ความหลากหลายของเฟิร์นและพืชใกล้เคียงเฟิร์นบริเวณเขาเขียว อุทยานแห่งชาติเขาใหญ่

นางสาววสินี ไขว้พันธุ์

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต
สาขาวิชาพฤกษศาสตร์ ภาควิชาพฤกษศาสตร์
คณะวิทยาศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย
ปีการศึกษา 2548

ISBN 974-53-2823-5

DIVERSITY OF FERNS AND FERN ALLIES AT KHAO KHIAO AREA IN KHAO YAI NATIONAL PARK

Miss Wasinee Khwaiphan

A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Science Program in Botany
Department of Botany
Faculty of Science
Chulalongkorn University
Academic Year 2005

ISBN 974-53-2823-5

Thesis Title	DIVERSITY OF FERNS AND FERN ALLIES AT KHAO KHIAO AREA IN KHAO YAI NATIONAL PARK
By	Miss Wasinee Khwaiphan
Field of Study	Botany
Thesis Advisor	Associate Professor Thaweesakdi Boonkerd, Ph.D.

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วสินี ไขว้พันธุ์: ความหลากหลายของเฟิร์นและพืชใกล้เคียงเฟิร์นบริเวณเขาเขียว อุทยานแห่งชาติเขาใหญ่ (DIVERSITY OF FERNS AND FERN ALLIES AT KHAO KHIAO AREA IN KHAO YAI NATIONAL PARK) อาจารย์ที่ปรึกษา: รศ. ดร. ทวีศักดิ์ บุญเกิด 214 หน้า. ISBN 974-53-2823-5.

จากการศึกษาความหลากหลายของเฟิร์นและพืชใกล้เคียงเฟิร์นบริเวณเขาเขียว อุทยานแห่งชาติเขาใหญ่ ซึ่งมีความสูงจากระดับน้ำทะเล 600-1,300 เมตร เก็บตัวอย่างระหว่างเดือนธันวาคม 2546 ถึงเดือนพฤษภาคม 2548 ได้ทั้งหมด 219 ตัวอย่าง สามารถจำแนกได้ 25 วงศ์ 59 สกุล 113 ชนิด 2 พันธุ์ จัดเป็นเฟิร์น จำนวน 22 วงศ์ 55 สกุล 105 ชนิด 2 พันธุ์ และพืชใกล้เคียงเฟิร์น จำนวน 3 วงศ์ 4 สกุล 8 ชนิด วงศ์ที่พบมากที่สุด คือ Polypodiaceae, Thelypteridaceae และ Dryopteridaceae จำนวน 17, 13 และ 12 ชนิด ตามลำดับ สามารถแบ่งตามลักษณะถิ่นอาศัยได้ 3 แบบ คือ ขึ้นบนดิน 58 ชนิด พืชอิงอาศัย 30 ชนิด และขึ้นบนหิน 7 ชนิด 2 พันธุ์ และพบพืชกลุ่มนี้ที่มีลักษณะถิ่นอาศัยมากกว่า 1 แบบขึ้นไป จำนวน 18 ชนิด นอกจากนั้นยังสามารถแบ่งพืชกลุ่มนี้ตามสภาพป่าได้ 3 แบบ คือ ป่าดิบชื้น จำนวน 53 ชนิด 2 พันธุ์ ป่าดิบเขา จำนวน 34 ชนิด และทุ่งหญ้าและป่ารุ่น จำนวน 6 ชนิด และพบ 20 ชนิดที่สามารถพบได้ในป่ามากกว่า 1 แบบ ได้จัดทำคำบรรยายลักษณะของพันธุ์ไม้แต่ละชนิดพร้อมทั้งข้อมูลนิเวศวิทยา การกระจายพันธุ์ ชื่อพื้นเมือง ประโยชน์ของเฟิร์นและพืชใกล้เคียงเฟิร์นบางชนิด พร้อมทั้งภาพประกอบ ได้จัดทำรูปวิธานเพื่อจำแนกสกุลและชนิด ตัวอย่างพันธุ์ไม้ที่เก็บได้นำไปเก็บที่พิพิธภัณฑ์พืชศาสตราจารย์กสิน สุวตะพันธุ์ ภาควิชาพฤกษศาสตร์ คณะวิทยาศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย และหอพรรณไม้ กรมอุทยานแห่งชาติ สัตว์ป่า และพันธุ์พืช

ภาควิชา.....พฤกษศาสตร์.....ลายมือชื่อนิสิต.....วสินี ไขว้พันธุ์.....

สาขาวิชา.....พฤกษศาสตร์.....ลายมือชื่ออาจารย์ที่ปรึกษา.....

ปีการศึกษา 2548

4672403823: MAJOR BOTANY
KEY WORD: DIVERSITY / FERNS / FERN ALLIES / KHAO KHIAO /
KHAO YAI NATIONAL PARK

WASINEE KHWAIPHAN: DIVERSITY OF FERNS AND FERN ALLIES AT KHAO KHIAO AREA IN KHAO YAI NATIONAL PARK. THESIS ADVISOR: ASSOC. PROF. THAWEESAKDI BOONKERD, Ph.D. 214 pp. ISBN 974-53-2823-5.

Diversity of pteridophyte at Khao Khiao, Khao Yai National Park was explored from December 2003 to May 2005 at elevations ranging from 600 to 1,300 m above mean sea level. Two hundred and nineteen specimens were collected from their natural habitats and were determined into 113 species and 2 varieties, in 59 genera within 25 families. Among these, 22 families, 55 genera, 105 species and 2 varieties were ferns, while 3 families, 4 genera and 8 species were fern allies. Three families of ferns namely, Polypodiaceae, Thelypteridaceae, Dryopteridaceae, were among the common families which included 17, 13 and 12 species, respectively. As regard to habitat, there were 58 species of terrestrials, 30 species of epiphytes and 7 species and 2 varieties of lithophytes. However 18 species of ferns and fern allies could be found in more than one habitat. In addition, it can be concluded that 53 species and 2 varieties were found in tropical evergreen forest. While 34 species were found in hill evergreen forest and 6 species were found in grassland and secondary forest. However, 20 species grew in more than one forest types. Full description together with ecological data, distribution, vernacular name, utilization of and photographs of each species were prepared. Keys to the genera and species were also constructed. The voucher specimens were deposited at the Professor Kasin Suvatabhandhu Herbarium, Department of Botany, Faculty of Science, Chulalongkorn University and The Forest Herbarium, National Park, Wildlife and Plant Conservation Department.

Department.....Botany.....Student's signature....Wasinee Khwaiphan.....
Field of study.....Botany.....Advisor's signature....Thaweesakdi Boonkerd.....
Academic Year 2005

ACKNOWLEDGEMENTS

I would like to express my deepest thanks to my thesis advisor, Associate Professor Dr. Thaweesakdi Boonkerd, for his valuable advice and encouragement that make accomplishment for this thesis.

I wish to extremely thanks to thesis committee, Associate Professer Nantana Angkinand, Dr. Tosak Seelanan, Dr. Somran Suddee for their encouragement and valuable suggestions.

My sincere thanks to Mr. Sahut Chantanaorrapint for help in taking photographs in the field and collecting for the specimens. Miss Amonrat Buakhai, Mr. Yosawate Sirijamorn, Miss Oratai Neamsuwan, Miss Hathaikarn Sittha, Miss Apirada Sathapattayanon, Miss Pankamon Sornsuwan, for their kindness help exploring and collecting for the specimens. All my friends at Department of Botany, Faculty of Science, Chulalongkorn University are also thanked for their friendship.

I am grateful to staff of Professor Kasin Suvatabhandhu Herbarium and Plants of Thailand Research Unit, Department of Botany, Faculty of Science, Chulalongkorn University for providing laboratory facilities for this research.

Special thanks are to the chief and staff of Khao Yai National Park for cooperation and accommodation during specimen collection within the National Park.

I would like to thanks to Assistant Professor Dr. Kansri Boonpragob and Mr. Udom Nawapanich for helps in various ways.

This work was supported by the TRF/BIOTEC Special Program for Biodiversity Research and Training grant T_148010; the Center of Excellence in Biodiversity, Faculty of Science, Chulalongkorn University, under the Research Program on conservation and utilization of Biodiversity CEB_M_3_2005 and Graduate School, Chulalongkorn University.

Finally, I would like to express my deepest thanks to my parents, my sister and my brother for their love and supports.

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CHAPTER I

INTRODUCTION

Thailand is situated in the middle of Indo-Chinese Peninsula which is a part of Southeast Asia, lining between latitudes N 5^{o} 36′ and 20^{o} 27′ and longitude E 97^{o} 20′ and 105^{o} 37′ which covers an area of 513,115 km^2 (ราชบัณฑิตสถาน, 2545). As one of the tropical countries located near the Equator in Southeast Asian region, it tends to be rich in plant diversity. It is estimated that there are about 15,000 species of vascular plant throughout the country (วีระชัย, 2537). Of these 671 species are ferns and fern allies (Boonkerd and Pollawatn, 2000). However, Thailand does not have unique floristic elements due to its great variations in topographies and climates. She usually has plant species in common with the neighboring countries. Therefore, she is considered a collective center of plant diversity from three major floristic regions, i.e. Indo-Burmese, Indo-Chinese and Malesian regions (ธวัชชัย, 2532). Previously, many protected areas, National parks and wildlife sanctuaries for example, were botanically explored. But most of them have never been intensively explored all year round, especially Khao Yai National Park .

Khao Yai National Park is the first national park in Thailand, covers an approximated area of 2,165.55 km^2 and parts of Saraburi, Nakhon Ratchasima, Nakhon Nayok and Prachin Buri Provinces, Recently, it was included in the list of UNESCO World Heritage due to its great diversity in flora and fauna (UNESCO World Heritage Centre, 2005). In general, the park is the mountainous area, with Khao Khiao as one of the high peaks. Khao Khiao covers an approximated area of 60 km^2 and ranging in elevations from 600 to 1,300 m above mean sea level. This area is an interesting site for fern exploration (Boonkerd, 1996), however it has a scarce botanical exploration despite its extensive diversity of vegetation, viz. hill evergreen forest, tropical rain forest, grassland and secondary forests. During the last five decades, most explorations of plant diversity in Khao Yai were focused mainly on flowering plants and usually excluded detailed study of pteridophytes. Previously, only 118 species of pteridophytes were recorded at Khao Yai (Tagawa and Iwatsuki, 1979-1989). It can be seen that data of pteridophyte diversity in this area were rather

small compared with the vast area of the park. This study aims to explore pteridophyte diversity at Khao Khiao area in Khao Yai National Park. It is expected that an up-to-date data of pteridophyte diversity will be collected and can be further used for conservation and management of this ferny site.

Aims of Thesis:

To explore diversity of ferns and fern allies at Khao Khiao area in Khao Yai National Park.

CHAPTER II

LITERATURE REVIEW

Previous botanical explorations

During 1899-1900, Johanes Schmidt, a Danish botanist explored plant diversity at Koh Chang and nearby small islands. After he got back to Copenhagen, he distributed his collections to various taxonomists in Europe. In 1900, H.Christ, a pteridophyte specialist, studied the ferns and fern allies collections. The genus *Selaginella* was studied by G.Hieronymus. Eight families, 37 genera, 73 species of ferns and fern allies were enumerated and published in the Flora of Koh Chang part III. Fifteen years latter, these ferns and fern allies were revised by Carl Christensen. He enumerated 66 species of ferns and fern allies. The revision of ferns and fern allies of Koh Chang were published in the Flora of Koh Chang part X (Schmidt, 1900-1916).

In 1968, Tem Smitinand, a curator of the Forest Herbarium, Royal Forest Department, studied vegetation of Khao Yai National Park from the existing specimens from Khao Laem, collected by Dr. A. F. G. Kerr and his own collections with Dr. R. G. Robbins from the hill evergreen forest of Khao Khiao. A total of 40 families, 98 genera, and 125 species of vascular plants were reported. Of these 8 families, 22 genera, 26 species were ferns and fern allies. Examples of ferns and fern allies from high altitudes of Khao Yai were *Hymenophyllum exsertum* Wall.ex Hook., *Grammitis dorsipila* (Christ) C.Chr. & Tardieu, *Diacalpe aspidiodes* Blume, *Oleandra musifolia* (Blume) C.Presl, *Selaginella siamensis* Hieron. (Smitinand, 1968).

M.Tagawa and K.Iwatsuki, the Japanese botanists studied the existing herbarium species of ferns and fern allies collected from Thailand and specimens from their own field explorations. A total of 34 families, 132 genera, 633 species were enumerated. Among these, there were 25 new species and 21 endemic species of Thailand. The account of ferns and fern allies of Thailand were subsequently published in Flora of Thailand (Volume III, Part 1-4) from 1979 to 1989. Of 633 enumerated species, 118 species were recorded from Khao Yai National Park (Tagawa and Iwatsuki, 1979, 1985,1988, 1989).

During 1973-1975, Thaweesakdi Boonkerd explored pteridophyte diversity at Sakaerat Environmental Research Station, Nakhon Ratchasima Province. This area is a protected area of about 80 km^2 north of Khao Yai National Park. It is about 60 km. from Khao Yai National Park along the highway 304. The vegetation of the Sakaerat Environmental Research Station includes dry evergreen forest, mixed deciduous forest, dry dipterocarp forest and grassland. Nineteen families, 29 genera, 52 species, 1 varieties of ferns and fern allies were listed, including 3 new records for Thailand viz. *Thelypteris heterocarpa* (Blume) C.V.Morton, *Thelypteris terminans* (Hook.) Tagawa & K.Iwats and *Lomariopsis cochinensis* Fée. (Boonkerd, 1975). Then, during 1975-1977, an additional survey of ferns and fern allies in this area were made. Seventeen species of ferns were collected. In all, 19 families, 32 genera, 66 species and 2 varieties were record from this protected area (ทวีศักดิ์ บุญเกิด, 2520).

During 1985-1986, Suteera Arkarakraisri studied spore, rhizome, leaf and hair morphology in the family Dennstaedtiaceae in Thailand. Her study included 16 species, 2 subspecies, 4 varieties of ferns. Keys to genera, species and varieties were prepared base on their qualitative morphological characters, especially spore morphological characters (สุธีรา อรรคไกรสีห์, 2529).

Winai Somprasong reported his survey and collection of ferns from Khao Samlan National Park, Saraburi Province during 1994-1996. This national park covers an approximated area of 44.75 km^2. It is bounded on the east by Khao Yai National Park. The vegetation of the National Park includes dry evergreen forest and mixed deciduous forest. Fifteen families, 23 genera, 37 species of ferns were reported (วินัย สมประสงค์, 2541).

During 1994-1997, Piyakaset Suksathan studied taxonomy and ecology of pteridophytes at Doi Chiang Dao, Chiang Mai Province. Ecological study showed that the epiphytes and lithophytes thrived in different ecology types such as, dry evergreen forest, mixed deciduous forest, pine forest, lower montane rain forest, upper montane rain forest, Oak forest, grassland, sub-alpine zone. Fourteen families, 35 genera, 84 species of pteridophytes were listed. Among these, *Cheilanthes argentia* (Gmel.) Kunze was a new record for Thailand (ปิยเกษตร สุขสถาน, 2541).

During 1996-1999, Thaweesakdi Boonkerd and Piyapong Rachata explored diversity of ferns and fern allies at Khunkorn Waterfall Forest Park, Chiang Rai Province. The vegetation of this area includes mixed deciduous forest and hill evergreen forest. They enumerated 154 species and 11 infraspecific taxa in 24 families and 64 genera of ferns and fern allies. Two species were new records for Thailand. They are *Dicranopteris linearis* (Burm.f.) Underw. var. *montana* Holttum. and *Selaginella ciliaris* (Retz.) Spring (Boonkerd and Rachata, 2002).

During 1999-2000, Yuttaya Yuyen and Thaweesakdi Boonkerd explored diversity of ferns and fern allies at Huaiyang Waterfall National Park, Prachaup Khiri Khan Province. This National Park situated in the Southwest part of Thailand. It covers an area of approximately 161 km^2. The vegetations include mixed deciduous forest, dry evergreen forest, tropical rain forest and hill evergreen forest. Twenty six families, 63 genera, 128 species were identified (Yuyen and Boonkerd, 2002).

In 2000, Thaweesakdi Boonkerd and Rossarin Pollawatn compiled information on pteridophytes from several sources as well as from their own explorations. A new Checklist of the pteridophytes in Thailand was made. This booklet proposed a new system of classification for pteridophytes in Thailand. They listed 35 families, 139 genera, 671 species, 4 subspecies and 28 varieties of ferns and fern allies. Twenty-seven species were new records for Thailand (Boonkerd and Pollawatn, 2000).

During 2000-2001, Songsri Sooksoi studies taxonomy of ferns and spore morphology of 20 species at Phuchongnayoi National Park, Ubon Ratchathani Province. The vegetation of the park includes hill evergreen forest, tropical rain forest, mixed deciduous forest and dry deciduous dipterocarp forest. Twenty families, 36 genera and 70 species were enumerated. It was found that some characters of pollen were useful for classification i.e. aperture, size, shape, and exine sculpturing (ส่องศรี สุขสร้อย, 2545).

During 2001-2002, Orawan Vannasri explored diversity of ferns and fern allies in natural forest and along natural gas pipeline in Thong Pha Phum District, Kanchanaburi Province. Seventeen families, 31 genera and 46 species of ferns and fern allies were reported. It was concluded that species richness and species diversity

in natural forest were significantly higher than those along natural gas pipeline (Vannasri, 2002).

During 2001-2002, Wilawan Rattanathirakul studied taxonomy of ferns and fern allies at Phu Hin Rong Kla National Park, Phitsanulok Province. This national park covers an area of 307 km^2. The vegetation of this area includes mixed deciduous forest, dry deciduous dipterocarp forest, dry evergreen forest and hill evergreen forest. Twenty three families, 55 genera, 112 species and 2 varieties of ferns and ferns allies were reported from this area. In addition, *Acrorumohra diffracta* (Baker) H. Itô, was a new record for Thailand (Rattanathirakul, 2002).

During 2001-2003, Apirada Sathapattayanon investigated diversity of pteridophytes along a gradient of disturbance within mines in Thong Pha Phum Distinct, Kanchanaburi Province. She enumerated 20 families, 40 genera, 65 species, 1 subspecies, 5 varieties from all studied sites. In all, species richness and species diversity of abandoned mines were generally lower than those of the remnants of forest in mine area and the adjacent natural forests (Sathapattayanon, 2003).

From the above mentioned reviews it can be seen that there are scarce information of ferns and fern allies from Khao Khiao area in Khao Yai National Park despite its rich in pteridophytes. Therefore, Khao Khiao area is a suitable site for the purpose of diversity exploration and augmentation of pteridophyte data in Thailand.

CHAPTER III

STUDY SITE

3.1 Location and Vegetation

Khao Yai National Park was established in 1962 as the first national park of the country (Fig. 3.3), covers an approximated area of 2,165.55 km^2 and lining between latitudes N 14^o 05' and 14^o 15' and longitudes E 101^o 05' and 101^o 50' (ป่าไม้, 2544). The park occupies Kaeng Khoi District, Saraburi Province in the west; Pak Chong District, Nakhon Ratchasima Province and Kabin Buri District, Prachin Buri Province in the east; Pak Chong District, Nakhon Ratchasima Province in the north, and Nakhon Nayok Province in the south (Fig. 3.1). The national park is a mountainous area, part of the Phanom Dongrak Range with altitudes ranging from 250-1,400 m. The northern and eastern sides are gradually sloping down towards the Highway number 2 (Mitraphap) between Pak Chong and Nakhon Ratchasima and towards the Highway number 304 (Nakhon Rathchasima-Kabin Buri) in Kabin Buri. The south and west slopes steeply drop into the agricultural areas. Its high peaks includes Khao Rom (1,351 m) in the South-East, Khao Laem (1,326 m) in the North-East, and Khao Khiao (1,292 m) in the South-East and Khao Sam Yot (1,200 m) in the West. The vegetation of the park was classified into 5 types, viz. dry evergreen forest, dry mixed deciduous forest, tropical rain forest, hill evergreen forest, and grassland and secondary forest (Smitinand, 1968).

Khao Khiao is in the central part of Khao Yai National Park, elevations ranging from 600-1292 m above mean sea level and covering an approximated area of 60 km^2. Khao Khiao is the origin of the various waterfalls and streams, i.e. Heo Narok Waterfall, Sarika Waterfall, Nakhon Nayok River. (การท่องเที่ยวแห่งประเทศไทย, 2543) It consists of 3 vegetation, viz. tropical rain forest, hill evergreen forest, and grassland and secondary forest (Fig. 3.4, 3.5, 3.6, 3.7). Hill evergreen forest is rather dense, usually found from 1,000 m elevation upwards, Trees are member of tropical rain forest of the higher elevation, examples include those of gymnosperms: *Podocarpus neriifolius* (Phaya mai), *Dacrycarpus imbricatus* (Phaya ma kham pom), *Dacrydium elatum* (Sam phan pi). Flowering trees include *Rhus succedanea* (Sadao

chang), *Premna* sp., *Eugenia* sp., *Betula alnoides* (Kamlang suea khrong), *Olea brachiata* (Ket san), *Litsea multiumbellata*, *Vaccinium sprengelii* (Hua waen) etc. Many species of shrubs are ground flora, for example *Melastoma malabathricum* (Khlong khleng), *Combretum quadratum*, *Macropanax dispermus* (Phia fan), *Senecio walkeri* etc. Ground floras also include herbaceous species e.g. *Polygonum* sp., *Burmannia disticha* (Ya khao kam), *Osbeckia chinensis* (En a noi), *Xyris* sp., *Fimbristylis trichoides* (Kok khao khiao) etc. Bamboo species are also observed in this area (Fig.3.8). The area has two attraction sites, i.e. Pha Daew Dai and Pha Trom Jai (Fig.3.9, 3.10) due to their unique panoramic and pictorial views. Tourists can easily visit these two sites by car all year round via highway number 3182.

Epiphytes are common on trunks and branches of trees and shrubs. Many of them are pteridophytes, the other plants include *Agapetes bracteata*, and a number of orchid species: *Bulbophyllum* spp., *Eria* spp., *Dendrobium* spp., *Porpax* sp. etc. These epiphytes usually grow together with a number of mosses and leafy liverworts (Smitinand, 1968).

Tropical rain forest occupies vast area of Khao Khiao from altitudes 600-1,000 m elevation. Common tree species include *Dipterocarpus dyeri* (Yang klong), *D. baudii* (Yang khon), *D. gracilis* (Yang sian), *Anisoptera costata* (Krabak), *Duabanga grandiflora* (Lamphu pa), *Anthocephalus cadamba*. The ground flora is rather dense, include members of Marantaceae, Zingiberaceae and terrestrial species of ferns (Smitinand, 1968).

Grassland and secondary forests are found at low altitude of Khao Khiao. It is fully exposed area due mainly to human disturbance of tropical rain forest in the last 80 years. Common species include *Imperata cylindrical* (Ya kha), *Neyraudia reynaudiana* (Phong), *Themeda arundinacea* (Khaem luang), *Saccharum spontaneum* (Lao) and *Thysanolaena maxima* (Tong kong). There are also some pioneer tree species, e.g. *Macaranga* sp., *Mallotus paniculatus* (Soi dao), *Duabanga grandiflora* (Lamphu pa), *Melia azedarach* (Lian) etc. Some pteridophytes adapt themselves to survive in this critical habitat (Smitinand, 1968).

3.2 Geology

Underlying bedrock comprises Palaeozoic sediments of the Kanchanaburi series. During the Permian period this bedrock was overlain by limestone and shale then forming the Ratburi series. Granitic and grandioritic intrusions caused the

Kanchanaburi and Ratburi beds to fold and uplift to form mountains that subsequently eroded to form the red sandstone, shale, gypsum and salt of Korat series which now forms the western edge of the Korat plateau. However, the majority of the park substrate comprises eroded rhyolitic flows from the last volcanic activity. Soils throughout the park are the Kabin Buri, Chiang Mai, Chatturat, Korat, Khao Yai and Lam Narai series. These are mostly red-yellow podzols and reddish-brown laterites, characterised by sandy texture, moderate to good drainage and moderate soil fertility. In the north of the park soils are Pak Chong series, comprising very fine clayey kaolinite of reddish-brown laterites, it is generally deep, well-drained, with a high water-holding capacity but only moderate fertility. While Muak Lek series soils are found in the north and east, they are loamy skeletals of non-calcic brown soils. This series is well-drained, shallow, low fertility and highly susceptible to erosion (UNEP-WCMC, 1991).

3.3 Climate

Khao Yai National Park has three main seasons. The summer season is observed during March-April, it is dry and often windy. The rainy season occurs during May-October, it rains most days and the atmosphere is humid. The cold season usually starts in November and finishes in February, the weather is clear, sunny and cool (Meteorological Department, 2004). The nearest Meteorological station of the study site is Pak Chong Agromet Station, it has data of humidity, temperature and rainfalls from 1974-2004. The National Park experiences both the south-west and north-east monsoons and the distribution of rainfall is influenced by topography (UNEP-WCMC, 1991).

The Climatological data from 1974-2004 (Fig. 3.2) at Pak Chong Agromet Station consist an average annual relative humidity of 70.2 %. The average maximum relative humidity is 98.9 % in October and the average minimum relative humidity 22.9 % in February. The average annual temperature is 25.8 ^{o}C, while the average maximum temperature is 37.5 ^{o}C in April and the average minimum temperature is 10.2 ^{o}C in December. The average annual rainfall is 1090.8 mm., while the highest average monthly rainfall is 214.5 mm in September and the lowest monthly rainfall of about 5.6 mm in December (Meteorological Department, 2004).

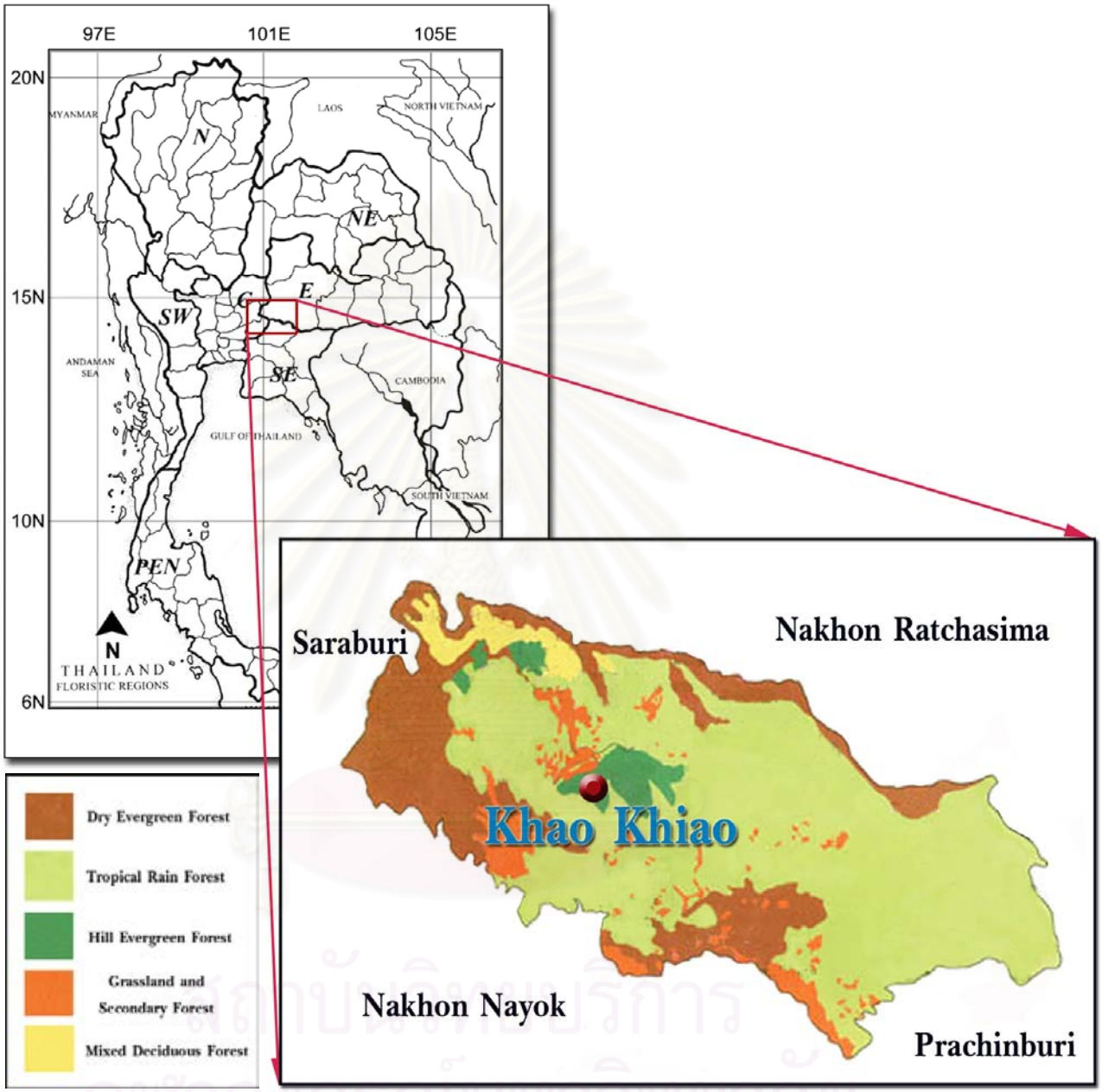

Fig 3.1 Location of Khao Khiao area, Khao Yai National Park and the vegetation of this park

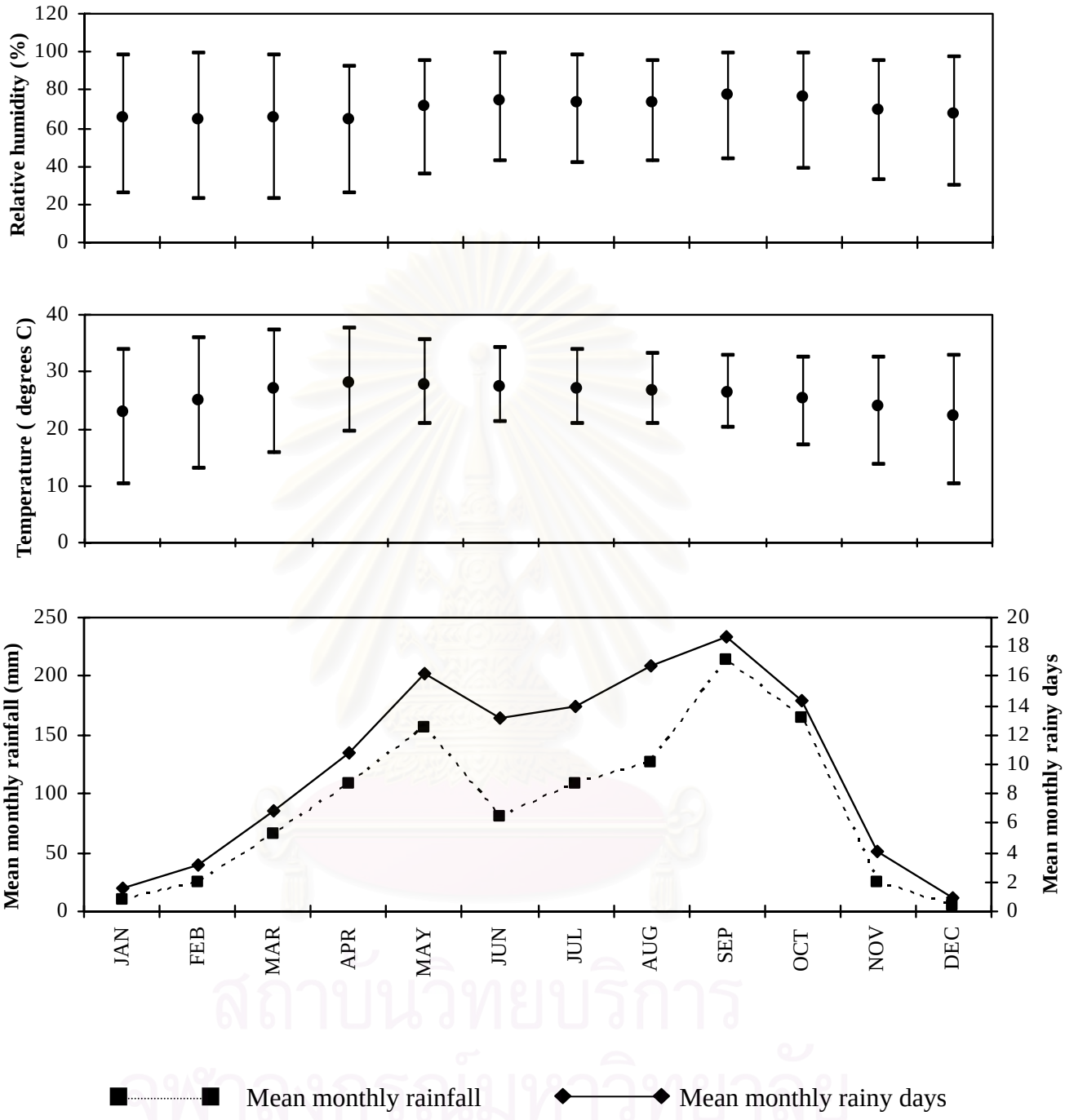

Fig. 3.2 Climatological data during the period, 1974-2004, from Pak Chong Agromet Station (Data from the Department of Meteorology, Bangkok, Thailand).

