ed. Keller 3, 45-48. 1763; Tagawa & K. Iwats., Fl. Thailand 3(3): 393. 1988.- *Thelypteris* subg. *Pneumatopteris* K. Iwats. Mem. Coll. Sci. Univ. Kyoto B, 31: 33. 1964.- *Cyclosorus sensu* Ching, Bull. Fan Mem. Inst. Biol. Bot. 8: 230. 1938; Holttum, Rev. Fl. Malaya 2: 255. 1955.

Rhizome short, erect. **Stipe** slightly hairy; scales broad and thin. **Lamina** abruptly narrowed at base, lower surface pustular, nearly glabrous, without spherical sessile glands; aerophores present at base of lower pinnae; venation anastomosing. **Sori** usually covered with rather thin indusia; sporangia often bearing short club-shaped glandular hairs near annulus and on the stalk.

Pneumatopteris truncata (Poir.) Holttum, Blumea 21: 314. 1973; in Fl. Mal. II. 1: 429. f. 11 d-f. 1981; Kuo, Fl. Taiwan Vol. 1. 2nd ed.: 427. pl. 149. 1980.- *Polypodium truncatum* Poir. Encycl. 5: 534. 1804.- *Thelypteris truncata* (Poir.) K. Iwats., Mem. Coll. Sci. Kyoto Imp. Univ., Ser. B, Biol. 31: 33. 1964; Tagawa & K. Iwats., Fl. Thailand 3(3): 420. 1988.- *Nephrodium truncatum* (Poir.) C. Presl, Tent. Pterid.: 81. 1836; Bedd., Handb.: 280. f. 143. 1969.- *Cyclosorus truncatus* (Poir.) Tard. ex Tard. & C. Chr., Notul. Syst. 7: 78. 1938; Holttum, Rev. Fl. Malaya 2: 266. f. 152. 1955.

Rhizome short, erect; scales brown, thin, up to 1.5 by 4 mm, consisting of large cells, hairy. **Stipe** usually more than 50 cm long, pale, dark and scaly at base, pubescent, bearing reduced pinnae in upper part. **Lamina** oblong-lanceolate, up to 100 cm or more long, 50 cm wide; lower pinnae suddenly reduced to mere auricles, middle pinnae larger, straight, ascending, up to 30 by 3 cm, lobed to 1/3 way towards costa, gradually narrowing towards long acuminate apex, broadly cuneate at sessile base, nearly parallel at margin; segments obtuse at apex, minutely dentate; papyraceous, green, verrucose on lower surface, glabrous; veins pinnate, a few pairs of basal veinlets anastomosing, free ones ending in teeth at margin of segments. **Sori** medial; indusia pale, glabrous, persistent (Figure 5.91).

Thailand.- NORTHERN: Chiang Rai (Mae Kok, Doi Tung, Mae Lao, Doi Phacho), Chiang Mai (Doi Phahom Pok, Doi Chiang Dao, Doi Suthep, Mae Klang), Mae Hong Son (Mae La Noi), Lamphun (Doi Khun Tan), Tak (Ban Musoe) Phrae (Mae Sai, Huai Hok), Phitsanulok (Thung Salaeng Luang); NORTH-EASTERN: Loei (Phu Luang); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao);

PENINSULAR: Krabi (Phanom Bencha), Surat Thani (Ban Don), Nakhon Si Thammarat (Khao Luang), Trang (Khao Chong), Yala (Khao Kala Khiri).

Distribution.- Sri Lanka, S. India, Himalaya to S. China, Burma, Indochina, Ryukyu Is., Taiwan, W. Malesia to Philippines. Sometimes all the local species are considered to be conspecific with this, and the area is then widely extended. Type was said to come from Brazil, but it is considered to be a specimen from Asia.

Ecology.- On wet ground usually along streams in hill evergreen forest at 1200 m alt.

Vernacular.- Kut kan daeng (กูดก้านแดง) (Northern).

Specimens examined.- *W. Rattanathirakul* 66, 97 (BCU): *M. Tagawa* and *Y. Yamada* T 35; *K. Iwatsuki* and *N. Fukuoka* T 7323 (BKF).

4. PRONEPHRIUM

C. Presl, Abh. Konigl. Bohm. Ges. Wiss. 6: 618-619. 1851; Holttum, in Fl. Mal. II. 1: 507. f. 14-16. 1981; Kuo, Fl. Taiwan Vol. 1.2nd ed.: 429. 1980.- *Thelypteris* Schmidel, Icon. Pl., ed. Keller 3, 45-48. 1763; Tagawa & K. Iwats., Fl. Thailand 3(3): 393. 1988.- *Haplodictyum* Presl, l.c. 50; Ching, Sunyatsenia 5: 251. 1940.- *Abacopteris* Fée, Gen. Fil. 309. 1852; Holttum, Rev. Fl. Malaya 2: 285. 1955.- *Dimorphopteris* Tagawa & K. Iwats. Acta Phytotax. Geobot. 19: 8. 1961.

Rhizome creeping or suberect; **Lamina** 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 spherical glands or both glands and setae.

Pronephrium nudatum (Roxb.) Holttum, Blumea 20: 111. 1972.- *Polypodium nudatum* Roxb., Calc. J. Nat. Hist. 4: 491. 1844.- *Thelypteris nudata* (Roxb.) Morton, Contr. U.S. Nat. Herb. 38: 352. 1974; Tagawa & K. Iwats., Fl. Thailand 3(3): 411. f. 41. 1, 42. 2-3. 1988.- *Polypodium multilineatum* Wall. ex Hook., Sp. Fil. 5: 11. 1863.- *Nephrodium moulmeinense* Bedd., Ferns Br. Ind. Suppl. 18., Sp. Fil. 5: 11. 1876; Handb. 275. f. 141. 1969.- *Nephrodium multilineatum* (Wall. ex Hook.) Bedd., Handb. Suppl.: 80. 1892.- *Dryopteris moulmeinense* (Bedd.) C. Chr., Ind. Fil.: 278. 1905.- *Abacopteris multilineata* (Wall. ex Hook.) Ching, Bull. Fan Mem. Inst. Biol. 8: 253. 1938; Holttum, Rev. Fl. Malaya 2: 297. 1955.- *Cyclosorus multilineatus* (Wall. ex Hook.) Tard. & C. Chr. In Fl. Gén. I.-C. 7(2): 113. 1959.- *Dryopteris urophyllum*

auct. non (Mett.) C. Chr.: Bonap., Not. Pterid. 14: 49. 1923.- *Nephrodium urophyllum* auct. non (Mett.) Keys.: E. Smith, J. Siam. Soc. Nat. Hist. Suppl. 8: 5. 1929.

Rhizome creeping, about 5 mm diam.; scales caducous, dark brown, hairy. **Stipe** about 100 cm long, scaly at base. **Lamina** oblong, up to 120 by 50 cm; lateral pinnae lanceolate, sessile, ascending, gradually narrowing towards long-acuminate apex, rounded to narrowly cuneate at base, subentire or crenate, up to 30 by 6 cm; terminal pinnae like lateral ones, rounded to subtruncate at base; marginal lobes acute at apex, with cartilagious margin; chartaceous, green, verrucose on lower surface; venation meniscioid. **Sori** rather close to excurrent veinlets or medial in two rows between costules; indusia setose (Figure 5.92, 5.93).

Thailand.- NORTHERN: Chiang Rai (Mae Kok, Doi Tung, Doi Phacho), Chiang Mai (Doi Phahom Pok, Doi Chiang Dao, Pong Pa Po, Pang Kia, Ban Mae Kon, Doi Suthep, Wang Tao, Pong Khrai, Ban Huai Khrai), Mae Hong Son (Mae La Noi, Pha Mong), Lampang, Tak (Ban Musoe), Nan (Pha Sing), Phitsanulok (Thung Salaeng Luang), Phrae (Mai Sai); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao, Pong Nam Ron), Trat (Ko Chang); SOUTH-WESTERN: Kanchanaburi (Wangka); PENINSULAR: Surat Thani (Ko Tao), Nakhon Si Thammarat (Khao Luang, Khiriwong), Phangnga, Yala (Bannan Sata).

Distribution.- Himalaya (type), Burma, China and N. Vietnam.

Ecology.- On rather dry ground slopes in hill evergreen forest at 1450 m alt.

Vernacular.- Kut daeng (กูดแดง) (South-eastern).

Specimens examined.- *W. Rattanathirakul* 94; T. Boonkerd 712 (BCU): *K. Iwatsuki* and *N. Fukuoka* T 3439, T 7320 (BKF).

5. TRIGONOSPORA

Holttum, Blumea 19(1): 29. 1971; Holttum, Fl. Mal. II. 1: 373. 1981.- *Thelypteris* Schmidel, Icon. Pl., ed. Keller 3, 45-48. 1763; Tagawa & K. Iwats., Fl. Thailand 3(3): 393. 1988.- *Pseudocyclosorus* Ching, Acta Phytotax. Sinica 8. 322. 1963.

Rhizome short, erect; lacking reduced basal pinnae; veins free, unbranched, lowest acroscopic vein ending beside short sinus-membrane, basal basiscopic vein to edge above base of sinus; acicular unicellular hairs variously developed on lower surface; sori indusiate; glands and hairs lacking on body of sporangium, on its stalk usually a hair of several cells ending in a gland.

Trigonospora ciliata (Wall. ex Benth.) Holttum, Blumea 19: 29. 1971; in Fl. Mal. II. 1: 375. f. 5, c-e. 1981.- *Aspidium ciliatum* Wall. ex Benth., Fl. Hongk.: 455. 1861.- *Thelypteris ciliata* (wall. ex Benth.) Ching, Bull. Fan Mem. Inst. Biol., Bot. 6(5): 289. 1936; Holttum, Rev. Fl. Malaya 2: 250. f. 142. 1955; Tagawa & K. Iwats., Fl. Thailand 3(3): 401. f. 39. 6-9. 1988.- *Lastrea calcarata* var. *ciliata* (Benth.) Bedd., Handb.: 235. f. 121. 1883.

Rhizome short, erect; scales up to 3 by 1.5 cm, membranous, appressed, brown, hairy. **Stipe** Stramineous to grayish, hairy throughout, about 15 cm long. **Lamina** pinnate, oblong-lanceolate, acute at apex, 15-25 by 6-10 cm; lowest pinnae shortened, deflexed, pinnae of lower 1/3 largest, patent, subsessile, linear-lanceolate, caudately acuminate at apex, broadly cuneate at base, often auricled; rachis and costa densely hirsute;segments falcate, oblique, rounded at apex, subentire, hairy at margin; chartaceous or thicker, deep green; veins pinnate, veinlets simple, basal anterior ones running to sinus, hairy. **Sori** subcostular, often confluent at maturity; indusia firm, persistent, hairy.

Thailand.- NORTHERN: Chiang Rai (Doi Phacho), Chiang Mai (Doi Phahom Pok, Ya Na, Doi Suthep, Doi Inthanon), Tak (Huai Krasa), Phitsanulok (Salaeng Haeng), Phrae (Mae Sai); NORTH-EASTERN: Phetchabun (Phu Miang), Loei (Phu Tong); SOUTH-EASTERN: Chanthaburi (Khao Sabap); PENINSULAR: Nakhon Si Thammarat (Khao Luang, Ban Khiri Wong), Yala (Ban Chana).

Distribution.- Napal to W. Malesia, north to Hong Kong (type).

Ecology.- On humus-rich mountain slopes or on muddy stream-beds in hill evergreen forest at 1250 m alt.

Specimens examined.- *W. Rattanathirakul* 45, 84 (BCU): *K. Iwatsuki* and *N. Fukuoka* T 3691, T 3956; *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 5300 (BKF).

WOODSIACEAE

(Hook.) Herter, Revista Sudamer. Bot. 9. 14. 1949.- *Athyriaceae* Alston, Taxon 5: 25. 1956; Devol and Kuo, Fl. Taiwan Vol. 1.2nd ed.: 441. 1980; Tagawa & K. Iwats., Fl. Thailand 3(3): 436. 1988.

Rhizome usually short and stout, sometimes creeping and slender; scales thin, light brown to dark brown, lanceolate or ovate. **Lamina** usually thin, pinnate to decompound, rarely simple; veins usually free, goniopteroid or forming areolae, usually glabrous; rachis groove generally open to receive rachilla grooves but not in

all genera. **Sori** elongate or round to oblong, usually present, round-reniform or horse-shoe-shaped or naked.

Key to the genera

1. Indusia rarely on both sides of veins, horse-shoe-shaped or hooked **1. Athyrium**
1. Indusia usually on both sides of veins, sori elongate along veins **2. Diplazium**

1. ATHYRIUM

Roth, Röm. Mag. 2(1): 105. 1799; Tagawa & K. Iwats., Fl. Thailand 3(3): 445. 1988.

Rhizome creeping, ascending or erect, scaly; scales concolorous or discolorous, with thin cell walls, glabrous. **Lamina** simply pinnate to pinnately compound; rachis grooved, groove decurrent to that on costa, hairy or glabrous; veins pinnate, all free; hairs coarse, multicellular if any. **Sori** dorsal on veinlets, elongate or short; indusia unequally round- reniform, horse-shoe-shaped, hooked, or crescentic, very rarely wanting.

Athyrium mackinnonii (Hope) C. Chr., Ind. Fil.: 143. 1905; Tagawa & K. Iwats., Fl. Thailand 3(3): 446. f. 48. 2. 1988.- *Asplenium mackinnonii* Hope, J. Bot. 124. 1896.

Rhizome erect, with a few fromds at apex, scaly; scales narrow with long-tailed apex, up to 8 by 0.8 mm, dark brown, entire. **Stipe** up to 30 cm long, stramineous, dark brown and scaly at base. **Lamina** broadly oblong, acute at apex, up to 35 by 25 cm, bipinnate-tripinnatifid; pinnae about 10 pairs, lower pinnae stalked , ascending, oblong-lanceolate, up to 15 by 5 cm, the upper pinnae becoming smaller upwards; pinnules subsessile or shortly stalked, oblong, oblique, moderately acute to rounded at apex, truncate to auricled at anterior and cuneate at posterior bases, about 2.5 by 1 cm; ultimate segments oblong, rounded at apex, distinctly toothed; papyraceous to subcoriaceous; veins pinnate, veinlets simple or rarely forked, ending in teeth at margin of segments. **Sori** oblong, usually close to costules; indusia opening anteriorly, oblong, crenate at margin.

Thailand.- NORTHERN: Chiang Mai (Doi Phahom Pok, Doi Inthanon), Phitsanulok (Phu Miang); NORTH-EASTERN: Loei (Phu Kradueng); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao).

Distribution.- India (type), SW.. China and Indochina.

Ecology.- On rather dry mountain slopes in hill evergreen forest at 1500 m alt.

Specimens examined.- *W. Rattanathirakul* 9 (BCU): *K. Iwatsuki* and *N. Fukuoka* T 7168; *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 616, T 3026 (BKF).

2. DIPLAZIUM

SW., Schrad. J. Bot. 1800(2): 61. 1801; Tagawa & K. Iwats., Fl. Thailand 3(3): 449. 1988.- *Callipteris* Bory in Belanger, Voy. 1: 282. 1804.- *Athyrium* Roth, Röm. Mag. 2(1): 105. 1799.

Rhizome creeping to rect, scaly; rhizome-scales entire or toothed; rachis grooved, the grooves distinct, open. **Lamina** 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; indusia crescentic, often adjacent to the next ones, opening in opposite direction.

Key to the species

1. Frond pinnate
   2. Rhizome short, erect, lateral pinnae with lobed half-way to costa **1. D. siamense**
   2. Rhizome creeping, lateral pinnae with subentire or serrate at margin **3. D. sp.**
1. Frond bipinnate or more compound **2. D. simplicivenium.**

1. *Diplazium siamense* C. Chr., Contr. U. S. Nat. Herb. 26: 332. pl. 26. 1931; Tagawa & K. Iwats., Fl. Thailand 3(3): 460. 1988.- *Diplazium latilobum* Holttum, Dansk Bot. Ark. 23: 308. 1966.

Rhizome erect; scales concolorous, brown, about 12 by 1.2 mm, irregularly minutely toothed. **Stipe** about 50 cm long, stramineous with dark scaly basal portion. **Lamina** oblong with acute apex, up to 50 by 45 cm, pinnate; lateral pinnae about 7 pairs below indistinct terminal portion of frond, with distinct stalks more than 1 cm long, gradually narrowing towards long acuminate apex, rounded to cuneate at base, up to 30 cm long, 3.5 cm wide in middle, lobed half-way to costa; terminal portion of frond lobed near base, gradually narrowing towards attenuate apex, up to 20 cm long; rachis and costa often minutely scaly, veins pinnate with 6-9 pairs of simple veinlets, the basal anterior ones ending below the sinus between lobes; lobes oblong, oblique, rounded to obtuse at apex, serrate; thinly chartaceous, green to deep green, paler below. **Sori** along veinlets, those on basal anterior veinlets not exceptionally elongate, rarely diplazioid; indusia thin but firm, persistent (Figure 5.94).

Thailand.- NORTHERN: Chiang Rai (Doi Phacho), Chiang Mai (Doi Suthep type), Phitsanulok (Phu Rom Rot), Phrae (Mae Sai); NORTH-EASTERN: Phetchabun (Phu Miang), Loei (Phu Luang).

Distribution.- Endemic to northern Thailand.

Ecology.- On humus-rich mountain slopes in hill evergreen forest at 1300 m alt.

Specimens examined.- *W. Rattanathirakul* 98 (BCU): *E. Hennipman* 3621; *K. Iwatsuki* T 4462; *K. Iwatsuki* and *N. Fukuoka* T 3681(BKF).

2. *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.

Rhizome massive, erect, bearing a tuft of gigantic fronds; scales about 15 by 1.6 mm, brown, black-margined, toothed. **Stipe** up to 100 cm long. **Lamina** about 130 cm, bipinnate; lower pinnae about 50 by 25 cm, narrowly oblong with acute apex; larger pinnules shortly stalked or subsessile, narrowly oblong-subtriangular, gradually narrowing towards a long acuminate apex, broadly cuneate to sub truncate or subcordate at base, usually shallowly lobed, up to 13 by 3 cm; lobes subquadrangular, obtuse at apex, subentire, 5-8 mm in breadth; softly papyraceous, green; veins pinnate with 4-6 pairs of simple veinlets; veinlets hardly reaching the margin of lobes, basal anterior ones stopping far below the sinus. **Sori** about 8 mm long (Figure 5.95).

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.- Malaya (type) and probably also in Borneo.

Ecology.- On moist mountain in hill evergreen forest at 1600 m alt.

Specimens examined.- *W. Rattanathirakul* 57 (BCU): *M. Tagawa* and *I. Yamada* T 202; *Tagawa, K. Iwatsuki* and *N. Fukuoka* T 6982 (BKF).

3. Diplazium sp.

Rhizome creeping, stout, scales lanceolate, 7 by 1.2 mm, dark brown, toothed at margin. **Stipe** up to 45 cm long, stramineous with dark basal protion, glabrous. **Lamina** pinnate, up to 50 by 25 cm, terminal pinnae to 25 cm long by 3.5 cm wide, margin crenately lobed, lateral pinnae 5-6 pairs, about 20 by 2.5-3.5 cm, stalk distinct, more than 5 mm long, cuneate at base, subentire or serrate at margin, veins all free.

Sori linear, somewhat curved, reaching from costa to margin; indusia very narrow (Figure 5.96, 5.97).

Thailand.- NORTHERN: Phitsanulok (Phu Hin Rong Kla).

Distribution.- N/A

Ecology.- On humus-rich mountain slopes in hill evergreen forest at 1500 m alt.

Vernacular.- N/A

Specimens examined.- (BCU) *W. Rattanathirakul* 29, 106.

Note.- *Diplazium* sp. is a terrestrial fern on humus-rich mountain slopes in hill evergreen forest at 1500 m alt. It is a closed to *Diplazium. mettenianum* (Miq.) C. Chr. and Diplazium donianum (Mett.) Tardieu. However, their frond and sori characters are different.

ORDER DAVALLIALES

DAVALLIACEAE

Mett. ex A.B. Frank, Syn. Pflanzenk. (ed. 2) 3: 1453, 1474. 1877; Devol and Yang, Fl. Taiwan Vol. 1. 2nd ed.: 270. 1980.

Mostly epiphytes with long creeping scaly rhizomes. **Stipe** articulate to rhizome. **Lamina** uaually 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.