Fig. 3.3 Khao Yai National Park

Fig. 3.4 Tropical rain forest

Fig. 3.5 Hill evergreen forest

Fig. 3.6 Grassland and secondary forest

Fig. 3.7 Secondary forest

Fig. 3.8 Bamboo forest

Fig. 3.9 Pha Daew Dai

Fig. 3.10 Pha Trom Jai

CHAPTER IV

MATERIALS AND METHODS

4.1 Materials

4.1.1 Specimen collecting equipments

- a plant press, 30 x 45 cm
- sheets of newspapers
- corrugated cardboard
- hand pruners
- spade
- plastic bags
- field note
- digital camera, model: Nikon D 70
- altimeter
- The Global Position System (GPS) Equipment, Garmin model: Etrex/Vista
- collector's number card

4.1.2 Herbarium specimen preparing equipments

- deep freezer (-40^{0}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
- mounting glue (latex mixed with synthetic glue in ratio 1:1 by volume)
- 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

- microscopic slides and cover glasses
- related taxonomic literatures of ferns and fern allies
- voucher specimens in herbaria: Forest Herbarium (BKF) and Professor Kasin Suvatabhandhu Herbarium (BCU)

4.2 Methods

4.2.1 Literature review

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

4.2.3 Exploration and collection

Field collections of ferns and fern allies were conducted from December 2003 to March 2005 at Khao Khiao, Khao Yai National Park. Ferns and fern allies were gathered along 12 km of the road number 3182 (Khao Khiao-Pha Trom Jai), extending about 500-1,000 m from both sides. Three duplicates of specimens were collected and photographs were taken.

4.2.4 Laboratory study

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

The collected specimens were proved for identity by comparison to the voucher herbarium specimens that were deposited at BCU and BKF. Authors of scientific names and abbreviations used in this thesis are according to the author of plant names (Brummitt and Powell, 1992). Classification of ferns and fern allies were according to Boonkerd and Pollawatn (2000). The voucher specimens are deposited at the Professor Kasin Suvatabhandhu Herbarium, Department of Botany, Faculty of Science, Chulalongkorn University and the Forest Herbarium, National Park, Wildlife and Plant Conservation Department. Dichotomous keys to genera and species were

constructed based on their qualitative morphological characters. Descriptions of families, genus and species were undertaken based mainly on the collected specimens.

CHAPTER V

RESULT

Two hundred and nineteen specimens of ferns and fern allies were collected and determined into 113 species and 2 varieties, 59 genera, within 25 families. Details of each species, i.e. habit, habitat and its abundance were presented in Table 5.1.

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

Habit: Terrestrial herb = T, Epiphyte herb = E, Lithophyte herb = L
Habitat: Tropical rain forest = 1, Hill evergreen forest = 2, Grassland and secondary forest = 3
Abundance: R = rarely found, UC = uncommon, C = common, A = abundant

Taxon	Habit	Habitat&Abundance
Lycopodiaceae		
Huperzia hamiltonii (Spreng.) Trevis.	E	2, UC
Huperzia phlegmaria (L.) Rothm.	E	1, C
Huperzia squarrosa (G.Forst.) Trevis.	E	1, 2, UC
Lycopodiella cernua (L.) Pic.Serm.	T	1, 2, 3, A
Selaginellaceae		
Selaginella biformis A.Braun ex Kuhn	T	1, C
Selaginella roxburghii (Hook. & Grev.) Spring	T, L	2, C
Selaginella siamensis Hieron.	T	1, 2, 3, A
Psilotaceae		
Psilotum nudum (L.) P.Beauv.	E, L	1, 2, UC
Marattiaceae		
Angiopteris evecta (G.Forst.) Hoffm.	T	1, C
Ophioglossaceae		
Helminthostachys zeylanica (L.) Hook.	T	3, C
Ophioglossum gramineum Willd.	T	3, UC
Ophioglossum petiolatum Hook.	T	3, UC
Hymenophyllaceae		
Crepidomanes latealatum (Bosch) Copel.	L	1, UC
Crepidomanes latemarginale (Eaton) Copel.	E	1, UC
Crepidomanes maximum (Blume) K.Iwats	L	2, R
Crepidomanes minutum (Blume) K.Iwats	E	1, UC

Taxon	Habit	Habitat&Abundance
Hymenophyllaceae (continued)		
Hymenophyllum barbatum (Bosch) Baker	E	1, UC
Hymenophyllum exsertum Wall. ex Hook.	E	2, C
Hymenophyllum polyanthos (Sw.) Sw.	E	2, C
Trichomanes motleyi Bosch	L	2, C
Gleicheniaceae		
Dicranopteris linearis (Burm.f.) Underw. var. *linearis*	T	1, 2, 3, A
Dicranopteris splendida (Hand.-Mazz.) Tagawa	T	1, 2, A
Gleichenia norrisii Mett. ex Kuhn	T	2, A
Schizaeaceae		
Lygodium microphyllum (Cav.) R.Br.	T	3, C
Lygodium polystachyum Wall. ex T.Moore	T	1, UC
Lygodium salicifolium C.Presl.	T	1, 3, C
Dennstaedtiaceae		
Microlepia herbacea Ching & C.Chr. ex Tardieu & C.Chr.	T	1, C
Pteridium aquilinum (L.) Kuhn subsp. *Caudatum* (L.) R.M.Tryon var. *yarrabense* Domin	T	1, 2, 3, A
Dicksoniaceae		
Cibotium barometz (L.) J.Sm.	T	1, C
Lindsaeaceae		
Lindsaea chienii Ching	T	2, UC
Lindsaea ensifolia Sw.	T	2, 3, C
Lindsaea heterophylla Dryand.	T	1, R
Lindsaea lucida Blume	T	1, UC
Cyatheaceae		
Cyathea giganthea (Wall. ex Hook.) Holttum	T	1, 2, UC
Cyathea latebrosa (Wall. ex Hook.) Copel.	T	1, 2, UC
Adiantaceae		
Adiantum philippense L.	L	1, A
Cheilanthes pseudofarinosa (Ching & S.K.Wu) K.Iwats.	T, L	1, UC
Cheilanthes tenuifolia (Burm.f.) Sw.	T	3, C
Pityrogramma calomelanos (L.) Link	T, L	1, 2, UC
Taenitis blechnoides (Willd.) Sw.	T	2, R
Pteridaceae		
Pteris aspericaulis Wall. ex J.Agardh	T	1, C
Pteris biaurita L.	T	1, C
Pteris grevilleana Wall. ex J.Agardh	T	1, UC

Taxon	Habit	Habitat&Abundance
Pteridaceae (continued)		
Pteris vittata L.	T	1, C
Vittariaceae		
Antrophyum callifolium Blume	E	1, UC
Vittaria angustifolia Blume	E	1, 2, UC
Vittaria elongata Sw.	E	1, 2, UC
Vittaria flexuosa Fée	E	1, 2, UC
Aspleniaceae		
Asplenium apogamum N.Murak. & Hatan.	E	1, C
Asplenium crinicaule Hance	T, E	2, C
Asplenium nidus L. var. *nidus*	E	1, UC
Asplenium normale D.Don	T, E	2, A
Asplenium yoshinagae Makino	E, L	2, C
Asplenium sp.	E	1, UC
Blechnaceae		
Blechum orientale L.	T	1 , UC
Lomariopsidaceae		
Bolbitis appendiculata (Willd.) K.Iwats	T, L	1, UC
Bolbitis heteroclita (C.Presl.) Ching ex C.Chr.	T, E	1, A
Bolbitis sinensis (Baker) K.Iwats var. *sinensis*	L	2, A
Bolbitis virens (Wall. ex Hook.& Grev.) Schott var. *virens*	L	1, R
Bolbitis virens (Wall. ex Hook. & Grev.) Schott var. *compacta* Hennipman	L	1, R
Elaphoglossum malayense Holttum	E	2, UC
Woodsiaceae		
Diplazium bantamense Blume	T	1, UC
Diplazium donianum (Mett.) Tardieu	T	1, UC
Diplazium esculentum (Retz.) Sw.	T	1, R
Diplazium simplicivenium Holttum	T	1, UC
Dryopteridaceae		
Arachniodes cavalerii (Christ) Ohwi	T, L	2, UC
Diacalpe aspidioides Blume	T	2, C
Dryopteris polita Rosenst.	T	2, R
Dryopteris sparsa (D.Don) Kuntze	T	2 , R
Dryopteis subtriangularis (C.Hope) C.Chr.	T	1, 2, C
Heterogonium gurupahense (C.Chr.) Holttum	T	1, UC
Pleocnemia irregularis (C.Presl) Holttum	T	1, UC
Polystichum biaristatum (Blume) T.Moore	T	2, UC
Tectaria griffithii (Baker) C.Chr.	T	1, UC

Taxon	Habit	Habitat&Abundance
Dryopteridaceae (continued)		
Tectaria maingayi (Baker) C.Chr.	T	1, UC
Tectaria sp.1	T	2, UC
Tectaria sp.2	T	1, R
Thelypteridaceae		
Amphineuron immersum (Blume) Holttum	T	1, R
Amphineuron terminans (J.Sm.) Holttum	T	1, UC
Christella appendiculata (C.Presl) Holttum	T	1, UC
Christella hispidula (Decne) Holttum	T	1, UC
Christella papilio (C.Hope) Holttum	T	1, UC
Christella parasitica (L.) H.Lév.	T	1, 2, A
Christella subelata (Baker) Holttum	T	1, UC
Christella subpubescens (Blume) Holttum	T	1, UC
Macrothelypteris torresiana (Gaudich.) Ching	T	1, UC
Pneumatopteris truncata (Poir.) Holttum	T	1, UC
Pronephrium nudatum (Roxb.) Holttum	T	1, C
Pronephrium triphyllum (Sw.) Holttum	T	1, C
Trigonospora ciliata (Wall. ex Benth.) Holttum	T, L	1, UC
Davalliaceae		
Davallia embolostegia Copel.	T	2, UC
Davallia trichomanoides Blume var. *trichomanoides*	E	1, 2, UC
Humata repens (L.f.) Diels	E, L	2, A
Leucostegia immersa (Wall. ex Hook.) C.Presl.	T, L	2, UC
Oleandraceae		
Oleandra musifolia (Blume) C.Presl.	E, L	2, A
Polypodiaceae		
Aglaomorpha coranans (Wall. ex Mett.) Coepl.	E	1, 2, UC
Belvisia annamensis (C.Chr.) Tagawa	E	2, UC
Belvisia henryi (Hieron. ex. C.Chr.) Tagawa	E	2, UC
Belvisia mucronata (Fée) Copel.	E	1, 2, UC
Crypsinus oxylobus (Wall. ex Kunze) Sledge	T, E	2, UC
Drynaria rigidula (Sw.) Bedd.	E	1, UC
Drynaria sparsisora (Desv.) T.Moore	E	1, C
Goniophlebium subauriculatum (Blume) C.Presl	E	2, C
Goniophlebium sp.	T	2, UC
Lepisorus scolopendrium (Buch.-Ham. ex D.Don) Tagawa	E	2, C
Loxogramme involuta (D.Don) C.Presl.	E	1, UC
Microsorum insigne (Blume) Copel.	E, L	1, R
Microsorum pteropus (Blume) Copel.	L	1, C
Microsorum punctatum (L.) Copel.	E	1, C

Taxon	Habit	Habitat&Abundance
Polypodiaceae (continued)		
Phymatosorus nigrescens (Blume) Pic.Serm.	T, E	1, UC
Pyrrosia lingua (Thunb.) Farw. var. *heteractis* (Mett. ex Kuhn) Hovenkamp	T, E	2, A
Pyrrosia piloselloides (L.) M.G.Price	E	3, UC
Grammitidaceae		
Grammitis dorsipila (Christ) C.Chr. & Tardieu	E	2, UC
Prosaptia khasyana (Hook.) C.Chr. & Tardieu	E	2, UC

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

FERN ALLIES

CLASS LYCOPODIOPSIDA

ORDER LYCOPODIALES

LYCOPODIACEAE

P.Beauv. ex Mirb., Hist. Nat. Veg. 4: 293. 1802; B.Øllg., The families and genera of vascular plants. vol. I. 31. 1990.

Terrestrial or epiphytic, erect to pendulous herbs or climbers. Stems dichotomously branched, rarely with lateral branching. Leaves simple, with one simple vein, arranged in low alternating spirals or irregular whorls, or decussate, homophyllous or heterophyllous, isophyllous or anisophyllous. Sporophyll like the foliage leaves or modified, sometime specialized and aggregated into distinct strobili. Sporangia solitary, in the leaf axils or on the upper side of the sporaphyll base.

KEY TO THE GENERA

1. Stems isotomously branched throughout; epiphyte plant.....**1. Huperzia**
1. Stems anisotomously branched almost throughout, terrestrial plant . **2. Lycopodiella**

HUPERZIA

Bernh., J. Bot. (Schrader). 1800(2): 126. 1801; B.Øllg., The families and genera of vascular plants. vol. I. 33. 1990.

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

KEY TO THE SPECIES

1. Strobilus distinct; sporophylls much smaller than the sterile leaves.....
   .....**2. H. phlegmaria**
1. Strobilus not distinct; sporophylls hardly smaller than the sterile leaves
   2. Stem less than 3 mm in diameter; leaves adpressed or subpatent .....
      .....**1. H. hamiltonii**
   2. Stem to more than 5 mm in diameter; leaves patent and squarrose .....
      .....**3. H. squarrosum**

1. Huperzia hamiltonii (Spreng.) Trevis., Atti Soc. Ital. Sci. Nat. 17: 248. 1874.— *Lycopodium hamiltonii* Spreng., Syst. Veg. 5: 429. 1828; Alston in Fl. Gén. I.-C. 7(2): 549. 1951; Tagawa & K.Iwats., Fl. Thailand 3(1): 9. 1979. Fig. 5.1.

Stems usually pendulous, 14-18 cm long, dichotomously branching, 1-2 mm in diameter near base. **Leaves** ascending or subadnate, lanceolate, acute to acuminate at apex, narrowing towards sessile or very shortly stalked base, those on middle or lower part the largest, 1-1.2 cm long, 1-2.5 mm broad, entire; veins more or less distinct beneath; texture softly chartaceous to thicker, green to yellowish green. **Sporophylls** usually smaller than the trophophylls, to 6 mm long, 1 mm broad, usually gathered in apical portion, forming no distinct strobilus, up to 3.5-6 cm long.

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-EASTERN: 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.— Epiphyte on mossy tree-trunks in hill evergreen forest about 1,000-1,300 m alt.

Specimens examined.— W. Khwaiphan 074, T. Boonkerd 77, 1370 [BCU]; K. Larsen 33, 504, T. Smitinand 2481 [BKF].

2. Huperzia phlegmaria (L.) Rothm., Feddes Repert. Spec. Nov. Regni Veg. 54: 62. 1944.— *Lycopodium phlegmaria* L., Sp. Pl.: 1101. 1753; Alston in Fl. Gén. I.-C. 7(2): 551. 1951; Tagawa & K.Iwats., Fl. Thailand 3(1): 10. 1979. Fig. 5.2.

Stems pendulous, dichotomously branching in irregular intervals, to more than 50 cm long, 2-6 mm in diameter near the base. **Leaves** patent, oblong-lanceolate to ovate-subdeltoid, acuminate at apex, round to roundly truncate at base or rarely cordate, subsessile or very shortly stalked, 4-8 cm long, 2-4 mm broad, entire; veins more or less visible; texture coriaceous, green to yellow green. **Strobilus** distinct, located at apex of sterile branches, dichotomously branching a few times, slender, 2-10 cm long by 0.5-1 mm in diameter; sporophylls ovate subdeltoid, adpressed, about 1 mm long.

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

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

Ecology.— Epiphyte on mossy-tree trunks in tropical rain forest at 700-800 m alt.

Vernacular.— Chong nang khli (ช้องนางคลี่) (South-western); klet nakkharat (เกล็ดนาคราช) (North-eastern); raya (ระย้า) (Peninsular); yom doi (ยมโดย) (Central).

Specimens examined.— W. Khwaiphan 065, T. Boonkerd 77, 1370 [BCU]; C. Niyomdham et al. 6074, C. Phengklai et al. 12973 [BKF].

3. Huperzia squarrosa (G.Forst.) Trevis., Atti Soc. Crittog. Ital. 17: 247. 1875.— *Lycopodium squarrosum* G.Forst., Fl. Ins. Ustr. Prod.: 479. 1786; Alston in Fl. Gén. I.-C. 7(2): 550. 1951; Tagawa & K.Iwats., Fl. Thailand 3(1): 9. 1979. Fig. 5.3.

Stems to 90 cm or more in length, dichotomously branching a few times, usually up to 5 mm in diameter near base. **Leaves** dense, usually patent and squarrose, linear lanceolate, acuminate at apex, hardly narrowing towards the sessile base, to 1.2 cm long, 1-1.5 mm broad at the broadest portion, entire, the basal leaves smaller, more sparse, upper ones usually narrower; veins visible on both surfaces; texture coriaceous, green. **Sporophylls** more or less smaller, or sometimes not different from the trophophylls, forming no distinct cones but having slender apical fertile portions.

Thailand.— NORTHERN: Phitsanulok (Phu Miang); NORTH-EASTERN: Loei (Phu Luang, Phu Kradung); EASTERN: Nakhon Ratchasima (Khao Laem); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi (Phriu), Trat (Dan Chumphon); SOUTH-WESTERN: Kanchanaburi (Klang Dong, Song Tho); PENINSULAR: Surat Thani (Ban Kop Kaep), Phangnga (Bang To), Nakhon Si Thammarat (Khiriwong).

Distribution.— Madagascar, Seychelles, Mascarene Islands, tropics of Asia and Oceania (type from Tahiti), north to E. Himalaya.

Ecology.— Epiphyte on tree-trunks in tropical rain forest and hill evergreen forest about 700-1,300 m alt.

Vernacular.— Chong nang khli (ช้องนางคลี่) (Northern); hang khang (หางค่าง) (Peninsular).

Specimens examined.— W. Khwaiphan 216, T. Boonkerd 349, K. Sridith 86 [BCU]; Musset 1006, R. Schlechter 17067 [BKF].

2. LYCOPODIELLA

Holub, Preslia 36: 20, 22. 1964; B.Øllg., The families and genera of vascular plants vol. I. 37. 1990.

Plants terrestrial, anisotomously branched, with horizontal, creeping, or arching-looping indeterminate shoots rooting at short to long intervals along the underside, and dorsally arising, determinate, erect, simple or profusely tree-like branched aerial shoots; or with irregularly, truly laterally branched, subterranean stems. Stem steles radial, sometimes with highly dissected xylem. Leaves isophyllous to anisophyllous. Strobili pendent and sessile, or erect and terminating simple (rarely forked), dorsally arising branches. Sporophylls subpeltate, with a thin basal decurrent wing, or with coalescent basal membranes which almost enclose the sporangia, with a mucilage cavity in base and sometime along the vein. Sporangia reniform to subglobose.

Lycopodiella cernua (L.) Pic.Serm., Webbia 23(1): 166. 1968.— *Lycopodium cernuum* L., Sp. Pl.: 1103. 1753; Alston in Fl. Gén. I.-C. 7(2): 548. 1951; Tagawa & K.Iwats., Fl. Thailand 3(1): 12. 1979. Fig. 5.4.

Stems of two kinds, creeping and erect; main creeping stems indefinite length; main erect stems to more than 70 cm tall, bearing many branches densely covered with leaves (not so dense on lower portion), 2-4 mm in diameter; lateral branches 0.5-1 mm in diameter, densely covered with leaves, usually about 10-13 cm long, copiously branching. **Leaves** linear, pointed at apex, 2-4 mm long, to 0.5 mm broad, entire, patent and recurved in upper portion; texture thick but soft, yellowish green. **Strobilus** solitary or two at each apex of the branches, pendulous, 3-5 cm long, about 2 mm in diameter; sporophylls ovoid, acuminate at apex, with minute projection at margin.

Thailand.— NORTHERN: Chiang Rai (Doi Tung, Kiu Thap Yang, Mae Lao, Doi Phacho), Chiang Mai (Doi Chiang Dao, Wang Tao, Doi Suthep, Mae Rim), Lampang (Mae Tam), Phitsanulok (Thung Salaeng Luang), Tak (Doi Musoe); NORTH-EASTERN: Loei (Phu Kradung); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-WESTERN: Kanchanaburi (Wang Ka); PENINSULAR: Chumphon (Bang Son), Surat

Thani (Ban Don), Satun (Tarutao), Nakhon Si Thammarat (Thung Song, Ron Phibun), Trang (Khao Chong, Thale Song Hong, Sam Roi Yoi), Songkhla (Saba Yoi), Narathiwat (Bacho, Nikhom Waeng), Yala (Gunong Ina, Ban To, Padang Besar).

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

Ecology.— Terrestrial on mountain slopes, dry ground to marshy places, usually in open places at various altitudes.

Vernacular.— Khut khon (กูดขน) (Northern); ya kan phiang (หญ้าก้านเพียง), yaeng yae (แหยงแย้) (North-eastern); slap (สลาบ), dok hin (ดอกหิน) (South-eastern); rang kai (รังไก่), ruai kai (รวยไก่), sam rai yot (สามร้อยยอด) (Peninsular).

Specimens examined.— W. Khwaiphan 020, T. Boonkerd 470, 1280 [BCU]; K. Larsen et al. 529, 1665 [BKF].

CLASS SELAGINELLOPSIDA
ORDER SELAGINELLALES

SELAGINELLACEAE

Willk, Anleit. Stud. Bot. 2: 163. 1854; Devol, Fl. Taiwan vol. 1. 2nd ed.: 41. 1980.

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

SELAGINELLA

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

Stems elongate, bearing leaves and rhizophores, branching dichotomously or pinnately, usually of foliar appearance; rhizophores geotropic, dichotomously branching, bearing roots in the earth; leaves microphyllous, monomorphic and spirally arranged, 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 strobili, uniform and arranged in four rows forming squarroid spikes, or dimorphic and arranged in four rows, the dorsal and ventral rows unequal.

KEY TO THE SPECIES

1. Branches pubescent; stem erect ..... **1. S. biformis**
1. Branches glabrous
   2. Stem scandent, or growing indefinitely; ventral leaves ovate-oblong .... **3. S. siamensis**
   2. Stem not scandent, nor growing indefinitely; ventral leaves falcate..... ..... **2. S. roxburghii**

1. Selaginella biformis A.Braun ex Kuhn, Forsch. Gaz. 4. Bot. 6: 17, 19. 1889; Alston in Fl. Gén. I.-C. 7(2): 570. 1951; Tagawa & K.Iwats., Fl. Thailand 3(1): 17. f. 2. 6-8. 1979. Fig. 5.5.

Stems erect, plants about 30 cm tall; main stems about 1.5-2 mm in diameter near base, sparsely bearing leaves, pubescent on lower surface or glabrescent in lower portion; lateral branches bipinnate to tripinnate, densely pubescent below; ultimate branches about 3 mm in breadth. **Runners** branching from the main stems, rooting and forming new erect plants at the apex, bearing rhizophores throughout. **Leaves** on basal portion of erect stem uniform, sparse and not imbricate; ventral leaves ascending, oblong subdeltoid, gradually narrowing and falcate towards acute apex, cordate at base, 2-3 mm long, 1-1.5 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. **Strobilus** about 1 mm in diameter; sporophylls uniform, ovate subtriangular with long mucronate apex, about 1.5 mm long, 0.5 mm broad.

Thailand.— NORTHERN: Chiang Rai, Chiang Mai (Doi Phu Pa, Huay Tong), Nan (Pha Sing), Phrae (Mae Sai), Phitsanulok (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.— Terrestrial on humus rich floor in tropical rain forest at 700-800 m alt.

Vernacular.— Foen phaeng (เฟินแผง) (North-eastern).

Specimens examined.— W. Khwaiphan 059, A. Sathapattayanon 131, 133, T. Boonkerd 25 [BCU]; K. Iwatsuki 31479, K. Iwatsuki & N. Fukuoka T-7402 [BKF].

2. Selaginella roxburghii (Hook. & Grev.) Spring, Bull. Acad. Roy. Sci. Brux. 10: 288. 1843; Tagawa & K.Iwats., Fl. Thailand 3(1): 25. 1979.— *Lycopodium roxburghii* Hook. & Grev. in Hook., Bot. Misc. 2: 390. 1831.— *Selaginella* sp.; Tagawa & K.Iwats., Southeast As. St. 3(3): 71. 1965. Fig. 5.6.

Plants to more than 30 cm long. **Stems** thick, 2 mm in diameter near base, bearing rhizophores only on basal portion, or often on the upper portion as well, with leaves dimorphic nearly to the base; lateral branches many, simple to bipinnate; ultimate branches up to 7 mm broad. **Ventral leaves** patent, elliptic, falcate and narrowing towards acute apex, unequally subcordate at base, 4-5 mm long, to 1 mm broad, usually with distinct false veins; edges minutely dentate, or ciliate in lower half, texture soft papyraceous, green, paler beneath; dorsal leaves smaller, ovate to suborbicular, about 1.5-2 mm long with apical tails of about the same length, ciliate. **Strobilus** up to 1 mm in diameter; sporophylls ovate with long apical tails, dentate.

Thailand.— NORTHERN: Chiang Mai (Fang, Doi Chiang Dao, Doi suthep, Mae Klang); NORTH-EASTERN: Loei (Phu Kradung); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Trat (Ko Chang); PENINSULAR: Nakhon Si Thammarat (Khao Luang), Narathiwat (Su-ngai Padi).

Distribution.— Malaya (type) and Sumatra.

Ecology.— Terrestrial on rather dry ground in light shade at low to medium altitudes.

Specimens examined.— W. Khwaiphan 115, O. Thaithong 567 [BCU]; Tagawa et al. T-5288, T. Smitinand 1052 [BKF].

3. Selaginella siamensis Hieron., Bot. Tidsskr. 24: 113. 1901; Alston in Fl. Gén. I.-C. 7(2): 560. f. 65, 6-10. 1951; Tagawa & K.Iwats., Fl. Thailand 3(1): 18. 1979.— *Selaginella reptans* Ridl., J. Str. Br. Roy. As. Soc. 80: 155. 1919, non Sodiro 1893.— *Selaginella ridleyana* Kümmerle, Magyar Bot. Lapok 26: 100. 1938. Fig. 5.7.

Stems 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 2-2.5 mm wide. **Ventral leaves** ascending, ovate-oblong, acute to mucronate with long aristae at apex, cordate at base, to 2 mm long, 1 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. **Strobilus** usually 4-5 mm long, about 1.5 mm in diameter; sporophylls uniform, ovate-subtriangular with long tail.

Thailand.— NORTHERN: Chiang Rai (Doi Phacho), Chiang Mai (Khun Khong), Lampang, Phitsanulok (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 at 700-1300 m alt.

Vernacular.— Phak nok yung (ผักนกยูง) (North-eastern).

Specimens examined.— W. Khwaiphan 092, O. Thaithong 558 [BCU]; Iwatsuki et Fukuoka T-7491, E. Hennipman 3942 [BKF].

CLASS PSILOTOPSIDA
ORDER PSILOTALES

PSILOTACEAE

Eichler, Syllabus (ed. 4) 22. 1886; Devol, Fl. Taiwan vol. 1. 2nd ed.: 23. 1980.

Vascular plants without roots; stem erect or pendent, dichotomously branched or unbranched. leaves absent, bearing enation, scale-like, lacking midrib, or elliptical with midrib. Sporangia borne in axils of enation, 2-3 lobed, eusporangiate, homosporous.

PSILOTUM

Sw., Syn. Fil.: 117. 1806; Tagawa & K.Iwats., Fl. Thailand 3(1): 5. 1979.

Stems consisting of rhizomes and aerial stems, both branching dichotomously, without roots or leaves; branches of aerial stems bearing enation; synangia consisting of three sporangia, borne on ridges of the branches and bearing forked scaly projection at base.

Psilotum nudum (L.) P.Beauv., Prod. Aethéog.: 112. 1805; Tagawa & K.Iwats., Fl. Thailand 3(1): 5. 1979.— *Lycopodium nudum* L., Sp. Pl.: 1100. 1753.— *Psilotum triquetrum* Sw., Syn. Fil.: 117. 1806; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 596. f. 64. 4-5. 1951. Fig. 5.8.

Rhizome creeping, dichotomously branching at irregular intervals, 0.5-1 mm in diameter, densely beset with brown to dark brown to dark brown rhizoids. **Aerial stems** fasciculate, erect, patent, or pendulous, 15-20 cm in height, green, glabrous, dichotomously branching several times in upper portion, grooved. With several distinct ridges 1-1.5 mm in diameter. **Enation** small, to 1 mm long, oval with subulate apex, irregularly and sparsely borne on ridges. **Synangia** borne adaxially to the enation projections, glabrous, about 1.5 mm in diameter, green at first, yellow when mature.

Thailand.— NORTHERN: Chiang Rai, Chiang Mai (Mae Rim, Doi Inthanon, Om Koi), Tak (Lan Sang); NORTH-EASTERN; Loei (Wang Saphung), Khon Kaen (Phu Wieng); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chon Buri (Si Racha), Chanthaburi (Pong Nam Ron, Soi Dao); SOUTH-WESTERN: Kanchanaburi (Ban Kaeng Liang), Prachuap Khiri Khan (Huai Yang); PENINSULAR: Chumphon (Ko Wieng, Bang Son), Surat Thani (Ko Pha-ngan), Nakhon Si Thammarat (Khao Luang).

Distribution.— Tropics and subtropics throughout the world (type from India), north to Quelpaert.

Ecology.— Terrestrial or epiphytic on mossy tree-trunks or on bare rocks in tropical rain forest and hill evergreen forest about 800-1,000 m alt.

Specimens examined.— W. Khwaiphan 113, T. Boonkerd 1320, K. Sridith 16, Y. Yuyen 8 [BCU]; L. B. et al. 9622 A, Franc 29 [BKF].

FERNS
CLASS POLYPODIOPSIDA
ORDER MARATTIALES

MARATTIACEAE

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

Eusporangiate, terrestrial ferns; caudex short, globose, erect; or rhizome fleshy, creeping to suberect. Fronds pinnately compound, often very large, circinate when young, base of stipes with 2 large leathery persistent stipules; pulvinus at or

near base of stipes and pulvini at base of rachillae. Sporangia in closely arranged, elongate or circular sori, or synangia.

ANGIOPTERIS

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

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

Angiopteris evecta (G.Forst.) Hoffm., Comm. Soc. Reg. Gott. 12: 29. t. 5. 1796; Holttum, Rev. Fl. Malaya 2: 44. f. 3. 1954; Tagawa & K.Iwats., Fl. Thailand 3(1): 41. 1979.— *Polypodium evectum* G.Forst., Fl. Ins. Austr. Prod.: 81. 1786.— *Angiopteris crassipes* Wall. ex C.Presl, Suppl. Tent. Pterid.: 23. 1845; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 20. 1939.— *Angiopteris helferiana* C.Presl, Suppl. Tent. Pterid.: 22. 1845.— *Angiopteris* sp.; C.Chr., Contr. U. S. Nat. Herb. 26: 329. 1931. Fig. 5.9-5.10.

Rhizome short, erect, massive, bearing several large fronds in a tuft. **Stipes** smooth, green with scattered whitish streaks, about 100 cm long. **Fronds** bipinnate, about 180 cm long, to 150 cm wide; rachis green, fleshy, glabrous; pinnae to 70 cm long, bearing pinnules about 13-16 by 2.6-3 cm, oblong-lanceolate, long acuminate apex, each with short swollen fleshy stalk, base unequal, the basiscopic side usually rounded and approaching the rachis a little nearer than the more cuneate acroscopic side, edges parallel for most of their length, with small blunt tooth to each vein-ending, more strongly toothed at apex; texture subcoriaceous, green, pale below, glabrous, sometimes grooved along sporangia line in the upper surface; veins simple or forked, nearly at the right angles to costa, raised on both surface; recurrent vein slender, usually not distinct much beyond the sori, indistinct darker line. **Sori** about 1 mm from the edge, usually 12-20 sporangia.

Thailand.— This species is common throughout Thailand.

Distribution.— Malaysia and Polynesia.

Ecology.— Terrestrial in light shade by streams in tropical rain forest about 700-800 m alt.

Vernacular.— Wan kip ma (ว่านกีบม้า), wan kip raet (ว่านกีบแรด) (Central); kip ma lom (กีบม้าลม), kip raet (กีบแรต) (Northern); duhu (ดูกู) (Malay/Peninsular).

Use.— Rhizome used in local medicine.

Specimens examined.— W. Khwaiphan 133, P. Ratchata 31, T. Boonkerd 190, 1252 [BCU]; K. Iwatsuki et al. 10923; B. Hansen & T. Smitinand 11965 [BKF].

ORDER OPHIOGLOSSALES

OPHIOGLOSSACEAE

(R.Br.) J.Agardh, Aphor. Bot. 8: 113. 1822; Devol & Kuo, Fl. Taiwan vol. 1. 2nd ed.: 347. 1980.

Succulent herbs, terrestrial; caudex fleshy, short or rhizome fleshy, creeping; roots long, fleshy. Fronds simple, pinnate or ternate, not circinate; fertile segments branching from sterile fronds. Sporangia borne in a simple or compound eusporangiate fertile spike.

KEY TO THE GENERA

1. Trophophylls simple or forked near the apex; venation reticulate... **2. Ophioglossum**
1. Trophophylls compound; venation free ..... **1. Helminthostachys**

1. HELMINTHOSTACHYS

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

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

Helminthostachys zeylanica (L.) Hook., Gen. Fil.: t. 47b. 1840; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 10. f. 1, 1-2. 1939; Holttum, Rev. Fl. Malaya 2: 42. f. 2. 1954; Seidenf., Nat. Hist. Bull. Siam Soc. 19: 85. 1958; Tagawa & K.Iwats., Fl. Thailand 3(1): 38. 1979.— *Osmanda zeylanica* L., Sp. Pl.: 1063. 1753. Fig. 5.11.

Rhiozome creeping, up to 5 mm in diameter, bearing the numerous fleshy roots and a fronds. **Trophophylls** 40-45 cm long, fleshy, green or purplish brown; trophophylls up to 15 cm long, 26 cm wide, tripartite, each with a terminal lobe and one or two pairs of sessile lateral lobes, rachis winged; lobe oblong to oblong-lanceolate, round to acute at apex, cuneate and more or less decurrent at base, up to 14 cm long, 2 cm broad; veinlets once or twice forked, all free; texture softly herbaceous. **Sporophyll**s with stalks up to 6.5 cm in length, placed at base of tripartite trophophyll; spikes up to 4.5 cm long, with numerous short bearing round sessile sporangia.

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

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

Ecology.— Terrestrial in grassland about 700-800 m alt.

Vernacular.— Kut chong (กูดจ๊อง), kut sang (กูดซัง), kut tin hung (กูดตีนฮุ้ง), phak tin kwang (ผักตีนกวาง), (Northern); tin nok yung (ตีนนกยูง) (South-eastern, Peninsular); Phak nok yung (ผักนกยูง) (Eastern).

Specimens examined.— W. Khwaiphan 218, T. Boonkerd 350, 573, 1151 [BCU]; Larsen et al 30600, M. Tagawa, K. Iwatsuki and N. Fukuoka 1107 [BKF].

2. OPHIOGLOSSUM

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

Rhizome short, erect; trophophylls 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.

KEY TO THE SPECIES

1. Trophophylls linear-lanceolate; fronds 5-6 cm long.....**1. O. gramineum**
1. Trophophylls ovate to oblong; fronds 12-15 cm long.....**2. O. petiolatum**

1. Ophioglossum gramineum Willd., Nov. Acad. Erf. 2: 18. t.1. f. 1; Wieffer., Blumea 12: 324. 1964; Tagawa & K.Iwats., Fl. Thailand 3(1): 36. 1979. Fig. 5.12.

Rhizome subglobose, bearing several fleshy roots and 1-2 fronds simultaneously. **Fronds** 5-6 cm long; phyllomophores 1-2 cm long; trophophylls linear-lanceolate, acute at apex, narrowly cuneate at sessile base, 1.5-2 cm long, to 2 cm broad, costules not distinct; veins recticulate forming very long-stretched areoles without included veinlets; texture papyraceous; sporophylls simple, with stalks 1.7-2 cm long, spikes 0.8-1 cm long.

Thailand.— CENTRAL: Nakhon Nayok (Khao Yai), Saraburi (Sam Lan Forest).

Distribution.— Probably pantropic.

Ecology.— Terrestrial in grassland about 700-800 m alt.

Specimens examined.— W. Khwaiphan 219 [BCU]; T. Smitinand 11912, 11514, S. P. R. 7747 [BKF].

2. Ophioglossum petiolatum Hook., Exot. Fl. 1: t. 56. 1823; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 7. f. 1, 3-4. 1939; Tagawa & K.Iwats., Fl. Thailand 3(1): 37. 1979.— *Ophioglossum reticulatum* auct. non L.: Bedd., Handb.: 465. f. 290. 1883; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 7. 1939. Fig. 5.13.

Rhizome cylindrical, 3-4 mm in diameter, to 1 cm long, bearing many roots. **Fronds** 12-15 cm long, 1 or 2 on a rhizome; phyllomophore to 10 cm long; trophophyll variable in size and form, ovate to oblong, round to moderately acute at apex, or acute in some cases, cuneate, round or more commonly deeply cordate at base, 2-3 cm long, 1.2-2.5 cm broad; costae not differentiated; vein reticulate, areoles visible, many, free included veinlets often present, simple or branched; texture softly herbaceous, rather fleshy; sporophylls simple, with stalks of 6-10 cm in length; spikes 2-2.5 cm long. **Sporangia** up to 0.5 mm in diameter.

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: Bangkok; SOUTH-EASTERN: Chanthaburi (Khao Soi Dao, Pong Namron); SOUTH-WESTERN: Kanchanaburi (Hin Dat); PENINSULAR: Surat Thani (Ban Don).

Distribution.— Pantropic (type: cult. at Liverpool, originated from W. Indies).

Ecology.— Terrestrial in grassland about 700-800 m alt.

Specimens examined.— W. Khwaiphan 112, P. Ratchata 198, Y. Yuyen 172, T. Boonkerd 1017 [BCU]; K. Iwatsuki 34167, T. Smitinand 3459 [BKF].

ORDER HYMENOPHYLLALES

HYMENOPHYLLACEAE

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

Rhizome usually slender and long-creeping with distant fronds, the young parts covered with hairs, sometimes rootless. Fronds of many shapes, from very small and simple to fairly large and highly divided, the ultimate divisions always small, in

most cases one-veined; frond one cell in thickness except for the veins. Sori terminal on the ultimate one-veined lobes, or marginal at vein-endings on leaflets with many veins; receptacle columnar, more or less elongated, its base enclosed in the tubular or conical hollow base of the indusium, the apical part of the indusium more or less dilated, often more or less deeply divided into two lips; sporangia with oblique annulus.

KEY TO THE GENERA

1. Involucres tubular; receptacles extruded
   2. Venation anadromous; fronds mediocre to larger ..... **1. Crepidomanes**
   2. Venation catadromous; fronds generally smaller ..... **3. Trichomanes**
1. Involucres bilabiate throughout or to the middle; receptacles intruded .... **2. Hymenophyllum**

1. CREPIDOMANES

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

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

KEY TO THE SPECIES

1. False veinlet present
   2. Submarginal false veinlets distinct, oblique striae absent or few .... **2. C. latermarginale**
   2. Submarginal false veinlets absent, oblique striae many or a few .... **1. C. latealatum**
1. False veinlet absent
   3. Rhizomes very slender; axes proliferous ..... **4. C. minutum**
   3. Rhizomes more than 1 mm in diameter; axes not proliferous ..... **3. C. maximum**

1. Crepidomanes latealatum (Bosch) Copel., Phil. J. Sci. 67: 60. 1938.— *Didymoglossum latealatum* Bosch, Ned. Kruid. Arch. 5: 138. 1863; Tagawa & K.Iwats., Fl. Thailand 3(4): 613. 1989.— *Trichomanes latealatum* (Bosch) Christ, Verh Nat. Ges. Basel 11: 424. 1896; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 64. 1939; Holttum, Rev. Fl. Malaya 2: 101. 1954.— *Trichomanes bipunctatum* Poir var. *latealatum* (Bosch) C.B.Clarke, Tr. Linn. Soc. II. Bot. 1: 49. 1880.— *Trichomanes plicatum* (Bosch) Bedd., Ferns Br. Ind.: t. 285. 1868; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 65. 1939.— *Trichomanes bipunctatum* Poir var. *plicatum*. (Bosch) Bedd., Handb.: 42. 1883.— *Didymoglossum plicatum* Bosch, Ned. Kruid. Arch. 5: 139. 1863. Fig. 5.14.

Rhizome about 0.4 cm in diameter, covered with dark brownish hairs. **Stipes** about 4 mm long, winged along almost to the base, bearing short hairs. **Fronds** ovate to oblong, round to acute at apex, tripinnatifid, usually 2.5 cm long, 1-2 cm wide; pinnae 5-8 in pairs, the larger ones 1-1.5 cm long, 0.5-0.8 cm wide, shortly or sessile in the upper ones; pinnules oblong to subdeltoid, with about 10 segments; ultimate segments linear-lanceolate, at a narrow angle to each other, acute at apex, entire and flat at margin; submarginal false veinlets absent, the other striae numerous, oblique. **Sori** on the apices of short axillary lobes; involucres tubular, 1-1.8 mm long, winged, mouths bilabiate, lips round to acute, as wide as long.

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

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

Ecology.— Lithophyte on rocks by stream in tropical rain forest about 700-800 m alt.

Specimens examined.— W. Khwaiphan 217, A. Sathapattayanon 294 [BCU].

2. Crepidomanes latemarginale (Eaton) Copel., Phil. J. Sci. 67: 60. 1938; Ching, Fl. Reip. Pop. Sin. 2: 164. 1959; Tagawa & K.Iwats., Fl. Thailand 3(4): 613. 1989.— *Trichomanes latemarginale* Eaton, Proc. Am. Acad. 4: 111. 1858; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 63. 1939; Holttum, Rev. Fl. Malaya 2: 101. 1954.— *Trichomanes nanum* auct. non Bosch: Christ, Bot. Tidsskr. 24: 103. 1901.— *Trichomanes parvulum* auct. non Poir.: E. Smith, J. Siam Soc. Nat. Hist. Suppl. 8: 2. 1929. Fig. 5.15.

Rhizome very slender, densely covered with short brownish hairs. **Stipes** about 0.5 mm apart, 5 mm long, very narrowly winged in the upper part, hairy especially in the basal part. **Fronds** almost circular to oblong-subdeltoid in outline, about 2 cm long, 1-2 cm wide, often digitate in appearance but typically pinnate in branching; segments 10-15, linear-lanceolate, round to moderately acute at apex, entire but sometimes obscurely crisped at margin, with a single vein, 0.5-0.8 mm wide; false veinlets marginal, continuous, with two rows of marginal cells outside the false veinlets. **Sori** sunk in the apices or segment; involucre tubular with bilabiate mouth, about 1 mm in diameter, the mouth just wider than the segments.

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

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

Ecology.— Epiphyte on tree trunks in tropical rain forest about 700-900 m alt.

Specimens examined.— W. Khwaiphan 060 [BCU].

3. Crepidomanes maximum (Blume) K.Iwats., J. Fac. Sci. U. Tokyo III. 13: 531. 1985; Tagawa & K.Iwats., Fl. Thailand 3(4): 613. 1989.— *Trichomanes maximum* Blume, En. Pl. Jav. : 228. 1828; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 72. 1939; Holttum, Rev. Fl. Malaya 2: 107. 1954; Tagawa & K.Iwats., Fl. Thailand 3(1): 83. 1979.— *Vandenboschia maxima* (Blume) Copel., Phil. J. Sci. 67: 54. 1938. Fig. 5.16.

Rhizome creeping, thick, 2 mm in diameter, densely covered with stiff dark brownish hairs when young. **Stipes** rather close to each other, stramineous, very narrowly winged in the upper part, hairy at base, 6.5-9.5 cm long. **Fronds** oblong-subdeltoid, acute at apex, one or two pairs of basal pinnae smaller than the next above forming round outline the base, 4.2 cm long 1.5 cm wide, finely decompound to quadripinnatifid; rachis narrowly winged throughout, wings entire and flat; pinnae oblong-subdeltiod to oblong-lanceolate, acute to acuminate at apex, unequally cuneate and stalked at base, larger ones 0.5-0.7 mm broad, at a narrow angle to the next larger division of the fronds, round to moderately acute at apex, often curved inwardly; the wings of various axes narrower than the ultimate lobes, entire, flat. **Sori** on short axillary lobes usually near the pinna-or pinnule-rachis; involucres tubular, with short stalk and dilated mouth, narrowly winged, about 1 mm long, 0.9 mm in diameter. the mouth 0.5 mm or more in diameter.

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

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

Ecology.— Epiphyte on mossy tree trunks in hill evergreen forest about 1,000-1,200 m alt.

Specimens examined.— W. Khwaiphan 136, T. Boonkerd 345 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka 4810, 5297 [BKF].

4. Crepidomanes minutum (Blume) K.Iwats., J. Fac. Sci. U. Tokyo III. 13: 524. 1985; Tagawa & K.Iwats., Fl. Thailand 3(4): 613. 1989.— *Gonocormus saxifragoides* (C.Presl) Bosch, Hymen. Jav.: 9. 1861; Tagawa & K.Iwats., Fl. Thailand 3(1): 80. 1979.— *Trichomanes saxifragoides* C.Presl, Hymen.: 16, 39. 1843.— *Trichomanes parvulum* Blume, En. Pl. Jav. : 223. 1828 ; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 65. 1939.—*Trichomanes minutum* auct. non Blume: Holttum, Rev. Fl. Malaya 2: 96. 1954.— *Gonocormus minutus* auct. non (Blume) Bosch: Copel., Phil. J. Sci. 67: 57. 1938. Fig. 5.17.

Rhizome long-creeping, very slender, covered with dark brownish hairs, the hairs caducous. **Stipes** slender, wingless, about 6 mm long. **Fronds** seeming flabellate to bipinnate, irregularly branching dichotomously or with short main axes, about 1 cm long, often wider than long, not or rarely proliferous; ultimate segments with a single veinlet, about 0.8 mm wide, round to moderately acute at apex, the margin entire, thickened and somewhat curved inwardly. **Sori** at apices of ultimate segments; involucres tubular, winged, the mouth conspicuously dilated.

Thailand.— NORTH-EASTERN: Loei (Phu Luang, Phu Kradung); PENINSULAR: Surat Thani (Ko Tao), Phangnga (Khao Katha Khwam), Phuket (Khao Phra).

Distribution.— Old World tropics (type from Luzon), east to Polynesia and north to Japan.

Ecology.— Epiphyte on mossy tree trunks in tropical rain forest about 700-800 m alt.

Specimens examined.— W. Khwaiphan 174, W. Rattanathirakul 6 [BCU]; Larsen et al. 197, K. Iwatsuki, H. Koyama, M. Hutch & A. Chintayungkun T-8356 [BKF].

2. HYMENOPHYLLUM

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

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

KEY TO THE SPECIES

1. Margin of pinnae lobes toothed. Stipes narrowly winged in the upper part, rather densely hairy ..... **1. H. barbatum**
1. Margin of pinnae lobes entire

2. Stipes, rachis and pinna-rachis covered with hairs; pinnae more than 10 pairs ....**2. H. exsertum**
2. Stipes, rachis and pinna-rachis glabrous; pinnae less than 10 pairs..... .....**3. H. polyanthos**

1. Hymenophyllum barbatum (Bosch) Baker, Syn. Fil.: 68. 1867; Tagawa & K.Iwats., Fl. Thailand 3(1): 74. 1989.— *Leptocionium barbatum* Bosch, Ned. Kruid. Arch. 5(2): 146. 1863. Fig. 5.18.

Rhizome about 0.2 mm in diameter, covered with stiff brownish hairs when young. **Stipes** 1-1.5 cm apart, narrowly winged in the upper part, rather densely hairy, about 1 cm long. **Fronds** bipinnatifid to tripinnatifid, oblong to oblong-lanceolate, moderately acute at apex, gradually narrowing or broadly cuneate to base, 3-5 cm long by 2.5 cm wide; rachis distinctly winged, rather densely hairy on the underside; pinnae linear-subdeltoid, acute at apex, unequally cuneate at base, the largest 1.5 cm long and 0.7 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 axes rather distinct, hairy on the underside. **Sori** in the apices of short segments; involucre bilabiate almost to the base, 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.— Epiphyte on mossy tree trunks in tropical rain forest about 700-800 m alt.

Specimens examined.— W. Khwaiphan 078, Y. Yuyen 196 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka 2671, 2673 [BKF].

2. Hymenophyllum exsertum Wall. ex Hook., Sp. Fil. 1: 109. pl. 38A. 1844; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 53. 1939; Holttum, Rev. Fl. Malaya 2: 86. f. 28. 1954; Tagawa & K.Iwats., Fl. Thailand 3(4): 611. f. 5: 13. 1989.— *Mecodium exsertum* (Wall. ex Hook.) Copel., Phil. J. Sci. 67: 23. 1938; Tagawa & K.Iwats., Fl. Thailand 3(1): 73. 1979. Fig. 5.19.

Rhizome wiry, hairy throughout, laxly branched, about 0.2 mm in diameter. **Stipes** remote, hairy on the abaxial side, about 1.5 cm long, sometimes winged on the upper part. **Fronds** oblong-ovate to oblong-lanceolate, round to acute at apex, tripinnatisect, 10-12 cm long, 1.5-2.3 cm wide; rachis like the upper part of stipes, hairy throughout, more densely on abaxial side, winged throughout by flat wings, wings of the upper part broader, to 0.5 mm wide on both side; pinnae many, more than 10 in pairs on lower fronds, oblong to oblong-lanceolate, slightly falcate, round to moderately acute at apex, at most 1 cm long, 0.5 cm wide; pinnules with a few to several segments in larger ones pinnately decompound; ultimate segments to 2 mm long, 1 mm broad, entire and flat; hairs on every axes, rather sparse on upper axes, brown, up to 1 mm long. **Sori** usually on upper side of pinnae, dispersing from near rachis outward, the base constricted; involucres bilabiate; lips subtriangular, moderately acute, entire and flat, to 2 mm long, 1 mm broad; receptacles clavate.

Thailand.— NORTHERN: Chiang Rai (Doi Tung, Doi Phacho), Mae Hong Son (Doi Khun Huai Pong), Chiang Mai (Doi Phahom Pok, Doi Suthep, Doi Inthanon, Doi Chang), Lamphun (Doi Khun Tan), Phitsanulok (Phu Miang); NORTH-EASTERN: Loei (Phu Luang, Phu 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 (Khao Luang), Trang (Khao Sung, Khao Chong).

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

Ecology.— Epiphyte on mossy tree trunks in hill evergreen forest about 1,000-1,200 m alt.

Specimens examined.— W. Khwaiphan 132, T. Boonkerd 93, P. Ratchata 186 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T 68011, T. Smitinand 3092 [BKF].

3. Hymenophyllum polyanthos (Sw.) Sw., Schrad. J. Bot. 1800(2): 102. 1801; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 54. 1939; Holttum, Rev. Fl. Malaya 2: 81. f. 23. 1954; Seidenf., Nat. Hist. Bull. Siam Soc. 19: 85. 1958; Tagawa & K.Iwats., Fl. Thailand 3(4): 611. 1989.— *Mecodium polyanthos* (Sw.) Copel.; Phil. J. Sci. 67: 19. 1938; Tagawa & K.Iwats., Fl. Thailand 3(1): 70. 1979.— *Trichomanes polyanthos* Sw., Prod. Fl. Ind. Occ.: 137. 1788. Fig. 5.20.

Rhizome slender, about 1 mm in diameter with hairy rootlets. **Stipes** 1-2.5 cm long, wingless except the uppermost part, glabrous. **Fronds** very variable both in size and form, lanceolate, oblong-lanceolate, oblong or subdeltoid, acute to acuminate at apex, 7-9 cm long, 1.7-3.5 cm wide, usually tripinnatifid, light green, herbaceous; rachis winged throughout, wing very narrow, entire, flat; pinnae less than 10 pairs, the largest one in the middle of the fronds, reducing in size both upward and downward, the larger ones oblong-subdeltoid or oblong-lanceolate, somewhat falcate; ultimate segments linear or narrowly lanceolate, round to obtuse at apex, the margin entire and flat, usually about 1 mm in length. **Sori** usually longer than the breadth, deeply divided; lips round or moderately acute, entire or slightly crenate; receptacles clavate, included.

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

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

Ecology.— Epiphytic on tree trunks in light shade in hill evergreen forest about 1,000-1,300 m alt.

Specimens examined.— W. Khwaiphan 110, T. Boonkerd 1052 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T-631, T-1282 [BKF].

3. TRICHOMANES

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

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

Trichomanes motleyi Bosch, Ned. Kruid. Arch. 5: 145. 1861; Tagawa & K.Iwats., Fl. Thailand 3(4): 614. 1989.— *Microgonium motleyi* Bosch, Hymen. Jav.: 5. t. 1. 1861; Tagawa & K.Iwats., Fl. Thailand 3(1): 94. 1979. Fig. 5.21-5.22.

Rhizome creeping, about 0.5 mm in diameter, densely hairly with short dark brownish hairs. **Fronds** almost sessile or on very short stipes, simple, imbricate, circular or orbicular–oblong, margin entire and plane, costae short, at most halfway to the apex of fronds, without any branching; false veinlets many, simple or branched. **Sori** one on a fronds, in a sinus at end of short main vein, deeply immersed; involucres tubular with dilated mouth, less than 1 mm long, 0.4 mm broad, the mouth up to 1 mm in diameter.

Thailand.— NORTHERN: Tak (Doi Musoe); PENINSULAR: Chumphon (Khlong Wa), Surat Thani (Sawi), Phangnga (Khao Katha Khwam, Khao Bangto), Phuket (Khao Phra), Trang (Khao Chong).

Distribution.— Malaya and Borneo (type).

Ecology.— Lithophyte on cliffs in hill evergreen forest about 1,000-1,100 m alt.

Specimens examined.— W. Khwaiphan 095, T. Boonkerd 1467 [BCU]; E. Hennipman 3063, 3739B [BKF].

ORDER GLEICHENIALES

GLEICHENIACEAE

(J.Presl) C.Presl, Reliq. Haenk. 1: 70. 1825; Holttum, Rev. Fl. Malaya 2: 115. 1954.

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

KEY TO THE GENERA

1. Veins simple or once forked; sori with 2-5 large sporangia ..... **2. Gleichenia**
1. Veins forked more than once; sori with 8-15 or more sporangia... **1. Dicranopteris**

1. DICRANOPTERIS

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

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

KEY TO THE SPECIES

1. Sori in a single rather irregular row at each side of costules; costule 1-1.2 cm apart .....**1. D. linearis var. linearis**
1. Sori more than one row at each side of costules; costule 0.3-0.5 cm apart..... ..... **2. D. splendida**

1. Dicranopteris linearis (Burm.f.) Underw. **var. linearis**, Bull. Tor. Bot. Club 34: 249. 1907; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 49. 1939; Holttum, Fl. Males., Ser. II. 1: 33. f. 12, 14 f-i. 1959; Tagawa & K.Iwats., Fl. Thailand 3(1): 55. 1979.— *Polypodium linearis* Burm.f., Fl. Ind.: 235. t. 67. f. 2. 1768.— *Gleichenia linearis* (Burm.f.) C.B.Clarke, Tr. Linn. Soc. II. Bot. 1: 428. 1880; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 49. 1939; Holttum, Rev. Fl. Malaya 2: 68. f. 16. 1954. Fig. 5.23-5.24.