Key to the genera

1. Sori indusiate
   2. Rhizome scaly, or scaly and hairy, roots borne on all sides of rhizome, rachis not raised on adaxial side **4. Leucostegia**
   2. Rhizome scaly, not hairy, rooth restricted to the ventral side of rhizome, rachis raised on adaxial side.
      3. Indusia attached by base and sides **1. Davallia**
      3. Indusia attached by base only, or rarely also by a little above the base **3. Humata**
1. Sori exindusiate, rachis not raised on the adaxial side **2. Gymnogrammitis**

1. DAVALLIA

J. E. Smith, Mém. Acad. Turin. 5: 414. 1793; Tagawa & K. Iwats., Fl. Thailand 3(2): 157. 1985.

Rhizome long-creeping, usually thick, densely scaly with peltate or cordate scales. **Stipe** neked, articulated to rhizome. Lamina of fronds in Thai species finely dissected, usually deltoid, coriaceous to chartaceous, green, glabrous. **Sori** round, terminal on veins, usually closes to margin; indusia attached by base and sides, cup-shaped.

Davallia trichomanoides Blume, En. Pl. Jav.: 238. 1828; Holttum, Rev. Fl. Malaya 2: 361. 1955; Tagawa & K. Iwats., Fl. Thailand 3(2): 162. 1985.

Rhizome long-creeping, 3-5 mm diam., densely throughout; scales various as noted in the key to the varieties. **Stipe** stramineous, about 10-14 cm long. **Lamina** deltoid or roundly pentagonous, gradually narrowed from base to apex, about 14 cm long and wide, or up to 28 cm long, tripinnate to quadripinnatifid; basal pinnae the largest, gradually narrowed from base to acute apex, normally 13 by 6 cm, shortly stalked; upper pinnae gradually smaller upwards; pinnules subsessile or larger ones very shortly stalked, moderately acute to acute at apex, cuneate at base, lobed at margin; lobes acute at apex, subcoriaceous, glabrescent, green, paler beneath; veins pinnate, hardly distinct. **Sori** terminal on veinlets; indusia cup-shaped, up to 2 mm long, 0.7 diam.

Key to the varieties

1. Scales gradually narrowing from peltate base to acuminate apex, bright brown, entire and nearly glabrous to short-hairy at margin. Ultimate segments lobed more than half-way towards midribs **a.** var. **trichomanoides**
1. Scales abruptly narrowing above the base to from long tail, dark except for those on young rhizome, with long paler hairs at margin; hairs longer than the breadth of scales. Ultimate segments very shallowly lobed **b.** var. **lorrainii**

a. var. **trichomanoides**- *Davallia bullata* Wall. ex Hook., Sp. Fil. 1: 169. t. 50 B. 1846; Bedd., Handb.: 61. f. 31. 1969; Tagawa & K. Iwats., Fl. Thailand 3(2): 163. 1985 (Figure 5.99).

Thailand.- NORTHERN: Chiang Mai (Doi Phahom Pok); PENINSULAR: Surat Thani (Ban Don).

Distribution.- Ceylon, Himalayas, Indochina (Tonkin) and Malesia (type from Java).

Ecology.- On mossy tree-trunks in hill evergreen forest at 1350 m alt.

Specimens examined.- *W. Rattanathirakul* 123 (BCU): *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 401, T 4691, T 5287 (BKF).

b. var. **lorrainii** (Hance) Holttum, Rev. Fl. Malaya 2: 361. 1955; Tagawa & K. Iwats., Fl. Thailand 3(2): 163. 1985.- *Davallia lorrainii* Hance, Ann. Sci. Nat. 5: 254. 1866; Bedd., Handb.: 61. 1969 (Figure 5.98)

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

Distribution.- Central Burma, Indochina and throughout Malesia (type from Malaya).

Ecology.- On mossy rocks or bases of tree-trunks in hill evergreen forest at 1300 m alt.

Specimens examined.- *W. Rattanathirakul* 124 (BCU): *T. Shimizu, M. Hutoh* and *D Chaiglom* T 8957; *M. Tagawa, K. Iwatsuki, H. Koyama, N. Fukuoka, A. Nalampoon* and *A. Chintayungkun* T 9326 (BKF).

2. GYMNOGRAMMITIS

Griff., Ic. Pl. As. 2: pl. 129. f. 1. 1849.- *Araiostegia* Copel., Phil. J. Sci. 34: 240. 1927.- Tagawa & K. Iwats., Fl. Thailand 3(2): 150. 1985.

Rhizome long-creeping, scaly throughout; scales attached basally, concolorously brown, broad, moderately acute to acuminate, not aciculate. **Stipe**

articulated to rhizome; rachis groove decurrent to those of costa and costule. **Lamina** pinnately decompound, usually finely dissected, thin, glabrous. **Sori** round, dorsal on veinlets, one for each segment, exindusiate.

Gymnogrammitis dareiformis (Hook.) Ching ex Tardieu & C. Chr. in Fl. Gén. 1.- C. 7(2): 117. f. 14, 1-2. 1939.- *Polypodium dareiforme* Hook., Sec. Cent. Ferns: t. 24. 1860.- *Araiostegia dareiformis* (Hook.) Copel., Univ. Calif. Publ. Bot. 12: 398. 1931; Tagawa & K. Iwats., Fl. Thailand 3(2): 151. f. 11.1. 1985.- Bedd., Handb.: 316. f. 169. 1969.- *Leucostegia dareiformis* (Hook.) Bedd., Ferns Br. Ind. Suppl.: 4. 1876.

Rhizome wide-creeping, about 3 mm diam., densely scaly; scales gradually narrowing from base towards tailed apex, 4.5 mm long, up to 0.7 mm broad, pale brown or brown in age with dark brown central portion, thin and ferrugineous. **Stipe** stramineous to brown, scaly at base, glabrous upwards. **Lamina** oblong, acute to acuminate at apex, tripinnate to quadripinnatifid, up to 25 by 13 cm; costae like the upper part of pinnae, winged in upper portion; pinnae about 10 pairs, alternate, oblong-subdeltoid, gradually narrowing towards acute apex, falcate, up to 8 by 3 cm, distinctly stalked; pinnules subdeltoid on short stalks, acute at apex, broadly cuneate at base, up to 3 by 2 cm; ultimate segments simple or forked, one-nerved, entire, acute at apex; herbaceous to softly papyraceous, deep green, glabrous. **Sori** dorsal on veinlets, one for each segment, exindusiate (Figure 5.100).

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

Distribution.- Himalaya (type from Khasia Hills), SW.. China, Hainan and Tonkin.

Ecology.- Epiphytic on mossy tree-trunks in hill evergreen forest at 1600 m alt.

Vernacular.- Kut long (กูดลอง) (Northern).

Specimens examined.- *W. Rattanathirakul* 149; *T. Boonkerd* 88 (BCU): *K. Iwatsuki*, *N. Fukuoka* and *A. Chintayungkun* T 9639 (BKF).

3. HUMATA

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

Rhizome long-creeping, densely scaly with peltate scales, bearing stipes remotely. **Stipe** articulated to rhizome, grooved above. **Lamina** simple to

tripinnatifid, coriaceous, glabrous. **Sori** round, terminal on veinlets, marginal; induaia attached only by base, or rarely by the sides a little above the base as well.

Humata repens (L. f.) J. Small ex Diels, in Pflanzenfam. 1(4): 209. 1899; Holttum, Rev. Fl. Malaya 2: 371. f. 216. 1955; Devol and Yang, Fl. Taiwan Vol. 1. 2nd ed.: 276. 1980; 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., Hand. Suppl.: 12. 1892.

Rhizome long-creeping, about 1.5 mm diam., glabrous, densely scaly throughout; scales acuminate at basal edge, long-acuminate at apex, up to 7.5 by 1 mm, brown. **Stipe** stramineous, terete, up to 7 cm long, sparsely scaly. **Lamina** oblong-subdeltoid or roundly pentagonous, 7.5 by 4.5 cm; basal pinnae the largest, oblong-subdeltoid, pinnatifid to pinnate; upper pinnae shallowly lobed or entire, sessile or adnate; basal pinnules of basal pinnae lobed in larger ones, coriaceous, glabrous. **Sori** marginal, small; indusia nearly semi-circular, entire and free except for the base to 1 mm broad (Figure 5.102).

Thailand.- NORTHERN: Mae Hong Son (Doi Pha Dam), Chiang Rai (Doi Tung), Chiang Mai (Doi Chiang Dao, Doi 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 (Ko 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 Mi), Trang (Khao Chong), Yala (Gunong Ina, Khao Kala Khiri).

Distribution.- Widely distributed in the tropics of the Old World: Madagascar and Seychelles, Mascarene Islands, Himalayas to S. Japan (type), SE. Asia generally, through Malesia to Polynesia and Australia.

Ecology.- On mossy tree-trunks in hill evergreen forest at 1600 m alt.

Vernacular.- Kut hom bai yoi (กูดห้อมใบย่อย) (Northern); Kut thong (กูดทอง) (North-eastern); Nakkharat tua mia (นาครราชตัวเมีย) (South-eastern).

Specimens examined.- *W. Rattanathirakul* 109; *T. Boonkerd* 131, 467 (BCU): *E. Hennipman* 3645; *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 4800, T 6815 (BKF).

4. LEUCOSTEGIA

Presl, Tent. Pterid.: 94. 1836; Tagawa & K. Iwats., Fl. Thailand 3(2): 168. 1985.

Terrestrial ferns. **Rhizome** creeping, bearing both hairs and scales, with hairy roots all over the surface; rhizome-scales broad, not distinctly bicoloured, entire. **Stipe** articulated to rhizome. **Lamina** pinnately decompound, herbaceous, pale green, glabrous, ultimate segments not narrow; rachis and costa grooved on upper surface. **Sori** round, large, with large indusia; indusia fixed at base or at base and sides, reaching or surpassing the margin of segments.

Leucostegia immersa C. Presl, Tent. Pterid.: 95. t. 4. f. 11. 1836; Holttum, Rev. Fl. Malaya 2: 352. 1955; Bedd., Handb.: 51. 1969; Devol and Yang, Fl. Taiwan Vol. 1. 2nd ed.: 279. pl. 98. 1980; Tagawa & K. Iwats., Fl. Thailand 3(2): 169. f. 12. 5. 1985.- *Davallia immersa* Wall. ex Hook., Sp. Fil. 1: 156. 1846.

Rhizome wide-creeping, bearing fronds remotely; hairs rather dense, golden-yellow, multicellular, wooly; scales narrowly lanceolate, up to 4 by 0.8 mm, light brown, membranous, entire at margin. **Stipe** stramineous or brownish on lower surface, scaly at base, glabrescent upwards, up to 25 cm long. **Lamina** oblong, acuminate at apex, quadripinnatifid, up to 40 by 30 cm; pinnae more than 10 pairs, the lowest the largest, with distinct petioles, lower ones asymmetrically oblong-subdeltoid, acuminate at apex, broadly cuneate at base, up to 28 cm long and wide; pinnules oblong to subdeltoid on stalks in larger ones, secondary pinnules oblong or narrower, with 1-6 segments; ultimate segments circular to oblong or terminal ones spathulate, coarsely dentate at margin; thin herbaceous, light green, glabrous. **Sori** terminal on veinlets, one to each segments; indusia circular, attached only by base, entire, 1.3-2 mm broad, white to pale brown, glabrous(Figure 5.101).

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

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

Ecology.- Terrestrial on mountain-slopes or in muddy crevices of rocks in hill evergreen forest at 1200 m alt.

Vernacular.- Kut Mak (กูดหมัก) (Northern).

Specimens examined.- *W. Rattanathirakul* 129; *T. Boonkerd* 497 (BCU): *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 947 (BKF).

OLEANDRACEAE

Ching ex Pic. Serm., Webbia 20(2): 745. 1965; Devol and Kuo, Fl. Taiwan Vol. 1. 2nd ed.: 318. 1980.

A small family of mostly tropical ferns. **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 (rhizome), stipes tufted, atout, non-articulate. **Lamina** simple or pinnate, pinnae articulate or rachis, often caducous; venation free, once or twice forked. **Sori** round, dorsal or submarginal, born on the end of a veinlet; indusia round or reniform, sinus usually narrow.

Key to the genera

1. Frond pinnate to bipinnate; pinnae articulated to rachis, stipe not articulated, sori terminal on anterior branches of veins. **1. Nephrolepis**
1. Frond simple, stipe articulated, sori dorsal on veins **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 frond, wiry roots, and slender stolons; scales peltate, appressed, small, bicoloured with pale edge; stolons spreading, usually forming buds; roots sometimes bearing 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 crena, arranged in one row, or continuous along margin; indusia rotund-reniform, or continuous along margin.

Nephrolepis cordifolia (L.) C. Presl, Tent. Pterid.: 79. 1836; Holttum, Rev. Fl. Malaya 2: 379. 1955; Bedd., Handb.: 282. f. 144. 1969; Tagawa & K. Iwats., Fl. Thailand 3(2): 172. 1985.- *Polypodium cordiforlium* L., Sp. Pl. 2: 1089. 1753.

Rhizome short, ascending to suberect, bearing a tuft of fronds, numerous wiry roots and stolons, densely scaly; scales acuminate at basal edge and long-tailed at apical edge, narrowly lanceolate, up to 6 by 0.6 mm broad, thin, pale brown. **Stipe** terete, up to about 13 cm long, scaly with narrow scales, stramineous or darker. **Lamina** linear-lanceolate moderately acute at apex, gradually narrowing towards base, up to 100 cm or more long, 8 cm wide, pinnate; rachis grooved on upper surface, scaly above; leteral pinnae up to 100 pairs; middle ones larger, patent, acute to moderately acute at apex, truncate at base, auricled at anterior base, sessile, up to 4 by 8 mm, shallowly serrate at margin, papyraceous; veins visible on lower surface, forked near costa. **Sori** at middle to submarginal position between costa and margin of pinnae, in one row; indusia broad, thin but stiff, large, brown, up to 2 mm broad (Figure 5.103, 5.104, 5.105).

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

Distribution.- Pantropics (type from America), north to Japan and south to New Zealand.

Ecology.- On tree-trunks or in muddy crevices of rocks in hill evergreen forest at 1250 m alt.

Uses.- This is commonly cultivated or an ornamental.

Vernacular.- Kut soi (กูดสร้อย) (Northern).

Specimens examined.- *W. Rattanathirakul* 107, 144 (BCU): *E. Hennipman* 3545; *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 1519 (BKF).

2. OLEANDRA

Cav., Ann. 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. **Stipe** with distinct articulation, leaving phyllopode (a stipe base remaining as a scar after leaf-shedding) of various heights. **Lamina** simple, entire, linear-lanceolate; veins usually once or twice forked near midrib, parallel and all free,

close, ending in distinct hydathode. **Sori** dosal on anterior branches of veins, close to midrib; indusia renifrom.

Key to the species

1. Midrib of lamina underneath scaly; phyllopode lower, less than 2 cm high; edge of lamina patent; indusia glabrous **1. O. musifolia**
1. Midrib of lamina underneath not scaly; phyllopode taller, 12 cm high; edge of lamina undulate; indusia hirsute or glabrescent **2. O. undulata**

1. *Oleandra musifolia* (Blume) C. Presl, Epim.: 42. 1849; Bedd., Handb.: 287. 1969; Tagawa & K. Iwats., Fl. Thailand 3(2): 181. 1985.- *Aspidium musifolium* Blume, En. Pl. Jav.: 141. 1828.

Rhizome long-creeping, up to 5 mm diam.; bearing a few fronds in scattered tufts, densely scaly throughout; scales appressed, lanceolate, round to moderately acute at basal edge, gradually narrowing from the broadest attached portion to tailed apex, about 7 by 1.2 mm, brown with dark attached point, paler and hairy at margin of apical portion. **Stipe** usually short, up to 1.5 cm including low phyllopode less than 1 cm tall, bearing both scales and hairs. **Lamina** linear-lanceolate, caudately acuminate at apex, gradually narrowing towards narrow and cuneate base, up to 35 by 3.2 cm, the margin entire and usually plane; midrib raised below, scaly with peltate, lanceolate, pale brown scales of up to 3 mm long, herbaceous, light green; veins once or twice forked near midrib, all free, ending just inside narrow cartilagineous margin. **Sori** irregular row near midrib; indusia up to 2 mm in breadth, glabrous (Figure 5.106).

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

Distribution.- Ceylon, Indochina to Malesia (type from Java).

Ecology.- On tree-trunks in hill evergreen forest at 1200 m alt.

Vernacular.- Thao nakkharat (เถานาคราช) (North-eastern).

Specimens examined.- *W. Rattanathirakul* 96, 132 (BCU): *E. Hennipman* 3092; *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 634 (BKF).

2. *Oleandra undulata* (Willd.) Ching, Lingn. Sci. J. 12: 565. 1933; Holttum, Rev. Fl. Malaya 2: 384. f. 223. 1955; Tagawa & K. Iwats., Fl. Thailand 3(2): 180. 1985.- *Polypodium undulatum* Willd., Sp. Pl. 5: 155. 1810.- *Oleandra cumingii* Hook. & Bak., Syn. Fil.: 303. 1867; Bedd., Handb.: 288. 1969.- *Oleandra pubescens* Copel., Univ. Calif. Publ. Bot. 12: 397. pl. 52-a. 1931.

Rhizome long-creeping, 3-4 mm diam., bearing distant fronds, or rather closely on some portions, densely scaly throughout; scales appressed, oblong, round to moderately acute at basal edge, acuminate at apical edge, up to 5 by 1.2 mm, brown, dark near attached point, long downy hairy. **Stipe** on tall phyllopode 8 cm high, stramineous, hairy, up to 20 cm or more long including phyllopode. **Lamina** simple, narrowly lanceolate, gradually narrowing towards both ends, up to 40 by 3.5-4.5 cm, the margin entire but more or less undulate, herbaceous to softly papyraceous; veins once or twice forked near midribs, costa and veins underneath as well as under surface of lamina hirsute but glabrous at margin of lamina. **Sori** in one regular row close to costa or rather irregularly arranged near costa, dorsal on acroscopic veinlets; indusia up to 2 mm broad, hirsute or glabrous.

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

Distribution.- Burma and S. China (type) to Malaya.

Ecology.- On crevices of rocks in open areas in hill evergreen forest at 1200 m alt.

Specimens examined.- *W. Rattanathirakul* 160 (BCU): *E. Hennipman* 3334; K. *Iwatsuki* and *N. Fukuoka* T 3424 (BKF).

ORDER POLYPODIALES

POLYPODIACEAE

Bercht. & J. Presl, Prir. Rostlin 272. 1820; Devol and Kuo, Fl. Taiwan Vol. 1. 2nd ed.: 165. 1980.

Usually epiphytes, growing on tree trunks, or moss-covered rocks, some terrestrial. **Rhizome** usually creeping; scales peltate, often clathrate. **Lamina** often simple, pinnatifid, pinnae or rarely digitately lobed. **Stipe** usually articulate to rhizome; veins anastomosing with included veinlets. **Sori** uaually round, oval or linear, and in some genera acrostichoid; exindusiate; peltate, paraphyses often present.

Key to the genera

1. Fronds simple
   2. Fronds covered with stellate hairs **13. Pyrrosia**
   2. Fronds not having stellate hairs
      3. Fronds bearing peltate scales on surface or in sori
         4. Sporangia acrostichoid scattered on the lower surface of narrow apical portion of fronds **2. Belvisia**
         4. Sori round or continuous along the margin of fronds
            5. Fronds coriaceous, rhizome-scale glabrous
               6. fronds less than 8 cm long, fronds dimorphic as a whole **6. Lemmaphyllum**
               6. Fronds usually over 8 cm long, fertile part not especially narrowed **7. Lepisorus**
            5. Fronds herbaceous, rhizome-scales bearing a few long hairs at base **11. Neocheiropteris**
      3. Fronds not bearing any peltate scale
         7. Fronds dimorphic and sporangia acrostichoid **8. Leptochilus**
         7. Fronds monomorphic or hardly dimorphic, never acrostichoid having distinct sori
            8. Sori round or nearly so
               9. At least the middle part of scales clathrate **10. Microsorum**
               9. Scales not clathrate throughout **4. Crypsinus**
            8. Sori forming continuous or broken lines oblique to the midribs of fronds
               10. Stipes jointed to rhizome; papyraceous **3. Colysis**
               10. Stipes not jointed to rhizome; chartaceous **9. Loxogramme**
1. Fronds pinnate or pinnately lobed
   11. Fronds very large, sessile, basal portion like nest leaves **1. Aglaomorpha**
   11. Frond without basal portion like nest leaves
      12. Fronds pinnate or deeply pinnatifid, pinnae articulate to rachis **5. Goniophlebium**

12. Fronds deeply pinnatifid or pinnate, not articulate to rachis
    13. Sori linear **3. Colysis**
    13. Sori round
        14. Sori small, multiseriate, veins copiously anastomosing **10. Microsorum**
        14. Sori large, in a single row on either side of costa **12. Polypodium**

1. AGLAOMORPHA

Schott, Gen. Fil.: ad pl. 20. 1834; Tagawa & K. Iwats., Fl. Thailand 3(4): 550. 1989.