Rhizome widely creeping, hairly. **Primary rachis-branches** usually twice or thrice forked, the two branches at each fork nearly equal; ultimate branches 15-17 cm long, 3-4 cm wide; ultimate segments linear, entire, round at apex, up to 4 mm broad; costules 0.3-0.5 cm apart, veins more or less prominent on lower surface and hairy, texture firm, lower surface slightly glaucous, glabrescent. **Sori** in a single rather irregular 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 (Khao 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.— Terrestrial on hill slope along roadside.

Vernacular.— Kiku kachoei (กิ๊กุกะเจ้ย) (Karen/Northern); kut pit (กูดปิ๊ด), kut muk (กูดหมึก) (Northern); kut taem (กูดแต้ม), chon lek (โจ้นเหล็ก), chon (โชน), (Peninsular); kuekae (กือแก), ruesae (รือแซ) (Malay/Peninsular).

Specimens examined.— W. Khwaiphan 011, T. Boonkerd 248, 574, 1469 [BCU]; K. Iwatsuki & N. Fukuoka 3421, K. Larsen, T. Smitinand & E. Warnke 1769 [BKF].

2. Dicranopteris splendida (Hand.-Mazz.) Tagawa, Acta Phytotax. Geobot. 8: 164. 1936; Tagawa & K.Iwats., Fl. Thailand 3(1): 55. 1979.— *Gleichenia splendida* Hand.-Mazz., Akad. Anz. Akad. Wien 81. 1924; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 50. 1939.— *Dicranopteris ampla* Ching & Chiu, Acta Phytotax. Sin. 8 : 132. 1959. Fig. 5.25-5.26.

Rhizome long-creeping, about 4 mm in diameter, densely hairy with shining brown stiff hairs. **Stipes** about 40 cm long, stramineous or brown, glabrescent. **Pinnae** twice forked; ultimate lobes bearing no accessory branches, narrowly oblong, 30-35 cm long, up to 10 cm wide; ultimate segments linear, round to moderately acute at apex, entire and usually flat at margin, to 5-6 cm long, about 1 cm broad; costules 1-1.2 cm apart; vein pinnate, distinct on both surfaces, texture rigid, green, glabrous, lower surface glaucous. **Sori** more than one row at each side of costules.

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

Distribution.— Khasia, Upper Myanmar, S. and SW. China, and Indochina.

Ecology.— Terrestrial on hill slope along roadside.

Specimens examined.— W. Khwaiphan 068 [BCU]; E. Hennipman 3948; Kyoji Yoda 378 [BKF].

2. GLEICHENIA

J. Sm., Mem. Acad. Turin. 5: 419. 1793; Tagawa & K.Iwats., Fl. Thailand 3(1): 50. 1979.— *Sticherus* C.Presl, Tent. Pterid.: 51. 1863; Copel., Gen. Fil.: 27. 1947.— *Hicriopteris* C.Presl, Epim. Bot.: 26. 1849.

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

Gleichenia norrisii Mett. ex Kuhn, Linnaea 36: 165. 1869; Holttum, Rev. Fl. Malaya 2: 67. 1954; in Fl. Males., Ser. II. 1 : 15. f. 6. 1959; Tagawa & K.Iwats., Fl. Thailand 3(1): 51. 1979. Fig. 5.27-5.28.

Rhizome widely creeping, bearing fronds remotely, about 5 mm in diameter, scaly throughout; scales bright brown, lanceolate, long-acuminate at apex, toothed at margin, to 5 mm long, 0.7 mm broad. **Stipes** thick, to more than 1 mm long, stramineous to pale green, scaly at base with the scale like those on rhizome, sparsely scaly upwards with scales like those on the main axes; rachis scales oblong-lanceolate, up to 4 mm long, 0.5 mm broad, concolourously dark brown, hairy; pinnae a few in opposite pairs, bipinnatifid, oblong-lanceolate, acuminate at apex, to 160 cm long, 30-35 cm wide; leaflets up to 20 cm long, 3 cm wide, shortly stalked, about 2 cm apart, all reflexed, basal leaflets not stipuliform, or with broad blunt lobes; scales on resting buds 4-5 mm long, narrow, brown, with short oblique concolourous setae at margin; lobes narrowly oblong, patent, round to moderately acute at apex, larger ones about 1.7 cm long, 5 mm broad, separated by sinus less than 1 mm in width; veinlets once or twice forked, distinct on both surfaces, dark brownish stellate hairs often present on lower surface of veins and fronds. **Sori** dorsal on acroscopic branch of veinlets, round.

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

Distribution.— Malaya (type), Sumatra and N. Borneo.

Ecology.— Terrestrial on hill slope along roadside about 800-1,100 m alt.

Specimens examined.— W. Khwaiphan 183, T. Boonkerd 1415 [BCU]; K. Iwatsuki & N. Fukuoka 7383, G. Murata et al. 16262 [BKF].

ORDER SCHIZAEALES

SCHIZAEACEAE

Kaulf., Wesen Farrenkr. 119. 1827; Holttum in Fl.Mal. II. 1: 37. 1959.

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

LYGODIUM

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

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

KEY TO THE SPECIES

1. Secondary rachis-branches pinnate with a few leaflets, or dichotomous; axes winged to some extent
   2. Primary rachis-branches distinct; rhizome long creeping .....**1. L. microphyllum**
   2. Primary rachis-branches indistinct; rhizome short creeping .....**3. L. salicifolium**
1. Secondary rachis-branches pinnate with 10-15 pairs of leaflets; axes terete and wingless throughout .....**2. L. polystachyum**

1. Lygodium microphyllum (Cav.) R.Br., Prod.: 162. 1810; Holttum in Fl. Males., Ser. II. 1: 47. f. 5e-f, 6, 7. 1959; Tagawa & K.Iwats., Fl. Thailand 3(1): 60. 1979. — *Ugenia microphyllum* Cav., Ic. Descr. Pl. 6: 76. t. 595. 1801.— *Lygodium scandens* Sw., Schrad. J. Bot 1800(2): 106. 1801; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 41. 1939; Holttum, Rev. Fl. Malaya 2: 58. f. 12. 1954; Seidenf., Nat. Hist. Bull. Siam Soc. 19: 85. 1958. Fig. 5.29.

Rhizome long creeping, irregularly branching, 2-3 mm in diameter, densely covered with blackish brown hairs. **Fronds** climbing, sometimes to several metres; stipes about 10 cm long, dark stramineous, glabrescent, very narrowly winged in the upper part; rachis like the upper part of stipes, stramineous, glabrescent narrowly winged throughout; pinnae numerous, 4-6 cm apart; primary rachis-branches 4 mm or so long, the apex densely covered with brown hairs, dormant but occasionally protruding to some extent; secondary rachis-branches 8-9 cm long, glabrescent, narrowly winged; leaflets several in pairs on secondary rachis-branches, with distinct stalks 2-3 mm long, deltoid to oblong-subdeltoid, gradually narrowing towards moderately acute apex, subtruncate or broadly cuneate at more or less auricled base, entire at margin, glabrescent, 1.2-2 cm long, about 0.7 cm broad. **Sorophores** narrow, protruding at margin of segments, 2-3 mm long, about 1 mm broad; indusia serrate at margin, glabrous.

Thailand.— NORTHERN: Chiang Mai (Tat Noi, Doi Suthep), Lampang (Mae Tam, Ban Du); NORTH-EASTERN: Loei (Phu Kradung); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi (Makham, Khao Sabap), Trat (Ban Saphan

Hin, Ko Chang); PENINSULAR: Surat Thani (Ban Don, Ko Samui, Khun Thale), Songkhla (Hat Yai), Yala (Banang Sta.)

Distribution.— Tropics of the Old World (type from Luzon), from Africa to Melanesia and Australia, north to the Ryukyus and south to New South Wales.

Ecology.— Terrestrial in grassland about 700-800 m alt.

Vernacular.— Kachot nu (กะฉอดหนู) (South-eastern); liphao yung (ลิเภายุ่ง) (Peninsular).

Specimens examined.— W. Khwaiphan 206, T. Boonkerd 662, 669, 735, 1561 [BCU]; M. Tagawa et al. 585, T-74051 [BKF].

2. Lygodium polystachyum Wall. ex T.Moore, Gard. Chron. 671. 1859; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 40. 1939; Holttum, Rev. Fl. Malaya 2: 56. f. 10. 1954; in Fl. Males., Ser. II. 1: 46. f. 5c, 8 a-c. 1959; Tagawa & K.Iwats., Fl. Thailand 3(1): 59. 1979. Fig. 5.30.

Rhizome shortly creeping, densely covered with black hairs. **Fronds** climbing, sometimes more than 3 m in length; stipes 30-40 cm, brown, densely hairs throughout, up to 4 mm in diameter, terete, wingless; hairs on stipes as well as on rachis setose, stiff, patent, multicellular, brown or paler, up to 2 mm long; rachis like the upper part of stipes, slender, paler, hairs less dense and short, terete; pinnae numerous, 15-20 cm apart; primary rachis-branches very short, usually 1-2 mm long, the apex densely, covered with brown hairs, dormant but occasionally a little protruding in the lower pinnae; secondary rachis-branches about 20 cm long, densely hairly with short unicellular hairs, wingless; leaflets about 7 pairs on secondary branches, with short stalks of 2 mm or so, oblong-subdeltoid, acute to moderately so at apex, subtruncate at base, indistinctly articulated at the junction of stalk and frond part, pinnately lobe to half way, hairy on veins and margin, 5.5 cm long and 2 cm wide at basal widest portion; ultimate lobes round at apex, entire. **Sorophores** narrow, 3-4 mm long, 1.5-2 mm wide; indusia densely covered with long pale hairs.

Thailand.— NORTHERN: Chiang Rai (Doi Tung, Nam Mae Kok), Chiang Mai (Doi Chiang Dao, Huai San, Doi Suthep, Doi Buak Ha, Tha Ko), Lampang, Phitsanulok (Thung Salaeng Luang); NORTH-EASTERN: Phetchabun (Phu Miang);

SOUTH-EASTERN: Chon Buri (Si Racha); CENTRAL: Nakhon Nayok; SOUTH-WESTERN: Prachup Khiri Khan (Bang Saphan); PENINSULAR: Chumphon, Surat Thani (Khao Tha Phet, Huai Mut, Ban Don, Ko Tao), Nakhon Si Thammarat (Ronphibun, Lan Saka), Phuket (Thalang), Songkhla (Khao Pak), Trang (Khao Chong), Naratthiwat (Bacho)

Distribution.— Assam, Myanmar, Sw. China (Kwangsi & Yunnan), Indochina and Malaya (type).

Ecology.— Terrestrial at the margin of tropical rain forest about 800-900 m alt.

Vernacular.— Kut Khua (กูดเคือ), kut kong (กูดก๊อง) (Northern); liphao (ลิเภา), liphao yong (ลิเภาย่อง) (Peninsular).

Specimens examined.— W. Khwaiphan 207, O. Vannasri 32, P. Ratchata 50, T. Boonkerd 668 [BCU]; David J. Middleton et al. 2055, K. Larsen et al. 1448 [BKF].

3. Lygodium salicifolium C.Presl, Suppl. Tent. Pterid.: 102. 1845; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 41. 1939; Holttum in Fl. Males., Ser. II. 1: 51. f. 6. 10, 13a-b. 1959. Seidenf., Nat. Hist. Bull. Siam Soc. 19: 85. 1958; Tagawa & K.Iwats., Fl. Thailand 3(1) : 64. 1979.— *Lygodium flexuosum* auct. non (L.) Sw.: Christ, Bot. Tidsskr. 24: 112. 1901; Holttum, Rev. Fl. Malaya 2: 57. f. 10. 1954; p.p.— *Lygodium circinatum* auct. non (Burm.f.) Sw.: Christ, Bot. Tidsskr. 24: 112. 1901; Seidenf., Nat. Hist. Bull. Siam Soc. 19: 85. 1958. Fig. 5.31-5.32.

Rhizome shortly creeping, densely covered with blackish brown hairs. **Fronds** climbing, to several metres tall; stipes stramineous, minutely pubescent, very narrowly winged or with a distinct line at both sides; rachis like the upper part of stipes, 1-1.2 mm in diameter; primary rachis-branches very short, about 2 mm long, the apex dormant, covered with brown hairs; secondary rachis-branches pinnate, with about 4 pairs of leaflets and a terminal usually deeply lobed one; tertiary leaflets oblong-lanceolate, moderately acute at apex, cordate, subhastate or in extreme form 5-lobed at base, minutely dentate at margin, typically 8.5 cm long, 2 cm broad; stalks of leaflets distinct but wanting in smaller leaflets, up to 1 cm long, with a distinct junction at base of fronds; lamina herbaceous to soft papyraceous, fresh green, almost glabrous on both surfaces except the hairy margin; every axes higher than the

secondary rachis-branches with narrow but distinct wings, pubescent throughout, somewhat swollen at every junction. **Sorophores** protruding at margin of tertiary leaflets, 2-3 mm long, about 1 mm broad; indusia glabrous.

Thailand.— NORTHERN: Chiang Rai (Doi Tung, Doi Chang, Nam Mae Kok), Chiang Mai (Doi Chiang Dao, Doi Suthep, Tha Ko), Phrae (Huai Ton Yang, Mae Sai); NORTH-EASTERN: Loei (Phu Luang); EASTERN: Nakhon Ratchasima; CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi (Makham, Khao Sabap), Chon Buri (Kroeng Kawai, Sai Yok), Prachuap Khiri Khan (Bang Saphan); PENINSULAR: Surat Thani (Ban Don, Ko Tao), Phangnga (Khao Nang Hong), Nakhon Si Thammarat (Thung Song, Ronphibun, Khiriwong), Trang (Khao Chong), Phatthalung, Satun (Tarutao), Narathiwat (Bacho Falls, Su-ngai Kolok), Yala (Bannang Sta).

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

Ecology.— Terrestrial in light shade in tropical evergreen forest about 600-900 m alt.

Vernacular.— Kut khue (กูดคือ), saiphan phi (สายพานผี), u taphao (อู่ตะเภา) (Northern); kachot (กะฉอด), kachot nu (กะฉอดหนู) (South-easthern); yan i-phao (ย่านอีเภา) yan yai phao (ย่ายยายเภา) (Peninsular); libu (ลีบู) (Malay/Peninsular).

Specimens examined.— W. Khwaiphan 066, O. Vannasri 32, T. Boonkerd 54, 666 [BCU]; M. Tagawa et al 1109, 3873, G. Murata et al T-51292 [BKF].

ORDER DICKSONIALES

DENNSTAEDTIACEAE

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

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

KEY TO THE GENERA

1. Sori round, solitary at apex of veinlets; indusia half cup-shaped ..... **1. Microlepia**
1. Sori elongate along margin of lobes; indusia 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, solenostelic, covered with short hairs. Stipes rather close, hairy. Frond pinnate to pinnately decompound, the ultimate pinnules usually obliquely incised in most cases hairy; axes grooved, grooves decurrent to those of the next order, vein all free. Sori terminal on veins, usually close to margin of lobes; indusia attached by sides and base, rather thin, thus half cup-shaped, often hairy.

Microlepia herbacea Ching & C.Chr. ex Tardieu & C.Chr., Not. Syst. 6: 6. pl. 1. f. 1-2. 1937; in Fl. Gén. I.-C. 7(2): 189. f. 22, 3-4. 1939; 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. Fig. 5.33-5.34.

Rhizome long-creeping, densely covered with stiff blackish hairs, about 4 mm in diameter. **Stipes** stramineous, densely hairy at base, glabrescent or minutely pubescent above, up to 50 cm long. **Fronds** oblong-lanceolate, gradually narrowing towards attenuately acuminate apex, round or cuneate at base, bipinnate, about 60 cm long, 30 cm wide; rachis stramineous, distinctly grooved on the upper surface, densely hirsute throughout; lateral pinnae usually more than 10 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 18 cm long, 4 cm wide; coste grooved, densely pubescent; pinnules oblong or roundly quadrangular, round or moderately acute at apex, cuneate at sessile base, lobes to 1/3 way to costules, the larger ones 3 cm long, 1.5 cm wide; ultimate lobes quagrangular, round or obtuse at apex, with a few distinct teeth at margin, sinus very narrow; herbaceous, light green, glabrous except the underside of veins, or minutely or rather densely hirsute on the lamina underneath. **Sori** terminal on basal acroscopic veinlets, at bottom of sinus between lobes, small; indusia cup-shaped, hairy.

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

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

Ecology.— Terrestrial by stream in tropical evergreen forest about 700-800 m alt.

Specimens examined.— W. Khwaiphan 153, 172, T. Boonkerd 450, 607, 649 [BCU]; M. Tagawa et al. T-591, T. Smitinand 6197 [BKF].

2. PTERIDIUM

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

Rhizome long-creeping, deep in earth, solenostelic, hairy; fronds tripinnate to quadripinnatifid at base; 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 edges of the leaflets and thin membranes attached just below the receptacles.

Pteridium aquilinum (L.) Kuhn in Deck., Reis. Ost.-Afr. 3(3): 11.1879; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 136. 1939; Holttum, Rev. Fl. Malaya 2: 389. f. 225. 1954; Tagawa & K.Iwats., Fl. Thailand 3(1): 125. 1979.

subsp. caudatum (L.) R.M.Tryon **var. yarrabense** Domin, Bilbl. Bot. 85(1): 161. f. 32. 1914; Tagawa & K.Iwats., Fl. Thailand 3(1) : 126. f. 9, 5,7. 1979.— *Pteris esculenta* G.Forst., Pl. Escul: 74. 1786.— *Pteridium esculentum* (G. Forst.) Nakai, Bot. Mag. Tokyo 39: 108. 1825; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 138. f. 17, 1. 1939; Holttum, Rev. Fl. Malaya 2: 390. f. 226. 1954. — *Pteridium aquilinum* var. *esculenta* (G.Forst.) Bedd., Handb.: 116. 1883. Fig. 5.35-5.36.

Rhizome long-creeping, covered with fine pale brown hairs. **Stipes** more than 1 m long, thick, dark brown to black in lower parts, stramineous upwards, densely covered with pale brown hairs. **Fronds** 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 80 cm long, 30 cm wide, or rather narrower; pinnule short stalked, segments rather widely spaced, terminal lobes distinct; ultimate leaflets small and narrow, subcoriaceous, usually covered with pale brown hairs, veins free, forked, raised beneath, hairy. **Sori** linear, submarginal, the apices of veins joined by vascular commissure, thus forming long continuous receptacles; indusia formed in two parts, one consisting of the thin reflexed edges of the leaflets, the other thin, almost transparent membranes attached just below the receptacles.

Thailand.— NORTHERN: Chiang Mai (Bo Luang); NORTH-EASTERN: Loei (Phu Luang, Phu Kradung); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Trat (Ko Chang); PENINSULAR: Chumphon (Bang Son), Surat Thani (Ban Don).

Distribution.— Himalaya through Malesia to Australia.

Ecology.— Usually grow in open area, up to 1,300 m alt**.**

Vernacular.— Kut kin (กูดกิน) (Northern).

Specimens examined.— W. Khwaiphan 193, T. Boonkerd 1096, 115, S.Arkakraisri 148 [BCU]; K. Iwatsuki & N. Fukuoka 7407, E. Hennipman 3617 [BKF].

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 hairs, stipes not articulate to rhizome. Fronds large, tripinnatifid; veins free. Sori marginal or submarginal, terminal on veinlets; indusia 2 lobed, outer lobes a continuation of the leaf margin and bent at about right angles to leaf surface; sporangia gradate, annuli complete, oblique; paraphyses abundant, spores trilete.

CIBOTIUM

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

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

Cibotium barometz (L.) J.Sm., Lond. J. Bot. 1: 437. 1842; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 78. f. 10, 6-7. 1939; Holttum, Rev. Fl. Malaya 2: 114. f. 45. 1954; in Fl. Males., Ser. II. 1: 165. f. 33, a-c. 1963; Tagawa & K.Iwats., Fl. Thailand 3(1): 109. f. 6, 8-10. 1988.— *Polypodium barometz* L., Sp. Pl.: 1092. 1753. Fig. 5.37.

Rhizome massive, prostrate, very densely covered with golden yellow hairs. **Stipes** thick, sometimes attaining to 2.5 cm in diameter, more than 1.6 m long in larger ones, densely covered with shining, golden yellow, long, slender or warty hairs at base, hairs on upper parts not so dense, brown to darker, setose, gradually becoming shorter upwards. **Fronds** larger, up to 1.8 m in length, more than 90 cm in width, bipinnate; pinnae many, the largest ones up to 50 cm long, 18.5 cm wide, with numerous pinnules; pinnules deeply pinnatifid throughout, very shortly stalked or subsessile at posterior parts of pinnae, linear-lanceolate, gradually narrowing towards acuminate apex, broadly cuneate to subtruncate at base, 8-10 cm long, 1-1.5 cm wide; ultimate segments oblong, oblique to subfalcate, acute at apex, shallowly but distinctly dentate at margin, glaucous in lower surface, 0.6-0.8 cm long, 2-3 mm broad, with intervals of 4 mm between the adjacent costules; costae and costules covered with pale, entangled, flaccid, appressed hairs below; veins distinct, once 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.

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.— Himalayas to S. China and Taiwan, south to W. Malesia, north to the Ryukyus.

Ecology.— Terrestrial on open hill slopes and stream banks in tropical rain forest about 700-1,000 m alt.

Vernacular.— Kut phipa (กูดผีป่า), kut phan (กูดพาน) (Northern); khon kai noi (ขนไก่น้อย) (North-eastern); la-ong faifa (ละอองไฟฟ้า), wan kai noi (ว่านไก่น้อย) (Central); kut sua (กูดเสือ), pho si (โพสี), ninla phosi (นิลโพสี) (Peninsular).

Specimens examined.— W. Khwaiphan 085, T. Boonkerd 123, 169, 172 [BCU]; M. Tagawa et al. 1325, G. Murata et al. 52369 [BKF].

LINDSAEACEAE

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

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

LINDSAEA

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

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

KEY TO THE SPECIES

1. Fronds simple pinnate with dimidiate pinnae
   2. Fronds with dimidiate pinnae; pinnae oblong-subdeltoid ..... **4. L. lucida**
   2. Fronds without dimidiate pinnae; pinnae linear-lanceolate.....**2. L. ensifolia**
1. Fronds bipinnate with pinnae gradually larger below
   3. Veins all free except those joined by sori; stipes castaneous to nearly black ....**1. L. chienii**
   3. Veins anatomosing; stipes brown to purplish..... **3. L. heterophylla**

1. Lindsaea chienii Ching, Sinensia 1: 4. 1929; Tagawa & K.Iwats., Fl. Thailand 3(2): 133. 1985.— *Lindsaea tenera* Dryand. var. *chienii* (Ching) Tardieu & C.Chr., Not. Syst. 5: 266. 1936; in Fl. Gén. I.-C. 7(2): 127. 1939.— *Lindsaea tenera* auct. non Dryand.: Tagawa & K.Iwats., Southeast As. St. 5: 75. 1967, p.p. Fig. 5.38.

Rhizome short-creeping, about 1.2 mm in diameter; scales linear, about 2 mm long, 3-4 cells, broad at base, brown, more or less bright. **Stipes** castaneous to nearly black, up to 40 cm long. **Fronds** bipinnate oblong-subtriangular; lateral pinnae 3-5 pairs, basal ones largest, shortly stalked, linear, up 11 by 3 cm; terminal pinnae large, up to 20 by 5 mm; pinnules of lateral pinnae oblong, inner and lower edges straight, or more or less dimidiate, meeting in cuneate base, outer and upper edges entire or lobed in larger ones, forming round apex, up to 20 by 6 mm, those of terminal pinnae oblong to subquadrangular, lower edges dimidiately curving, inner edge close or imbricate to rachis, upper edge more or less lobed, up to 20 by 5 mm, subcoriaceous; veins free except those united by sori, distinct on both surfaces. **Sori** marginal along outer and upper edges of pinnules, continuous in smaller ones, but usually interrupted.

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

Distribution.— S. Chiana (type), Annam, Taiwan, northwards to S. Japan.

Ecology.— Terrestrial in grassland about 700-900 m alt.

Vernacular.— Kut hang nok yung (กูดหางนกยูง) (North-eastern).

Specimens examined.— W. Khwaiphan 077 [BCU]; K. Iwatsuki, C. Phengklai, M. Wakabayshi and M. Kata 59, K. Iwatsuki & N. Fukuoka T 7153, T. Smitinand 5024 [BKF].

2. Lindsaea ensifolia Sw., Schrad. J. Bot. 1800(2): 77. 1801; Tagawa & K.Iwats., Fl. Thailand 3(2) : 131. 1985.— *Schizoloma ensifolium* (Sw.) J. Sm., J. Bot. 3; 414. 1841; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 129. f. 15, 1939; Holttum, Rev. Fl. Malaya 2: 346. f. 200. 1954; Seidenf., Nat. Hist. Bull. Siam Soc. 19: 86. 1958.— *Lindsaea griffithianum* Hook., Sp. Fil. 1: 219. t. 68 B. 1846.— *Schizoloma griffithianum* (Hook.) Fée, Gen. Fil.: 108. 1852.— *Diplazium bantamense* auct. non Blume.: Christ, Bot. Tidsskr. 24: 108. 1901. Fig. 5.39.

Rhizome creeping, 4-5 mm in diameter, brown to darker, scaly at least apically; scales linear, up to 2 mm long, 0.4 mm broad, brown, slightly shining. **Stipes** stramineous or castaneous at least at base. **Fronds** simply pinnate, ovate to oblong-lanceolate, lateral pinnae 3-5 pairs, linear-lanceolate, caudately acuminate at apex, cuneate, rounded or subtruncate at base, very shortly stalked, entire at margin, up to 18 cm long, 2 cm broad; terminal pinnae like lateral ones, subcoriaceous; vein, anastomosing forming 2-3 rows of areoles at each side of coste, distinct beneath. **Sori** continuous along margin; indusia firm, nearly reaching the edges.

Thailand.— NORTHERN: Chiang Mai (Doi Chiang Dao, Doi Suthep, Buak Ha), Phitsanulok (Thung Salaeng Luang); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng), Nong Khai (Phon Phisai); EASTERN: Ubon Ratchathani; CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Rayong (Khao Chamao), Chanthaburi (Khao Sabap, Makham, Phriu), Trat (Ko Chang, Ko Kut, Tha San Falls, Ban Saphan Hin); 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 or on sandy ground in hill evergreen forest and grassland about 600-1,300 m alt.

Vernacular.— Hang nok kaling (หางนกกะลิง).

Specimens examined.— W. Khwaiphan 055, 056, T. Boonkerd 40, 116, 736 [BCU]; Shimizu et al. T-10486, M. Tagawa 3937 [BKF].

3. Lindsaea heterophylla Dryand., Trans. Linn. Soc. 3: 41. pl. 8 f. 1. 1797; Kramer in Fl. Males., Ser. II. 1: 210 f. 17-18. 1971; Tagawa & K.Iwats., Fl. Thailand 3(2): 132. 1985.— *Schizoloma heterophyllum* (Dryand.) J. Sm., J. Bot. 3: 414. 1841; Holttum, Rev. Fl. Malaya 2: 345. 1954. Fig. 5.40.

Rhizome short-creeping, bearing fronds close together, about 4 mm in diameter, densely scaly at apex; scales linear, up to 2 mm in length, 3-4 cells broad at base, brown, more or less bright. **Stipes** brown to purplish, paler above, scaly at base,

grooved on upper surface, round beneath, up to 30 cm long. **Fronds** simply pinnate to bipinnate, up to 26 by 19 cm; lower pinnae pinnate, linear-subtriangular to narrowly subdeltoid, stalked; upper pinnae simple, subsessile, linear-lanceolate with entire margin, acuminate at apex, cuneate to subtruncate at base; pinnules larger ones like the upper pinnae, smaller ones fan-shaped or ovate, entire, all herbaceous green; veins anstomosing to form a row of areoles at each side of costae, otherwise free except for those united by sori. **Sori** continuous, not interrupted; indusia firm, hardly reaching the margin of pinnae or pinnules.

Thailand.— NORTHERN: Chiang Mai (Doi Suthep); NORTH-EASTERN: Loei (Phu Luang, Phu Kradung); SOUTH-EASTERN: Trat (Ko Chang, Ko Kut); PENINSUALR: Surat Thani (Ko Phangan).

Distribution.— Madagascar, S. India, Ceylon, Indochina, S. China, W. and N. Central Malesia throughout (type from Malacca), north to the Ryukyus.

Ecology.— Terrestrial on rather dry slopes in hill evergreen forest about 1,000-1,300 m.

Specimens examined.— W. Khwaiphan 165, T. Boonkerd 371, 571 [BCU]; C. Niyomdham 3201, C. Phengklai et al. 12988 [BKF].

4. Lindsaea lucida Blume, En. Pl. Jav.: 216. 1828; Tardieu & C.Chr., Not. Syst. 5: 266. 1936; in Fl. Gén. I.-C. 7(2): 122. 1939; Holttum, Rev. Fl. Malaya 2: 328. f. 187. 1954; Kramer in Fl. Males., Ser. II. 1: 233. 1971; Tagawa & K.Iwats., Fl. Thailand 3(2): 142. 1985. Fig. 5.41-5.42.