Rhizome creeping, thick, scaly. **Lamina** in one from, 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; 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.- *Drynaria coronans* (Wall. ex Mett.) J. Sm., J. Bot. 4: 61. 1841; Bedd., Handb.: 338. 1969.- *Pseudodrynaria coronans* (Wall. ex Mett.) Ching, Sunyatsenia 5: 262. 1940.- *Polypodium conjugatum* Bak., Syn. Fin.: 366. 1868.- *Drynaria conjugata* (Bak.) Bedd., Ferns Brit. India correct. 1870.- *Aglaomorpha heraclea* (Kunze) Copel. Sensu Holttum, Dansk Bot. Ark. 20: 21. 1961.

A large epiphyte. **Rhizome** creeping, thick, usually more than 1.5 cm diam., densely scaly throughout; scales brown, linear, 12 by more than 1 mm, sharply toothed at margin. **Lamina** sessile, usually more than 1 m long, about 50 cm wide, lobed almost to rachis; lobes continuing with wing less than 1 cm broad; the base of fronds broadly rounded to cordate, up to 15 cm broad, subentire or shallowly lobed, brown, like the nest-leaves of *Drynaria*; lobes of the upper part of fronds ascending, usually more than 12 pairs, linear-subtriangular, attenuately acuminate at apex, entire at margin, up to 30 by about 5 cm, every lobe falling at the abscission along rachis; veins raised on both surfaces, venation drynarioid, or with complicately reticulate, main areoles quadrangular, smaller areoles with free included veilets; coriaceous, green, glabrous. **Sori** one, or very rarely two, row(s) between main veins, more or less elongate, or sometimes uniting longitudinally, but rarely continuous beyond cross veins (Figure 5.107).

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 Kraduang); SOUTH-EASTERN: Prachin Buri (Khao Yai), 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 S. China, Indochina, Taiwan and northwards to the Ryukyus.

Ecology.- On rather dry mossy rocks or on tree-trunks in open places in hill evergreen forest at 1200 m alt.

Vernacular.- Bai kut om (ใบกูดอ้อม) (Northern).

Specimens examined.- *W. Rattanathirakul* 63; *T. Boonkerd* 587, 615 (BCU).

2. BELVISIA

Mirb., Hist. Nat. Veg. 5: 111. 1803; Tagawa & K. Iwats., Fl. Thailand 3(4): 519. 1989.- *Hymenolepis* Kaulf., Enum.: 146. 1824.

Rhizome short-creeping, bearing stipes uaually closely, densely scaly; scales peltate, usually dark, ovate to lanceolate. **Lamina** jointed to rhizome, with short indistinct stipes, simple, entire, papyraceous to chartaceous, 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 laminae.

Key to the species

1. Rhizome scales concolorous, clathrate, tooth at margin, lamina up to 5 cm wide **1. B. henryi**
1. Rhizome scales bicolored, with dark central portion and pale ferrugineous marginal portion, lamina up to 1 cm wide. **2. B. revoluta**

1. *Belvisia henryi* (Hieron. ex C. Chr.) Raymond, Fl. East. Himal.: 490. 1966; Tagawa & K. Iwats., Fl. Thailand 3(4): 520. 1989.- *Hymenolepis henryi* Hieron. ex C. Chr., Dansk Bot. Ark. 6(3): 67. f. 1. 1929.

Rhizome short-creeping, up to 5 mm diam., bearing fronds closely, densely scaly; scales narrowly subtriangular, gradually narrowing from base towards apex, long-attenuate and tailed at apex, up to 3.5 by 1 mm, broadest at basal portion, concolorously brown, clathrate, toothed at margin. **Stipe** short, castaneous, narrowly winged, scaly at base. **Lamina** narrowly oblong, rather suddenly narrowing at apex, bearing linear fertile portion, narrowly cuneate at base, the sterile portion about 25 by 4 cm; papyraceous to thin chartaceous, veins hardly visible, the margin of fronds usually plane; fertile portion linear, not constricted at base, up to 10 by 0.5 cm, sporangia occupying the whole under surface except the midrib and margin, the margin hardly revolute (Figure 5.110).

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

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

Ecology.- On mossy tree-trunks in hill evergreen forest at 1500 m alt.

Specimens examined.- *W. Rattanathirakul* 1, 155 (BCU): *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 1832, *T. Shimizu, M. Hutoh* and *D, Chaiglom* T 8979 (BKF).

2. *Belvisia revoluta* (Blume) Copel., Gen. Fil.: 192. 1947; Holttum, Rev. Fl. Malaya 2: 155. f. 67. 1955; Tagawa & K. Iwats., Fl. Thailand 3(4): 521. 1989.- *Hymenolepis revoluta* Blume, En. Pl. Jav.: 201. 1828.- *Gymnopteris spicata* (L.f.) Presl, Tent. 244. t. 11, f. 7. 1836; Bedd., Handb.: 432. f. 261. 1969.

Rhizome short-creeping, up to 3-5 mm diam., bearing many fronds closely, densely scaly; scales oblong-subtriangular, gradually narrowing from base towards apex, round at base, attenuate at apex, entire, about 2.5 by 0.8 mm, the central portion dark with thick internal walls, the marginal portion consisting in smaller cells with thinner internal wall, thus paler in colour. **Stipe** up to 2 cm long, not distinct from the midribs of fronds, narrowly winged on the upper portion, stramineous to pale castaneous, scaly at base. **Lamina** linear-lanceolate, usually broadest at middle portion, attenuate towards both ends, 9 cm long in sterile portion, 0.7 cm broad, the margin more or less revolute; softly chartaceous; veins hardly visible, copiously

anastomosing; fertile portion linear, with distinct constriction at base, up to 1.3 by 0.2 cm broad, covered wholly with sporangia except on the midribs and margin (Figure 5.111).

Thailand.- NORTHERN: Tak (Mae Sot, Ban Musoe); NORTH-EASTERN: Loei (Phu Luang, Phu Kradung); EASTERN: Nakhon Ratchasima; PENINSULAR: Nakhon Si Thammarat (Khao Luang), Trang (Khao Chong).

Distribution.- Tropic of Asia (type from Java), from Sri Lanka to Tahiti.

Ecology.- On mossy tree-trunks in hill evergreen forest at 1600 m alt.

Specimens examined.- *W. Rattanathirakul* 122, *T. Boonkerd* 1316 (BCU): *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 941 (BKF).

3. COLYSIS

Presl, Epim. Bot.: 146. 1849; Tagawa & K. Iwats., Fl. Thailand 3(4): 536. 1989.

Rhizome creeping, scaly; scales thin, clathrate, peltate. **Lamina** with distinct stipes, simple to pinnate, rarely dimorphic, articulate to rhizome; veins anastomosing to from irregularly arranged areoles with included veinlets; thin herbaceous. **Sori** linear, usually continuous, one between the adjacent lateral main veins, oblique to costae, naked, without peltate paraphyses.

Key to the species

1. Fronds simple, entire, sori round to shortly elongate — **1. C. hemionitidea**
1. Fronds pinnatifid to pinnate, sori linear
   2. Lateral pinnae up to 5 pairs — **2. C. pentaphylla**
   2. Lateral pinnae more than 6 pairs — **3. C. pothifolia**

1. *Colysis hemionitidea* (C. Presl) C. Presl, Abh. Konigl. Bohm. Ges. Wiss., ser. 5, 6: 507. 1851; Devol and Kuo, Fl. Taiwan Vol. 1. 2nd ed.: 170. pl. 58. 1980; Tagawa & K. Iwats., Fl. Thailand 3(4): 536. 1989.- *Selliguea hemionitidea* (Wall.) C. Presl, Tent. Pterid. 216, pl. 9, f. 17. 1836.- *Polypodium hemionitideum* Wall., Numer. List n. 284. 1828.- *Pleopeltis hemionitidea* (Presl) Moore, Ind.: 346. 1862; Bedd., Handb.: 358. f. 202. 1969.- *Colysis* sp.; Holttum, Dansk Bot. Ark. 20: 20. 1961.

Rhizome creeping, about 4 mm diam., scaly throughout; scales oblong-subtriangular, gradually narrowing from base towards long-acuminate apex, 3 by 0.5 mm, finely clathrate with larger longitudinal cells, slightly toothes at margin. **Stipe**

not distinct from the lower part of lamina with decurrent laminae froming wings of stipes, wingless part up to only 3 cm long. **Lamina** oblong to oblong-lanceolate, broadest at middle portion of frond, gradually narrowing toward acute apex roundly narrowing and then broadly decurrent downwards forming broad wings of stipes, 50 by 6 cm; lateral main veins raised, about 8 mm apart at broadest portion, the veins distinct, forming areoles with included veinlets; herbaceous, dark green, brownish in dried condition. **Sori** round to shortly elongate, arranging in one usually regular row between adjacent main veins (Figure 5.108, 5.109).

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

Distribution.- Himalayas (type) to S. China, Taiwan and The Ryukyus, south to N. Vietnam and the Philippines.

Ecology.- On wet rocks usually in stream-beds in hill evergreen forest at 1300 m alt.

Vernacular.- Kut hang nok kaling (กูดหางนกกระลิง) (Northern).

Specimens examined.- *W. Rattanathirakul* 85, 129 (BCU): *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 2657, *K. Iwatsuki* and *N. Fukuoka* T 7158 (BKF).

2. *Colysis pentaphylla* (Baker) Ching, Bull. Fan Mem. Inst. Biol. 3: 332. 1933; Tagawa & K. Iwats., Fl. Thailand 3(4): 540. f. 54. 4-5. 1989.- *Gymnogramma pentaphylla* Baker., Kew Bull. 233. 1898.- *Gymnopteris elliptica* (Thunb.) Bak. sensu Hoss., Beih. Bot. Centr. 28(2): 365. 1911.- *Colysis elliptica* (Thunb.) Ching sensu Holttum, Dansk Bot. Ark. 20: 19. 1961.

Rhizome creeping, bearing fronds sparsely, about 5 mm diam., scaly; scales oblong-subtriangular, gradually narrowing from round base towards long-acuminate apex, irregularly minutely toothed at margin, or subentire in young stage, up to 4.5 by about 1.2 mm broad, concolorously brown, clathrate. **Stipe** stramineous, brown at base, sparsely scaly on lower portion, up to 50 cm long, terete. **Lamina** imparipinnate, broadly ovate-subdeltoid to circular in outline, 45 by 25 cm; lateral pinnae up to 5 pairs, nearly equal in size, or the upper one or two slightly reduced, narrowly lanceolate to oblong-lanceolate, broadest at middle portion, caudately acuminate at apex, narrowly cuneate towards base, about 25 by 3 cm broad, the base decurrent to form very narrow wing of rachis; veins more or less obscure, forming two rows of areoles between adjacent main veins; herbaceous. **Sori** linear; continuous along a line between two rows of areoles, sometimes lacking on 1/4 part near margin (Figure 5.113).

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

Distribution.- SW. China (Yunnan, type) and Laos.

Ecology.- On mountain-slopes in hill evergreen forest at 1500 m alt.

Specimens examined.- *W. Rattanathirakul* 5, 74 (BCU): *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 4216, , *K. Iwatsuki, N. Fukuoka* and *A. Chintayungkun* T 9641 (BKF).

3. *Colysis pothifolia* (Buch.-Ham. ex D. Don) C. Presl, Abh. Konigl. Bohm. Ges. Wiss., ser. 5, 6: 508. 1851; Tagawa & K. Iwats., Fl. Thailand 3(4): 540. 1989.- *Hemionitis pothifolia* Buch.-Ham. ex D. Don, Prodr. Fl. Nepal.: 13. 1825.- *Colysis elliptica* var. *pothifolia* (D.Don) Ching, Bull. Fan Mem. Inst. Biol. 4: 334. 1933.- *Selliguea elliptica* (Thunb.) Bedd. sensu Bedd., Handb.: 392. 1883.

Rhizome usually thick, about 5 mm diam., sparsely bearing fronds, scaly; scales oblong-subtriangular minute toothed at margin, up to 5 by about 1.2 mm, concolorous, dark brown, clathrate. **Stipe** stramineous, about 50 cm long, terete. **Lamina** imparipinnate, broadly oblong, up to 45 by 25 cm; lateral pinnae up to 6 - 12 pairs, upper 2 – 3 reduced upwards, the other nearly equal in size, or the lowest ones slightly reduced, narrowly lanceolate, gradually narrowing towards acute wing, up to 25 by 3 cm; veins visible, forming two rows of areoles between the adjacent main veins; herbaceous, dark green in living condition, brownish in dried specimens. **Sori** linear, continuous along the line between two rows of areoles, usually forming 45° to costa (Figure 5.112).

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

Distribution.- Himalaya (type) to S. China and Taiwan, extending north to SW. Japan and the Ryukyus, south to Indochina and the Philippines.

Ecology.- On mountain-slopes in hill evergreen forest at 1500 m alt.

Specimens examined.- *W. Rattanathirakul* 87, 41 (BCU): *E. Hennipman* 3543, *M. Tagawa, T. Shimizu, H. Koyama, M. Hutoh* and *A. Nalampoon* T. 10006 (BKF).

4. CRYPSINUS

Presl, Epim. Bot.: 123. 1849; Tagawa & K. Iwats., Fl. Thailand 3(4): 553. 1989.

Rhizome long-creeping, scaly; scales gradually narrowing from peltate base to hairy apex, not or hardly clathrate. **Stipe** jointed to rhizome. **Lamina** simple, lobed or rarely pinnate, coriaceous or leatherly, glabrous, edges of lobes cartilagineous, more or less thickened; veins copiously anastomosing, areoles irregular, with included free veinlets. Sori round, one between adjacent main veins, in a single row at each side of costa, or scattered on the under surface of frond, sometimes sunk in deep cavities; paraphyses only in some species, simple.

Key to the species

1. Fronds deeply lobed, not dimorphic **1. C. oxylobus**
1. Fronds simple, moderately dimorphic **2. C. rhynchophyllus**

1. *Crypsinus oxylobus* (Wall. ex Kunze) Sledge, Bull. Brit. Mus. (Nat. Hist.) Bot. 2: 145. 1960; Tagawa & K. Iwats., Fl. Thailand 3(4): 559. f. 56. 6. 1989.- *Polypodium oxylobum* Wall. ex Kunze, Linnaea 24: 255. 1851.- *Phymatodes oxyloba* (Wall. ex Kunze) Presl ex Ching, Contr. Inst. Bot. Nat. Acad. Peiping 2: 67. 1933.- *Pleopeltis hastata* (Thunb.) Bedd., Handb.: 362. f. 205. 1883.- *Pleopeltis trifida*(D.Don) Bedd., Handb.: 96. 1892.- *Crypsinus taeniatus* var. *palmatus* (Blume) C.Cr, sensu Holttum. Dansk Bot. Ark. 23: 231. 1965.

Rhizome long-creeping, about 3 mm diam., densely scaly throughout; scales gradually narrowing from round peltate base to long-tailed apex, about 5.2 by 1.2 mm, brown in broader basal portion, paler in narrow tails, toothed at margin. **Stipe** stramineous or brown, jointed to rhizome at low scaly phyllopodes, glabrous upwards, 18 cm long. **Lamina** lobed, with 3 - 8 pairs of lateral lobes and terminal one, up to 25 by 20 cm; rachis brown beneath, paler on upper surface, winged with lobes 5 – 17 mm in breadth; lateral lobes usually longest at base, becoming smaller upwards, ascending, sometimes bending downwards, linear to oblong-subdeltoid, acute to acuminate at apex, up to 12 by 1.5 cm, entire, terminal lobes longer; midrib raised on both surfaces, main veins distinct, ascending, more or less zigzag, the other veins obscure, reticulate, forming irregular areoles with included veinlets; papyraceous, deep green to paler, paler on lower surface, glabrous. **Sori** between adjacent main veins, in a single row along both side of midrib, subcostular or medial, round, 3-4 mm diam., hardly raised on upper surface (Figure 5.114).

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

Distribution.- N. India (type), Upper Burma, SW. China (Yunnan & Szechuwan) and Indochina.

Ecology.- Epiphytie commonly on mossy tree-trunks or on wet rocks in hill evergreen forest at 1250-1600 m alt.

Vernacular.- Kut hom (กูดฮ่อม) (Northern).

Specimens examined.- *W. Rattanathirakul* 62, 76 (BCU): *M. Tagawa, T. Shimizu, H. Koyama, M. Hutoh* and *A. Nalampoon* T 9470, *T. Shimizu, H. Koyama,* and *A. Nalampoon* T 10098 (BKF).

2. *Crypsinus rhynchophyllus* (Hook.) Copel., Gen. Fil.: 206. 1947; Tagawa & K. Iwats., Fl. Thailand 3(4): 556. f. 56. 3. 1989.- *Polypodium rhynchophyllum* Hook., Ic. Pl.: t. 954. 1854.- *Pleopeltis rhynchophylla* (Hook.) Moore, Ind.: lxxviii. 1857; Bedd., Handb.: 353. f. 198. 1969.- *Phymatodes rhynchophylla* (Hook.) Ching, Contr. Inst. Bot. Nat. Acad. Peiping 2: 69. 1933.

Rhizome long-creeping, about 1.2 mm diam., densely scaly throughout; scales ovate with long tails up to 4 by 0.7 mm, membraneous, entire at margin, light brown. **Lamina** in two forms. *Smaller sterile fronds* on the short stipes of 2 cm in length, oval or ovate-oblong, round to moderately acute at both end, 4 by about 2 cm. *Larger soriferous fronds*: stipes 3.5 cm long, scaly at base, glabrescent upwards; laminae lanceolate, cuneate at base, broadest at 1/5-1/4 way from the base, narrowing at the soriferous portion of upper 1/4-1/2 part, acute to round at apex, 11 by 1.5 cm, the soriferous portion less than 1 cm in breadth; main lateral veins obscure at 1.5 cm inside the margin, other veinlets hardly visible, anastomosing to form irregular areoles with included free veinlets; coriaceous, green, paler beneath, glabrous. **Sori** between adjacent main veins, a single row at each side of midrib, half-way or a little closer to midrib, round, up to 2.5 mm diam.(Figure 5.115, 5.116).

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

Distribution.- N. India (type), Burma, SW. China and Indochina; also in the Philippines.

Ecology.- On mossy tree-trunks in hill evergreen forest at 1600 m alt.

Specimens examined.- *W. Rattanathirakul* 19, 139 (BCU): *E. Hennipman* 3143, *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 1511, T 1827 (BKF).

5. GONIOPHLEBIUM

C. Presl, Tent. Pterid.: 185, pl. 7, f.13-14. 1836; Devol and Kuo, Fl. Taiwan Vol. 1. 2nd ed.: 178. 1980.- *Polypodium* L., Sp. Pl. 2: 1082. 1753; Tagawa & K. Iwats., Fl. Thailand 3(4): 568. 1989.

Rhizome long creeping; scales clathrate, dark brown to black, iridescent, peltate, lanceolate, hair tipped. **Stipe** wingless, distant, articulate to podophylla. Lamina pinnate, pinnae linear or lanceolate, patent, articulate to rachis; venation reticulate, with 1-2 rows of areolae along costa, veins near margin free; included veinlet straight, not forked. **Sori** round, borne in a single row on either side of costa, at the end of the single included veinlet.

Key to the species

1. Lamina pinnate, terminal pinnae more or less distinct
   2. Sori superficial; base of pinnae deeply cordate, lateral pinnae up to 12 pairs **1. G. argutum**
   2. Sori distinctly immersed and raised on upper surface, lateral pinnae more than 20 pairs **3. G. subauriculatum**
1. Lamina deeply pinnatifid, without distinct terminal pinnae **2. G. microrhizoma**

1. *Goniophlebium argutum* J. Sm. ex Hook., Gen. Fil.: t. 51. 1840; Bedd., Handb.: 323. f. 174. 1969. Devol and Kuo, Fl. Taiwan Vol. 1. 2nd ed.: 178. Pl. 61. 1980.- *Polypodium argutum* (J. Sm. ex Hook. et Grev.) Hook., Sp. Fil. 5: 32. 1863; Tagawa & K. Iwats., Fl. Thailand 3(4): 572. 1989.

Rhizome long-creeping, about 4-5 mm diam., dark brown or slightly glaucous, densely scaly at least at apex; scales narrowly subtraingular, about 3 by 0.3 mm, irregularly toothed at margin, light brown, clathrate. **Stipe** up to 10 cm long, stramineous or faintly castaneous, scaly at base, glabrous upwards. **Lamina** pinnate with distinct terminal pinnae, oblong-lanceolate,up to 30 by 22 cm; rachis like the upper part of stipes, minutely scaly and hairy; lateral pinnae up to 9 pairs, the basal one either reduced or the longest, the upper one gradually becoming smaller upwards, slightly ascending, lower ones patent, straight or falcate, sessile, deeply cordate and

more or less roundly auricled at base, attenuately acuminate at apex, serrate at margin, the lobes toothed, the larger pinnae up to 12 by 1.2 cm; terminal one usually longer, sometimes deeply lobed at basal portion, up to 15 cm long; veins anastomosing to form 2-3 rows of areoles at each side of costa, each costal areole containing a simple free veinlets, the other veins free, ending inside the margin of lobes, visible on both surface; herbaceous, glabrous or minutely scaly underneath. **Sori** terminal on included veinlets of costal areoles, up to 2 mm diam., superficial (Figure 5.118).

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

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

Ecology.- On mossy tree-trunks in hill evergreen forest at 1600 m alt.

Specimens examined.- *W. Rattanathirakul* 77 (BCU): *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 1493, *K. Iwatsuki, N. Fukuoka* and *A. Chintayungkun* T 9574 (BKF).

2. *Goniophlebium microrhizoma* (C.B. Clarke ex Baker) Clarke ex Bedd., Ferns Br. Ind. Suppl.: 21. t. 384. 1876; Handb.: 322. 1969. *Polypodium microrhizoma* C.B. Clark ex Baker, Syn. Fil. (ed. 2) 511. 1874; Tagawa & K. Iwats., Fl. Thailand 3(4): 570. f. 57: 9-10. 1989.

Rhizome wide-creeping, about 3 mm diam., dark brown, densely covered with scales; scales narrowly ovoid with tails, up to 7.5 by 1.7 mm, pale brown to greyish-brown. **Stipe** stramineous or faintly castaneous beneath, 22 cm long, scaly at base, glabrescent upwards. **Lamina** deeply pinnatifid to pinnatisect, narrowly lanceolate, up to 55 by about 25 cm; rachis stramineous and grooved on upper surface, castaneous beneath, glabrous, nearly wingless in the lowest portion; lateral lobe up to 30 pairs, basal ones not or very slightly deflexed, a little shorter than the next above, middle ones lanceolate, acute to acuminate at apex, tooth at margin, patent, straight, up to 15 by 2 cm; veins anastomosing to form a row of large costal areoles at each side of costa each containing a simple inclued veinlet, the other veins free; herbaceous or thinly papyraceous, green, glabrous. **Sori** round, at terminal of the free included veinlets of costal areoles, more or less immersed (Figure 5.117).

Thailand.- NORTHERN: Chiang Mai (Doi Phahom Pok, Doi Inthanon).

Distribution.- N. India (type), Upper Burma, SW. China (Yunnan & Szechuwan) and Taiwan.

Ecology.- On mossy tree-trunks in hill evergreen forest at 1450 m alt.

Specimens examined.- *W. Rattanathirakul* 82, 161 (BCU): *K. Iwatsuki, N. Fukuoka* and *A. Chintayungkun* T 9645; *G. Murato, K. Iwatsuki, C. Penklai* and *C. Charamphol* T 15960 (BKF).

3. *Goniophlebium subauriculatum* (Blume) C. Presl, Tent. Pterid.: 186. 1836, Bedd., Handb.: 323. f. 173. 1969.- *Polypodium subauriculatum* Blume., Enum. Pl. Javae 2: 133. 1828; Holttum, Rev. Fl. Malaya 2: 207. f. 108. 1955; Tagawa & K. Iwats., Fl. Thailand 3(4): 573. 1989.

Rhizome long-creeping, about 5 mm diam., distinctly glaucous, densely scaly; scales linear, about 7.5 by 0.3 mm, brown clathrate, toothed at margin. **Stipe** stramineous or brown, 20 – 25 cm long, densely scaly at base, minutely scaly upwards or glabrescent. **Lamina** imparipinnate, lanceolate, 40 – 70 by 20 – 25 cm; rachis pale brown, minutely scaly throughout; lateral pinnae more than 20 pairs, a few basal pairs usually a little shorter than the next above, deflexed or patent, middle ones the largest, subopposite, sessile, linear, subcordate or subtruncate roundly auricled on both sides at base, gradually narrowing from base to long-attenuate apex, serrate at margin, patent or slightly ascending, straight or a little falcate, up to 20 cm by 1-1.5 cm, upper pinnae gradually bacoming smaller; terminal pinna not so large, 3 – 10 cm long, irregularly lobed at basal portion; veins anastomosing to form 1 – 3 rows of areoles at each side of costa, more or less visible; herbaceous to subcoriaceous, deep green, glabrous. **Sori** terminal on simple included veinlets in costal areoles, in one row at each side of costa, costular, more than 1.5 mm diam., distinctly immersed and raised on the upper surface (Figure 5.119, 5.122).

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

Distribution.- NE. India, SW. China, Laos, Vietnam, Malesia throughout (type from Java) to Australia (Queenland); also in the Tenasserim.

Ecology.- On mossy tree-trunks or mossy rocks in hill evergreen forest at 1300-1600 m alt.

Specimens examined.- *W. Rattanathirakul* 180, 186 (BCU): *E. Hennipman* 3363 *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 1294, *K. Iwatsuki* and *N. Fukuoka* T 3440 (BKF).

6. LEMMAPHYLLUM

Presl, Epim. Bot.: 157. 1849; Tagawa & K. Iwats., Fl. Thailand 3(4): 515. 1989.- *Weatherbya* Copel., Gen. Fil.: 191. 1947.

Rhizome long-creeping, slender, bearing fronds rather remotely, scaly; scales peltate, concolorously dark, clathrate. **Lamina** simple, entire, usually dimorphic, leatherly, bearing peltate scales or glabrescent, sterile fronds usually smaller, ovate to oblong-pyrifrom; veins hardly visible, copiously anastomosing with included free veinlets in areoles. **Sori** round and polypodioid, or continuous along margin, with peltate toothed paraphyses.

Lemmaphyllum carnosum (J. Sm. ex Hook.) C. Presl, Epim. Bot.: 158. 1849; Tagawa & K. Iwats., Fl. Thailand 3(4): 518. f. 52: 2-3. 1989.- *Drymoglossum carnosum* J. Sm. ex Hook., Gen. Fil.: pl. 78 A. 1841; Bedd., Handb.: 411. f. 243. 1969.- *Microsorium* sp.; Holttum., Dansk Bot. Ark. 20: 20. 1961.

Rhizome long-creeping, slender, about 1 mm diam., bearing fronds more than 2 mm apart, densely scaly throughout; scales ovate, each with a long tail, the ovate basal portion about 1 mm in diameter, pale brown with thin-walled cells, the central portion continuous to the tail, up to 2 cm or more in length, with thick-walled long cells, dark brown. **Lamina** simple, dimorphic; *Sterile fronds*: stipes very short, up to 1 cm long, densely scaly at base; laminae ovate to ovate-oblong, acuminate at apex, cuneatly attenuate at base, 8 by 1.7 cm; coriaceous, midrib distinct, veins more or less visible, copiously anastomosing, the margin cartilagineous. *Fertile fronds*: stipes up to 4 cm long, slender; laminae up to 6 cm long, about 0.3 cm broad. **Sporangia** covering whole the under surface of laminae except midrib and margin (Figure 5.120).

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

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

Ecology.- On branches of tree-trunks in hill evergreen forest at 1600 m alt.

Specimens examined.- *W. Rattanathirakul* 151 (BCU): *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 4203, *M. Tagawa* and *K. Iwatsuki* T 4393 (BKF).

7. LEPISORUS

(J. Sm.) Ching, Bull. Fan Mem. Inst. Piol. 4: 47. 1933; Tagawa & K. Iwats., Fl. Thailand 3(4): 507. 1989.- *Drynaria & Lepisorus* J. Sm., Bot. Mag. 72. Comp. 13. 1846.- *Pleopeltis* Humb. & Bonpl. ex Willd., Sp. Pl. 5: 211. 1810.

Rhizome creeping, bearing fronds closely, scaly; scales peltate, more or less clathrate. **Stipe** articulate to rhizome, sometimes indistinct from laminae, scaly at least at base. **Lamina** 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.

Key to the species

1. Fronds persistent, texture subcoriaceous to coriaceous
   2. Rhizome-scales brown, clathrate with narrow central band **1. L. contortus**
   2 Rhizome-scales dark brown to black, clathrate only at marginal portion, with irregular teeth at margin
      3 Sori ovate-oblong, far apart **2. L.heterolepis**
      3. Sori often twice as long as broad **4. L. subconfluens**
1. Fronds annual, texture herbaceous to chartaceous **3. L. scolopendrium**

1. *Lepisorus contortus* (H. Christ) Ching, Bull. Fan Mem. Inst. Biol. 4: 90. 1993; Tagawa & K. Iwats., Fl. Thailand 3(4): 513. f. 51. 3. 1989.- *Polypodium lineare* var. *contortum* Christ, Nuov. Giorn. Bot. Soc. Ital. N.S. 4: 98. pl. 1. f. 3. 1897.- *Polypodium contortum* Christ, Bot. Gaz. 51: 347. 1911.- *Pleopeltis contorta* (Christ) Alst. & Bonn., Candollea 15: 209. 1956.

Rhizome creeping, about 2.5 mm diam., bearing fronds with intervals less than 0.5 cm, densely scaly throughout; scales dark brown, slightly clathrate, minutely toothed at margin, oblong-subdeltoid, gradually narrowing towards attenuate apex, up to 2.5 by 1.2 mm. **Stipe** very short, indistinct. **Lamina** simple, linear, attenuate towards both ends, in matured large fronds about 20 cm by 1 cm, the margin more or less recurved; coriaceous; veins hardly visible, copiously anastomosing. **Sori** round, medial, oblong.

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

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

Ecology.- On mossy tree-trunks in hill evergreen forest at 1600 m alt.

Specimens examined.- *W. Rattanathirakul* 83; *T. Boonkerd* 32, *P. Ratchata* 307 (BCU).

2. *Lepisorus heterolepis* (Rosenst.) Ching, , Bull. Fan Mem. Inst. Biol. 4: 86. 1993; Tagawa & K. Iwats., Fl. Thailand 3(4): 514. f. 51. 1. 1989.- *Polypodium lineare* var. *heterolepis* Rosenst., Rep. Sp. Nov. 12: 247. 1913.- *Pleopeltis heterolepis* (Rosenst.) Tagawa & K. Iwats., Acta Phytotax. Geobot. 22: 100. 1967.

Rhizome creeping, about 2.5 mm diam., bearing fronds with intervals of less than 1 cm, densely scaly; scales linear-subtriangular, long-attenuate at apex, toothed at margin, up to 3 by 0.7 mm, central portion with longitudinal, thick-walled cells, marginal portion with more or less clathrate cells, black in colour. **Stipe** up to 1 cm long, variously winged on upper part, castaneous to stramineous, scaly at base. **Lamina** simple, linear, long-attenuate at both ends, up to 25 by 0.8 cm; coriaceous; veins invisible, copiously anastomosing. **Sori** medial, round to elliptic, only on the upper half of frond, sometimes fusing to the next ones in the upper portion (Figure 5.124).

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

Distribution.- Sikkim (type) and SW. China (Yunnan).

Ecology.- On mossy tree-trunks in hill evergreen forest at 1600 m alt.

Specimens examined.- (BCU) *W. Rattanathirakul* 72, 189; *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 1284 (BKF).

3. *Lepisorus scolopendrium* (Buch.-Ham. ex D. Don) Mehra & Bir, Fl. East. Himal. 494. 1966; Tagawa & K. Iwats., Fl. Thailand 3(4): 511. f. 51. 6. 1989.- *Polypodium scolopendrium* Ham. ex D.Don, Prodr. Fl. Nepal.: 1. 1825.- *Lepisorus excavatus* var. *scolopendrium* (Ham. ex D.Don) Ching, Bull. Fan Mem. Inst. Biol. 4: 69. 1933.- *Pleopeltis scolopendrium* (Ham. ex D.Don) Alst. & Bonn., Candollea 15: 207. 1956.- *Polypodium excavatum* Bory ex Willd., Sp. 5: 158. 1810.

Rhizome creeping, bearing a few fronds closely, dark brown on surface, scaly; scales dense, thin, gradually narrowing towards acuminate apex, up to 5 by 1 mm, concolorously light brown, clathrate, rather irregular at paler margin. **Stipe** short, indistinct. **Lamina** simple, linear-lanceolate, often broadest at 1/3 part from base up

to 25 by 2 cm, gradually narrowing towards both ends, entire but variously waved at margin; midrib raised on both surface; papyraceous to herbaceous, light green; veins copiously anastomosing with branched included veinlets. **Sori** round to oblong, large, one between adjacent main veins, medial, up to 4 mm broad, sometimes obliquely elongate up to 1 cm or more long, never fused to the next ones, the receptacles raised with hollows on upper surface (Figure 5.123).

Thailand.- NORTHERN: Chiang Rai (Doi Tung), Chiang Mai (Pong Pho, Doi Pha Hom Pok, Doi Chiang Dao, Doi Suthep, Doi Inthanon, Doi Hua Mot, Huai Mae Pan), Lamphun (Doi Khun Tan), Phitsanulok (Phu Mieng); NORTH-EASTERN: Loei (Phu Luang); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); PENINSULAR: Surat Thani (Ban Don).

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

Ecology.- On mossy tree-trunks in hill evergreen forest at 1500 m alt.

Vernacular.- Kut chak khep (กูดจักเข็บ) (Northern).

Specimens examined.- *W. Rattanathirakul* 141, 158; *T. Boonkerd* 1038 (BCU): *K. Iwatsuki, H. Koyama, N. Fukuoka* and *A. Nalampoon* T 9404 (BKF).

4. *Lepisorus subconfluens* Ching, , Bull. Fan Mem. Inst. Biol. 4: 85. 1993; Tagawa & K. Iwats., Fl. Thailand 3(4): 514. f. 51. 2. 1989.- *Pleopeltis subconfluens* (Ching) Tagawa & K. Iwats., Acta Phytotax. Geobot. 22: 100. 1967.- *Polypodium lineare* auct. non Thunb. sensu C. Chr., Contr. U.S. Nat. Herb. 26. 334. 1931.

Rhizome creeping, about 2.5 mm diam., bearing fronds rather closely near apex, scaly; scales oblong-subtriangular with round base and long-attenuate at apex, sharply toothed at margin, up to 3.5 by 1 mm, dark brown to nearly black, the basal marginal portion brown and more or less clathrate. **Stipe** up to 1 cm long, indistinct from the base of fronds, scaly at base, dark stramineous. **Lamina** simple, linear, long-attenuate at both ends, up to 24 by 0.5 cm, attenuate towards both ends; leatherly. **Sori** medial, round to elliptic, about 2.5 mm broad, up to 5 mm long, sometimes fusing to the next one; the sterile portion of frond usually revoluted, in contrast to the remaining soriferous portion (Figure 5.121).

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

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

Ecology.- On mossy tree-trunks in hill evergreen forest at 1200 m alt.

Specimens examined.- *W. Rattanathirakul* 159, 181 (BCU): *E. Hennipman* 3375, *K. Iwatsuki*, *N. Fukuoka* and Chintayungkun T 9589 (BKF).

8. LEPTOCHILUS

Kaulf., Enum.: 147. pl. 1. f. 10. 1824; Tagawa & K. Iwats., Fl. Thailand 3(4): 541. 1989.- *Paraleptochilus* Copel., Gen. Fil.: 198. 1947.

Terrestrial or on tree-trunk. **Rhizome** long-creeping, scaly; scales dark, peltate, more or less clathrate. **Lamina** biserrate, articulate to rhizome, distinctly dimorphic. *Sterile fronds* simple herbaceous to subcoriaceous, glabrous, with copiously reticulate venation, usually blackish when dried. *Fertile frpnds* prominently contracted, linear. **Sori** covering the whole under surface of linear fertile laminae except on midrib and at margin, without peltate paraphyses.

Key to the species

1. Lateral main veins indistinct, sterile fronds lanceolate **1. L. axillaris**
1. Lateral main veins distinct nearly to the edge of frond, sterile fronds oblong to oblong-lanceolate **2. L. decurrens**

1. *Leptochilus axillaris* (Cav.) Kaulf., Enum. Fil.: 147. t. 1. f. 10. 1824; Holttum, Rev. Fl. Malaya 2: 164. f. 75. 1955; Tagawa & K. Iwats., Fl. Thailand 3(4): 542. f. 54. 6. 1989.- *Acrostichum axillare* Cav., Ann. Hist. Nat. 1: 101. 1799.- *Gymnopteris variabilis* var. *axillaria* (Cav.) Bedd., Handb.: 430. 1883.

Rhizome long-creeping, on tree-trunks, more or lees flattened, about 2.5 mm broad, sparsely scaly; scales small, up to 2.3 by about 0.3 mm, ovate with long tails, dark, clathrate, entire. **Stipe** usually more than 1.5 cm apart from each other, winged nearly to the base, 3 cm long but indistinct from the base of laminae. *Sterile laminae* simple, entire, lanceolate, broadest at middle portion, gradually narrowing towards both base and apex, acuminate at apex, attenuate at base, up to 25 by about 3 cm, herbaceous, glabrous, green to dark green; veins more or less visible, lateral main veins not distinct, forming copious anastomosis. *Fertile laminae* linear, up to 17 cm by 0.4 cm. **Sori** covering the whole under surface of linear fertile fronds.

Thailand.- NORTHERN: Chiang Rai, Chiang Mai (Mae Rim), Phrae (Mae Sai), Tak; SOUTH-WESTERN: Kanchanaburi (Wangka).

Distribution.- S. India, Himalayas, Indochina and Malesia, (type from Luzon) to Polynesia.

Ecology.- Epiphytic on tree-trunks in hill evergreen forest at 1600 m alt.

Specimens examined.- *W. Rattanathirakul* 22 (BCU): *Winit* 1023, *J. F. Maxwell* 93-892 (BKF).

2. *Leptochilus decurrens* Blume, En. Pl. Jav.: 206. 1828; Holttum, Rev. Fl. Malaya 2: 164. f. 74. 1955; Devol and Kuo, Fl. Taiwan Vol. 1. 2nd ed.: 189. pl. 65. 1980; Tagawa & K. Iwats., Fl. Thailand 3(4): 542. f. 54. 7. 1989.- *Acrostichum variabile* Hook., Sp. Fil. 5: 277. 1864.- *Gymnopteris variabilis* (Hook.) Bedd., Ferns Br. Ind.: t. 272. 1868; Handb.: 429. f. 258. 1969.

Rhizome long-creeping, up to 3 mm diam., bearing fronds more than 1 cm apart, scaly throughout; scales narrowly-subtriangular, gradually narrowing from base towards long-attenuate apex, up to 2.5 by 0.5 mm, distinct clathrate, concolorously brown. **Lamina** dimorphic. *Sterile fronds*: stipes up to 15 cm long, more or less winged at least on the upper part, sparsely scaly at lower portion, stramineous; laminae oblong to oblong-lanceolate, broadest near base, round or broadly cuneate at base and decurrent downwards to form wings of stipes, gradually narrowing upwards and then caudately acuminate at apex, up to 30 by about 7.5 cm, 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, dark in dried condition. *Fertile fronds*: stipes up to 35 cm long, stramineous, wingless; laminae linear, up to 20 by 0.3 cm broad, wholly covered by sporangia except on the midrib (Figure 5.126, 5.127).

Thailand.- NORTHERN: Chiang Rai (Doi Phacho), Chiang Mai (Doi Chiang Dao, Tintok, 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-EASTERN: Chanthaburi (Khao Ram, Khao Soi Dao), Trat (Ko Chang); SOUTH-WESTERN: Uthai Thani (Noen Pradu), Kanchanaburi (Kha Thalai); PENINSULAR: Nakhon Si Thammarat (Khao Luang).

Distribution.- S. India, Himalayas to S. China and Taiwan, Indochina, Malesia (type from Java) and Polynesia throughout.

Ecology.- On mossy tree-trunks in hill evergreen forest at 1300-1600 m alt.

Specimens examined.- *W. Rattanathirakul* 34, *T. Boonkerd* 509, 618 (BCU): *E. Hennipman* 3836, *M. Tagawa*, *K. Iwatsuki* and *N. Fukuoka* T 4209 (BKF).