Rhizome very short-creeping, about 1.5 mm in diameter, bearing stipes close together, scaly near apex, scales very narrow, up to 2 mm long, 0.2 mm broad, brown, shining. **Stipes** brown to castaneous and scaly at base, stramineous or pale-green, up to 4-8 cm long. **Fronds** simply pinnate, linear, up to 20 by 2 cm; rachis like the upper part of stipes; pinnae close, sessile; middle ones larger, patent, oblong-subdeltoid, 1 by 0.4 cm, the lower edge straight or curved, inner edge close to rachis, forming cuneate base with lower edge, rounded to moderately acute at apex; upper pinnae gradually becoming smaller, ascending, acute at apex, forming no terminal pinnae, lower ones more remote, smaller, patent or deflexed, herbaceous; veins distinct on

both surfaces, free, except those joined by sori. **Indusia** narrow, thin, nearly reaching the margin of pinnae.

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

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

Ecology.— Terrestrial by stream in tropical rain forest about 700-800 m alt.

Specimens examined.— W. Khwaiphan 170, T. Boonkerd 1088 [BCU]; K. Larsen et al. 32806, T. Smitinand 1312 [BKF].

ORDER CYATHEALES

CYATHEACEAE

Kaulf., Wesen Farrenkr. 119. 1827; Holttum, Rev. Fl. Malaya 2: 115. 1954.

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

CYATHEA

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

Terrestrial tree ferns; stems 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, veins usually free; sori round, dorsal on veinlets, on distinct receptacles; indusia distinct or wanting; annulus oblique, complete.

KEY TO THE SPECIES

1. Sori with indusia; pinnae lobed nearly to costa .....**2. C. latebrosa**
1. Sori without indusia; pinnae lobed less than ½ way towards costae .. **1. C. gigantea**

1. Cythea gigantea (Wall. ex Hook.) Holttum, Gard. Bull. S. 8: 318. 1935; Rev. Fl. Malaya 2: 218. f. 53. 1954; in Fl. Males., Ser. 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. (Blume) Copel.: Bedd., Handb.: 14. 1883; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 83. 1939. Fig. 5.43-5.44.

Trunks up to 2 m or more tall. **Stipes** up to 60 cm or more long, with short spines throughout, nearly black or deep castaneous, polished, densely covered with spreading scales; scales up to 2 cm long, 1.5 mm broad, dark brown to nearly black, shining, stiff, edges ferrugineous, rather broad, pale; pneumathodes small, in a single row, distinct; main rachis castaneous to nearly black, minutely scaly, smooth; pinnae up to 65 cm or more long, 22 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, shortly stalked, up to 12 cm long, 2.2 cm wide, lobed to more than 1/3 way towards costae; lobes round subdeltoid, round at apex, oblique, falcate, serrate at margin, up to 4.5 mm broad, with narrow sinus; texture thin, papyraceous, green, veins pinnate, veinlets simple, all free. **Sori** close to costule or medial, naked.

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 (Khao Luang, Chawang Nok Nang), Satun, Yala (Ban Chana).

Distribution.— E. Himalaya (type), S. India, Celoy, Myanmar, S. China, Indochina, Malaya, Sumatra and W. Java.

Ecology.— Terrestrial on mountain slopes usually in tropical evergreen forest and hill evergreen forest about 700-1,100 m alt.

Vernacular.— Maha sadam (มหาสะดำ) (South-eastern); maha sadaeng (มหาสะแดง) (Peninsular); kut ngong (กูดโง่ง), kut yong (กูดโย่ง), kut hang nok yung (กูดหางนกยูง) (Northern); khasudo (คาซูโด) (Karen/Northern).

Specimens examined.— W. Khwaiphan 099, 197, T. Boonkerd 1118 [BCU]; M. Tagawa, K. Larsen et al. 1635; M. Tagawa 3844 [BKF].

2. Cyathea latebrosa (Wall. ex Hook.) Copel., Phil. J. Sci. 4: 52. 1909; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 85. 1939; Holttum. Rev. Fl. Malaya 2: 120. f. 48. 1954; in Fl. Males., Ser. II. 1: 115. 1963; Tagawa & K.Iwats., Fl. Thailand 3(1): 104. 1979.— *Alsophila latebrosa* Wall. ex Hook., Sp. Fil. 1: 37. 1844. Fig. 5.45-5.46.

Trunks 3-5 m or more tall. **Stipes** 30-40 cm long, with very short spines, yellowish brown to darker, scaly at base; scales linear, up to 1 cm long, 1.5 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; lower pinnae reduced to 10 cm long, irregular in form, rather distant, larger pinnae about 50 cm long, 13 cm wide, narrowly oblong, caudately acuminate at apex; pinna-rachis warty beneath, hairy and sparsely scaly on upper surface; pinnules more than 25 pairs, larger ones about 1.7 cm apart, oblong-lanceolate, gradually narrowing towards acuminate apex, subtruncate at base, sessile, up to 7.5 cm long, 1.7 cm wide, lobed nearly to costa; lobes oblique, falcate, round at

apex, entire or slightly serrate at margin, to 1 cm long, 2 mm broad; costae hairy on upper surface, costae and costules scaly beneath with elongate, flat, brown scales in basal part, with pale bullate scales in distal part; texture papyraceous, deep green, paler beneath, veins forked or distal ones simple. **Sori** close to costules; indusia small; scales at costular side of receptacles, hidden by mature sori.

Thailand.— NORTHERN: Chiang Mai (Doi Suthep); CENTRAL: Nakon 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 (Su-ngai Padi), Yala (Muang Wieng, Khao Kalakhiri).

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

Ecology.— Terrestrial on mountain slopes in tropical rain forest and hill evergreen forest 700-1,100m alt.

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

Specimens examined.— W. Khwaiphan 098, 121, T. Boonkerd 541, 542, 1476 [BCU]; K. Iwatsuki & N. Fukuoka 7393, T. Smitinand 923 [BKF].

ORDER PTERIDALES

ADIANTACEAE

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

Terrestrial ferns. Rhizome erect, oblique or creeping, solenostelic or dictystelic, clothed with either hairs or narrow brownish scales. Fronds uniform or rarely subdimorphic, 1-4 pinnate or pedate, rarely simple, not articulate to rhizome; veins free or rarely anastomosing without included free veinlets. Sori superficial, linear, following the course of veins, exindusiate or close to the margin, borne along the apical part of fertile veins on the underside of the sharply reflexed discolored

membranaceous or coriaceous leaf-margin, which protect the sori as a false indusia; sporangia with a vertical annulus, developing in mixed sequence; spores tetrahedral.

KEY TO THE GENERA

1. Stipes castaneous, dark purple to black, polished
   2. Lower surface of frond without white waxy powder
      3. Frond monomorphic; pinnae crescent-shaped ..... **1. Adiantum**
      3. Frond dimorphic, deltoid in outline; pinnae subtriangular ..... **2. Cheilanthes**
   2. Lower surface of frond covered with white waxy powder
      4. Sori supercial, margin of leaflets not reflexed..... **3. Pityrogramma**
      4. Sori marginal, protected by reflexed margin of leaflets ..... **2. Cheilanthes**
1. Stipes stramineous to green; sori superficial, elongate midway between costa and margin of pinnae ..... **4. Taenitis**

1. ADIANTUM

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

Rhizome creeping to erect, scaly with small scales. Stipes not jointed to rachis. Fronds simple to pinnately decompound or pedate, usually with dimidiate or flabellate leaflets; soft to papyraceous, glabrous or hairy, rarely glaucous beneath; 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; spores tetrahedral.

Adiantum philippense L., Sp. Pl. 2: 1094. 1753; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 182. 1939; Holttum. Rev, Fl. Malaya 2: 598. f. 350. 1954; Tagawa & K.Iwats., Fl. Thailand 3(2): 211. 1985.— *Adiantum lunulatum* Burm. f., Fl. Ind.: 235. 1768. Fig. 5.47-5.48.

Rhizome short, suberect; scales linear, a little broader at base, entire, up to 1.5 mm long, bicoloured. **Stipes** bright castaneous to black, glabrous or sparsely scaly at basal portion, about 8.5 cm long; scales on stipes like those on rhizome except in being concolorous brown. **Fronds** linear-lanceolate to oblong, pinnate, 18.3 cm long, 4.1 cm wide, rachis glabrous occasionally prolonged, leafless on upper part, and

rooting at tip, an apical pinna like lateral ones; lateral pinnae large at base, slightly reduced in size upwards, distinctly stalked; stalks 3-5 mm long, with an angle of about 45^{o} to rachis; leaflets crescent-shaped, 1.5-2 by 0.7-1.3 cm, in the upper leaflets the lower two edges meeting at stalks to form cuneate base; thin, softly herbaceous, glabrous on both surfaces; veins a little raised, outer edge of leaflets subentire, crisped or lobed to about ¼ 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 3-7 mm long.

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 Kradueng); CENTRAL: Nakhon Nayok, Bangkok; SOUTH-EASTERN: Prachin Buri, Chon Buri (Si Racha), Chanthaburi (Khao Sabap); SOUTH-WESTERN: Kanchanaburi (Sai Yok, Wangka, Bangka, Bang Kasi, Thung Kang Yang Hills, Tha Po); PENINSULAR: Nakhon Si Thammarat (Thung Song).

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

Ecology.— Lithophyte on cliffs in tropical rain forest about 800-900 m alt.

Vernacular.— Kut hu khwak (กูดหูควาก), hua khwak (หัวขวาก), Ya khwak (หญ้าขวาก), Phak kachot nu (ผักกะฉอดหนู) (South-eastern); hang chingcha (หางชิงช้า) (Peninsular).

Specimens examined.— W. Khwaiphan 155, O. Vannasri 17, T. Boonkerd 442,1020 [BCU]; M. Tagawa & N. Fukuoka T 3958, E. Hennipman 3338 [BKF].

2. CHEILANTHES

Sw., Syn. Fil.: 5, 126. 1806; Tagawa & K.Iwats., Fl. Thailand 3(2): 200. 1985.

Rhizome short, suberect to ascending, scaly. Stipes without articulation; axes grooved on adaxial surface, grooves decurrent. Fronds pinnately divided; veins all

free. Sori at end of veinlets, in appearance often continuous along the margin of lobes, protected by reflexed margin of lobes.

KEY TO THE SPECIES

1. Fronds monomorphic; lower surface of lamina covered with waxy powder..... .....**1. C. pseudofarinosa**
1. Fronds dimorphic; lower surface of lamina not powdery ..... **2. C. tenuifolia**

1. Cheilanthes pseudofarinosa (Ching & S.K.Wu) K.Iwats.; Tagawa & K.Iwats., Fl. Thailand. 3(4): 618. 1989.— *Aleuritopteris pseudofarinosa* Ching & S.K.Wu, Acta Phytotax. Sin. 19: 72. 1981.— *Cheilanthes farinosa* (Forssk.) Kaulf. sensu Tagawa & K.Iwats., Fl. Thailand 3(2): 203. 1985, p.p. Fig. 5.49-5.50.

Rhizome short, scaly at apex; scales 6 cm long, 0.8 cm wide, linear-lanceolate, dark in the center and light brown at marginal portion. **Stipes** castaneous, about 5 cm, scaly at base. **Fronds** bipinnatifid, oblong subtriangular about 4-8 by 2.5-4 cm, round at apex, basiscopic side wider than acroscopic side, covered with white waxy powder on lower surface. **Indusia** broad, interrupted, fimbriate.

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

Distribution.— Nepal, India and China (S. of Yangtze River, type from Yunnan), and the Philippines.

Ecology.— Terrestrial or lithophyte on rocks in light shade in tropical rain forest 700-800 m alt.

Specimens examined.— W. Khwaiphan 114, 123, P. Ratchata 227, T. Boonkerd 1015, 1217 [BCU]; Piengpim Pissmai 4, J. F. Maxwell 94-4 [BKF].

2. Cheilanthes tenuifolia (Burm. f.) Sw., Syn. Fil.: 129, 332. 1806; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 173. 1939; Holttum. Rev. Fl. Malaya 2: 590. f. 347. 1954; Tagawa & K.Iwats., Fl. Thailand 3(2): 201. 1985; Fl. Thailand 3(4): 617. 1989.— *Trichomanes tenuifolium* Burm. f., Fl. Ind.: 237. 1768. Fig. 5.51-5.52.

Rhizome short, ascending, covered with scales; scales light brown, very narrow, entire, 3-4 mm long. **Stipes** castaneous, polished, slightly swollen and

sensely scaly at base, sparsely and minutely scaly upward 15-28 cm long, grooved on adaxial surface. **Fronds** dimorphic; sterile lamina smaller, with stipes 6-8 cm in length, deltoid. Fertile lamina tripinnate, or the larger quadripinnatifid, subdeltoid in outline, up to 10 by 6 cm; rachis and pinna-rachis scaly, grooved on upper surface; pinnae 7 or more pairs, basal ones the largest, subtriangular, acute at apex; middle pinnae oblong-subtriangular; larger pinnules pinnatisect with few pairs of lobes and a large terminal ones, terminal lobes of pinnules like terminal pinnae and pinnules, oblong, round at apex, 5 by 2 mm, entire; ultimate lobes round or oval, 4 mm long, up to 1.5 mm broad, papyraceous, green; veins all free, obscure. **Sporangia** confined to the end of veins but appearing continuous at margin of lobes, when young protected by reflexed margin of lobes, edges uneven, pellucid.

Thailand.— NORTHERN: Chiang Mai (Doi Chiang Dao, Doi Suthep, Mae Klang), Mae Hong Son (Mae Sariang, Doi Pha Dam), Lampang (Doi Phalat), Lamphun (Doi Khun Tan), Phrae (Mae Ban), Phitsanulok (Thung Salaeng Luang), Tak (Doi Musoe); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi (Khao Sabap), Trat (Ko Chang); PENINSULAR: Chumphon (Tha Ko), Surat Thani (Bang Bao, Ban Don), Songkla, Phangnga, Satun, Trang (Khao Chong), Yala (Bannang Sta).

Distribution.— Tropics of Asia and Oceania, from India and S. China through Malesia (type from India) to Polynesia, Australia and New Zealand.

Ecology.— Terrestrial in grassland about 700-800 m alt.

Specimens examined.— W. Khwaiphan 114, 123, P. Ratchata 227, T. Boonkerd 1015, 1217 [BCU]; M. Tagawa et al. 9234, K. Iwatsuki et al. T-10352 [BKF].

3. PITYROGRAMMA

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

Rhizome short, ascending, scaly ; scales narrow, aciculate, brown. Stipes dark, polished. Lamina pinnately compound, herbaceous to papyraceous, the lower surface usually covered with waxy powder; veins all free. Sori along veins, without indusia, with no paraphyses.

Pityrogramma calomelanos (L.) Link, Handb. Gew. 3: 20.1833; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 189. f. 22, 3-4. 1939; Holttum, Rev. Fl. Malaya 2: 593. f. 348. 1954; Tagawa & K.Iwats., Fl. Thailand 3(2) : 193. 1985.— *Acrostichum calomelanos* L., Sp. Pl.: 1072. 1753.— *Pellaea calomelanos* (L.) Link, Fil. Sp.: 61. 1841. Fig. 5.53-5.54.

Rhizome short, erect, bearing a tuft of fronds, covered with scales; scales bright brown, narrow, 3-4 mm long, thin, entire. **Stipes** up to 25 cm long, dark purple, polished, scaly on lower part, glabrous upwards. **Fronds** oblong, with acuminate apex, bipinnate-tripinnatifid, 17-24 by 6-10 cm; rachis grooved on upper surface; lateral pinnae gradually smaller upwards; lower ones stalked, linear-subtriangular, acuminate to long-tailed at apex, up to 5 by 1.3 cm; pinna-rachis slender, grooved; grooves decurrent to those on rachis; pinnules oblong to oblong-lanceolate, cuneate at base, acute to acuminate at apex, lobed or pinnatisect in larger ones, up to 1 cm long by 0.4 cm wide; lobes oblanceolate to spathulate, acute and dentate at apical portion, herbaceous, light green, glabrous but coated with white waxy powder; vein free, pinnate in larger ones, to several times forked. **Sporangia** placed along veins throughout thelower surface, without any protection.

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

Distribution.— Pantropics (type from America); this may have been spread to the palaeotropics by man.

Ecology.— Terrestrial or lithophyte on open mountain slopes in tropical rain forest and hill evergreen forest about 700-1,100 m alt.

Vernacular.— Foen ngoen (เฟินเงิน).

Uses. — Often cultivated as an ornamental.

Specimens examined.— W. Khwaiphan 034, 128, O. Vannasri 9, T. Boonkerd 1024, 1214 [BCU]; T. Shimizu et al 26836, M. Tagawa, K. Iwatsuki & N. Fukuoka T 5291 [BKF].

4. TAENITIS

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

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

Taenitis blechnoides (Willd.) Sw., Syn. Fil.: 24, 220. 1806; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 134. f. 16, 3-4. 1939; Holttum, Rev. Fl. Malaya 2: 586. f. 346. 1954; Blumea 16: 89. f. 1. 1968; Seidenf., Nat. Hist. Bull. Siam Soc. 19: 87. 1958; Tagawa & K.Iwats., Fl. Thailand 3(2): 193. 1985.— *Pteris blechnoides* Willd., Phytogr.: 13. t. 9. f. 3. 1794. Fig. 5.55.

Rhizome creeping, up to 5 mm in diameter, covered with bristles in apical portion; bristles dark brown to nearly black, shining, stiff, up to 5 mm long. **Stipes** stramineous to green upwards, castaneous in lower part, glabrous in larger plants up to 75 cm long. **Fronds** simply pinnate, or simple one, up to 35 by 26 cm; grooves of rachis decurrent to that on costae; lateral pinnae 4-5 pairs, alternate at apex, very narrowly cuneate at base, stalked, entire or slightly undulate at margin, up to 22 by 2.3 cm in fertile pinnae; sterile pinnae broader, up to 4 cm broad; costa distinctly raised on lower surface, sunken on upper surface; veins copiously reticulate without included veinlets; texture thickly papyraceous to chartaceous, glabrous. **Sori** midway between costa and the margin of pinna, rarely interrupted, 1 mm in breadth.

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

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

Ecology.— Terrestrial by stream in hill evergreen forest about 1,000-1,200 m alt.

Specimens examined.— W. Khwaiphan 087, T. Boonkerd 594, 716, 1329 [BCU]; E. Hennipman 3713, K. Larsen et al. 30729 [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. Fronds uniform or subdimorphic, 1-3 pinnate or variously divided, not articulate to rhizome; veins free or anastomosing without included free veinlets. Sori round or oblong, borne on distal ends or on the apical parts of veins or forming continuous 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; sporangia developing in mixed sequence with vertical annululi.

PTERIS

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

Rhizome usually short, erect or creeping, scaly; scales usually small, concolorous or bicolored with pale ferrugineous edges. Stipes, rachis and costae distinctly grooved on upper surface, the edges distinct, usually spinose on costae, the grooves decurrent into those in the next order. Fronds in most cases bipinnatisect in opposite pairs, or in some cases simple, pinnate, tripartite, each basal pinna or branch terminal lobes like the lateral ones or longer; veins pinnate in plane, in some species with costal and costular areoles, the others free except for the soral commissure, basal branches sometimes arising directly from costae. Sori continuous along margin of ultimate segments, indusiate; indusia formed by reflexed margin of lobes or pinnae, usually transparent, glabrous.

KEY TO THE SPECIES

1. Pinnae all simple, entire or at most serrate at apical margin, basal pinnae not branched ..... **4. P. vittata**
1. Pinnae deeply lobed, or each of the lowest pinnae with one or a few branches near base
   2. Veins free except those united apically by soral commissure
      3. Veins more or less distinct, short lines between veins lacking; pinnae usually more than 3 pairs ..... **1. P. aspericaulis**
      3. Veins indistinct, with numerous short superficial lines between them; lateral pinnae 1-3 pairs..... **3. P. grevilleana**
   2. Veins anastomosing to form regular costal areoles..... **2. P. biaurita**

1. Pteris aspericaulis Wall. ex J.Agardh, Rec. Pterid.: 22. 1839; Tagawa & K.Iwats., Fl. Thailand 3(2): 253. 1985.— *Pteris quadriaurita* Retz. var. *aspericaulis* (Wall. ex J.Agardh) Bedd., Handb.: 111. 1883. Fig. 5.56.

Rhizome short, erect or ascending, densely scaly at apex; scales brown, up to 7 by 0.5 mm, with pale ferrugineous edges. **Stipes** castaneous to deep purplish, puberulous and minutely warty upwards, about 45 cm long. **Fronds** oblong-subdeltoid, deeply bipinnatisect, about 30-38 by 25-28 cm; lateral pinnae 6-7 pairs, sessile or very shortly stalked, ascending or subpatent, nearly straight or slight falcate, in lower ones sometimes deflexed, linear-lanceolate, caudately acuminate at apex, up to 13 by 3.5 cm, basal ones usually the largest, each bearing ones, up to 17 by 4.5 cm; pinnules oblong, oblique, moderately acute at apex, dilated towards base, continuous with neighboring ones by very narrow wings of costae; the spines on costae at base of costule prominent, usually more than 1 mm, papyraceous or firmer; veins forked, all free, visible on both surfaces. **Sori** continuous along margin of segments, usually from base upwards; indusia thin but firm, brown.

Thailand.— NORTHERN: Chaing Mai (Doi Chiang Dao, Doi Inthanon).

Distribution.— N. India (type), Upper Myanmar and Yunnan.

Ecology.— Terrestrial by stream in tropical rain foreat about 700-800 m alt.

Specimens examined.— W. Khwaiphan 101, P. Ratchata 262, 278 [BCU]; G. Murata et al. 51604, M. Tagawa et al. T-2875 [BKF].

2. Pteris biaurita L., Sp. Pl.: 1076. 1753; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 159. 1939; Holttum, Rev. Fl. Malaya 2: 407. f. 237. 1954; Tagawa & K.Iwats., Fl. Thailand 3(2): 237. 1985.— *Campteria biaurita* (L.) Hook., Gen. Fil.: t. 65 A. 1841.— *Pteris quadriaurita* Retz. var. *grevilleana* Christ, Bot. Tidsskr. 24: 106. 1901, p.p. excl. type.— *Pteris repandula* Link, Fil. Sp.: 56. 1841. Fig. 5.57.

Rhizome short, erect, bearing fronds in a tuft, densely scaly at apex; scales up to 4 by 0.6 mm, nearly black margin by pale ferrugineous edges with toothed margin. **Stipes** up to 90 cm long, dark brown and scaly at apex deeply bipinnatifid, up to 75 cm long in length, 50 cm wide. **Fronds** deeply bipinnatifid, up to 40 cm lond, 35 cm wide, pinnate opposite or nearly so, up to 14 pairs, straight, ascending, linear-lanceolate, broadly cuneate at base, gradually narrowing towards acuminate apex, up to 28 by 4 cm, deeply lobed to 5/6 way towards costa, basal pinnae bearing a long basiscopic pinnule just like lateral ones; ultimate segments oblong, falcate, rounded or moderately acute at apex, with rounded sinus, up to 5 mm broad, firm, green, glabrous; basal veinlets uniting with those of opposite groups forming arches close to costa, bearing a few branches on posterior side, the other veinlets forked, all free. **Sori** marginal, usually continuous along segments except at bottom of sinus and at apex; indusia thin, pale.

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

Distribution.— Pantropic (type from tropical America).

Ecology.— Terrestrail in light shade in tropical rain forest about 700-800 m alt.

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

Specimens examined.— W. Khwaiphan 175, O. Vannasri 8, T. Boonkerd 714, 592, 641 [BCU]; G. Murata et al 16714, E. Hennipman 3033 [BKF].

3. Pteris grevilleana Wall. ex J.Agardh, Rec. Pterid: 23. 1839; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 153. 1939; Holttum, Rev. Fl. Malaya 2: 402. f. 235. 1954; Tagawa & K.Iwats., Fl. Thailand 3(2): 247. 1985.— *Pteris ensiformis* Burm.f. var. *grevilleana* (Wall. ex J.Agardh) Bedd., Handb.: 108. 1883. Fig. 5.58.

Rhizome short, erect, scaly at apex; scales small, up to 2 by 1.5 mm, dark brown, entire. **Fronds** dimorphic. **Sterile fronds:** stipes shining, deep purple to pale castaneous, glabrescent upwards, 17-20 cm long, narrowly winged in upper portion; lamina ovate in outline, up to 11 by 9 cm, each consisting in a terminal pinna and one or rarely two pairs of lateral pinnae each bearing a large basiscopic pinnule almost as big as the pinna, thus seemingly pentaphyllous, terminal pinna deeply lobed to ¾ way towards midribs, acute at apex, cuneate and decurrent at base continuing to wings of stipes, up to 10 by 3 cm, lateral pinnae narrower, up to 8.5 by 2.5 cm, rounded to cuneate, the basiscopic projections up to 5 cm 1.8 cm; pinnules or ultimate lobes oblong, rounded at apex, serrate at margin, up to 1.2 cm wide, softly papyraceous, deep green; veins forked, hardly visible. **Fertlie fronds:** stipes 35-50 cm long; lamina like sterile one or with an additional lateral pair of pinnae smaller in size than the lowest one, larger, up to 17 by 12 cm. **Sori** continuous along margin of lobes except at apex and sinus; indusia pale brown, thin.

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

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

Ecology.— Terrestrial on humus-rich floor by stream in tropical rain forest about 700-800 m alt.

Vernacular.— Ya rang kai (หญ้ารังไก่) (Peninsular).

Specimens examined.— W. Khwaiphan 122 [BCU]; E. Hennipman 3979, G. Murata et al. 49542 [BKF].

4. Pteris vittata L., Sp. Pl.: 1074. 1753; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 143. 1939; Holttum, Rev. Fl. Malaya 2: 396. f. 230. 1954; Tagawa & K.Iwats., Fl. Thailand 3(2): 247. 1985.— *Pteris longifolia* auct. non Retz. Bedd., Handb.: 106. f. 55. 1883. Fig. 5.59.

Rhizome short, ascending, bearing a tuft of fronds, scaly; scales light brown, narrow, up to 9 mm long. **Stipes** up to 17 cm long, densely scaly on lower part, stramineous. **Fronds** 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 13 cm by 5-7 mm, sessile and cordate at base, caudately long-acuminate at apex, serrate at non-soriferous margin: terminal pinnae usually much longer, up to 18 cm or more long, about 5 mm broad; rachis grooved on upper surface, minutely scaly; veins forked free except when connected by soral commissure. **Sori** marginal, continuous along margin of pinnae; indusia thin, pale.

Thailand.— NORTHERN: 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.— Terrestrial in open places in tropical rain forest about 700-900 m alt.

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

Specimens examined.— W. Khwaiphan 195, T. Boonkerd 594, 716, 1329 [BCU]; David J. Middlton et al. 2089, 2141 [BKF].

VITTARIACEAE

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

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

KEY TO THE GENERA

1. Fronds obovate to oblong-lanceolate; costae absent; sori usually in more than two row……...**1. Antrophyum**
1. Fronds linear; costae distinct or hardly visible; sori in a single row at each side ....**2. Vittaria**

1. ANTROPHYUM

Kaulf., Enum.: 197. 1824; Tagawa & K.Iwats., Fl. Thailand 3(2): 221. 1985.

Rhizome short-creeping, densely covered with clathrate scales. Fronds obovate to oblong-lanceolate, rarely forked at apex; costa wanting or rarely partial; veins forming large elongate areoles without included free veinlets. Sori elongate along veins.

Antrophyum callifolium Blume, En. Pl. Jav.: 111. 1828; Fl. Jav. Fil.: 83. t. 35. 1829; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 204. 1939; Holttum, Rev. Fl. Malaya 2: 605. f. 356. f. 90. 1954; Tagawa & K.Iwats., Fl. Thailand 3(2): 221. 1985.— *Antrophyum reticulatum* auct. non (G.Forst.) Kaulf.: Bedd., Handb.: 401. f. 235. 1883.— *Antrophyum semicostatum* auct. non Blume: Bonap., Not. Pterid. 14: 63. 1923.— *Antrophyum* sp. Holttum, Dansk Bot. Ark. 20: 34. 1961. Fig. 5.60.

Rhizome short-creeping, bearing a few to several fronds in tuft, scaly; scales narrowly subtriangular, gradually narrowing from base towards long-tailed apex, up to 6 by 0.5 mm., dark brown to blackish, sharply toothed at margin. **Stipes** short, indistinctly merging with the basal portion of fronds, scaly. **Fronds** usually oblong-lanceolate to broadly oblanceolate, gradually narrowing towards acuminate apex, gradually narrowing downwards, up to 25 by 3 cm, but soriferous even when less than 5 cm, leathery; costa distinct only in the lowest portion of fronds; veins more or less distinct, anastomosing without included free veinlets. **Sori** linear, anastomosing along veins, usually on the whole undersurface except for the lowest middle portion; paraphyses filamentous, numerous.

Thailand.— NORTHERN: Chiang Mai (Doi Suthep, Chiang Mai, Mae Taeng, Lamoo), Tak (Huai Krasa); NORTH-EASTERN: Nong Khai, Loei (Phu Luang, Phu Kradueng, Khao Huai Khae); CENTRAL: Nakhon Nayok (Khao Yai, Nang Rong Falls); SOUTH-EASTERN: 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 (Su-ngai Padi), Phangnga (Thap Put), Phuket, Trang (Khao Chong), Satun, Yala (Bannang Sta).

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

Ecology.— Epiphyte on mossy tree-trunks usually in tropical rain forest about 700-800 m alt.

Specimens examined.— W. Khwaiphan 124, T. Boonkerd 709, 1398, 1532 [BCU]; David J. Middleton et al. 1419, T. Smitinand 3200 [BKF].