9. LOXOGRAMME

(Blume) 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. **Lamina** not distincty articulate, monomorphic to dimorphic, simple and entire, usually oblanceolate in outline, coriaceous to fleshy, glabrous; main veins hardly distinct, veins all invisible, reticulate to from areoles without, or rarely with, included free veinlets. **Sori** elongate, usually oblique to midrib, superficial or slightly immersed, naked.

Loxogramme chinensis Ching, Sinensia 1: 13. 1929; Tagawa & K. Iwats., Fl. Thailand 3(4): 578. 1989.- *Loxogramme lanceolata* (SW.) Presl sensu Bedd., Handb.: 392. 1883.

Rhizome long-creeping, slender, about 1.5 mm diam., densely scaly throughout; scales ovate with rather broad tails, up to 3.5 mm long including tails about 1.5 mm in length, 0.7 mm broad, deeply cordate, entire clathrate. **Stipe** indistinct, densely scaly at base, pale green, narrowly winged to the very base. **Lamina** linear-lanceolate, acuminate at apex, gradually narrowing and decurrent downwards to the wings of indistinct stipes, up to 22 by 1.2 cm, edges entire, more or less involute; midrib raised on both surfaces, dark; thick, coriaceous, fleshy, deep green on upper surface, paler beneath, glabrous. **Sori** nearly parallel to midrib or a little oblique, usually in a single row or often uniting with neighboring to form linear coenosori, usually 10 by 1.5 mm, naked, superficial (Figure 5.125).

Thailand.- NORTHERN: Chiang Rai (Phu Langka), Chiang Mai (Doi Chiang Dao, Doi Suthep, Doi Inthanon).

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

Ecology.- On mossy tree-trunks in hill evergreen forest at 1350 m alt.

Specimens examined.- *W. Rattanathirakul* 126, *T. Boonkerd* 585, 499 (BCU).

10. 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, uaually thin, brown to darker, distinctly clathrate. Stipe articulate to rhizome, sometimes indistinct from the attenuate base of laminae. Lamina simple and entire, lobed, hastate, or pinnate, the margin of laminae or lobes not toothed; venation copiously anastomosing with free included veinlets in areoles. Sori round to oblong, usually small and scattered, rarely fused, without peltate paraphyses.

Key to the species

1. Fronds of well-grown plants deeply lobed
   2. Fronds pinnatifid with more than five pairs of lateral lobed, stipes and midribs not densely scaly; light green in color **1. M. dilatatum**
   2. Fronds simple to trifoliate, stipes and midribs beneath scaly; dark green to blackish in color **3. M. pteropus**
1. Fronds usually simple, entire or slightly undulate
   3. Rhizome thick, short-creeping, fronds up to 16 cm broad **2. M. membranaceum**
4. Rhizome slender, scandent, with fronds far apart, fronds up to 3 cm broad **4. M. superficiale**

1. ***Microsorum dilatatum*** (Bedd.) Sledge, Bull. Brit. Mus. (Nat. Hist.) Bot. 2: 143. 1960; Devol and Kuo, Fl. Taiwan Vol. 1. 2nd ed.: 194. 1980; Tagawa & K. Iwats., Fl. Thailand 3(4): 530. 1989.- *Pleopeltis dilatata* Bedd., Ferns Brit. Ind.: t. 122. 1866; Handb.: 367. f. 209. 1969, based on *Polypodium dilatatum* Wall. ex Hook., Sp. Fil. 5: 85. 1863.- *Microsorium hancockii* (Bak.) Ching, Bull. Fan Mem. Inst. Biol. 4: 309. 1933; Holttum, Rev. Fl. Malaya 2: 174. f. 82. 1955.

Rhizome creeping, thick more than 6 mm diam., dark, bearing fronds closely, scaly; scales oblong-subtriangular, gradually narrowing towards long-acuminate apex, round at base, up to 4.5 by 1.2 mm, brown to dark brown, clathrate, decaying from outside, round to oblong-ovate on older rhizome. **Stipe** up to 30 cm long, distinctly winged nearly to the base, scaly at base. **Lamina** pinnatifid, pinnate with more than 10 pairs of lateral pinnae and winged rachis, about 60 by 35 cm, the lower lateral pinnae or lobes adnate at base, oblong to rarrowly oblong-lanceolate, caudate at apex, entire, up to 24 by 4 cm, the upper ones gradually becoming smaller, the terminal

lobes oblong, gradually narrowing towards apex, undulate at margin, those of pinnate large fronds smaller; rachis and midrib raised, main lateral veins distinct, the other veins visible, copiously anastomosing; papyraceous, light green. **Sori** round, smaller, irregularly scattered on the lower surface, about 1.5 mm diam. at maturity (Figure 5.128).

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

Distribution.- In Sri Lanka and Himalayas (type) to Malaya and Indochina

Ecology.- On muddy rocks usually near streams in hill evergreen forest at 1250 m alt.

Specimens examined.- *W. Rattanathirakul* 69, 91, *T. Boonkerd* 1335 (BCU): *E. Hennipman* 3383, *K. Iwatsuki* and *N. Fukuoka* T 7172 (BKF).

2. *Microsorum membranaceum* (D. Don) Ching, Bull. Fan Mem. Inst. Biol. 4: 309. 1933; Devol and Kuo, Fl. Taiwan Vol. 1. 2nd ed.: 196. 1980; Tagawa & K. Iwats., Fl. Thailand 3(4): 526. f. 53. 2. 1989.- *Polypodium membranaceum* D. Don, Prodr. Fl. Nepal.: 2. 1825.- *Pleopeltis membranacea* (D. Don) Moore, Ind.: 191. 1860; Bedd., Handb.: 355. 1969.

Rhizome creeping, up to 6 mm or more diam., bearing fronds closely, usually near apical portion, scaly; scales larger, oblong-subtriangular, gradually narrowing towards apex, up to 10 by 2.2 mm, clathrate with smaller cells, bi-coloured, the central portion dark greyish-brown, the margin brown and more or less fringed. **Stipe** about 15 cm long, winged almost to the base, stramineous or greenish. **Lamina** narrowly oblong, broadest at basal 1/4 to 1/6 portion, roundly narrowing and then attenuate to the base, gradually narrowing towards acuminate apex, subentire to dully waved at margin, up to 90 by 16 cm; midrib raised prominently beneath, main lateral veins prominent, main areoles visible, smaller areoles hardly visible, many in number and irregularly arranged; membraneous to thinly herbaceous. **Sori** at joint of veins, round and distinct, small, irregularly scattered usually in 2 – 5 rows between main lateral veins, up to 1.5 mm diam.(Figure 5.129, 5.130).

Thailand.- NORTHERN: Chiang Rai (Doi Tung), Chiang Mai (Doi Phahom Pok, Doi Chiang Dao, Doi Suthep, Doi Inthanon), Mae Hong Son (Mae Sariang), Lamphun (Doi Khun Tan), Lampang (Mae Ngao), Tak (Khao Phra Wo).

Distribution.- Sri Lanka, Himalayas (type from Nepal) to S. China, Taiwan, N Vietnam and the Philippines.

Ecology.- On moist mossy rocks in hill evergreen forest at 1450 m alt.

Specimens examined.- *W. Rattanathirakul* 75 (BCU): *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 2649. *G. Murata, K. Iwatsuki* and *C. Pengklai* T 14973 (BKF).

3. *Microsorum pteropus* (Blume) Copel., Univ. Calif. Publ. Bot. 16: 112. 1929; Holttum, Rev. Fl. Malaya 2: 172. f. 80. 1955; Devol and Kuo, Fl. Taiwan Vol. 1. 2nd ed.: 196. 1980; Tagawa & K. Iwats., Fl. Thailand 3(4): 529. 1989.- *Polypodium pteropus* Blume, En. Pl. Jav. 2: add. 3. 1828.- *Pleopeltis pteropus* (Blume) Bedd., Handb.: 359. f. 203. 1883.

Rhizome long-creeping, 1-2 mm diam., bearing fronds rather closely, densely scaly; scales oblong-lanceolate, gradually narrowing towards apex, round at base, up to 3 by 1 mm, brown, distinctly clathrate, the cells rather regularly arranged longitudinally, the margin entire. **Stipe** stramineous, with the scales like those on rhizome but smaller in size, up to10 cm long, winged on upper portion. **Lamina** simple to trifoliate, simple laminae broadest at lower 1/3 portion, narrowing towards attenuate base, decurrent downwards as wings of stipes, narrowing towards attenuately very long-acuminate apex, entire, up to 15 by 3 cm, the lateral lobe of trifoliate laminae various in size and form, rarely almost the same as the terminal lobes, usually narrower, terminal lobes like simple laminae; midrib raised on both surfaces, more or less minutely scaly; lateral main veins distinct beneath, the other veins hardly visible or distinct, anastomosing with a row of main areoles along both sides of midrib and many smaller areoles in irregular arrangement; thinly papyraceous to herbaceous, dark green to blackish in colour. **Sori** round to more or less elongate, many, irregularly scattered on the under surface of fronds (Figure 5.132, 5.133).

Thailand.- NORTHERN: Chiang Rai (Mae Lao), Chiang Mai (Doi Chiang Dao, Doi Saket), Lampang (Mae Long), Tak, Phitsanulok (Thung Salaeng Luang); NORTH-EASTERN: Loei (Phu Luang); EASTERN: Buri Ram (Bu Khanun), Chaiyaphum; CENTRAL: Nakhon Nayok (Khao Yai), Saraburi (Muak Lek); SOUTH-EASTERN: Chanthaburi (Pong Nam Ron); SOUTH-WESTERN: Ratchaburi, Kanchanaburi (Khao Ri Yai), Prachuap Khiri Khan (Huai Yang); PENINSULAR: Chumphon (Ban Tha Ngo), Ranong (Mueang Laen), Surat Thani (Ko Samui, Ban Don), Nakhon Si Thammarat (Khao Luang, Thap Chang, Khiriwong), Trang (Khao Chong), Satun (Bukit Racha Wang), Yala (Bannang Sata).

Distribution.- India to Malesia (type from Java), north to S. China and the Ryukyus.

Ecology.- On moist mossy rocks in hill evergreen forest at 1300 m alt.

Vernacular.- Kut hang nok kaling (กูดหางนกกระลิง) (Peninsular).

Specimens examined.- *W. Rattanathirakul* 206, *T. Boonkerd* 538,1185 (BCU): *E. Hennipman* 3955; *K. Iwatsuki, H. Koyama, M. Hutoh and A. Chintayungkun* T 8509 (BKF).

4. *Microsorum superficiale* (Blume) Ching, Bull. Fan Mem. Inst. Biol. 4: 299. 1933; Tagawa & K. Iwats., Fl. Thailand 3(4): 525. f. 53. 1. 1989.- *Polypodium superficiale* Blume, Fl. Jav. Fil.: 136. t. 56. f. 1. 1828.- *Pleopeltis superficialis* (Blume) Bedd., Handb.: 350. 1883.

Rhizome very long-creeping, scandent on tree, about 3 mm diam., scaly throughout; scales narrowly oblong-subtriangular, gradually narrowing towards apex, irregularly round at base, entire, about 3.5 by 1.7 mm, brown, consisting in smaller cells with distinct internal walls. **Stipe** 17 cm long, winged only on the upper portion, scaly at base, green, stramineous or dark at basal portion. **Lamina** lanceolate, broadest at middle, gradually narrowing towards both ends, acuminate at apex, attenuate at base, entire and flat at margin, 45 by 2.5 cm; midrib distinctly raised beneath, veins more or less visible, copiously anastomosing; thin chartaceous. **Sori** round, punctate, at junction of veinlets, scattered on the whole under surface of fronds, up to 2 mm diam. (Figure 5.131).

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

Distribution.- Himalayas to Malesia throughout (type from Java).

Ecology.- On mossy tree-trunks in hill evergreen forest at 1600 m alt.

Specimens examined.- *W. Rattanathirakul* 42 (BCU): *E. Hennipman* 3283, *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 2643; *T. Shimizu, K. Iwatsuki, N. Fukuoka, M. Hutoh* and *D, Chaiglom* T 11598 (BKF).

11. NEOCHEIROPTERIS

Christ, Bull. Soc. Bot. France 62 Mém. 1:2. 1905; Tagawa & K. Iwats., Fl. Thailand 3(4): 522. 1989.- *Neolepisorus* Ching, Bull. Fan Mem. Inst. Biol. 10:11. 1940.

Rhizome long-creeping, rather fleshy, scaly; scales usually fuscous, peltate, more or less clathrate, with a tuft of setose, long, browning hairs at the point of attachment. **Stipe** jointed to rhizome, indistinct with the attenuate base of fronds. **Lamina** simple and entire, lobed, or pedate, herbaceous to chartaceous; venation copiously anastomosing with free included veinlets in areoles. **Sori** round, somewhat irregularly arranging in one or two rows between midrib and the margin of leaves, covered when young with peltate umbrella-shaped paraphyses.

Neocheiropteris normalis (D. Don) Tagawa, J. Jap. Bot. 27: 217. 1952; Tagawa & K. Iwats., Fl. Thailand 3(4): 523. f. 52. 7-8. 1989.- *Polypodium normale* D. Don, Prodr. Fl. Nepal.: 1. 1825.- *Pleopeltis normalis* (D. Don) Moore, Tnd.: 347. 1862; Bedd., Handb.: 353. 1969.- *Microsorium normale* (D. Don) Ching, Bull. Fan Mem. Inst. Biol. 4: 299. 1933; Holttum, Rev. Fl. Malaya 2: 175. f. 83. 1955.- *Neolepisorus normalis* (D. Don) Ching, Bull. Fan Mem. Inst. Biol. 10: 13. 1940.

Rhizome long-creeping, 3-5 mm diam., bearing fronds with irregular intervals, 0.5-3 cm remote, densely scaly throughout; scales ovate, round at base, moderately acute at apex, entire, about 2 by 0.7 mm, pale brown, concolorous, hardly clathrate, bearing a tuft of setose hairs, dark brown, up to 1 mm in length. **Stipe** up to 4 cm long, winged at upper part, scaly at lower portion, stramineous. **Lamina** narrowly lanceolate, attenuately long-acuminate at apex, broadest at middle portion, gradually narrowing downwards towards attenuate base, entire and flat or slightly waved at margin, up to 35 by 2.5 cm; midrib distinctly raised on both surfaces; lateral veins more or less visible, copiously anastomosing; herbaceous, the margin of fronds cartilagineous. **Sori** rather irregular in one row between midrib and the margin of fronds, costular, round, up to 2.5 mm diam.(Figure 5.134, 5.135).

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

Distribution.- Himalayas (type from Nepal), Upper Burma, S. China, Vietnam and W Malesia (Malaya & Sumatra)

Ecology.- Scandent highly on tree-trunks in hill evergreen forest at 1600 m alt.

Vernacular.- Kut chak khep (กูดจักเขี่ย) (Chiang Mai).

Specimens examined.- *W. Rattanathirakul* 2; *T. Boonkerd* 83, 1051 (BCU): *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 2457, T 2885 (BKF).

12. POLYPODIUM

L., Sp. Pl. 2: 1082. 1753; Tagawa & K. Iwats., Fl. Thailand 3(4): 568. 1989; ; Devol and Kuo, Fl. Taiwan Vol. 1.2nd ed.: 202. 1980.- *Goniophlebium* (Blume) Presl, Tent. Pterid.: 185. 1836.

Rhizome creeping, covered with scales at least when young, scales clathrate, brown to black, peltate near base; stipes articulate. **Lamina** pinnate or deeply pinnatifid, venation usually reticulate, forming at least one row of costal areolae with included forked veinlets, sometimes free and forked. **Sori** round, usually in row on either side of costa, borne in the areole at end of included veinlet, or on the acroscopic branch of a free forked vein.

Polypodium manmeiense H. Christ, Bull. Herb. Boiss. 6: 870. 1898; Tagawa & K. Iwats., Fl. Thailand 3(4): 568. f. 57: 7-8. 1989.

Rhizome wide-creeping, about 1.5 mm diam., dark green to brown, densely covered with scales; scales narrowly subtriangular, acuminate at apex, entire, up to 2.7 by 0.5 mm, dark greyish-brown. **Stipe** stramineous, 8-10 cm long, densely scaly at base. **Lamina** deeply pinnatifid, usually decurrent to the next lobes by very narrow wing of rachis less than 1 mm in breadth in the lower part, narrowly oblong with rather suddenly narrowing acuminate apex, 22 by 4 cm; lobed up to 20 pairs, narrowly lanceolate, patent except more or less deflexed lower one or two pair(s), about 2 by 0.5 cm, acute to moderately acute at apex, incised to undulate at edge at least at distal portion, upper ones rather suddenly becoming smaller, the apex usually forming lobed terminal pinnae; costa 5-7 mm from the next one, raised on both surfaces, glabrous, stramineous to darker; veins forked, terminal of veinlets ending in elliptic hydathodes inside the margin of lobes; herbaceous, glabrous. **Sori** terminal or subterminal on acroscopic veinlets, medial, less than 1 mm diam., superficial or immersed in cavities (Figure 5.138).

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

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

Ecology.- On moist mossy rocks in light shade in hill evergreen forest at 1450 m alt.

Vernacular.- Kut pha (กูดผา) (Northern).

Specimens examined.- *W. Rattanathirakul* 78, 160 (BCU): *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 1507; *K. Iwatsuki, N. Fukuoka* and *A. Chintayungkun* T 9643 (BKF).

13. PYRROSIA

Mirbe., Hist. Nat. Veg. 5: 91. 1803; Tagawa & K. Iwats., Fl. Thailand 3(4): 491. 1989.- *Niphobolus* Kaulf., Enum. Fil.: 124. 1824.

Rhizome long-creeping, usually slender, scaly; scales peltate, fringed with hatrs or entire, not clathrate. **Lamina** simple to palmately lobed, entire, fleshy, rarely dimorphic; venation anastomosing, completely hidden; surfaces more or less entirely covered with stellate hairs, generally caducous on upper surface. **Sori** round, large, in a single row or more commonly in several close rows at each side of midribs, sometime taking an appearance of the acrostichoid condition, naked, but protected when young by a dense matt of stellate hairs.

Pyrrosia lingua var. ***heteractis*** (Mett. ex Kuhn) Hovenkamp, Blumea 30: 208. 1984.- *Polypodium heteractis* Mett. ex Kuhn, Linnaea 36: 140. 1869.- *Pyrrosia heteractis* (Mett. ex Kuhn) Ching, Bull. Chin. Bot. Soc. 1(1): 57. 1935; Tagawa & K. Iwats., Fl. Thailand 3(4): 506. f. 50: 11-12. 1989 .- *Niphobolus heteractis* (Mett. ex Kuhn) J. Sm. Ferns Brit. For. 296. 1877.- *Pyrrosia eberhardtii* (Christ) Ching, Bull. Chin. Bot. Soc. 1: 59. 1935; Tagawa & K. Iwats., Fl. Thailand 3(4): 505. f. 50: 9-10. 1989.- *Cyclophorus eberhardtii* Christ, J. Bot. France 21: 237, 270. 1908.- *Pyrrosia mannii* (Gies.) Ching et *Pyrrosia stigmosa* (SW.) Ching sensu Holttum, Dansk Bot. Ark. 20: 19. 1961.- *Pyrrosia lingua* (Thunb.) Farw. Var. *heteractis* Hovenkamp, Blumea 30: 208. 1984.

Rhizome long-creeping, 1.5-3.5 mm diam., bearing fronds 2-5 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 5-7.5 by 1-1.5 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 8-20 cm long, scaly at base with those like rhizome-scales, densely hairs throughout, brown. **Lamina** oblong-lanceolate to oblong, acute to acuminate at apex, caudate or very shortly decurrent at base, 10-18 by 2.5-4 cm, sterile fronds usually lower and broader; midrib and main veins distinct, raised beneath, veins hardly visible, anastomosing; rigidly coriaceous, upper surface stellate hairy or glabrescent, with scattered hydathodes, the lower

surface densely covered with 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 (Figure 5.136, 5.137).

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

Distribution.- S. China (Hainan) and Vietnam (type).

Ecology.- On dry to moist rocks usually in light shade in hill evergreen forest at 1300 m alt.

Vernacular.- Lin kuram (ลิ้นกุรัม) (Eastern).

Specimens examined.- *W. Rattanathirakul* 130; *T. Boonkerd* 588, 673 (BCU): *E. Hennipman* 383; *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 632, T 4779 (BKF).

GRAMMITIDACEAE

Newman, Hist. Brit. Ferns 7. 1840; Devol, Fl. Taiwan Vol. 1.2nd ed.: 216. 1980.

Mostly small epiphytes growing on tree trunks or on rocks. **Rhizome** short-creeping or suberect; scales usually opaque or sometimes clathrate with clear lumen. **Stipe** tufted nearly, usually not articulate to rhizome. **Lamina** simple, pinnate, pinnatifid, bipinnatifid, venation often hidden, usually free; patent hairs usually borne on stipe, rachis and one or both surface of lamina. **Sori** round, oval or linear, dorsal or marginal, superficial or immersed.

Key to the genera

1. Sori superficial or almost so, fronds pinnate or bipinnate **1. Ctenopteris**
1. Sori immersed in soral cavities, fronds pinnatifid **2. Prosaptia**

1. CTENOPTERIS

Blume, Fl. Jav. Fil.: 2: 132. 1828; Tagawa & K. Iwats., Fl. Thailand 3(4): 588. 1989.

Rhizome short, scaly. **Lamina** pinnate or rarely pinnatifid or bipinnate, the lower pinnae reduced, hairy usually with red setose hairs; veins pinnate in pinnae, not simple nor once forked. **Sori** one to several on a pinna, terminal on veins, usually superficial.

Ctenopteris subfalcata (Blume) Kunze, Bot. Zeit. 6: 120. 1848; Devol, Fl. Taiwan Vol. 1.2nd ed.: 220. 1980; Tagawa & K. Iwats., Fl. Thailand 3(4): 590. 1989.- *Polypodium subfalcatum* Blume, En. Pl. Jav.: 130. 1828; Bedd., Handb.: 314. f. 168. 1969.- *Polypodium subminutum* v. A. v. Ros., Mal. Ferns: 598. 1909.- *Ctenopteris subminuta* (v. A. v. Ros.) Holttum, Rev. Fl. Malaya 2: 228. f. 127. 1955.

Rhizome short, erect, bearing a tuft of fronds at apex, scaly; scales thin, membraneous, light brown. **Stipe** indistinct, densely hairly with setose pale, patent hairs up to 1 mm in length. **Lamina** oblong-lanceolate, gradually narrowing towards both apex and base, up to 5 by 0.8 cm; pinnae ascending, narrow, round or moderately acute at apex, gross dentate about 1/5 to 1/3 way towards costa, up to 4 by 2 mm, the lobes round-subdeltoid, round to moderately acute at apex, each containing a veinlet; thinly herbaceous, densely hairy on both surfaces with long, pale setose hairs up to 1 mm in length. **Sori** round, one to each lobe, usually fusing with the next ones at maturity (Figures.140, 5.141).

Thailand.- NORTHERN: Chiang Mai (Doi Phahom Pok, Doi Khun Huai Pong, Doi Suthep, Doi Inthanon); PENINSULAR: Nakhon Si Thammarat (Khao Luang).

Distribution.- Sri Lanka, Himalayas, S. China, W Malesia (type from Java) and Taiwan.

Ecology.- On mossy tree-trunks in hill evergreen forest at 1600 m alt.

Specimens examined.- *W. Rattanathirakul* 12 (BCU): *G. Murata, K. Iwatsuki, C. Pengklai* and *C. Charamphol* T 16075 (BKF).

2. PROSAPTIA

Presl, Tent. Pterid.: 165. 1836; Tagawa & K. Iwats., Fl. Thailand 3(4): 591. 1989.

Rhizome short-creeping or ascending, scaly. **Lamina** in tuft, pinnatifid with free venation. **Sori** round to elliptic, more or less sunk in cavities at margin or on lower surface of fronds.

Prosaptia khasyana (Hook.) C. Chr. & Tardieu, Not. Syst. 8: 180. 1939; Tagawa & K. Iwats., Fl. Thailand 3(4): 591. 1989.- *Polypodium khasyanum* Hook., Ic. Pl.: t. 949. 1854; Bedd., Handb.: 308. 1969.- *Ctenopteris khasyana* (Hook.) Holttum, Rev. Fl. Malaya 2: 233. f. 134. 1955.

Rhizome short, ascending, bearing a tuft of fronds at apex, scaly; scales oblong- subdeltoid, pale brown, pubescent at margin. **Stipe** very stout, castaneous, densely pubescent. **Lamina** narrowly lanceolate, gradually narrowing towards both ends, 7 by up to 1.3 cm, deeply lobe to midrib with a wing; lobes oblique, oblong-subtriangular, moderately acute at apex, entire, the lower ones gradually reducing in length, the upper ones gradually becoming smaller upwards; thinly leathery, veins simple, the lowest basiscopic one usually running direct from midrib, the upper surface glabrous or very sparsely hairy, the margin and lower surface hairy, marginal hairs sometimes in tuft, setose, dark brown. **Sori** terminal at veins, round to subelliptic, medial or nearly so, sunk in cavities without prominent edges (Figure 5.139).

Thailand.- NORTH-EASTERN: Loei (Phu Luang, Phu Kradung, Phu Lom Lo); SOUTH-EASTERN: Prachin Buri (Khao Yai); SOUTH-WESTERN: Prachuap Khiri Khan (Khao Luang); PENINSULAR: Krabi (Phanom Bencha), Phangnga (khao Bang To).

Distribution.- Himalayas (type) to W Malesia, also in S. China (Hainan).

Ecology.- On mossy tree-trunks in hill evergreen forest at 1300 m alt.

Specimens examined.- *W. Rattanathirakul* 82 (BCU): *M. Tagawa, K. Iwatsuki* and *N. Fukuoka* T 1305; *C. Charamphol, K. Larsen* and *E. Warncke* 4276 (BKF).

Fig. 5.1 Phu Hin Rong kla National Park

Fig. 5.2 A panorama view on the way to Man Daeng waterfall

Fig. 5.3 A forest trail on the way to Man Daeng waterfall

Fig. 5.4 Man Daeng waterfall, level 8

Fig. 5.5 Hill evergreen forest at 1,600 m alt. in Man Daeng waterfall

Fig. 5.6 Man Daeng waterfall, level 1

Fig. 5.7 Rom Klao-Paradorn waterfall

Fig. 5.8 Habitat of ferns; a., b. Terrestrial plants; c., d. Lithophytes; e., f. Epiphytes; g., h. Ferns that were found in more than one habitat.

Fig. 5.9 *Huperzia hamiltonii* (Spreng.) Trevis, strobilus

Fig. 5.10 *Huperzia hamiltonii* (Spreng.) Trevis, habitat

Fig. 5.11 *Huperzia phlegmaria* L., strobilus

Fig. 5.12 *Selaginella biformis* A. Braun ex Kuhn, habitat

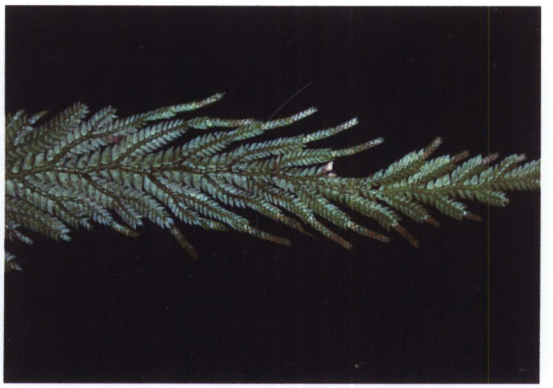

Fig. 5.13 *Selaginella biformis* A. Braun ex Kuhn, strobilus

Fig. 5.14 *Selaginella siamensis* Hieron., habitat

Fig. 5.15 *Selaginella siamensis* Hieron., strobilus

Fig. 5.16 *Angiopteris evecta* (G. Forst.) Hoffm., habitat

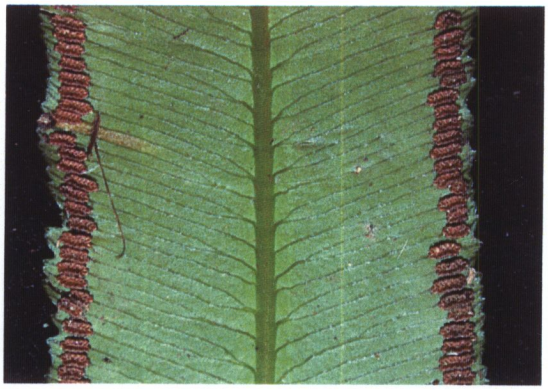

Fig. 5.17 Angiopteris evecta (G. Forst.) Hoffm., sori

Fig. 5.18 *Ophioglossum petiolatum* Hook

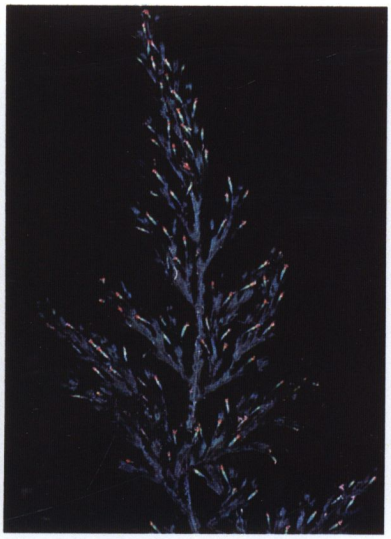

Fig. 5.19 *Crepidomanes birmanicum* (Bedd.) K. Iwats., sori

Fig. 5.20 *Hymenophyllum exsertum* Wall. ex Hook., sori

Fig. 5.21 *Hymenophyllum exsertum* Wall. ex Hook., habitat

Fig. 5.22 *Crepidomanes bipunctatum* (Poir.) Copel., habitat

Fig. 5.23 *Microlepia calvescens* (Wall. ex Hook.) C. Presl

Fig. 5.24 *Microlepia herbacea* Ching & C. Chr. ex C. Chr. & Tardieu

Fig. 5.25 *Microlepia puberula* v. A. v. R.

Fig. 5.26 *Pteridium aquilinum* var. *wightianum* (J. Agardh) R.M. Tryon

Fig. 5.27 *Cibotium barometz* J. Sm.

Fig. 5.28 *Lindsaea ensifolia* Sw., sori

Fig. 5.29 *Cyathea latebrosa* (Wall. ex Hook.) Copel., sori

Fig. 5.30 *Cyathea gigantea* (Wall. ex Hook.) Holttum, sori

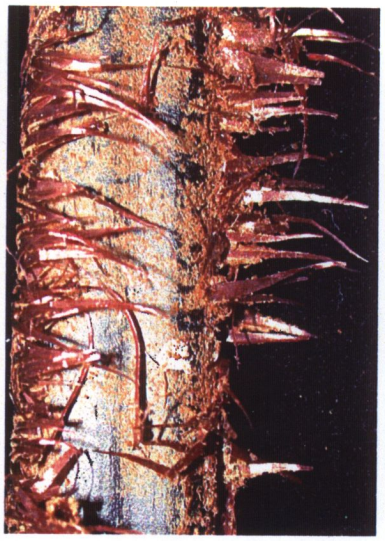

Fig. 5.31 *Cyathea gigantea* (Wall. ex Hook.) Holttum, scales

Fig. 5.32 *Coniogramme petelotii* Tardieu, habitat

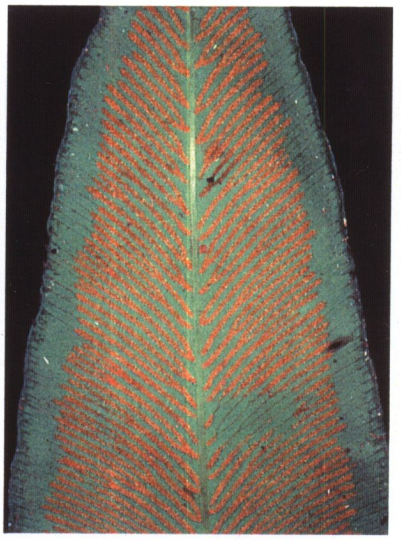

Fig. 5.33 *Coniogramme petelotii* Tardieu, sori

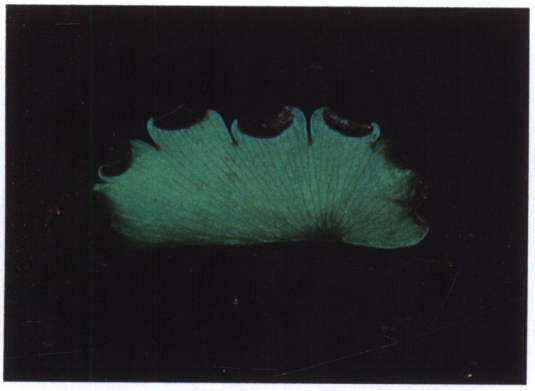

Fig. 5.34 *Adiantum philippense* L, sori

Fig. 5.35 *Pteris tokioi* Masam., habitat

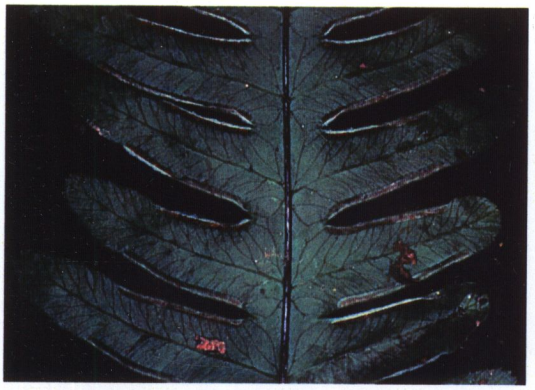

Fig. 5.36 *Pteris tokioi* Masam., sori

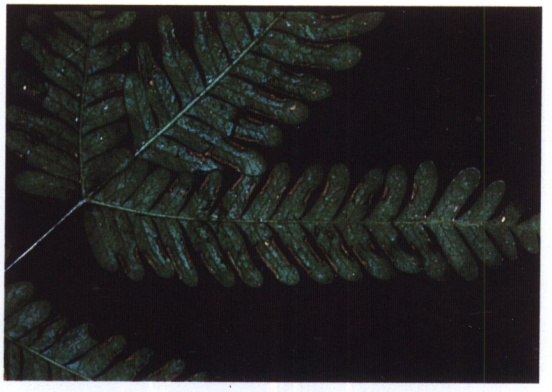

Fig. 5.37 *Pteris bella* Tagawa, sori

Fig. 5.38 *Pteris longipinnula* Wall. ex J. Agardh, sori

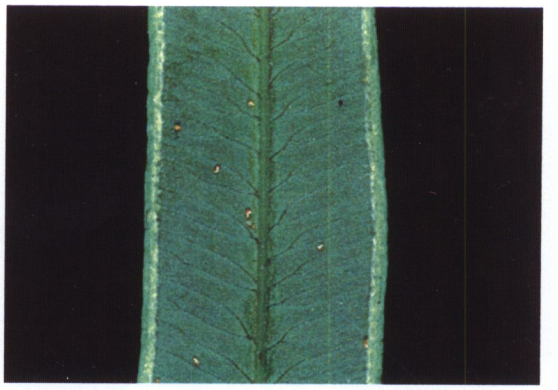

Fig. 5.39 *Pteris vittata* L., sori

Fig. 5.40 *Antrophyum callifolium* Blume, habitat

Fig. 5.41 *Antrophyum callifolium* Blume, sori

Fig. 5.42 *Vittaria angustifolia* Blume, habitat

Fig. 5.43 *Vittaria angustifolia* Blume, sori

Fig. 5.44 *Vittaria amboinensis* Fee, sori

Fig. 5.45 *Vittaria sikkimensis* Kuhn, sori

Fig. 5.46 *Vittaria sikkimensis* Kuhn, habitat

Fig. 5.47 *Vittaria flexuosa* Fee, habitat

Fig. 5.48 *Asplenium cheilosorum* Kunze ex Mett., sori

Fig. 5.49 *Asplenium confusum* Tardieu & Ching, sori

Fig. 5.50 *Asplenium exisum* C.Presl, sori

Fig. 5.51 *Asplenium ensiforme* Wall. ex Hook. & Grev., habitat

Fig. 5.52 *Asplenium ensiforme* Wall. ex Hook. & Grev., sori

Fig. 5.53 *Asplenium nidus* L. var. *nidus*, habitat

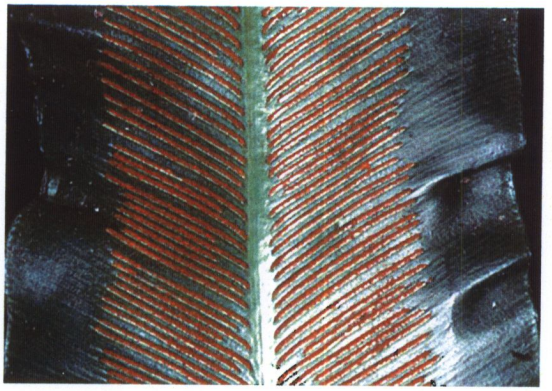

Fig. 5.54 *Asplenium nidus* L. var. *nidus*, sori

Fig. 5.55 *Asplenium normale* D.Don, habitat

Fig. 5.56 *Asplenium normale* D.Don, sori

Fig. 5.57 *Asplenium paradoxum* Blume, habitat

Fig. 5.58 *Asplenium paradoxum* Blume, sori

Fig. 5.59 *Asplenium phyllitidis* D.Don subsp. *phillitidis*, habitat

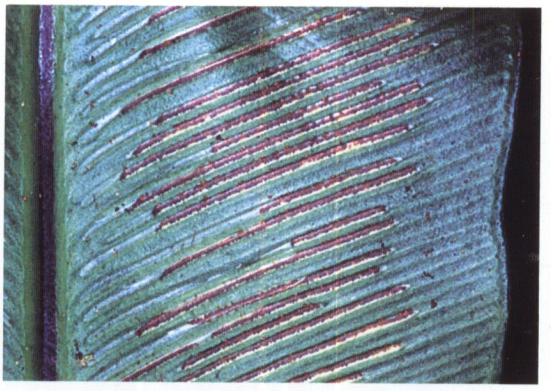

Fig. 5.60 *Asplenium phyllitidis* D.Don subsp. *phillitidis*, sori

Fig. 5.61 *Asplenium scortechinii* Bedd., sori

Fig. 5.62 *Asplenium* sp.1, sori

Fig. 5.63 *Asplenium* sp.1

Fig. 5.64 *Asplenium* sp.2, sori

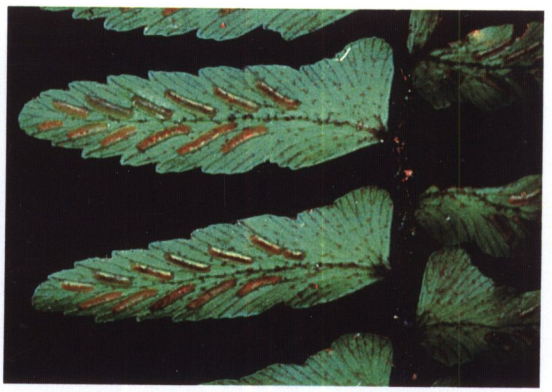

Fig. 5.65 *Asplenium pellucidum* Lam., sori

Fig. 5.66 *Asplenium yoshinagae* Makino, sori

Fig. 5.67 *Asplenium perakense* B. Mathew & H. Christ, sori

Fig. 5.68 *Asplenium perakense* B. Mathew & H. Christ, habitat

Fig. 5.69 *Asplenium scortechinii* Bedd., habitat

Fig. 5.70 *Blechnum orientale* L., habitat

Fig. 5.71 *Arachniodes spectabilis* (Ching) Ching, sori

Fig. 5.72 *Didymochlaena truncatula* (Sw.) J. Sm., sori and scale

Fig. 5.73 *Didymochlaena truncatula* (Sw.) J. Sm., habitat

Fig. 5.74 *Arachniodes spectabilis* (Ching) Ching, habitat

Fig. 5.75 *Acrorumohra diffracta* (Baker) H. Itô, habitat

Fig. 5.76 *Acrorumohra diffracta* (Baker) H. Itô, leaf

Fig. 5.77 *Acrorumohra diffracta* (Baker) H. Itô, sori

Fig. 5.78 *Dryopteris sparsa* (D. Don) Kuntze, sori

Fig. 5.79 *Dryopteris polita* Rosenst., sori

Fig. 5.80 *Tectaria impressa* (Fee) Holttum, sori

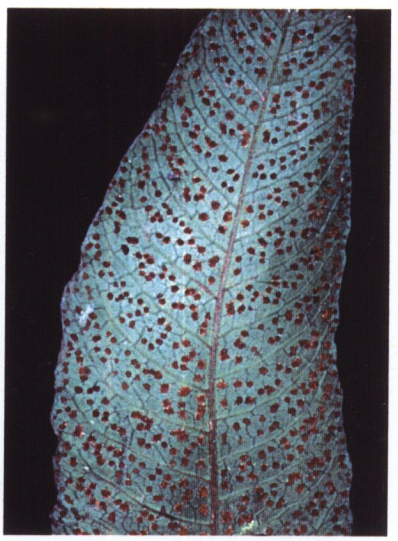

Fig. 5.81 *Tectaria simonsii* (Baker) Ching, sori

Fig. 5.82 *Bolbitis sinensis* (Baker) K. Iwats. var. *sinensis*, habitat

Fig. 5.83 *Bolbitis sinensis* (Baker) K. Iwats. var. *sinensis*, sori

Fig. 5.84 *Bolbitis virens* (Wall. ex Hook. & Grev.) Schott var. *virens*, sori

Fig. 5.85 *Bolbitis virens* (Wall. ex Hook. & Grev.) Schott var. *virens*

Fig. 5.86 *Elaphoglossum stelligerum* (Wall. ex Baker in Hook. & Baker) T. Moore ex Alston & Bonner