2. VITTARIA

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

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

KEY TO THE SPECIES

1. Costae more or less distinct on lower surface
   2. Fronds 17-37 cm long, 4-6 mm broad; sori marginal grooves....**1. V. angustifolia**
   2. Fronds up to 70 cm long, 1-1.5 cm broad; sori submarginal grooves ....**3. V. flexuosa**
1. Costae flat or hardly visible on lower surface; frond up to 90 long, 0.7-1.2 cm broad.....**2. V. elongata**

1. Vittaria angustifolia Blume, En. Pl. Jav.: 199. 1828; Holttum, Rev. Fl. Malaya 2: 610. 1954; Tagawa & K.Iwats., Fl. Thailand 3(2): 225. 1985.— *Vittaria ensiformis* auct. non Sw.: Tagawa & K.Iwats., Southeast As. St. 5: 111. 1967.— *Haplopteris angustifolia* (Blume) E.H.Crane, Syst. Bot. 22 (3) : 514. 1998. Fig. 5.61.

Rhizome creeping , usually about 3 mm in diameter, bearing fronds rather sparsely, densely scaly throughout; scales narrow, gradually narrowing from base towards hair-pointed apex, up to 4 by 0.2 mm, fuscous, clathrate, minutely toothed at margin. **Stipes** short, green or dark at the very base. **Fronds** linear, 20-37 cm long, to 4-5 mm or more broad, usually curved and pendulous, acute at apex, gradually narrowing downwards and merging into very narrow wings of stipes, leathery; costae visible on upper and lower surfaces, the margin flat or inrolled. **Sori** immersed in deep groove almost at margin of fronds, usually limited to the upper half.

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

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

Ecology.— Epiphyte on tree-trunks in tropical rain forest and hill evergreen forest about 700-1,300 m alt.

Specimens examined.— W. Khwaiphan 007, 014, 018; P. Ratchata 183, 315; T. Boonkerd 1091 [BCU]; K. Larsen et al. 62; C. Niyomdham et al. 5973 [BKF].

2. Vittaria elongata Sw., Syn. Fil: 109, 302. 1806; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 197. 1939; Holttum, Rev. Fl. Malaya 2: 614. f. 360. 1954; Seidenf., Nat. Hist. Bull. Siam Soc. 19: 87. 1958; Tagawa & K.Iwats., Fl. Thailand 3(2): 223. 1985.— *Haplopteris elongata* (Sw.) E.H.Crane, Syst. Bot. 22 (3) : 514. 1998. Fig. 5.62-5.63.

Rhizome short-creeping, bearing fronds closely or up to 1 cm apart, 3-4 in diameter, very densely scaly throughtout; scales linear, gradually narrowing from cordate base towards long-tailed apex, up to 4 mm or more long, 0.5 mm broad, greyish-brown to dark, distinctly clathrate, minutely toothed at margin. **Stipes** usually short, indistinct from the lower portion of fronds, green to darker. **Fronds** linear, up to 90 cm or more long, 0.7-1.2 cm broad, gradually narrowing towards both ends, coriaceous to leathery; costae usually distinct above on the lower portion; veins more or less visible, anastomosing to form a row of elongate oblique areoles at each side of midribs. **Sori** immersed in marginal two-lipped groove, usually along the whole margin of fronds.

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

Distribution.— Tropics of the old world generally (type from 'India orientalis'), north to Sikkim, Hainan and south of Japan.

Ecology.— Epiphyte on tree-trunks in tropical rain forest and hill evergreen forest about 700-1,300 m alt.

Specimens examined.— W. Khwaiphan 125, T. Boonkerd 706, 707, 708 [BCU]; E. Hennipman 3584, B. Hansen &T. Smitinand 12470 [BKF].

3. Vittaria flexuosa Fée, 3^{me} Mém.: 16. 1852; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 199. 1939; Holttum, Rev. Fl. Malaya 2: 611. 1954; Tagawa & K.Iwats., Fl. Thailand 3(2): 225. 1985.— *Vittaria lineata* auct. non Sw.: Bedd., Handb.: 407. 1883. — *Haplopteris flexuosa* (Fée) E.H.Crane, Syst. Bot. 22 (3): 514. 1998. Fig. 5.64.

Rhizome short, up to 4 mm in diameter, bearing close fronds, densely scaly; scales linear, gradually narrowing towards hair-pointed apex, up to 4 by 0.7 mm, brown, clathrate, minutely toothed at margin. **Stipes** narrowly winged throughout, dark at the very base. **Fronds** linear, usually inrolled at the margin in dried condition, 27-70 by up to 1 cm, gradually narrowing towards long-tailed apex, gradually narrowing downwards into the narrow wings of stipes; costa strongly raised to the apex on lower surface, indistinct on upper surface, pale. **Sori** in submarginal grooves usually at 1/5-1/4 way from margin to midrib, sometimes not wholly immersed, usually on upper half of fronds except the very apex.

Thailand.— NORTHERN: Chiang Rai (Doi Chang), Chiang Mai (Doi Phahom Pok, Doi Suthep, Doi Inthanon), Lampang (Doi Luang), Tak (Ban Musoe), Phetchabun (Phu Miang); NORTH-EASTERN: 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.— Epiphyte on tree-trunks in tropical rain forest and hill evergreen forest about 700-1,300 m alt.

Specimens examined.— W. Khwaiphan 043, T. Boonkerd & R. Pollawatn 57; T. Boonkerd 1408 [BCU]; E. Hennipman 3584A, M. Iwatsuki & N. Fukuoka 3190 [BKF].

ORDER BLECHNALES

ASPLENIACEAE

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

Terrestrial or epiphytic ferns of a wide variety of forms; rhizomes dictyostelic, creeping or erect; scales usually clathrate, narrowly lanceolate, dark brown to black. Fronds simple, pinnate to decompound; stipes not articulate to rhizome, with two vascular strands at base of stipes, uniting to form an X-shaped strand in upper part of stipes; venation usually free and forking. Sori linear, borne on side of a veinlets; indusia linear, narrow.

ASPLENIUM

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

Rhozome short, erect or long-creeping; scales clathrate, glabrous. Fronds simple to pinnately compound; veins free, uniting at apex to form submarginal veins. Sori elongate along veins, superficial, with indusia of the same shape.

KEY TO THE SPECIES

1. Fronds simple, entire-undulate, up to 1.3 m long, 15 cm wide, midrib strongly raised on upper surface……..……**3. A. nidus**
1. Fronds pinnate
   2. Scales gradually narrowing from base towards hair-pointed apex
      3. Rhizome long creeping; basal pinnae shortly stalked..... **1. A. apogamous**
      3. Rhizome short, erect or ascending
         4. Pinnae sessile
            5. Pinnae narrowly elliptic, falcate, lobed few toothed.....**2. A. crinicaule**
            5. Pinnae oblong, lobed round..... **4. A. normale**
         4. Pinnae stalked, oblong to narrowly oblong-subdeltoid.....**6. A. sp.**
   2. Scales narrow, subulate; pinnae rhomboid, stalked.....**5. A. yoshinagae**

1. Asplenium apogamous N.Murak. & Hatan., J. Fac. Sci. U. Tokyo III. 14 : 193. f. 6. 1988; Tagawa & K.Iwats., Fl. Thailand 3(4): 620. 1989.— *Asplenium unilaterale* auct. non. Lam.: Tagawa & K.Iwats., Fl. Thailand 3(2): 277. 1985. Fig. 5.65.

Rhizome long-creeping, 4-5 mm in diameter, bearing many roots on ventral and two rows of fronds on dorsal surfaces, scaly; scales gradually narrowing from base towards hair-pointed apex, up to 3 by 0.3 mm, dark brown to nigrescent, clathrate. **Stipes** close or up to 0.5 mm apart, castaneous to purplish, polished, scaly near the base, 23-28 cm long. **Fronds** 1-pinnate, lanceolate, broadest at basal 1/5-1/8 portion, almost parallel or slightly narrowing upwards and then rather suddenly narrowing to caudate apex, 25-35 cm long, about 7 cm wide; rachis terete throughout; pinnae usually 25-30 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 round at apex, up to 4 by 1 cm, a few lowest pairs shortly stalked, slightly smaller, more or less reflexed thin, herbaceous, light green; veins visible. **Sori** 4-7 mm long; indusia herbaceous, pale, opening towards anterior side.

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

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

Ecology.— Terrestrial on wet sandy slopes or on moist muddy rocks by stream in tropical rain forest at 700-800 m alt.

Specimens examined.— W. Khwaiphan 039, 154, 187, T. Boonkerd 507, 556 [BCU]; C. Phengklai 571, K. Iwatsuki & N. Fukuoka 7430 [BKF].

2. Asplenium crinicaule Hance, Ann. Sci. Nat. V. 5: 254. 1866; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 227. 1939; Tagawa & K.Iwats., Fl. Thailand 3(2): 284. 1985.— *Asplenium pellucidum* auct. non Lam.: Christ, Bot. Tidsskr. 24: 108. 1901. Fig. 5.66-5.67.

Rhizome short, erect, densely scaly; scales gradually narrowing from base towards hairy pointed apex, up to 10 by 0.7 mm, the margin bearing irregular and sparse projections, brown to black. **Stipes** usually up to 11 cm or more long, dark brownish-purple to nearly black, bearing narrow scales throughout. **Fronds** narrowly lanceolate, gradually narrowing towards both ends, acuminate at apex, usually about 30 by 7 cm; rachis with very narrow hair-like scales; lateral pinnae about 35 pairs, sessile, narrowly elliptic, falcate or nearly patent, acute at apex, auricled at acroscopic base, narrowly cuneate at basiscopic base, the middle pinnae the largest ones 2.5-4 by 0.5-1 cm, indistinctly lobed; lobes with a few tooth, each containing a single veinlet, softly chartaceous, deep green in living condition and getting brown when dried. **Sori** long, crescent-shaped along the posterior veinlets, opening towards posterior.

Thailand.— NORTHERN: Chiang Rai (Doi Phacho), Chiang Mai (Doi Chiang Dao, Doi Suthep), Lampang (Mae Tai), Lamphun (Doi Khun Tan); NORTH-EASTERN: Loei (Phu Luang, Phu Kradung); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi (Khao Sabap), Trat (Ko Chang); SOUTH-WESTERN: Kanchanaburi (Sai Yok), Prachuap Khiri Khan (Huai Yang).

Distribution.— India, S. China (type) and Indochina.

Ecology.— Terrestrial or epiphyte on mossy tree-trunks in hill evergreen about 1,200-1,300 m alt.

Specimens examined.— W. Khwaiphan 064, 145 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T-944, G. Murata et al. 49613 [BKF].

3. Asplenium nidus L. var. nidus, Sp. Pl.: 1079. 1753 ; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 219. 1939; Holttum. Rev. Fl. Malaya 2: 419. 1954. Tagawa & K.Iwats., Fl. Thailand 3(2): 266. 1985.— *Thamnopteris nidus* (L.) C.Presl, Epim.: 68. 1849. Fig. 5.68.

Rhizome short, erect or ascending, stout, bearing a rosette of fronds, usually with a mass of roots, scaly; scales brown to darker, membranous, up to 1.5 cm long, 3 mm broad, clathrate. **Stipes** stramineous to darker, 3-5 cm long, scaly at base. **Fronds** simple, up to 1.3 m or more long, up to 15 cm wide; broadest at middle, apex gradually attenuate; coriaceous, light green when living, paler below; midrib raised on upper surface, flat below, veins once or rarely twice forked, the first forking near midrib and then running parallel, uniting at apex to form submarginal veins about 1 mm inside leaf margin. **Sori** elongate along veins extending from near midrib half-way to the margin, usually on every veins; indusia about 0.5 mm broad.

Thailand.— NORTHERN: Chiang Rai (Doi Pacho), Chiang Mai (Doi Chiang Dao, Ban Du, Doi Suthep), Lampang; NORTH-EASTERN: Loei (Phu Luang, Phu Kradung), Nong Khai (Nong Khai 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 Java).

Ecology.— Epiphyte on tree-trunks in light shade in tropical rain forest about 700-900 m alt.

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

Specimens examined.— W. Khwaiphan 107, Y. Yuyen 122, K. Lukchant 5; T. Boonkerd 1, 168, 346 [BCU]; M. Tagawa, K. Iwatsuki and N. Fukuoka 4511, K. Iwatsuki and N. Fukuoka T-3687 [BKF];

4. Asplenium normale D.Don, Prod. Fl. Nepal.: 7. 1825; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 225. 1939; Holttum, Rev. Fl. Malaya 2: 436. f. 254. 1954; Tagawa & K.Iwats., Fl. Thailand 3(2): 280. 1985. Fig. 5.69.

Rhizome short, erect, scaly; scales gradually narrowing from base towards hair-pointed apex, up to 4 by 0.8 mm, bicoloured, the central portion black, with longitudinal cells, the edges brown to dark brown. **Stipes** very deep castaneous to nearly black, more or less polished, up to 13 cm long, usually about 10 cm long,

grooved with two low but distinct ridges on adaxial surface. **Fronds** lanceolate to narrower, pinnate, slightly narrowing at base, gradually narrowing upwards caudately acuminate at apex, up to 30 by 4 cm; rachis wingless throughout, viviparous; lateral pinnae up to 50 pairs, sessile, patent or slightly reflexed, oblong, rounded at apex, lobed to 1/5 way on both margins, narrowly cuneate at basiscopic base, auricle and truncate at acroscopic base, about 20 by 7 mm; midribs rarely viviparous; veinlets simple or forked, not running to the very top of lobes. **Sori** up to 4 mm long; indusia thin.

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

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

Ecology.— Terrestrial on mountain slopes, humus-rich slopes or epiphyte on mossy basal tree-trunks in hill evergreen forests usually about 1,000-1,300 m alt.

Specimens examined.— W. Khwaiphan 005, 017, 049, 052, T. Boonkerd 578, 1258, 1404 [BCU]; E. Hennipman 3862, R. Shimizu et al. 18041 [BKF].

5. Asplenium yoshinagae Makino, Phan. Pterid. Jap. Ic. Ill. 1: pl. 64. 1900; Tagawa & K.Iwats., Fl. Thailand 3(2): 285. f. 23, 1. 1985.— *Asplenium planicaule* Wall. ex Mett., Abhandl. Senckenb. Naturf. Ges. 3: 201. 1859; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 231. 1939.— *Asplenium indicum* Sledge, Bul. Brit. Mus. (Nat. Hist.) Bot. 3: 264. 1965. Fig. 5.70.

Rhizome short, erect, scaly; scales dark brown to nearly black, narrow, subulate, entire, up to 0.5 by 0.7 mm. **Stipes** usually up to 0.3 cm long, dark green to brownish, not polished, sparsely scaly. **Fronds** narrowly lanceolate, commonly about 25 by 15 cm, acute to acuminate at apex, pinnate; rachis like the upper part of stipes, pinnae 10-15 pairs, stalked, dimidiate, rhomboid, acute at apex, broadly cuneate and auricled at acroscopic base, narrowly cuneate and entire at basiscopic base, margin

irregularly lobed, 6.2 cm long, 2.3 cm wide, chartaceous, deep green. **Sori** elongate, near the costae.

Thailand.— NORTHERN: Chiang Rai (Doi Phacho), 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 to Japan (type).

Ecology.— Lithophyte or epiphyte on mossy tree-trunks in hill evergreen forests about 1,000-1,200 m alt.

Specimens examined.— W. Khwaiphan 088, 134, O. Vannasri 41, P. Ratchata 306, 103 [BCU]; G. Murata et al 51077, Smitinand & Anderson 7285 [BKF].

6. Asplenium sp. Fig. 5.71-5.72.

Rhizome short, ascending, up to 0.5 cm in diameter, densely scaly; scales gradually narrowing towards hair-pointed apex, about 5 by 1 mm, brown. **Stipes** up to 12 cm long, stramineous, glabresent. **Fronds** oblong, up to 25 by 9 cm, imparipinnate; lateral pinnae 6-8 pairs, oblong to narrowly oblong-subdeltoid, cuneate at bases, gradually narrowing towards caudately acuminate apex, up to 7 by 2 cm, with stalks less than 5 mm long, distinctly toothed at margin, chartaceous; veins more visible on lower surface. **Sori** elongate along acroscopic branches of veins, indusia thin.

Thailand.— CENTRAL: Prachin Buri (Khao Yai).

Distribution.—

Ecology.— By stream in tropical rain forest at about 700-800 m alt.

Specimens examined.— W. Khwaiphan 109 [BCU].

Note.— *Asplenium* sp. is a terrestrial plant and found by stream in tropical rain forest. It has an affinity with *Asplenium macrophyllum*, but differs by the scales of rhizome and the shape of pinnae.

BLECHNACEAE

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

Rhizome erect, sometimes having small tree-like trunks, or rhizome creeping 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 costal row of areole. Sori costal, discrete or in a coenosori; 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; scales narrow, entire, margin usually with pale cartilaginous edges. Fronds 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 forked. 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; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 207. f.. 26, 1-2. 1939; Holttum, Rev. Fl. Malaya 2: 446. f. 262. 1954; Seidenf., Nat. Hist. Bull. Siam Soc. 19: 87. 1958; Tagawa & K.Iwats., Fl. Thailand 3(3): 298. 1988. Fig. 5.73-5.74.

Rhizome thick, ascending or suberect, densely covered with scales; scales linear, gradually narrowing towards apex, 1 cm or more long, up to 1 mm broad, tailed at apex, dark brown with pale cartilaginous edges which sometimes becoming uneven. **Stipes** stout, stramineous, or sometimes purplish when youn, up to 50 cm long, densely scaly at base, bearing small auricles throughout. **Lateral pinnae** many in number, close, 2-3 cm apart from each other, ascending, linear, gradually narrowing towards long-tailed apex, round or subtruncate at sessile base, or decurrent at posterior base and adnate in the upper ones, entire, 20 by 1.2 cm; veins simple or

forked usually near costa, distinct on both surfaces, very close, up to 0.5 mm apart; coriaceous, green, glabrous throughout. **Sori** narrow, long-continuous along costa; indusia narrow, usually broken before maturity.

Thailand.— NORTHERN: Chaing Rai (Doi Tung), Chiang Mai (Kong Kat, Doi Suthep, Mae Rim), Tak (Ban Musoe, Rahaeng); 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 (Ko 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 Sta).

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

Ecology.— Terrestrial on rather dry open slopes or in light shade in tropical rain forest about 800-900 m alt.

Vernacular.— Kut khang fan (กูดข้างฝ่าน) (Northern); kut doi (กูดดอย) (Central); mahasadam (มหาสะดำ) (South-eastern).

Specimens examined.— W. Khwaiphan 084, T. Boonkerd 331, 572, 1114 [BCU]; M. Tagawa, K. Iwatsuki and N. Fukuoka T 600,T 1253 [BKF].

LOMARIOPSIDACEAE

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

Rhizome creeping, or scandent, dorsiventral, bearing roots on ventral side and two or more rows of fronds from upper side, stipes distant or tufted; scales brown, ovate or lanceolate, peltately attached near base; stipes with one or two grooves on upper side, rounded on underside. Fronds dimorphic, simple or pinnate, the basiscopic edge of each pinna decurrent and continuous with ridge of rachis; veins free, simple or once forked, or anastomosing and forming areoles without included veinlets, or with free excurrent veinlets. Fertile fronds usually with longer stipes and narrower lamina; sporangia acrostichoid.

KEY TO THE GENERA

1. Fronds simple; stipes usually jointed to rhizome..... **2. Elaphoglossum**
1. Fronds pinnate to decompound; stipes usually not jointed to rhizome..... **1. Bolbitis**

1. BOLBITIS

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

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

KEY TO THE SPECIES

1. Vein all free
   2. Base of lateral pinnae unequal, with auricles at acroscopic base; scale linear..... .....**1. B. appendiculata**
   2. Base of lateral pinnae nearly equal; scales narrowly subtriangular with long-acuminate apex.....**3. B. sinensis var. sinensis**
1. Veins anastomosing
   3. Areoles not included free veinlets; scales linear .....**2. B. heteroclita**
   3. Areoles included free veinlets ..... **4. B. virens**
      4. Pinnae of fertile fronds more than 15 times as long as wide.... **4.1 var. virens**
      4. Pinnae of fertile fronds 3-5 time as long as wide ..... **4.2 var. compacta**

1. Bolbitis appendiculata (Willd.) K.Iwats., Acta Phytotax. Geobot. 18: 48 1959; Hennipman, in Fl. Males., Ser. II. 1: 322. f. 26b, 27 d-f. 1978; Tagawa & K.Iwats., Fl. Thailand 3(3): 316. 1988.— *Acrostichum appendiculatum* Willd., Sp. Pl. 5: 114. 1810.— *Polybotrya appendiculata* (Willd.) J. Sm., J. Bot. 4: 150. 1841.— *Egenolfia appendiculata* (Willd.) J. Sm., Ferns Br. For.: 111. 1866; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 426. 1939; Holttum, Rev. Fl. Malaya 2 : 459. f. 270. 1954; Seidenf., Nat. Hist. Bull. Siam Soc. 19: 87. 1958.— *Polybotrya helferiana* Kunze, Farnkr. 2:

35. 1849.— *Polybotrya appendiculata* var. *helferiana* (Kunze) H.Christ, Bot. Tidsskr. 24: 109. 1901.— *Egenolfia helferiana* (Kunze) C.Chr., Contr. U.S. Nat. Herb. 26: 292. 1931.— *Polybotrya appendiculata* var. *marginata* (Blume) C.Chr., Bot. Tidsskr. 32: 343. 1916.— *Polybotrya marginata* Blume, En. Pl. Jav.: 100. 1828, nom superf. — *Egenolfia appendiculata* (Willd.) J.Sm.var. *moniliformis* Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 427. 1939.— *Acrostichum* sp. Hosseus, Beih. Bot. Centr. 28(2): 363. 1911. Fig. 5.75-5.76.

Rhizome creeping; scales light brown, linear, up to 4 by 0.3 mm. **Sterile fronds**: stipes stramineous, sparsely scaly, about 16 cm long; lamina lanceolate, acuminate at apex, 16-31 by 3.5-10 cm; rachis scaly beneath, winged at least on upper part, sometimes viviparous near apex; pinnae 15-19 pairs, basal ones slightly shorter than the next above, middle ones the largest, patent or ascending, stalked, oblong to longer or gradually narrowing from base to apex, rounded to acute at apex, more or less auricled at acroscopic and dimidiate at basiscopic bases, margin shallow lobed, 3.3-5 by 0.6-1 cm, the apical pinna variable in shape and size, usually narrowly subtriangular; vein pinnate, all free; lobes shallow, round, with a distinct tooth at each sinus; papyraceous, deep green. **Fertile fronds** taller: stipes up to 22 cm long; lamina linear-lanceolate, about 19 by 1.5 cm; rachis wingless, seldom viviparous; pinnae very shortly stalked or subsessile, linear or narrowly oblong, often moniliform, partent, straight or a little falcate, 6 by 2 mm; veins simple, forked or pinnate; sporangia dispersed on the lower surface of pinnae or lobes.

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

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

Ecology.— Lithophyte on muddy rocks near streams in tropical rain forest about 700-900 m alt.

Specimens examined.— W. Khwaiphan 176, T. Boonkerd 28, 52, 1273 [BCU]; E. Hennipman 3835, K. Iwatsuki & N. Fukuoka 5486 [BKF].

2. Bolbitis heteroclita (C.Presl) Ching ex C.Chr., Ind. Fil. Suppl. III.: 48. 1934. Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 411. f. 35, 1-2. 1939; Holttum, Rev. Fl. Malaya 2: 462. f. 271. 1954; Hennipman., in Fl. Males., Ser. II.1: 325. f. 25d, 31a-g. 1978; Tagawa & K.Iwats., Fl. Thailand 3(3): 320. 1988.— *Acrostichum heteroclitum* C.Presl, Rel. Haenk. I.: 15 pl. 2. f. 2. 1825.— *Leptochilus heteroclitus* (C.Presl) C.Chr., Ind. Fil.: 385. 1906. Fig. 5.77-5.78.

Rhizome long-creeping, scaly; scales nearly black with narrow brown ferrugineous margin, linear, up to 4 by 1 mm. **Sterile fronds**: stipes 14-26 cm long, stramineous; lamina imparipinnate with one or two pairs of lateral pinnae; lateral pinnae oblong-lanceolate, cuneate and shortly stalked at base, caudate at apex, 15-30 by 3-6 cm, almosts entire or irregularly shallowly waved, terminal pinna oblong or often very long-tailed with narrow linear tail about 30-50 cm long, up to 15-20 cm long excluding the tail, 5 cm broad; rachis narrowly winged, glabrescent; sometimes viviparous; veins distinct on both surfaces, finely reticulated, rare free veinlets; herbaceous or softly papyraceous, glabrous, deep green, blackish when dry. **Fertile fronds**: stipes nearly the same as those of sterile ones; lateral pinnae about 3 pairs oblong, about 7 by 1.5 cm, apical pinnae a little larger than lateral ones, veins reticulate; sporangia spread over the whole undersurface of pinnae.

Thailand.— NORTHERN: Chiang Rai (Mae Kok), Chiang Mai (Doi Chiang Dao), Lampang, Phitsanulok (Nakhon Thani, Thung Salaeng Luang); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chon Buri (Si Racha), 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.— Terrestrial on wet ground by streams or rarely epiphytic on base of tree-trunks in tropical rain forest about 700-800 m alt.

Vernacular.— Kut pao (กูดเป๋า), kut hang nok.

Specimens examined.— W. Khwaiphan 215, P. Ratchata 144, 219, T. Boonkerd 1324 [BCU]; David J. Middleton et al. 1726; K. Iwatsuki 10915 [BKF].

3. Bolbitis sinensis (Baker) K.Iwats. **var. sinensis**, Acta Phytotax. Geobot. 18: 49. 1959; Hennipman in Fl. Males., Ser. II. 1: 325. f. 27 h. 1978; Tagawa & K.Iwats., Fl. Thailand 3(3): 318. f. 26. 1-4. 1988.— *Acrostichum sinense* Baker, Kew Bull.14. 1906.— *Egenolfia sinensis* (Baker) Maxon, Proc. Biol. Soc. Wash. 36: 173. 1923; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 424. f. 48, 1-2. 1939. Fig. 5.79.

Rhizome creeping, scales brown, narrowly subtriangular with long-acuminate apex, entire, up to 7 by 1 mm**. Sterile fronds**: stipes 24-36 cm long, scaly at base with brown, appressed, membranous, small, broadly oblong scales. **Lamina** 30-50 by 10-20 cm, narrowly subtriangular, the apex attenuately long-tailed, often viviparous at apex; rachis sparsely scaly, winged in upper part; lateral pinnae up to 11-20 pairs, basal pinnae asymmetrically oblong-subtriangular, caudately acuminate at apex, lobed to 4/5 way towards costa, up to 10-13 cm long, 2.3-3 cm wide; lobes oblique, rounded at apex, 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 fronds** about the same height as or lower than the sterile ones; stipes 28-36 cm long; lamina narrower, 2.2-3.2 cm long, 0.4-0.6 broad; 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 5 cm long; veins pinnate, veinlets simple, all free, the apex ending inside the distinct cartilaginous margin; sporangia dispersed on the undersurface, naked.

Thailand.— NORTHERN: Chiang Rai (Doi Tung, Doi Pacho), Chiang Mai (Doi Chiang, 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.— N. India, Myanmar, Sw. China (type) and Tonkin.

Ecology.— Lithophyte on humus-rich rocks in hill evergreen forest about 1,000-1,200 m alt.

Vernacular.— Kut bong (กูดบ้อง) (Northern).

Specimens examined.— W. Khwaiphan 178, Y. Yuyen 91, T. Boonkerd 82 [BCU]; M Tagawa et al T-9986; M. Tagawa, K. Iwatsuki and N. Fukuoka 4214 [BKF].

4. Bolbitis virens (Wall. ex Hook. & Grev.) Schott, Gen. Fil.: ad t. 14. 1834; Holttum, Rev. Fl. Malaya 2: 468. f. 275. 1955; Hennipman, Blumea 18: 149. 1970.— *Acrostichum virens* Wall. ex Hook. & Grev., Ic. Fill. II: pl. 231. 1831.— *Campium virens* (Wall ex Hook. & Grev.) C.Presl, Tent. Pterid.: 239. 1836.

4.1 var. virens.— *Bolbitis costata* auct. non (C.Presl) Ching: Holttum, Dansk Bot. Ark. 20: 30. 1961. Fig. 5.80.

Rhizome creeping, thick, densely scaly; scales thin but firm, dark brown, up to 7 by 1 mm. **Sterile fronds:** stipes 20-27 cm long, densely scaly throughout, scales on upper portion light brown, ferrugineous; lamina oblong, about 30 by 19 cm; lateral pinnae 5-6 pairs, stalked, straight, ascending or patent in lower ones, oblong-lanceolate, acuminate at apex, cuneate or unequally rounded at base, up to 13 by 3.5 cm, toothed at margin, more waved; costae glabrous; veins slightly raised on undersurface, reticulate with a few included veinlets in each areole; subcoriaceous, glabrous, green both in living and dried condition, terminal pinnae slightly larger lateral ones, viviparous near apex. **Fertile frond:** nearly as high as the sterile ones: stipes up to 25 cm long; lamina about 15 by 13 cm; pinnae about 5 pairs, linear, acuminate at apex, stalked, up to 6.5 by 0.5 cm; sporangia dispersed on the whole undersurface of pinnae.

Thailand.— NORTHERN: Chiang Mai (Doi Chiang Dao, Doi Suthep), Lamphun (Doi Khun Tan), Phrae (Mae Sai), Tak (Huai Krasa); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng); 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.— Lithophyte near streams in tropical rain forests about 700-800 m alt.

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

Specimens examined.— W. Khwaiphan 041 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T-372, 1086 [BKF].

4.2 var. compacta Hennipman, Blumea 18: 149. 1970; in Fl. Males., Ser. II. 1: 321. f. 25 a-c. 1978; Tagawa & K.Iwats., Fl. Thailand 3(3): 316. 1988. Fig. 5.81.