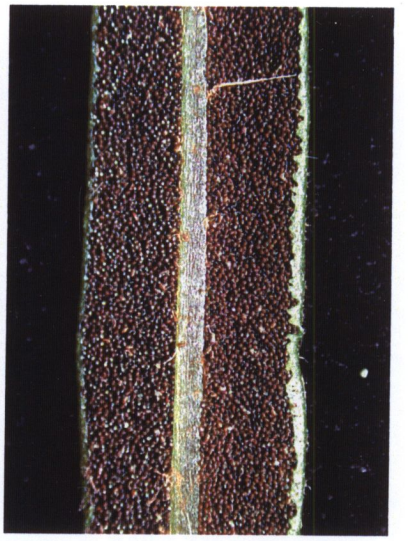

Fig. 5.87 *Elaphoglossum stelligerum* (Wall. ex Baker in Hook. & Baker) T. Moore ex Alston & Bonner, sori

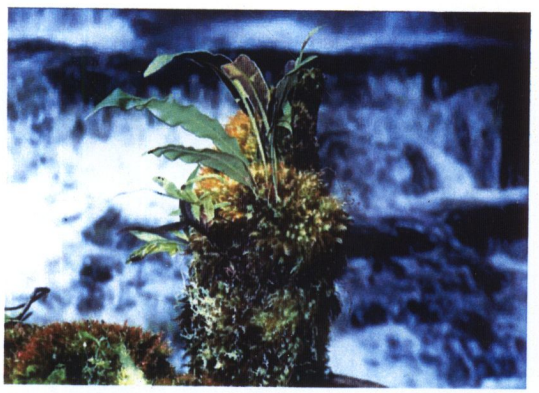

Fig. 5.88 *Elaphoglossum malayense* Holttum, habitat

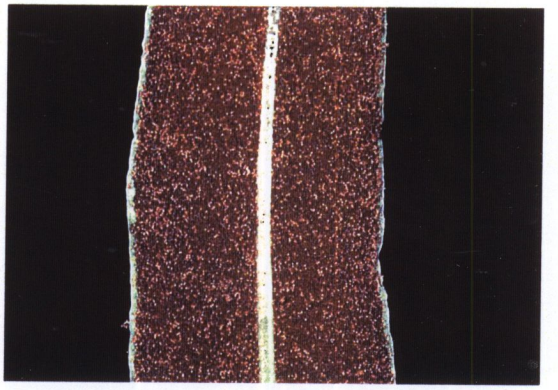

Fig. 5.89 *Elaphoglossum malayense* Holttum, sori

Fig. 5.90 *Christella siamensis* Tagawa & K. Iwats.

Fig. 5.91 *Pneumatopteris truncata* (Poir.) Holttum

Fig. 5.92 *Pronephrium nudatum* (Roxb.) Holttum, habitat

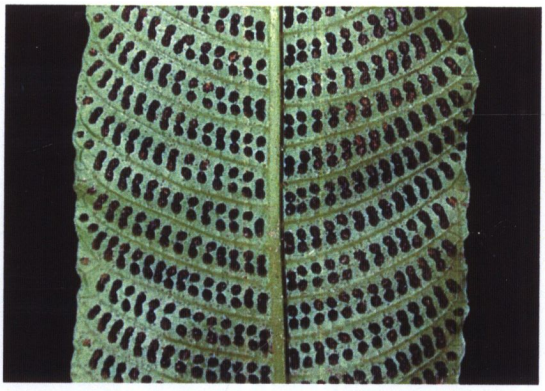

Fig. 5.93 *Pronephrium nudatum* (Roxb.) Holttum, sori

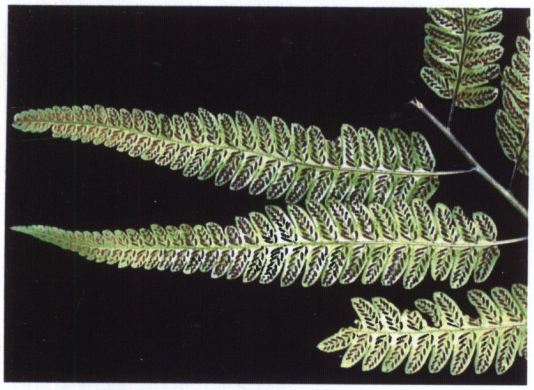

Fig. 5.94 *Diplazium siamense* C. Chr, sori

Fig. 5.95 *Diplazium simplicivenium* Holttum, sori

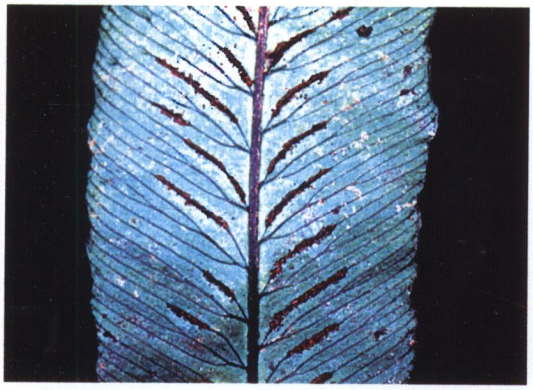

Fig. 5.96 *Diplazium* sp., sori

Fig. 5.97 *Diplazium* sp., habitat

Fig. 5.98 *Davallia trichomanoides* Blume var. *lorrainii* (Hance) Holttum, sori

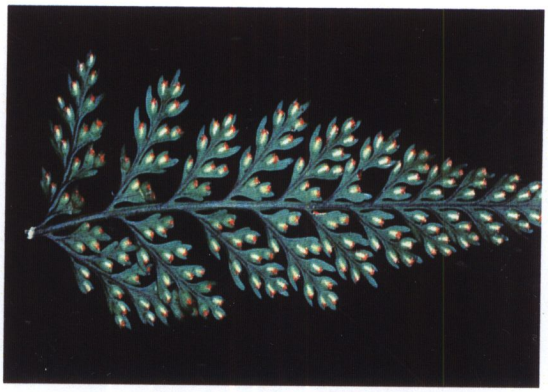

Fig. 5.99 *Davallia trichomanoides* Blume var. *trichomanoides*, sori

Fig. 5.100 *Gymnogrammitis dareiformis* (Hook.) Ching ex Tardieu & C. Chr., sori

Fig. 5.101 *Leucostegia immersa* C. Presl, sori

Fig. 5.102 *Humata repens* (L. f.) J. Small ex Diels

Fig. 5.103 *Nephrolepis cordifolia* (L.) C. Presl, rhizome

Fig. 5.104 *Nephrolepis cordifolia* (L.) C. Presl, habitat

Fig. 5.105 *Nephrolepis cordifolia (*L.) C. Presl, sori

Fig. 5.106 *Oleandra musifolia* (Blume) C. Presl, sori

Fig. 5.107 *Aglaomorpha coronans* (Wall. ex Mett.) Copel., sori

Fig. 5.108 *Colysis hemionitidea* (C. Presl) C. Presl, sori

Fig. 5.109 *Colysis hemionitidea* (C. Presl) C. Presl, habitat

Fig. 5.110 *Belvisia henryi* (Hieron. Ex C. Chr.) Raymond, sori

Fig. 5.111 *Belvisia revoluta* (Blume) Copel., sori

Fig. 5.112 *Colysis pothifolia* (Buch. -Ham. ex D. Don) C. Presl, habitat

Fig. 5.113 *Colysis pentaphylla* (Baker) Ching, sori

Fig. 5.114 *Crypsinus oxylobus* (Wall. ex Kunze) Sledge, sori

Fig. 5.115 *Crypsinus rhynchophyllus* (Hook.) Copel., habitat

Fig. 5.116 *Crypsinus rhynchophyllus* (Hook.) Copel., sori

Fig. 5.117 *Goniophlebium microrhizoma* (C.B. Clarke ex Baker) Clarke ex Bedd., sori

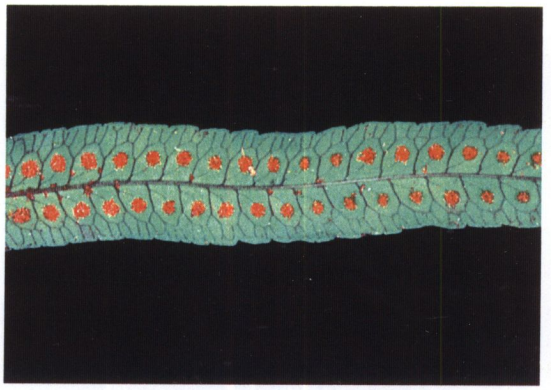

Fig. 5.118 *Goniophlebium argutum* J. Sm. ex Hook., sori

Fig. 5.119 *Goniophlebium subauriculatum* (Blume) C. Presl, habitat

Fig. 5.120 *Lemmaphyllum carnosum* (J. Sm. ex Hook.) C. Presl, habitat

Fig. 5.121 *Lepisorus subconfluens* Ching

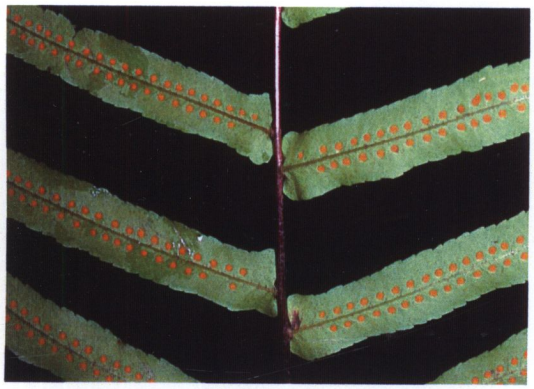

Fig. 5.122 *Goniophlebium subauriculatum* (Blume) C. Presl, sori

Fig.5.123 *Lepisorus scolopendrium* (Buch.-Ham. ex D. Don) Mehra & Bir, sori

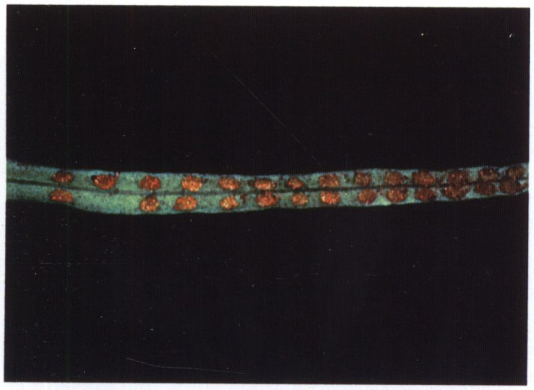

Fig. 5.124 *Lepisorus heterolepis* (Rosenst.) Ching, sori

Fig. 5.125 *Loxogramme chinensis* Ching, sori

Fig. 5.126 *Leptochilus decurrens* Blume, habitat

Fig. 5.127 *Leptochilus decurrens* Blume, sori

Fig. 5.128 *Microsorum dilatatum* (Bedd.) Sledge, habitat

Fig. 5.129 *Microsorum membranaceum* (D. Don) Ching, habitat

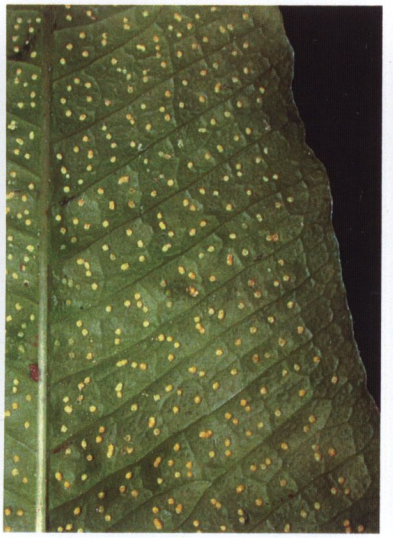

Fig. 5.130 *Microsorum membranaceum* (D. Don) Ching, sori

Fig. 5.131 *Microsorum superficiale* (Blume) Ching, sori

Fig. 5.132 *Microsorum pteropus* (Blume) Copel., habitat

Fig. 5.133 *Microsorum pteropus* (Blume) Copel., sori

Fig. 5.134 *Neocheiropteris normalis* (D. Don) Tagawa, habitat

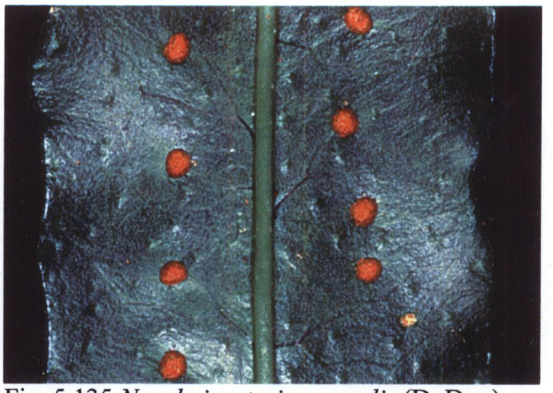

Fig. 5.135 *Neocheiropteris normalis* (D. Don) Tagawa, sori

Fig. 5.136 *Pyrrosia lingua* var. *heteractis* (Mett. ex Kuhn) Hovenkamp

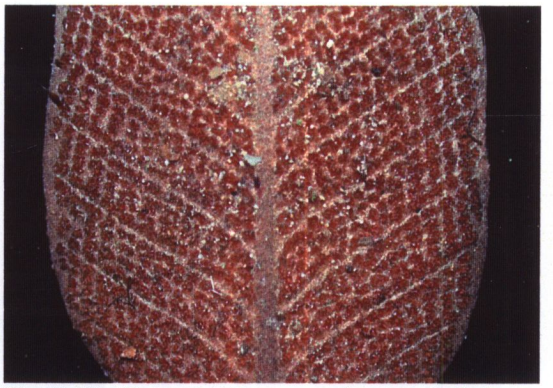

Fig. 5.137 *Pyrrosia lingua* var. *heteractis* (Mett. ex Kuhn) Hovenkamp

Fig. 5.138 *Polypodium manmeiense* H. Christ, sori

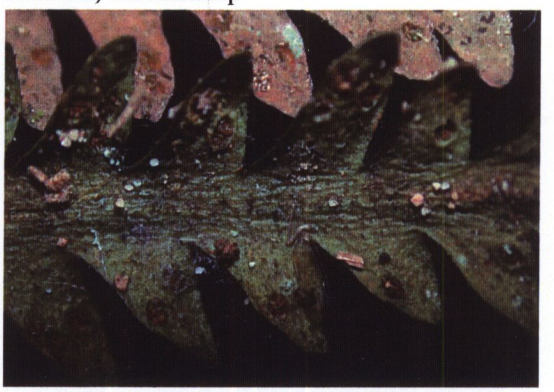

Fig. 5.139 *Prosaptia khasyana* (Hook.) C. Chr. & Tardieu, sori

Fig. 5.140 *Ctenopteris subfalcata* (Blume) Kunze, habitat

Fig. 5.141 *Ctenopteris subfalcata* (Blume) Kunze, sori

CHAPTER 6

DISCUSSION AND CONCLUSION

Taxonomic survey of ferns and fern allies at Phu Hin Rong Kla National Park was investigated from March 2001 to July 2002. Two hundreds and seventeen specimens were collected. A total of 23 families, 55 genera, 112 species and 2 varieties were identified. Among these 21 families, 53 genera, 108 species and 2 varieties are ferns, while 2 families, 2 genera and 4 species are fern allies.

6.1 Habitat and Diversity of Ferns and Fern Allies

Specimen collections were mainly focused on two waterfalls in hill evergreen forest, i.e. Man Daeng Waterfall, Rom Klao-Paradon Waterfall and nearby sites. The altitude of the areas ranging from 1,200 to 1650 m. It is rather fertile forest as compared with the other forest types below these levels. Tree trunk and branches are usually covered with bryophytes and filmy ferns. This forest type has rather deep, humus-rich and high humidity soils. Pteridophytes include common families of ferns, such as Polypodiaceae, Aspleniaceae, Dennstaedtiaceae, Dryopteridaceae and Woodsiaceae. It was found that ferns and fern allies thrive in various habitats, such as terrestrial, on rock (lithophytes) and on tree-branches or tree-trunks (epiphyte). Morever, some species occur in more than one habitat (Fig. 6.1).

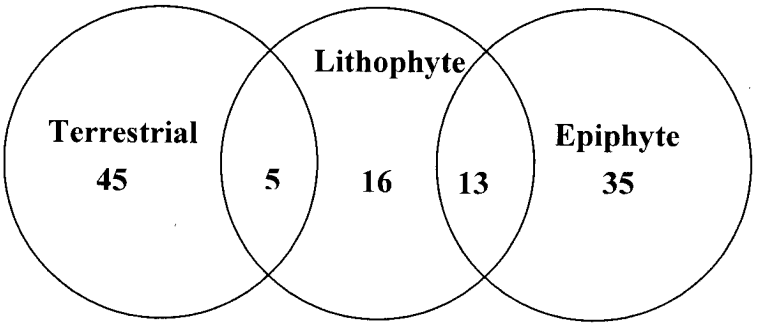

Fig. 6.1 Number of ferns and fern allies in each habitat

6.1.1 Terrestrial plants

It was found that 44 species and 1 variety of ferns were terrestrial plants. Terrestrial habitat includes mountain slopes, shady areas, stream banks and open ground. Common families of ferns, such as Dennstaedtiaceae, Dryopteridaceae, Thelypteridaceae, Pteridaceae and Woodsiaceae are found. Most ferns are observed on mountain slopes. The common species included *Diplazium simplicivenium*, *Microlepia calvescens*, *Didymochlaena truncatula*, *Christella siamensis* and *Pteris tokioi*. These ferns usually occupy humus-rich mountain slopes. Wheres *Microlepia strigosa*, *Arachniodes spectabilis* and *Christella dentata* can be found on rather dry slopes. Along stream banks, where air humidity is rather high, there exist some large terrestrial ferns or tree ferns, such as *Angiopteris evecta*, *Cibotium barometz* and *Cyathea gigantea*. While *Pneumatopteris truncata* and *Coniogramme petelotii* will be found on wet ground, especially along stream banks where sunlight can penetrate to the forest floor. In exposed ground, the two most common terrestrial sun-ferns can be found, i.e. *Pteridium aquilinum* var. *wightianum*, *Dicranopteris linearis* var. *linearis*. They form dense long-persistent thickets in open places and become weedy species. Though the two species are sun-loving ferns, the two do not normally complete together. Because these two ferns have different soil preferences. It was found that *Pteridium aquilinum* prefer well-drained soil, whilst *Dicranopteris linearis* grows on clayey soil (Holttum, 1969).

6.1.2 Lithophytes

It was found that 16 species of ferns and fern allies are lithophytes. These species grow on bare rocks, humus-rich rocks, muddy rock, in rock crevices or cliffs. Lithophytes are confined to high humidity areas, such as along stream banks. They usually have long creeping rhizome with numerous clinging roots adhere on rock surface. Some lithophytes are established in muddy rock crevices in partial shade, such as *Adiantum philippense*, *Oleandra undulata*. Whilst some ferns are inhabited on muddy rocks or on moist cliffs by streams, such as *Elaphoglossum stelligerum*, *Asplenium paradoxum*. On moist muddy rock, it can be found *Asplenium cheilosorum*, *Microsorum membranaceum* and *Vittaria sikkimensis*. Whilst *Goniophlebium subauriculatum* can be found on moist mossy-rock. On wet ground or muddy rocks near streams, there occur some medium-sized ferns, for example, *Bolbitis heteroclita*, *Colysis hemionitidea* and *Microsorum dilatatum*. In some exposed bare rocks or cliffs, some ferns, for example *Oleandra undulata* adapt themselves coinciding with the changing of environment, especially in dry season. This fern can survive over the dry summer by shedding their fronds in order to reduce transpiration. Some lithophytes, for example, *Pyrrosia lingua, Oleandra undulata* have long slender creeping rhizomes, these species are usually found on bare rocks in

full sunlight. They can protect the whole plant from water loss by having dense overlapping scales.