Rhizome creeping, thick, densely scaly; scales thin but firm, dark brown, up to 3 by 1.5 mm. **Sterile fronds**: stipes about 35 cm long, densely scaly throughout, scales on upper portion light brown, ferrugineous, appressed, irregular in shape; lamina oblong-ovate to oblong, 29.4 by 25.3 cm; lateral pinnae 3-4 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 16.5 by 4 cm, toothed at margin, more or less waved; costae minutedly scaly beneath; veins slightly raised on undersurface, reticulate with a few included veinlets in each areole; subcoriaceous, glabrous, green both in living and dried condition, terminal pinnae like lateral ones or slightly larger, viviparous near apex. **Fertile fronds** nearly as high as the sterile ones: stipes up to 50 cm long; lamina up to 22 by 13 cm; pinnae 4-5 pairs, linear, acuminate at apex, stalked, up to 6-7.5 by 1 cm; sporangia dispersed on the whole undersurface of pinnae.

Thailand.— PENINSULAR: Phangnga (Khao Phra Mi), Trang (Khao Chong, type).

Distribution.— Malaya, also Cochinchina

Ecology.— Terrestrial by stream in tropical rain forest about 700-800 m alt.

Specimens examined.— W. Khwaiphan 156, Y. Yuyen 32, T. Boonkerd 1537 [BCU]; Tagawa & Yamada T-214; TDBS 11836 [BKF].

2. ELAPHOGLOSSUM

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

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

Elaphoglossum malayense Holttum, Blumea 14: 322. 1966; in Fl. Males., Ser. II. 1: 308. 1978.— *Elaphoglossum callifolium* auct. non (Blume) Moore: Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 541. 1939; Holttum, Rev. Fl. Malaya 2: 459. f. 269. 1954. Fig. 5.82.

Rhizome short, densely covered with scales; scales brown, membranous, oblong-lanceolate, up to 7 by 3 mm, entire or with irregular projections at margin. **Sterile fronds**: stipes 7-9 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, 20-28 by 2.5-4 cm, entire, narrowly marginate with cartilaginous membrane; midrib raised on both surfaces, glabrescent, coriaceous, veins visible on both surfaces, green or irredescent blue in field. **Fertile fronds**: stipes about 12 cm long; lamina elliptic, gradually narrowing towards both ends, about 15 cm long, about 2 cm broad.

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

Distribution.— Annam and Malaya (type).

Ecology.— Epiphyte on mossy tree-trunks in hill evergreen forest about 1,000-1,300 m alt.

Specimens examined.— W. Khwaiphan 116, T. Boonkerd 55, 1492 [BCU]; M. Tagawa, K. Iwatsuki and N. Fukuoka T-4798,T-4801 [BKF].

WOODSIACEAE

(Hook.) Herter, Revista Sudamer. Bot. 9: 14. 1949.— *Athyriaceae* Alston, Taxon 5: 25. 1956; Devol, Fl. Taiwan vol. 1. 2nd ed.: 441. 1980.

Rhizome usually short and stout, sometimes creeping and slender; scales thin, light brown to dark brown, lanceolate or ovate. Fronds usually thin, pinnate to decompound, rarely simple; veins usually free, goniopteroid or forming areolae, usually glabrous; rachis grooves generally open to receive rachilla grooves but not in all genera. Sori elongate or round to oblong. Indusia round-reniform or horse-shoe shaped or naked.

DIPLAZIUM

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

Rhizome creeping to erect, scaly; rhizome-scales entire or toothed; rachis grooved, the grooves distinct, open. Fronds simple to pinnately compound; veins pinnate, or reticulate to form rather regular quadrangular areoles at each side of veinlets; usually glabrous or minutely scaly on axes. Sori elongate along veins; indusiate, often adjacent to the next ones, opening in opposite direction.

KEY TO THE SPECIES

1. Fronds pinnate, mediocre
   2. Vein free; pinnae distinct stalked
      3. Rhizome short, erect to ascending; pinnae subcoriaceous... **1. D. bantamense**
      3. Rhizome creeping; pinnae chartaceous ..... **2. D. donianum**
   2. Vein anastomosing; pinnae papyraceous..... **3. D. esculentum**
1. Fronds bipinnate, large..... **4. D. simplicivenium**

1. Diplazium bantamense Blume, En. Pl. Jav.: 191. 1828; Tagawa & K.Iwats., Fl. Thailand 3(3): 455. 1988.— *Athyrium bantamense* (Blume) Milde, Bot. Zeit. 353: 1870. Holttum, Rev. Fl. Malaya 2: 558. f. 330. 1954. Fig. 5.83.

Rhizome short, erect or ascending, bearing a few fronds at apex; scales narrow, 7 by 1.5 mm, concolorous, dark brown, minutely toothed at margin. **Stipes** up to 32 cm long, brownish, darker in lower portion, grooved on adxial surface. **Fronds** imparipinnate, oblong, 50-60 cm long 28 cm broad; rachis grooved on upper surface; lateral pinnae 5-6 pairs, upper ones smaller, ascending, shortly stalked, oblong, caudate at apex, round at apex, subentire, serrate at margin, up to 18 by 4.5 cm; subcoriaceous, surface glabrescent; costae raised below, grooved with minute hairs on upper surface; veins several times forked, all free. **Sori** elongate along veins, longest on basal acroscopic veinlets, usually on both sides of veins; indusia thin, brown.

Thailand.— PENINSULAR: Surat Thani (Khao Khieo Range), Nakhon Si Thammarat (Khao Luang), Trang (Khao Chong), Yala (Ban Chana, Ban Malao, Bannang Sata).

Distribution.— W. Malesia (type from Java).

Ecology.— Terrestrial by stream in tropical rain forest about 700-800 m alt.

Specimens examined.— W. Khwaiphan 148, Y. Yuyen 190 [BCU]; E. Hennipman 3683, M. Tagawa, K. Iwatsuki and N. Fukuoka 5303 [BKF].

2. Diplazium donianum (Mett.) Tardieu, Aspl. Tonkin.: 58. t. 5. 1932 ; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 249. 1939; Tagawa & K.Iwats., Fl. Thailand 3(3): 455. f. 48. 4. 1988.— *Asplenium donianum* Mett., Fil. Lechl.: 177. 1859.— *Athyrium bantamense* auct. non (Blume) Milde: Bedd., Handb.: 177. f. 86. 1883. Fig. 5.84-5.85.

Rhizome long-creeping, 5-7 mm in diameter; scales lanceolate, 9 by 1 mm, blackish, minutely toothed at margin. **Stipes** up to 36 cm long, light green, grooved on upper surface. **Fronds** imparipinnate, oblong, 40-50 cm long, 25 cm broad; lateral pinnae 3-4 pairs, stalks distinct, more than 5 mm long, oblong, caudate at apex, cuneate at base, crenate at margin, up to 25 by 4 cm; chartaceous, surface glabrescent; costae raised below, grooved on upper surface; veins several time forked, all free. **Sori** usually elongate along the whole length of veinlets.

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

Distribution.— N. India (type) to S. China and Taiwan, north to S. Japan, south to Indochina.

Ecology.— Terrestrial by stream in tropical rain forest about 700-800 m alt.

Specimens examined.— W. Khwaiphan 213, Y. Yuyen 43 [BCU]; M. Tagawa, K. Iwatsuki and N. Fukuoka 2039, K. Iwatsuki and N. Fukuoka 7392 [BKF].

3. Diplazium esculentum (Retz.) Sw., Schrad. J. Bot. 1801(2); 312. 1803; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 269. 1939; Tagawa & K.Iwats., Fl. Thailand 3(3): 466. 1988.— *Hemionitis esculenta* Retz., Obs. Bot.: 38. 1791.— *Anisogonium esculentum* (Retz.) C.Presl, Tent. Pterid.: 116. 1836.— *Athyrium esculentum* (Retz.) Copel., Phil. Sci. Bot. 3: 295. 1908; Holttum, Rev. Fl. Malaya 2: 562. f. 333. 1954. Fig. 5.86-5.87.

Rhizome erect, bearing a truft of fronds; scales up to 5 by 1.5 mm, dark brown, black-margined, toothed. **Stipes** about 15 cm long. **Fronds** 1-2 pinnate, more than 45 cm long, pinnae up to 8.5 by 1.6 cm, subsessile, subcordate at base, narrowing towards acuminate apex, lobed to ¼ way to costules; lobes rounded at apex, serrate, papyraceous; veins pinnate, veinlets up to 7 pairs, uniting with the opposite ones forming excurrent veinlets. **Sori** on the whole length of veinlets, often uniting with opposite ones.

Thailand.— NORTHERN: Chiang Rai (Mae Kok), Chiang Mai (Fang, Ban Mae Kon, Mae Klang, Kang Kat, Sop Aep), Mae Hong Son (Mae La Noi, Mae Su Rin), Lampang, Tak; EASTERN: Chiyachum (Nam Phrom); CENTRAL: Nakhon Nayok (Khao Yai), Saraburi (Muak Lek), Bangkok; SOUTH-EASTERN: Chon Buri (Si Racha); SOUTH-WETERN: Kanchanaburi (Kroeng Kawia, Phomphi, Sai Yok); PENINSULAR: Surat Thani (Khao Pok, Ban Don), Satun, Narathiwat (Waeng).

Distribution.— Tropics of Asia, north to Central China and S. Japan, east to S. Pacific Islands.

Ecology.— Terrestrial on mountain slope in hill evergreen forest about 1,200-1,300 m alt.

Use.— Young fronds locally consumed as vegetable.

Vernacular.— Hatsadam (หัสดำ) (Peninsular); Kut kin (กูดกิน) (Northern).

Specimens examined.— W. Khwaiphan 182 [BCU].

4. Diplazium simplicivenium Holttum, Gard. Bull. S.S. 11: 100. 1940; Tagawa & K.Iwats., Fl. Thailand 3(3): 464. 1988.— *Athyrium simplicivenium* (Holttum) Holttum, Rev. Fl. Malaya 2: 573. f. 340. 1954. Fig. 5.88.

Rhizome massive, erect, bearing a turf of large fronds; scales about 15 by 1.5 mm, brown, black-margined, toothed. **Stipes** up to 50 cm long, about 7 mm in diameter near base. **Fronds** about 1.5 by 1 m, bipinnate; lower pinnae about 60 by 28 cm, narrow oblong with acute apex; larger pinnules shortly stalked or sessile, narrowly oblong-subtriangular, gradually narrowing towards a long acuminate apex, broadly cuneate to subtruncate or subcordate at base, usually shallowly lobed, up to 14 by 2.2 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 6 mm long.

Thailand.— SOUTH-WESTERN: Kanchanaburi (Khao Ngi Yai), Uthai Thani (Ban Rai); PENINSULAR: Surat Thani (Klong Ton), Nakhon Si Tahmmarat (Khao Luang), Phangnga (Khao Pok), Trang (Khao Chong), Satun, Yala (Muang Wing).

Distribution.— Malaya (type) and probably also in Borneo.

Ecology.— Terrestrial by stream in tropical rain forest about 1,200-1,300 m alt.

Specimens examined.— W. Khwaiphan 147, T. Boonkerd 1245, 1339 [BCU]; M. Tagawa, K. Iwatsuki, N. Fukuoka 4803 [BKF].

DRYOPTERIDACEAE

Herter, Revista Sudamericana de Botánica 9:15. 1949; Devol & Kuo, Fl. Taiwan vol. 1. 2nd ed.: 354. 1980.

Medium sized terrestrial ferns, rhizomes dictyostelic, covered with persistent leaf bases, usually short and erect, or long creeping; stipes with a ring of several vascular bundles, usually tufted, or distant, scaly at least at base; scales opaque and quite diverse in size, shape, texture and color; venation free in nearly all genera; rachis deeply grooved on upper side and usually open to receive rachillae grooves. Sori round, dorsal or terminal on veins; indusia round, peltate and centrally attached or attached by a deep sinus, rarely absent, sometimes globose and stalked.

KEY TO THE GENERA

1. Costae grooved; fronds bearing no articulated hairs; veins free
   2. Articulated hairs present on axes of fronds .....**2. Diacalpe**
   2. Articulated hair not present on axes of fronds
      3. Indusia round, peltate..... **6. Polystichum**
      3. Indusia round-reniform
         4. Rhizome creeping .....**1. Arachniodes**
         4. Rhizome short erect or suberect.....**3. Dryopteris**
1. Costae raised on upper surface and often hairy; fronds usually bearing articulate hairs; veins free or anastomosing
   5. Sinus-teeth present between lobes of pinnae.....**5. Pleocnemia**
   5. Sinus-teeth not present between lobes of pinnae
      6. Basal pinnae lobed with short basal posterior lobes or pinnules.....
      .....**4. Heterogonium**
      6. Basal pinnae unlobed, or when lobed the basal basiscopic lobes or pinnules longest .....**7. Tectaria**

1. ARACHNIODES

Blume, En. Pl. Jav. 2: 241. 1828; Tagawa & K.Iwats., Fl. Thailand 3(3): 339. 1988.

Rhizome creeping, short or more commonly long, scaly; scales usually entire and glabrous, concolorous; stipes scaly or glabrescent. Fronds ovate with broad base, tripinnatifid or more compound, anadromic in sequence of fronds architecture or basal posterior pinnules interior to basal anterior ones; ultimate 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 cavalerii (Christ) Ohwi, J. Jap. Bot. 37: 36. 1962 ; Tagawa & K.Iwats., Fl. Thailand 3(3): 340. f. 30, 1-2. 1988.— *Aspidium cavalerii* Christ, Bull. Acad. Géogr. Bot. 1904: 116.— *Rumohra cavalerii* auct. non (Christ) Ching, Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 328. 1939. Fig. 5.89-5.90.

Rhizome short creeping, scaly; scales dark brown, small, entire, up to 1 by 0.1 cm long. **Stipes** stramineous, up to 25 cm long, scaly in lower portion. **Fronds** subdeltoid, about 18 by 14 cm at base, bipinnate to tripinnatifid; rachis like the upper part of stipes, grooved, above, glabrecent; basal pinnae the largest, distinctly stalked with petioles of up to 1 cm in length, subtriangular with large bipinnatifid basal pinnules and acuminate apex, about 13 by 6 cm; basal basiscopic pinnule like the second basal pinnae; larger pinnules of middle pinnae or secondary pinnules of larger pinnae parallelogram-shaped, subsessile or shortly stalked, acute at apex, cuneate at base, crenate with blunt margin, never aristate-mucronate at apex of lobes; chartaceous. **Sori** larger, dorsal on veinlets, usually in one row close to each side of midrib; indusia round-reniform, up to 2 mm in diameter.

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

Distribution.— S. China (type), N. Vietnam and southern edge of Japan.

Ecology.— Terrestrial or lithophyte in rock crevices in hill evergreen forest about 1,000-1,300 m alt.

Specimens examined.— W. Khwaiphan 143, 198 [BCU]; E. Hennipman 3664, T. Smitinand & P. Suvanakoses 376 [BKF].

2. DIACALPE

Blume, En. Pl. Jav. 2: 241. 1828; Tagawa & K.Iwats., Fl. Thailand 3(3): 330. 1988.

Rhizome short, ascending or erect, dense scaly; scales not peltate, castaneous, not clathrate. Stipes dense scaly. Fronds finely dissected to quadripinnate, deltoid-ovate; pinnae opposite, at right angles to rachis; veins all free; hairs on upper surface of veins, costules, costae and rachis coarse, articulate. Sori dorsal on veinlets, indusia firm, completely covering the sori, globose, tearing irregularly at maturity.

Diacalpe aspidioides Blume, En. Pl. Jav. 2: 241. 1828; Tagawa & K.Iwats., Fl. Thailand 3(3): 345. f. 28, 3-7. 1988. Fig. 5.91.

Rhizome short, ascending, covered with scales; scales linear-subtriangular, up to 12 by 2 mm, entire, glabrous, brown. **Stipes** dark stramineous to brown, deep brown on abaxial surface, polished up to 50 cm long, scaly throughout. **Fronds** oblong-subdeltoid, about 50 cm long, tripinnate to quadripinnate; rachis minutely scaly throughout; pinnae more than 15 pairs, basal ones the largest, up to 21 by 15 cm, asymmetrically subtriangular, middle ones falcate, oblong-subtriangular, caudately acute at apex, unequally broadly cuneate at base, about 14 by 5.5 cm; pinnules oblong-subdeltoid, acute at apex, unequally broadly caudate to subsessile base, 4-9 by 1.5-4 cm, posterior side of basal pinnae more than 9 cm in length; segments oblong to spathulate, oblique, sessile, subentire or pinnate in larger ones, rounded at apex, narrowly cuneate at base, about 5 by 2 mm in those of middle pinnae; pinnae papyraceous, green to deep green, sparsely hairy on veins, hairs articulated. **Sori** dorsal on veinlets, round, about 1 mm in diameter.

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

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

Ecology.— Terrestrail on humus-rich floor in hill evergreen forests about 1,000-1,300 m alt.

Specimens examined.— W. Khwaiphan 016, 044, C. Khunwasi 50, T. Boonkerd 364, 1107 [BCU]; M. Tagawa, K. Iwatsuki and N. Fukuoka 597, 1517 [BKF].

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. Stipes usually in a tuft at apex of rhizome, scaly. Fronds mostly broad at base, pinnate to decompound, basal anterior pinnules interior to basal posterior ones or catadromic in sequence of fronds-architecture; usually papyraceous or firm, typically glabrous; veins all free. Sori dorsal on veinlets, round with punctate receptacles; indusia round-reniform, attached at the inner end of sinus, or rarely wanting.

KEY TO THE SPECIES

1. Sori exindusiate; scale linear, light brown ..... **1. D. polita**
1. Sori indusiate
   2. Scale oblong-ovate, light brown; stipes castanenous at base, stramineous above ..... **2. D. sparsa**
   2. Scales linear, nearly black; stipes dark stramineous throughout .... **3. D. subtriangularis**

1. Dryopteris polita Rosenst. in Fedde, Rep. Sp. Nov. 13: 218. 1914; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 317. 1939; Holttum, Rev. Fl. Malaya 2: 492. 1954; Devol and Kuo, Fl. Taiwan vol. 1. 2nd ed.: 378. 1980; Tagawa & K.Iwats., Fl. Thailand 3(3): 345. f. 32, 9-11. 1988.— *Dryopteris chapensis* auct. non C.Chr. & Ching: Holttum, Dansk Bot. Ark. 20: 30. 1961. Fig. 5.92.

Rhizome short, ascending or suberect, scales linear, light brown, entire, up to 11 by 1.5 mm. **Stipes** stramineous, scaly at base with the scales similar to those on

rhizome, more sparsely scaly upwards with smaller ones, up to 20.5 cm long. **Fronds** oblong with acuminate apex, bipinnate, up to 31 by 21 cm; about 9 lower lateral pinnae nearly equal in size or slightly smaller upwards, with stalks of 1 cm long, narrowly subtriangular with acuminate apex, unequally broadly cuneate at base, 13.1 by 4.5 cm; upper pinnae rather suddenly shortened, very shortly stalked, sessile or adnate at base, oblong-subdeltoid with acute apex, shollowly lobed at margin; pinnules oblong-subdeltoid, round at apex, round or cuneate at base or acroscopically auricled in larger ones, up to 2.1 by 1.8 cm, serrate at margin; papyraceous, not very thick or harsh, deep green. **Sori** dorsal on veinlets, medial or just beyond midway from midrib to margin of pinnule, in one row, exindusiate.

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, Sumatra, Borneo, Taiwan (type), and northwards to southern edge of Japan.

Ecology.— Terretrial on mountain slopes in hill evergreen forests about 1,100-1,300 m alt.

Specimens examined.— W. Khwaiphan 204 [BCU]; T. Shimizu et al. 23039; E. Hennipman 3932A, Kyoji Yoda 465 [BKF].

2. Dryopteris sparsa (D.Don) Kuntze., Rev. Gen. Pl. 2 : 813. 1891; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 318. 1939; Holttum, Rev. Fl. Malaya 2 : 492. f. 292. 1954; Devol and Kuo, Fl. Taiwan vol. 1. 2nd ed.: 380. 1980; Tagawa & K.Iwats., Fl. Thailand 3(3): 352. 1988.— *Nephrodium sparsum* D.Don, Prod. Fl. Nepal.: 6. 1825.— *Lastrea sparsa* (D.Don) T.Moore, Ind. Fil.: 87, 104. 1858. Fig. 5.93.

Rhizome short, erect; scales membranous light brown, oblong-ovate, about 5 by 3 mm. **Stipes** castanenous at base, stramineous above, densely scaly at base, sparsely so above, up to 33 cm long. **Fronds** oblong-subdeltoid, acuminate at apex, bipinnate or tripinnate at widest base, up to 30 by 26 cm; basal pinnae the largest, asymmetrically subtriangular, acuminate at apex, up to 13 by 4 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 10 by 3 cm, lobed 1/3 way to midribs; 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.

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.— Terrestrial on mountain slope in hill evergreen forests about 1,200-1,300 m alt.

Specimens examined.— W. Khwaiphan 196, Y. Yuyen 35 [BCU]; E. Hennipman 3580 A; K. Iwatsuki, N. Fukuoka 7193 [BKF].

3. Dryopteris subtriangularis (C.Hope) C.Chr., Ind. Fil.: 296. 1905; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 315. f. 35, 1-2. 1939; Tagawa & K.Iwats., Fl. Thailand 3(3): 355. 1988.— *Nephrodium subtriangulare* C.Hope, J. Bot. 28: 327. 1890.— *Dryopteris chapensis* auct. non C.Chr. & Ching: Holttum, Dansk Bot. Ark. 20: 30. 1964. Fig. 5.94.

Rhizome short, erect, densely scaly at apex; scales linear, entire, 12 by 1 mm, nearly black. **Stipes** dark stramineous to pale brown, densely scaly at base, sparsely upwards, upper scales smaller, 30-40 cm long. **Fronds** oblong-ovate with acuminate apex, 30-35 by about 26 cm, bipinnate to tripinnatifid at base; rachis like the upper part of stipes, with linear scales, grooved above; pinnae subopposite, 10 pairs below an indistinct apical pinnae, shortly stalked, narrowly subtriangular, caudate-acuminate at apex, subtruncate to broadly cuneate at base, up to 16 by 4.5 cm; pinna-rachis bullate-scaly, slightly ascending; pinnules oblong to oblong-subdeltoid, rounded to obtuse at apex, broadly cuneate and auricled on both sides at base, up to 2 by 0.6 cm, lobed almost to the base in larger ones, light green in living condition, drying brown;

softly papyraceous, rather thin but coarse. **Sori** dorsal on veinlets, medial; indusia about 0.8 mm in diameter.

Thailand.— NORTHERN: Chiang Mai (Doi Suthep); NORTH-EASTERN: Loei (Phu Kradung); CENTRAL: Nakhon Nayok (Khao Khieo)

Distribution.— India (Assam, type), S. China and Vietnam.

Ecology.— Terrestrial on rather dry sandy slopes in hill evergreen forest about 1,100-1,300 m alt.

Specimens examined.— W. Khwaiphan 006, 045, 090, 091, 093, 157, 162 [BCU]; M. Tagawa and K. Iwatsuki, N. Fukuoka 1297; M. Tagawa 3992 [BKF].

4. HETEROGONIUM

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

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

Heterogonium gurupahense (C.Chr.) Holttum, Reinwardtia 3: 272. 1955; Tagawa & K.Iwats., Fl. Thailand 3(3): 361. f. 33, 6-7. 1988.— *Dryopteris sagenioides* (Mett.) Kuntze var. *gurupaense* C.Chr., Svensk Bot. Tidsskr. 16: 95. f. 2. 1922.— *Aspidium sagenioides* auct. non Mett.: Christ, Bot. Tidsskr. 32: 342. 1961.— *Ctenitopsis sagenioides* (Mett.) Ching, Bull. Fan Mem. Inst. Biol. 8: 312. 1938. Fig. 5.95.

Rhizome short, ascending or suberect; scales oblong, gradually narrowing towards tailed apex, dark brown, stiff, paler and somewhat ferrugineous at margin, hairy, up to 3 by 1.5 mm. **Stipes** deep purple, polished, 35-40 cm long, minutely pubescent throughout. **Fronds** bipinnatifid, oblong-lanceolate, acuminate at apex, up to 38 by 21 cm; lateral pinnae about 10 pairs, sessile, lanceolate, caudate at apex, truncate at base, deeply lobed nearly to costa; basal pinna 10 by up to 4.5 cm; middle

pinnae up to 12 by 3 cm, upper ones gradually becoming smaller, adnate at base, forming indistinct apical portion; pinnules oblong to oblong-subdeltoid, rounded to acute at apex, entire or crenulate in larger ones about, herbaceous, deep green, hairy on both surfaces, costules and veins hairy, veinlets forked; hairs on upper surface of sterile pinnae dense, of two kinds, the larger ones about 1.5 mm long, 4-5 celled, more or less articulated, the shorter ones slender, 0.2-0.3 mm long, unicellular to 2 celled. **Sori** dorsal on veinlets, medial, round indusiate; indusia small, fugacious, densely hairy.

Thailand.— NORTHERN: Chiang Rai, Chiang Mai (ban Du), Phitsanulok (Thung Salaeng Luang); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Rayong (Khao Chamao), Chanthaburi (Khao Soi Dao), Khao Sabap), Trat (Bo Rai, Ko Chang); PENINSULAR: Ranong (Ko Bangghen), Surat Thani (Ban Don), Pangnga (Khao Katha Khwam, Khao Phra Mi), Phuket (Thalang), Nakhon Si Thammarat (Khao Luang), Trang (Khao Chong), Pattani (Yaring), Narathiwat (Waeng).

Distribution.— Myanmar (Mergui and Tenasserium), Vietnam, W. Malaysia and Celebes (type).

Ecology.— Terrestrial by stream in tropical rain forest about 700-800 m alt.

Specimens examined.— W. Khwaiphan 210; Y. Yuyen 197 [BCU]; M. Tagawa, K. Iwatsuki and N. Fukuoka 6808, E. Hennipman 3797 [BKF].

5. PLEOCNEMIA

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

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

Pleocnemia irregularis (C.Presl) Holttum, Kew Bull. 29: 347. 1974.— *Polypodium irregulare* C.Presl, Rel. Haenk. 1: 21. 1825; Tagawa & K.Iwats., Fl. Thailand 3(3): 387. 1988.— *Arcypteris irregularis* (C.Presl) Holttum, Reinwardtia 1: 193. f. 1-3. 1951; Rev. Fl. Malaya 2: 538. f. 317-318. 1954. Fig. 5.96-5.97.

Rhizome thick**,** suberect, short, densely scaly; scales linear, up to 25 by 1 mm, dark brown, thin and more or less crisped, entire or irregularly toothed at margin. **Stipes** up to 110 cm long, dark and scaly at base, stramineous upwards. **Fronds** bipinnate at base, oblong-subdeltoid, usually more than 1 m long, 70 cm wide at base; basal pinnae the largest, asymmetrically subdeltoid with large basiscopic pinnules, middle pinnae oblong-lanceolate, acute to acuminate at apex, shortly stalked, with several free pinnules, apical portion large, pinnatifid; rachis and pinna-rachis glabrescent; pinnules sessile or more or less adnate, oblong-subdeltoid, falcate, caudate at apex, cuneate at base, waved at margin, usually about 12 by 2-3 cm; chartaceous, green to yellow green, brownish in dried specimens, glandular hairy at margin and on lower surface; veins forming copious anastomoses, a distinct broad tooth at each sinus between pinnules and between crenae of pinnules. **Sori** small, dorsal on anastomosing veins, scattered irregularly; exindusiate.

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

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

Ecology.— Terrestrial by stream in tropical rain forest about 700-800 m alt.

Specimens examined.— W. Khwaiphan 169, T. Boonkerd 189, 440, 1392 [BCU]; K. Iwatsuki & N. Fukuoka 7195, E. Hennipman 3765 [BKF].

6. POLYSTICHUM

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

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

Polystichum biaristatum (Blume) T.Moore, Ind. Fil.: 86. 1858; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 342. f. 35, 1-2. 1939; Tagawa & K.Iwats., Fl. Thailand 3(3): 337. 1988.— *Aspidium biaristatum* Blume, En. Pl. Jav.: 164. 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. Fig. 5.98-5.99.

Rhizome short, suberect; scales narrowly subtriangular, attenuate at apex, entire at margin, up to 15 by 3 mm, bicolored, central portion shining black and tough, the margin brown to dark brown with ferrugineous margin. **Stipes** 25-27 cm long; scales at base of two kinds, one like those on rhizome, the other narrower, linear, up to 1 cm long, brown, toothed at margin, those on upper part linear, black with brown broader base. **Fronds** oblong-lanceolate, widest at middle, slightly narrowing towards base, acuminate at base, 40-42 by 23-25 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 14 by 2.5 cm; basal acroscopic pinnules larger; pinnules rather close, oblong or gradually narrowing towards apex, falcate, acute and ending in sharp awns at apex, sessile, 1.7 by 0.7 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 0.5 mm in 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 Java (type).

Ecology.— Terrestrial on humus-rich in hill evergreen forests about 1,000-1,300 m alt.

Specimens examined.— W. Khwaiphan 097, Y. Yuyen 204 [BCU]; M. Tagawa, I. Yamada T 28 and M. Tagawa et al. 10516 [BKF].

7. TECTARIA

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

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

KEY TO THE SPECIES

1. Fronds deeply lobed; sori exindusiate ..... **2. T. maingayi**
1. Fronds pinnate; sori indusiate
   2. Veins anastomosing; scales linear-subtriangular
      3. Sori usually terminal on included free veinlets; indusia large, glagrous ..... **1. T. griffithii**
      3. Sori on anastomosing veins; indusia small, pubescent ..... **3. T. sp. 1**
   2. Veins free; scales oblong-lanceolate, indusia small, pubescent ..... **4. T. sp. 2**

1. Tectaria griffithii (Baker) C.Chr., Ind. Fil. Suppl. 3 : 180. 1934; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 411. f. 35, 1-2. 1939; Tagawa & K.Iwats., Fl. Thailand 3(3): 370. 1988.— *Nephrodium griffithii* Baker, in Hook. & Baker, Syn. Fil.: 30. 1867.— *Nephrodium multicaudatum* C.B.Clarke, Trans. L. Soc. II. 1: 540. t. 77. 1880.— *Tectaria multicaudata* (C.B.Clarke) Ching, Sinensia 2: 20. 1931; Holttum, Rev. Fl.