6.1.3 Epiphytes

It was found those 34 species 1 variety of ferns and fern allies are epiphytes. In general, these pteridophytes grow on tree trunks, on mossy tree-trunks or on branches of trees. It includes common families of ferns, such as Polypodiaceae, Hymenophyllaceae, Aspleniaceae Vittariaceae and Davalliaceae. Examples of common epiphytes are *Huperzia hamiltonii*, *Hymenophyllum exsertum*, *Asplenium ensiforme*, *Vittaria elongata*, *Humata repens*, *Oleandra musifolia*, *Belvisia henryi*, *Lemmaphyllum carnosum* and *Crypsinus rhynchophyllus*. In dry season some epiphytes can adapt to withstand the dry summer months by reducing total surface of frond form transpiration by shrivelling, such as *Asplenium ensiforme*, *Asplenium perakense*, *Loxogramme chinensis* and filmy ferns.

6.1.4 Ferns that were found in more than one habitat

It was found that 18 species of ferns and fern allies could be found in more than one habitat (Fig. 6.1). For example, some ferns could be found as epiphytes or lithophytes. They have wide creeping rhizomes and short root system. These ferns grow well either on mossy tree trunks or humus-rich rocks, such as *Asplenium pellucidum*, *Nephrolepis cordifolia*, *Aglaomorpha coronans* and *Pyrrosia lingua* var. *heteractis*. Though some species can be either terrestrial plant or lithophyte, such as *Selaginella siamensis*, *Asplenium normale* and *Bolbitis sinensis* var. *sinensis*. and *Leptochilus decurrens*.

6.2 Endemic species

From taxonomic survey of ferns and fern allies, it can be concluded that two endemic species of Thailand occur in the study area.

6.2.1 *Christella siamensis*, was found in the northern provinces of Thailand, such as Chiang Rai (Khun Korn Waterfall), Phetchabun (Phu Miang) and Loei (Phu Luang, type). It occurs on humus-rich mountain slopes in hill evergreen forest at the elevation of 1,400 m (Boonkerd and Rachata, 2002; Tagawa and Iwatsuki, 1988).

6.2.2 *Diplazium siamense* is endemic to northern Thailand. This species grow on humus-rich mountain slopes in hill evergreen forest at the elevation of 1,400 m. It was earlier reported from Chiang Rai (Doi Pacho, Khun Korn Waterfall), Chiang Mai (Doi Suthep, type), Phitsanulok (Phu Rom Rot), Phrae (Mae Sai) and in north-

eastern Thailand, such as Phetchabun (Phu Miang) and Loei (Phu Luang) Provinces (Boonkerd and Rachata, 2002; Tagawa and Iwatsuki, 1988).

6.3 New recorded

It is found that *Acrorumohra diffracta* (Baker) H. Itô is a new recorded species for Thailand. It has been reported in China, Taiwan and Indochina. Its present distribution is in agreement with the distribution of the Indo-Chinese element. It occupies humus-rich mountain slopes and usually found along streams banks in some sunlit spots in hill evergreen forest at 1600 m alt. It is rather rare species and can be found only on the forest trail to Man Daeng Waterfall.

6.4 Dubious species

In this study, there are three species of ferns that cannot be determined to species level. Though attempts had been made to use key determination from the Flora of Thailand as well as keys from neighbouring countries. Herbarium specimens of related species are also studied from BCU and BKF, but they are still unidentified. They are two species of *Asplenium* and one species of *Diplazium*.

- *Asplenium* sp.1 is an epiphyte on mossy tree-trunks in hill evergreen forest at 1,600 m alt. It is similar to *Asplenium scortechinii* Bedd., but their details of fronds, such as, shape and size of lamina and venation are different.

- *Asplenium* sp.2 is a lithophyte on moist muddy rock in hill evergreen forest at 1300 m alt. It looks like *Asplenium pellucidum* Lam. This *Asplenium* species has short pinnae stalks, toothed leaf margin, lower pinnae not reduced, brownish to dark brown stipes, and bearing narrow scales throughout. These characters are different from *Asplenium pellucidum* Lam.

- *Diplazium* sp. a is terrestrial fern on humus-rich mountain slopes in hill evergreen forest at 1500 m alt. It is a closed to *Diplazium mettenianum* (Miq.) C. Chr. and *Diplazium donianum* (Mett.) Tardieu. However, their frond and sori characters are different.

It is actually essential to consult herbarium and/or type specimens outside Thailand in order to get the right botanical names for these species.

6.5 Comparisons with Pteridophytes from the other areas

Phu Miang, Phitsanulok and Phetchabun Provinces

Due to the perpetual activity of the Thai-Communist party at Phu Hin Rong Kla in the last 30 years, resulted in scanty plant explorations from this area. According to the Flora of Thailand Volume III (Tagawa and Iwatsuki; 1979, 1985, 1988, 1989), 78 species of ferns and fern allies were reported from Phu Miang. Phu Miang is located in Phetchabun mountain ranges in Phitsanulok and Phetchabun Provinces. It is marked out approximately by the geographical coordinates of 16° 51′- 17° 41′ north latitude and 100 ° 40′- 101 ° 7′ east longitudes. Altitude is ranging from 764 to 1,409 m. Of 112 species of ferns and fern allies from this study, 45 species are found in common with pteridophyte from Phu Miang (Table 6.1).

Khunkorn Waterfall Forest Park, Chiang Rai Province

Khunkorn Waterfall Forest Park is located in Chiang Rai Province. The park is marked out approximately by the geographical coordinates of 19 ° 51′- 19° 54′ north latitude and 99 ° 35′- 99 ° 39′ east longitudes. The climate of the area is monsoonal upon a strong alternation of wet and dry season. The annual relative humidity is about 77%, while the high relative humidity during August-December is 95% and the average annual rainfall of 1,755 mm was observed the vegetation includes dry mixed deciduous forest, moist mixed deciduous forest and hill evergreen forest (Boonkerd and Rachata, 2002).

One hundred and fifty-teen species and eleven infraspecific taxa in 24 families and 64 genera were reported from Khunkorn Waterfall Forest Park. It is found that 53 species of ferns and fern allies are in common with the pteridophytes from Phu Hin Rong Kla National Park (Table 6.1).

Table. 6.1 Comparison of ferns and fern allies diversity from Phu Hin Rong Kla, Phu Miang and Khunkorn Waterfall.

Note: **✓ = presence - = absence**

Family	Taxon (found in this study)	Phu Miang	Khunkorn Waterfall
Lycopodiaceae	*Huperzia hamiltonii* (Spreng.) Trevis.	✓	✓
	Huperzia phlegmaria L.	-	-

Family	Taxon (found in this study)	Phu Miang	Khunkorn Waterfall
Selaginellaceae	*Selaginella biformis* A. Braun ex Kuhn	✓	–
	Selaginella siamensis Hieron.	✓	–
Marattiaceae	*Angiopteris evecta* (G. Forst.) Hoffm.	–	✓
Ophioglossaceae	*Ophioglossum petiolatum* Hook.	–	✓
Hymenophyllaceae	*Crepidomanes bipunctatum* (Poir.) Copel.	–	–
	Crepidomanes birmanicum (Bedd.) K. Iwats.	–	–
	Crepidomanes minutum (Blume) K. Iwats.	–	–
	Hymenophyllum badium Hook. & Grev.	✓	–
	Hymenophyllum barbatum (Bosch) Baker	✓	–
	Hymenophyllum exsertum Wall. ex Hook.	✓	✓
	Hymenophyllum polyanthos (Sw.) Sw.	–	✓
Gleicheniaceae	*Dicranopteris linearis* (Burm. f.) Underw. var. *linearis*	–	✓
Dennstaedtiaceae	*Microlepia calvescens* (Wall. ex Hook.) C. Presl	✓	✓
	Microlepia herbacea Ching & C. Chr. ex C. Chr. & Tardieu	✓	–
	Microlepia hookeriana (Wall. ex Hook.) C. Presl	–	–
	Microlepia platyphylla (D. Don) J. Sm.	–	–
	Microlepia puberula v. A. v. R.	–	–
	Microlepia strigosa (Thunb.) C. Presl	–	✓
	Pteridium aquilinum var. *wightianum* (J. Agardh) R.M. Tryon	✓	✓
Dicksoniaceae	*Cibotium barometz* J. Sm.	✓	✓
Lindsaeaceae	*Lindsaea ensifolia* Sw.	–	✓
Cyatheaceae	*Cyathea gigantea* (Wall. ex Hook.) Holttum	–	✓
	Cyathea latebrosa (Wall. ex Hook.) Copel.	–	–
Adiantaceae	*Adiantum philippense* L.	✓	✓
	Coniogramme petelotii Tardieu	–	–
Pteridaceae	*Pteris bella* Tagawa	–	–
	Pteris longipinnula Wall. ex J. Agardh	–	–
	Pteris tokioi Masam.	✓	–
	Pteris vittata L.	–	✓
Vittariaceae	*Antrophyum callifolium* Blume	–	✓
	Vittaria angustifolia Blume	–	✓
	Vittaria amboinensis Fee	–	–
	Vittaria flexuosa Fee	✓	–
	Vittaria sikkimensis Kuhn	✓	✓
Aspleniaceae	*Asplenium cheilosorum* Kunze ex Mett.	✓	–
	Asplenium confusum Tardieu & Ching	–	–
	Asplenium ensiforme Wall. ex Hook. & Grev.	–	–
	Asplenium exisum C.Presl	–	–
	Asplenium nidus L. var. *nidus*	–	✓
	Asplenium normale D.Don	✓	–

Family	Taxon (found in this study)	Phu Miang	Khunkorn Waterfall
	Asplenium obscurum Blume	-	✓
	Asplenium paradoxum Blume	-	-
	Asplenium pellucidum Lam.	-	-
	Asplenium perakense B. Mathew & H. Christ	-	✓
	Asplenium phyllitidis D.Don subsp. *phillitidis*	-	-
	Asplenium scortechinii Bedd.	-	-
	Asplenium yoshinagae Makino	-	✓
	Asplenium sp.1	-	-
	Asplenium sp.2	-	-
Blechnaceae	*Blechnum orientale* L.	-	✓
Dryopteridaceae	*Acrorumohra diffracta* (Baker) H. Itô	-	-
	Arachniodes spectabilis (Ching) Ching	✓	-
	Didymochlaena truncatula (Sw.) J. Sm.	-	-
	Dryopteris hirtipes (Blume) Kuntze	✓	-
	Dryopteris polita Rosenst.	-	-
	Dryopteris sparsa (D. Don) Kuntze	-	-
	Polystichum biaristatum (Blume) T. Moore	-	-
	Tectaria impressa (Fee) Holttum	-	✓
	Tectaria simonsii (Baker) Ching	-	-
Lomariopsidaceae	*Bolbitis heteroclita* (C. Presl) Ching	-	✓
	Bolbitis sinensis (Baker) K. Iwats. var. *costulata* (Hook.) Tagawa & K. Iwats.	-	✓
	Bolbitis sinensis (Baker) K. Iwats. var. *sinensis*	✓	-
	Bolbitis virens (Wall. ex Hook. & Grev.) Schott var. *virens*	-	✓
	Elaphoglossum malayense Holttum	-	-
	Elaphoglossum stelligerum (Wall. ex Baker in Hook. & Baker) T. Moore ex Alston & Bonner	-	✓
Thelypteridaceae	*Amphineuron terminans* (J. Sm.) Holttum	-	✓
	Christella dentata (Forssk.) Holttum	✓	✓
	Christella siamensis Tagawa & K. Iwats.	✓	✓
	Christella subpubescens (Blume) Holttum	-	-
	Pneumatopteris truncata (Poir.) Holttum	-	✓
	Pronephrium nudatum (Roxb.) Holttum	-	✓
	Trigonospora ciliata (Wall. ex Benth.) Holttum	✓	-
Woodsiaceae	*Athyrium mackinnonii* (Hope) C. Chr.	✓	-
	Diplazium siamense C. Chr.	✓	✓
	Diplazium simplicivenium Holttum	-	✓
	Diplazium sp.	-	-
Davalliaceae	*Davallia trichomanoides* Blume var. *lorrainii* (Hance) Holttum	✓	✓
	Davallia trichomanoides Blume var. *trichomanoides*	-	✓
	Gymnogrammitis dareiformis (Hook.) Ching ex Tardieu & C. Chr.	✓	-

Family	Taxon (found in this study)	Phu Miang	Khunkorn Waterfall
	Humata repens (L. f.) J. Small ex Diels	✓	✓
	Leucostegia immersa C. Presl	✓	✓
Oleandraceae	*Nephrolepis cordifolia* (L.) C. Presl	✓	-
	Oleandra musifolia (Blume) C. Presl	✓	-
	Oleandra undulata (Willd.) Ching	-	✓
Polypodiaceae	*Aglaomorpha coronans* (Wall. ex Mett.) Copel.	-	✓
	Belvisia henryi (Hieron. Ex C. Chr.) Raymond	✓	✓
	Belvisia revoluta (Blume) Copel.	-	-
	Colysis hemionitidea (C. Presl) C. Presl	✓	-
	Colysis pentaphylla (Baker) Ching	✓	-
	Colysis pothifolia (Buch.-Ham. ex D. Don) C. Presl	✓	-
	Crypsinus oxylobus (Wall. ex Kunze) Sledge	✓	✓
	Crypsinus rhynchophyllus (Hook.) Copel.	✓	-
	Goniophlebium argutum J. Sm. Ex Hook.	✓	✓
	Goniophlebium microrhizoma (C.B. Clarke ex Baker) Clarke ex Bedd.	-	-
	Goniophlebium subauriculatum (Blume) C. Presl	✓	-
	Lemmaphyllum carnosum (J. Sm. ex Hook.) C. Presl	-	✓
	Lepisorus contortus (H. Christ) Ching	-	✓
	Lepisorus heterolepis (Rosenst.) Ching	✓	✓
	Lepisorus scolopendrium (Buch.-Ham. ex D. Don) Mehra & Bir	✓	✓
	Lepisorus subconfluens Ching	-	✓
	Leptochilus axillaris (Cav.) Kaulf.	-	-
	Leptochilus decurrens Blume	✓	✓
	Loxogramme chinensis Ching	-	✓
	Microsorum dilatatum (Bedd.) Sledge	-	-
	Microsorum membranaceum (D. Don) Ching	-	✓
	Microsorum pteropus (Blume) Copel.	-	✓
	Microsorum superficiale (Blume) Ching	✓	-
	Neocheiropteris normalis (D. Don) Tagawa	✓	-
	Polypodium manmeiense H. Christ	✓	-
	Pyrrosia lingua var. *heteractis* (Mett. ex Kuhn) Hovenkamp	✓	✓
Grammitidaceae	*Ctenopteris subfalcata* (Blume) Kunze	-	-
	Prosaptia khasyana (Hook.) C. Chr. & Tardieu	-	-

Table 6.2 Taxon of fern and fern allies from Phu Hin Rong Kla National Park, Phu Miang and Khunkorn Waterfall Forest Parks.

Study site	Family	Genus	Species
Phu Hin Rong Kla National Park, Phitsanulok and Phetchabun Provinces	23	55	112
Phu Miang, Phitsanulok and Phetchabun Provinces	16	33	45
Khunkorn Waterfall Forest Park, Chiang Rai Province	24	64	154

Table 6.1 shows comparison of pteridophyte diversity from three study areas. It can be seen that Khunkorn Waterfall Forest Park is the richest in diversity. The discrepancy in number of species from these three study sites may be in part due to the diversity of forest types. This pteridophyte study mainly focused only in hill evergreen forest since the rest vegetations have been severely destructive in the last 30 years. While the diversity of pteridophyte of Khunkorn Waterfall Forest Park has been studied from the whole area of the park which has much more habitat diversity. Unfortunately, detail habitat or vegetation type of Phu Miang is not available from the Flora of Thailand, Volume III (Tagawa and Iwatsuki, 1979, 1985, 1988, 1989) and its diversity of pteridophytes could not be compared. Anyhow, it can be focused on hill evergreen forest of Phu Hin Rong Kla National Park and Khunkorn Waterfall Forest Park. Boonkerd and Rachata (2002) reported 80 species of pteridophytes in hill evergreen forest from Khunkorn Waterfall Forest Park, while 112 species were found from this study. The higher number of species at Phu Hin Rong Kla National Park indicates the fertile hill evergreen forest of this park. This may due in part to the activity of the Thai-Communist party at Phu Hin Rong Kla in the last 30 years. Their activity help to protect the fertile hill evergreen forest from destruction as was happened in the other vegetations of the park.

6.6 New information on fern and fern allies distribution

Three species, namely *Amphineuron terminans*, *Angiopteris evecta* and *Tectaria impressa* are commonly found throughout the country. From Flora of Thailand, there are 5 species, which had never been found in northern and northeastern floristic regions before, viz. *Asplenium perakense*, *Christella subpubescens*, *Diplazium simplicivenium*, *Pteris longipinnula*, and *Vittaria angustifolia* (Tagawa and Iwatsuki; 1985, 1988).

- *Asplenium perakense* is an epiphyte. It can be found on tree-trunks usually in hill evergreen forest at 1450 m alt. It was previously from Nakhon Si Thammarat (Khao Luang) (Tagawa and Iwatsuki, 1985).

- *Christella subpubescens* is a terrestrial fern. It can be found on rather dry mountain slopes in hill evergreen forest at 1450 m alt. It was once reported from Chanthaburi (Khao Soi Dao) (Tagawa and Iwatsuki, 1988).

- *Diplazium simplicivenium* is a terrestrial fern. It can be found in moist areas of hill evergreen forest at 1600 m alt. It was earlier reported from Kanchanaburi (Khao Ngi Yai), Uthai Thani (Ban Rai) Surat Thani (Klong Ton), Nakhon Si Thammarat (Khao Luang), Phangnga (Khao Pok), Trang (Khao Chong), Satun and Yala (Muang Wing) (Boonkerd, 1980; Tagawa and Iwatsuki, 1988).

- *Pteris longipinnula* is a terrestrial fern. It can be found on humus-rich mountain slopes in hill evergreen forest at 1300 m alt. It was formerly reported from Surat Thani (Ban Don) and Yala (Bannang Sata) (Tagawa and Iwatsuki, 1985).

- *Vittaria angustifolia* is an epiphyte. It can be found on mossy tree-trunks in hill evergreen forest at 1600 m alt. It was previously reported from Chanthaburi (Khao Soi Dao, Khao Sabap), Nakhon Si Thammarat (Khao Luang), Trang (Khao Chong), Krabi (Phanom Bencha) and Yala (Khao Kalakhiri, Bla Hat) (Tagawa and Iwatsuki, 1985).

Among the 5 species above, 2 species, i.e. *Asplenium perakense* and *Pteris longipinnula* occur only in peninsular Thailand. It is previously noted that *Asplenium perakense* is found only in Malaysia. However, Boonkerd and Rachata (2002) indicated a disjunct distribution of *Asplenium perakense* since it is found at Khunkorn Waterfall Forest Park, Chiang Rai Province. So this study confirms the occurrence of *Asplenium perakense* in northern provinces of Thailand. While, *Pteris longipinnula* occur in S. India and Malesia. It absence from Northern and Northeastern floristic regions may partly due to lacking taxonomic study from these regions. Its occurrence in northern Thailand is in agreement with its present distribution in south India. So this study also confirms the distribution of this species in northern hemisphere.

6.7 Miscellaneous Uses

In this study, 2 species of ferns, namely *Angiopteris evecta* and *Cibotium barometz* are previously used in local medicine, especially silky hairs on buds of *Cibotium barometz* used as styptics. Two species of tree ferns, i.e. *Cyathea gigantea* and *Cyathea latebrosa*, have fibrous trunk used for orchid media. In addition, *Nephrolepis cordifolia* is commonly used as ornamental fern (Tagawa and Iwatsuki, 1979, 1985).

6.8 Problems in running this research

6.8.1 Phu Hin Rong Kla Nation Park is still a dangerous site due to abandon land mine from previous fighting. So, specimen collections were still limited.

6.8.2 Due to the time limit and difficulty to access in some studied areas, for example, steep cliffs. Some species may be overlooked.

6.8.3 The studied site is influenced by seasonal monsoons, with a heavy rainfall during the rainy season. It was rather difficult to take a picture during field trips in heavy rain.

6.8.4 The voucher specimens at BCU and BKF are not available in some problematical species, so uncertain determinations were made in some species.

6.9 Benefit of This Research

6.9.1 The fundamental data of species diversity of ferns and fern allies in Phu Hin Rong Kla National Park was known and can be used in conservation and tourism promotion programs.

6.9.2 Key to the genera and species of ferns and fern allies using plant materials collected from Phu Hin Rong Kla National Park can be used for this plant group in adjacent areas.

6.9.3 Total number of voucher species at the Professor Kasin Suvatabhanda Herbarium (BCU), Department of Botany will be increased by the collected specimen from this species.

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