Malaya: 507. f. 299. 1954.— *Aspidium multicaudatum* (C.B.Clarke) Bedd., Handb.: 222. 1883. Fig. 5.100.

Rhizome short, erect, scaly; scales linear-subtriangular, up to 15 by 2 mm, entire, dark brown. **Stipes** dark brown to castaneous, up to 60 cm long, scaly throughout but scales gradually sparse upwards, hairy at least on adaxial surface. **Fronds** oblong-subdeltoid or pentagonal, up to 65 by 55 cm; lateral pinnae 4-6 pairs, basal pinna the largest, with long stalk, asymmetrically subdeltoid,acute at apex, up to 37 by 30 cm, 1 or 2 basal basiscopic pinnules much larger, free with short stalks, oblong-lanceolate, caudate-acuminate, deeply lobed, up to 20 by 6.5 cm, 1 or 2 basal acroscopic pinnules free; middle pinnae smaller, with 1 or 2 free pinnules; apical pinna oblong-subdeltoid, acute at apex, broadly cuneate and a little decurrent at base, deeply lobed to pinnatifid; herbaceous, dark green, glabrous on both surface; rachis and pinna-rachis hairy above, sparsely scaly beneath; veins anastomosing to form copious areoles. **Sori** round, terminal on short free included veinlets, indusiate, in a single row at each side of midrib, medial or a little costular, more or less immersed and raised on upper surface; indusia large, up to 1.5 mm diam., glagrous, persistent.

Thailand.— NORTHERN: Lampang; NORTH-EASTERN: Loei (Tha Li); south-eastern: Chanthaburi (Khao Sabap), Trat (Huai Raeng); SOUTH-WESTERN: Kanchanaburi (Wangka, Khao Ngi Yai, Song Tho); PENINSULAR: Phangnga (Takua Pa, Khao Nang Hong), Krabi (Khao Ao Khuan), Nakhon Si Thammarat (Khao Luang), Yala (Bannang Sata, Waterfall).

Distribution.— N. India, Myanmar (type), Sw. China, Indochina, W. Malesia to the Philippines.

Ecology.— Terrestrial by stream in tropical rain forest about 700-800 m alt.

Vernacular.— Kachot raet (กะฉอดแรด) (South-eastern).

Specimens examined.— W. Khwaiphan 189, Y. Yuyen 44, T. Boonkerd 1164,1186 [BCU]; K. Iwatsuki et al 8510, Kyoji Yoda 671 [BKF].

2. Tectaria maingayi (Baker) C.Chr., Ind. Fil. Suppl. 3: 182. 1934; Holttum., Rev. Fl. Malaya 2 : 513. f. 302. 1954; Tagawa & K.Iwats., Fl. Thailand 3(3): 382. 1988.— *Gymnogramme maingayi* Baker, Syn. Fil.: 517. 1874. Fig. 5.101.

Rhizome short, erect, scaly; scales gradually narrowing from base towards apex, stiff, with ferrugineous paler edges, dark brown, bearing long coarse hairs, up to 7 by 1 mm. **Stipes** about 60 cm long, dark stramineous to brown, densely scaly at base, glabrescent upwards. **Fronds** imparipinnate with 1-3 pairs of free pinnae, up to 43 by 20 cm, the fertile lamina narrower; rachis like the upper part of stipes, glabrous; lateral pinnae oblong-ovate, gradually narrowing towards caudate apex, cuneate at sessile base, entire, up to 26 by 3.5 cm, rarely bearing basal basiscopic lobes, those of fertile ones smaller, usually up to 19.5 by 3 cm, the terminal pinna oblong, up to 27 by 17 cm; softly papyraceous, green, glabrous; costa and main veins raised beneath, cross-veins less distinct, veins anastomosing to form main areoles and smaller ones with included veinlets. **Sori** exindusiate, round or more or less elongate along reticulate veins, confluent, sometime covering the whole under surface of pinnae.

Thailand.— PENINSULAR: Suart Thani (Ban Don), Phangnga (Takua Pa), Phuket (Khao Phara, Khao Ao Kuang, Ko Talibong), Nakhon Si Thammarat (Khao Luang, Chawang), Trang (Khao Chong), Narathiwat (Waeng, Yala (Bannang Sata).

Distribution.— W. Malesia (type from W. Malaysia).

Ecology.— Terrestrial by stream in tropical rain forest about 700-800 m alt.

Specimens examined.— W. Khwaiphan 185 [BCU]; E. Hennipman 3993 [BKF].

3. Tectaria sp.1 Fig. 5.102-5.103.

Rhizome short, erect, about 2 cm in diameter, densely scaly; scales linear-subtriangular, up to 9 by 0.5 mm, brown. **Stipes** dark castaneous, pubescent throughout, up to 40 cm long. **Fronds** bipinnate at base, oblong, about 35 by 30 cm; rachis castaneous, pubescent; lateral pinnae about 4 pairs, basal pinnae trifoliate, terminal pinnules falcate, shallowly lobed, caudately acuminate at apex, cuneate at base, lateral pinnules broadly lanceolate, stalked at cuneate base, shallowly lobed at margin, up to 20 by 3 cm; terminal pinnae cuneate at base, lobed at basal part, caudate at apex; papyraceous, green, glabrous; costae and costules raised on both surfaces, castaneous, pubescent on both sides; main veins paler, pubescent beneath; veinlets forming irregular anastomosis with included free veinlets, pubescent beneath. **Sori** in

two irregular rows between main veins terminal on included free veinlets, round, about 1.5 mm in diameter; indusia small, pubescent.

Thailand.— SOUTH-EASTERN: Prachin Buri (Khao Yai).

Distribution.—

Ecology.— Terrestrial on mountain slope in hill evergreen forest 1,000-1,100 m alt.

Specimens examined.— W. Khwaiphan 096 [BCU].

Note.— *Tectaria* sp.1 is a terrestrial plant on humus-rich mountain slope in hill evergreen forest. It is closely related to *Tectaria impressa* (Fée) Holttum but differs in having shallowly lobed at margin of pinnae rather than deeply lobed to pinnatifid of pinnae.

4. Tectaria sp.2 Fig. 5.104.

Rhizome short, erect, densely scaly near apex; scales stiff, oblong, dark brown, entire about 6 by 1 mm. **Stipes** castaneous, scaly throughout, up to 17 cm long. **Fronds** oblong-subdeltoid, tripinnatifid at base, up to 25 by 20 cm; rachis winged at upper part; lateral pinnae about 6 pairs, basal pinnae the largest, asymmetrically oblong-subdeltoid, acuminate at apex, unequally broadly cuneate at base, up to 10 by 4 cm, stalked, upper pinnae sessile to adnate at base, middle pinnae ascending shortly stalked, oblong-lanceolate with caudate apex and broadly cuneate base, bearing large sessile basal basiscopic pinnules; herbaceous, green, pubescent on upper surface; costae and costules castaneous, densely pubescent; veins free. **Sori** terminal on veinlets, round, up to 1 mm; indusia small, pubescent.

Thailand.— SOUTH-EASTERN: Prachin Buri (Khao Yai).

Distribution.—

Ecology.— Terrestrial by stream in tropical rain forest about 700-800 m alt.

Specimens examined.— W. Khwaiphan 150 [BCU].

Note.— *Tectaria* sp.2 is terrestrial by stream in tropical rain forest about 700-800 m alt. It is closely related to *Tectaria fuscipes* (Wall. ex Bedd.) C.Chr. but differs from that species in having free veins in both fertile and sterile fronds.

THELYPTERIDACEAE

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

Terrestrial ferns. Rhizome short-creeping or long-creeping; rarely scandent; scales usually thin not peltate. Stipes not articulated to stem, contain two vascular bundles at base and uniting into a U-shaped bundle in the upper part. Fronds usually pinnate crenate or lobed pinnae, upper surfaces of costae grooved or not, if grooved, not open to admit grooves 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 reniform, glabrous or bearing hairs and or glands.

KEY TO THE GENERA

1. Fronds pinnate; costae grooved on upper surface
   2. Pinnae subentire..... **5. Pronephrium**
   2. Pinnae variously lobed
      3. Aerophore present at junction between rachis and costa
         5. Lower pinnae usually reduced; lower surface of rachis and costae not densely hairy ..... **4. Pneumatopteris**
         5. Lower pinnae not reduced; lower surface of rachis and costae not densely hairy ..... **6. Trigonospora**
      3. Aerophore absent at base of costa
         4. Basal pinnae much narrowed at base; 1-2 pairs of basal pinnae reduced .....**1. Amphineuron**
         4. Basal pinnae not much narrowed at base; a few pairs of basal pinnae reduced.....**2. Christella**
1. Fronds bipinnate; costae not grooved on upper surface.....**3. Macrothelypteris**

1. AMPHINEURON

Holttum, Blumea 19(1): 45-46, f. 19, 19a. 1971; Holttum, in Fl. Males., Ser. II. 1: 544. 1981;

Rhizome erect, or short-creeping; scales narrow, setiferous. Stipes minutely hairy, usually scaly at base. Fronds often very large, pinnate, pinnae deeply lobed; basal pinnae much narrowed at their bases; areophores absent; veins pinnate in the pinna-lobeds, simple, basal veins either free and passing to the margin separately, or connivent at the sinus-membrane, or anastomosing to form an excurrent vein; sinus-membrane usually ending in a prominent toothed; short acicular hairs always present on some part of the lower surface, also glandular hairs of varying size and shape, spherical to pyriform or club-shaped. Sori medial or supramedial; indusia usually present, bearing glands and or hairs.

KEY TO THE SPECIES

1. Rhizome short, erect; pinnae lobed more than half way ..... **1. A. immersum**
1. Rhizome long-creeping; pinnae lobed half way to costa ..... **2. A. terminans**

1. Amphineuron immersum (Blume) Holttum, in Nayar & Kaur, Comp. Bedd. Handb.: 203.1974; Blumea 23: 211. 1977; in Fl. Males., Ser. II. 1: 547. f. e. 1981.— *Aspidium immersum* Blume, En. Pl. Jav.: 156. 1828.— *Lastrea immerse* (Blume) T.Moore, Ind. Fil.: 89 . 1857.— *Thelypteris immersa* (Blume) Ching, Bull. Fan Mem. Inst. Biol., Bot. 6(5): 306. 1936.; Tagawa & K.Iwats., Fl. Thailand 3(3) : 433. f. 45. 1988. Fig. 5.105.

Rhizome short, erect, thick; scales linear, brown, up to 15 by 1 mm, hairy on dorsal surface as well as at margin. **Stipes** stramineous to pale castaneous, about 85 cm long, scaly near base, pubescent. **Fronds** oblong-lanceolate, pinnate, about 68 by 48 cm; lateral pinnae more than 20 pairs, lower ones opposite, linear-lanceolate, acuminate at apex, narrowing towards sessile base, about 28 by 3 cm, deeply lobed to costae leaving about 1 mm below the sinus; lobes patent or a little falcate, narrowly oblong, moderately acute at apex, entire, about 15 by 3 mm; thin, papyraceous , pale green; veins pinnate, veinlets simple, more than 17 pairs, covered densely with yellow

glands; costae, costules and veins hairy, hairs pale, setose, 1 mm or longer. **Sori** medial; indusia up to 0.8 mm in diameter, glabrous, persistent.

Thailand.— NORTHERN: Lampang; EASTERN: Chaiyaphum (Nam Phrom); SOUTH-EASTERN : Chantthaburi (Khao Soi Dao); SOUTH-WESTERN : Prachuap Khiri Khan (Sam Roi Yot), Kanchanaburi (Si Sawat); PENINSULAR : Nakhon Si Thammarat (Khao Luang), Phangnga (Yan Yao), Trang (Khao Chong), Satun, Yala (Bannang Sata).

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

Ecology.— Terrestrial on rather dry mountain in tropical rain forest about 600-700 m alt.

Specimens examined.— W. Khwaiphan 211, T. Boonkerd 69 [BCU]; D. Middleton et al. 400, 543, C. C, K. L & E. W 4098 [BKF].

2. Amphineuron terminans (Hook.) Holttum, Amer. Fern J. 63: 82. 1973; Blumea 23: 207. 1977; in Fl. Males., Ser. II. 1: 545. f. 19a. 1981.— *Nephrodium terminans* Hook., Sp. Fil. 4: 73.1862.— *Thelypteris terminans* (Hook.) Tagawa & K.Iwats., Acta Phytotax. Geobot. 26: 169. 1975; Fl. Thailand 3(3): 432. 1988. Fig. 5.106.

Rhizome long-creeping, about 1 cm in diameter; scales narrow, brown, up to 6 by 1 mm, hairy. **Stipes** 80 cm long, stramineous with dark scaly base. **Fronds** oblong-lanceolate, acute at apex, 50-80 by about 40 cm; lateral pinnae more than 25 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 30 by 1.5-2 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 pinnae 1-1.5 pairs uniting with those of the next group below sinus. **Sori** confined to upper part of segments, often hollowed; indusia persistent, hairy.

Thailand.— Common all over the country.

Distribution.— Tropics of Asia (type from Myanmar) to Australia (Queensland).

Ecology.— Terrestrial on rather dry mountain slopes in tropical rain forest about 800-900 m alt.

Specimens examined.— W. Khwaiphan 205, T. Boonkerd 71, 72, 605 [BCU]; Tagawa et al. 9747, T. Smitinand 8446 [BKF].

2. CHRISTELLA

H. Lév., Fl. Kouy-Tcheou 472. 1915; Kuo, Fl. Taiwan vol. 1. 2nd ed.: 402. 1980; Holttum, in Fl. Males., Ser. II. 1: 550. 1981.

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

KEY TO THE SPECIES

1. Lower pinnae reduced
   2. Rhizome erect
      3. Scales narrow; lower pinnae reduced to form butterfly-shaped auricles..... .....**2. C. hispidula**
      3. Scales broad, membranous; lower pinnae gradually becoming smaller downwards.....**3. C. papilio**
   2. Rhizome creeping
      4. Veinlets actually uniting about 1.5 pairs; indusia densely long hair..... ..... **5. C. subelata**
      4. Veinlets actually uniting more 2 pairs; indusia minutely short hair..... ..... **6. C. subpubescens**
1. Lower pinnae not or slightly reduced
   5. Fronds glandular, with short hairs.....**4. C. parasitica**
   5. Fronds not glandular, with dense long hairs..... **1. C. appendiculata**

1. Christella appendiculata (C.Presl) Holttum, Kew Bull 31(2): 311. 1976; Tagawa & K.Iwats., Fl. Thailand 3(3): 424. f. 44. 4-6. 1988.— *Aspidium molliusculum* Kuhn, Bot. Zeit. 26: 41. 1868.— *Nephrodium molliusculum* (Kuhn) Bedd., Handb. Suppl.: 68. 1892.— *Cyclosorus molliusculus* (Kuhn) Ching, Bull. Fan Mem. Inst. Biol. 8: 197. 1938.— *Thelypteris molliuscula* (Kuhn) K.Iwats. in Hara, Fl. E. Himal.: 484. 1966. Fig. 5.107.

Rhizome creeping, about 1 cm in diameter; scales narrow, up to 7 by 1 mm, brown, hairy. **Stipes** about 45 cm long, hairy throughout, scaly and dark at base. **Fronds** oblong-lanceolate, acute at apex, 55 by 23 cm; basal 1 or 2 pairs of pinnae patent or ascending, more or less falcate, caudate acuminate at apex, truncate at sessile base, basal of pinnae auricled at least at acroscopic side, deeply lobed nearly to costa, up to 12 by 1.8 cm; rachis and costae rather densely hairy throughout; segments oblong, oblique, moderately acute to rounded at apex, entire, up to 8 by 3 mm; veinlets towards callous-sinus, underside of veins and laminar surface densely hairy with long, patent, pale hairs, not glandular; texture thinly papyraceous, pale green, densely hairy with setose unicellular hairs, **Sori** medial; indusia densely long-hair.

Thailand.— NORTH-EASTERN: Phetchabun (Phu Miang); SOUTH-EASTERN: Prachin Buri (Khao Yai).

Distribution.— Himalaya (type) to N. Myanmar.

Ecology.— Terrestrial on mountain slopes in tropical rain forest about 700-800 m alt.

Specimens examined.— W. Khwaiphan 021, 024, 028, 209 [BCU];

2. Christella hispidula (Decne) Holttum, Kew Bull. 31(2): 312. 1976; in Fl. Males., Ser. II. 1: 557. f. 20 b-c. 1981.— *Aspidium hispidulum* Decne, Nouv. Ann. Mus. Hist. Nat. Paris 3: 346. 1834.— *Dryopteris hispidula* (Decne) Kuntze, Rev. Gen. Pl. 2: 813. 1891.— *Thelypteris hispidula* (Decne) C.F.Reed, Phytologia. 17: 283. 1968. Fig. 5.108.

Rhizome erect, with a tuft of fronds; scales narrow pale brown, hairy, about 13 by 1 mm. **Stipes** about 30 cm long, castaneous, bearing reduced pinnae on upper portion, scaly at base, hairy throughout. **Fronds** oblong, acute at apex, gradually

narrowing downwards, up to 35 by 14 cm; lateral pinnae about 30 pairs, patent, sessile, linear-lanceolate, more or less auricled at base, gradually narrowing towards long-acuminate apex, up to 7 by 1 cm, lobed 2/3 way to costae; lower pinnae gradually becoming smaller downwards, reduced segments oblong, oblique, rounded at apex, entire; hairs on lower surface, about 0.7 cm long, papyraceous. **Sori** medial round; indusia densely hairy.

Thailand.— SOUTH-EASTERN: Prachin Buri (Khao Yai).

Distribution.— Tropical America and wetter parts of tropical Africa; Ceylon & S. India; Khasya Hills southwards to Malaya; throughout Malesia: Caroline Island.

Ecology.— Terrestrial on mountain slopes in tropical rain forests about 800-900 m alt.

Specimens examined.— W. Khwaiphan 030 [BCU].

3. Christella papilio (C.Hope) Holttum, in Nayar & Kaur, Comp. Bedd. Handb.: 208. 1974; Kuo, Fl. Taiwan vol. 1. 2nd ed.: 402. 1980; Holttum in Fl. Mal. I. 1: 556. f. 20 d-e. 1981.— *Nephrodium papilio* C.Hope, J. Bombay Nat. Hist. Soc. 12: 625. t. 12. 1899.— *Cyclosorus papilio* (C.Hope) Ching, Bull. Fan Mem. Inst. Biol. 8: 214. 1938; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 382. 1941.— *Thelypteris papilio* (C.Hope) K.Iwats., Mem. Coll. Sci. Univ. Kyoto B, 31: 175. 1965. Fig. 5.109.-5.110.

Rhizome short, erect, ascending, with a tuft of fronds; scales broad, about 3 by 0.5 mm membranous, usually appressed, hairy. **Stipes** about 6-10 cm long, bearing reduced pinnae scaly at base, hairy throughout. **Fronds** oblong acute at apex, gradually narrowing downwards, up to 50 by 13 cm; lateral pinnae about 15 pairs, patent to ascending, sessile, linear-lanceolate, more or less auricled at base, gradually narrowing towards long-acuminate apex, up to 7.5 by 1.5 cm lobed 1/3 way to costa; lower reduced pinnae butterfly-shaped, usually opposite in pairs; segments oblong, oblique, rounded at apex, entire; paryraceous, green, glabrous on both surfaces; venation goniopteroid, basal 2 pairs anastomosing below callous-sinus. **Sori** medial, round; indusia rather sparsely hirsute.

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

Distribution.— Sri Lanka, Himalya (type), Taiwan, and Malaya.

Ecology.— Terrestrial on moist ground by stream in tropical rain forest about 700-800 m alt.

Specimens examined.— W. Khwaiphan 102, O. Vannasri 47, 48, P. Ratchata 269 [BCU]; Larsen et al 34518, J. F. Maxwall 98-815 [BKF].

4. Christella parasitica (L.) H.Lév., Fl. Kouy-Tcheou 475. 1915; Kuo, Fl. Taiwan vol. 1. 2nd ed.: 406. 1980; Holttum in Fl. Mal. I. 1: 559. f. 20 f. 1981.— *Polypodium parasiticum* L., Sp. Pl. 1090. 1753.— *Dryopteris parasitica* (L.) Kuntze, Rev. Gen. Pl. 2: 811. 1891.— *Cyclosorus parasiticus* (L.) Farwell, Amer. Midl. Nat. 12: 259. 1929; Holttum, Rev. Fl. Malaya 2: 281. f. 162. 1954.— *Thelypteris parasitica* (L.) Fosberg, Occ. Pap. B.P. Bishop Mus. 23: 30. 1962. Fig. 5.111.

Rhizome creeping, about 1 mm in diameter; scales narrow, up to 12 by 1 mm, dark brown, hairy. **Stipes** about 22.3 cm long, scaly at base, hairy throughout. **Fronds** oblong-lanceolate, acute at apex, about 41 by 15 cm; basal pinnae deflexed, lower pinnae patent or ascending, linear-lanceolate, sessile at acroscopic base, about 9 by 1 cm, lobed more than half-way towards costae; segments oblong, oblique, rounded at apex, entire; thinly papyraceous, underside of veins and laminar surface short hairy, the other veinlets running to margin of lobes, glandular; glands sessile, rod-shaped, orange to red. **Sori** supermedial, one or two veinlets; indusia persistent, hairy.

Thailand.— NORTHERN: Chiang Rai (Doi Tung, Mae Kok), Chiang Mai (Mae Hok, Doi Chiang Dao, Wang Tao, Doi Saket, Doi Suthep, Mae Klang, Pha Mon), Lampang (Mae Ngao), Tak (Mae Sot), Phitsanulok (Thung Salaeng Luang); EASTERN: Chaiyaphum (Nam Phrom); NORTH-EASTERN: Loei (Phu Kradueng); SOUTH-EASTERN: Chon Buri (Si Racha), Trat (Ko Chang); PENINSULAR: Surat Thani (ban Don, Ban Huai Tha), Nakhon Si Thammarat (Khiriwong), Phangnga, Trang, Satun.

Distribution.— Tropics and subtropics in Asia (type from S. China), north to S. Japan and south to New Zealand.

Ecology.— Terrestrial on rather dry slopes along path in open places or in tropical rain forests and hill evergreen forest about 700-1,300 m alt.

Specimens examined.— W. Khwaiphan 003, T. Boonkerd 290, 291 [BCU]; T. Smitinand 1276, J. F. Maxwall 87-700 [BKF].

5. Christella subelata (Baker) Holttum, Kew Bull. 31(2): 331. 1976.— *Nephrodium subelatum* Baker, Kew Bull. 11. 1906.— *Cyclosorus subelatus* (Baker) Ching, Bull. Fan Mem. Inst. Biol. 8: 224. 1938.— *Thelypteris subpubescens* auct. non (Blume) K.Iwats.: Tagawa & K.Iwats., Southeast As. St. 5: 65. 1967, p.p.; in Fl. Thailand 3(3): 429. 1988. Fig. 5.112-5.113.

Rhizome creeping, about 7 in diameter; scales narrow, up to 2 by 1 mm, dark brown hirsute. **Stipes** about 34 cm long, hairy throughout, bearing reduced lower pinnae on upper portion. **Fronds** oblong, acuminate at apex with long terminal pinna, up to 70 by 30 cm; lower lateral pinnae shortened to mere auricled, middle pinnae shortly stalked or subsessile, linear-lanceolate, gradually narrowing towards acuminate apex, round to broadly cuneate at base, about 15 by 2 cm, lobed more than 1/3 way to costa; segments oblong to subrectangular, oblique, rounded at apex, basal more 2 pairs anastomosing venation, papyraceous, dark to grayish-green, pale below, subglabrous to below callous-sinus. **Sori** medial; indusia round, persistent, densely long hairy.

Thailand.— NORTHERN: Chiang Rai (Doi Tung, Mae Sai, Mae Kok, Doi Phacho, Ban Doi Hang), Chiang Mai (Doi Phahom Pok, Fang, Doi Chinag Dao, Kang Kat, Doi Suthep, Ban Yang), Mae Hong Son (Ban Mae Pong), Lamphun (Doi Khun Tan), Lampang, Tak (Doi Musoe, Mae Sot), Phrae (Mae Sai), Phitsanulok (Phu Miang); NORTH-EASTERN: Nong Khai, Loei (Phu Kradung); SOUTH-EASTERN: Chon Buri (Si Racha), Chanthaburi (Khao Soi Dao, Ta Khamao Falls); SOUTH-WESTERN: Kanchanaburi (Sai Yok).

Distribution.— SW. China (type) and Upper Myanmar.

Ecology.— Terrestrial on mountain slopes in open places in tropical rain forest about 700-900 m alt.

Specimens examined.— W. Khwaiphan 212 [BCU]; M. Tagawa et al. T- 9237 [BKF].

6. Christella subpubescens (Blume) Holttum, Kew Bull. 31: 323 . 1976; in Fl. Males., Ser. II. 1: 558. f. 20 g. 1981.— *Aspidium subpubescens* Blume, En. P1. Jav.: 149. 1828.— *Dryopteris subpubescens* (Blume) C.Chr., Gard. Bull. S. S. 4: 390. 1929.— *Cyclosorus subpubescens* (Blume) Ching, Bull. Fan Mem. Inst. Biol. 8: 211. 1938; Holttum, Rev. Fl. Malaya 2: 273. f. 157. 1955.— *Cyclosorus parasiticus* (L.) Farw. var. *subpubescens* (Blume) Tardieu & C.Chr., Notul. Syst. 7: 78.1938; in Fl. Gén. I.-C. 7(2): 382. 1941; Seidenf., Nat. Hist. Bull. Siam Soc. 19: 86. 1958.— *Thelypteris subpubescens* (Blume) K.Iwats., Mem. Coll. Sci. Univ. Kyoto B. 3: 173. 1965; Tagawa & K.Iwats., Fl. Thailand 3(3): 428. 1988. Fig. 5.114.

Rhizome short-creeping; scales pale brown, hairy, about 5 by 1 mm. **Stipes** about 13 cm long, bearing lower pinnae gradually decrescent, scaly at base, hairy throughout. **Fronds** oblong, acute at apex, up to 24 by 9 cm, lateral pinnae about 12 pairs less deeply lobed, linear-lanceolate, more or less auricle at base, gradually narrowing towards long-acuminate apex, up to 5 by 0.7 cm, lobed 1/3 to 2/3 way to costa; segment oblong, moderately acute at apex, entire, basal 1.5 pairs anastomosing venation; lower surface of rachis, costae and costules bearing hairs about 0.2 mm. **Sori** medial, round; indusia rather large, thin, minutely short hairy.

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

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

Ecology.— Terrestrial on rather dry mountain-slopes in tropical rain forest about 800-900 m alt.

Specimens examined.— W. Khwaiphan 027 [BCU]; K. Iwatsuki, N. Fukuoka T 3430, 33831 [BKF].

3. MACROTHELYPTERIS

(H. Itô) Ching, Acta Phytotax. Sin. 8(4): 308-309. 1963; Holttum, Blumea 17: 25. 1969; in Fl. Males., Ser. II. 1: 347. f. 20 h-o. 1981.— *Thelypteris* group 10 Ching, Bull. Fan Mem. Inst. Biol. Bot. 6: 248. 1936.— *Thelypteris* sect. *Macrotelypteris* H. Itô in Nakai & Honda, Nov. Fl. Jap. n.4: 141. 1939.— *Thelypteris* subg. *Thelypteris* sect. *Metathelypteris* K.Iwats. Mem. Coll. Sci. Univ. Kyoto B, 31: 145. 1965, p.p.

Rhizome short, creeping or suberect; scales narrow, thickened at least near base, with marginal and superficial acicular and/ or capitate hairs. Fronds bipinnate-tripinnatifid with adnate pinnules; lowest pinnae little reduced; scales on rachis and pinna-rachis narrow, pallid, thickened at base and sometime wholly terete, with or without marginal hairs, hairs on surface of fronds slender and acicular or short and capitate, some long multicellular hairs always present. Sori small, usually with a small but persistent indusium, often hidden by mature sporangia.

Macrothelypteris torresiana (Gaudich) Ching, Acata Phytotax. Sinica 8: 310. 1963; Holttum, Blumea 17: 27. 1969; in Fl. Males., Ser. II. 1: 347. f. 2 h-j. 1981.— *Polystichum torresianum* Gaudich in Freyc. Voy. Uran. Physic. Bot. 333. 1828.— *Thelypteris torresiana* (Gaudich) Alston, Lilloa 30: 111. 1960; Tagawa & K.Iwats., Fl. Thailand 3(3): 398. 1988. Fig. 5.115-5.116.

Rhizome short, suberect; scales narrow, brown, up to 2 by 1 mm, hairy on dorsal surface as well as margin, the base often a few cells thick. **Stipes** up to 30 cm long, about 3 mm in diameter near base, sometimes spinose in lower part. **Fronds** oblong to oblong-ovate, tripinnate, up to 33 by 24 cm; pinnae oblong, acuminate at apex, up to 12 by 6 cm; larger pinnules sessile, oblong-subdeltoid, acuminate at apex, up to 4 by 1.3 cm; ultimate segments oblong, oblique, rounded to moderately acute at apex, lobed to ¾ way towards midrib; lobes oblong to subdeltoid, entire, sometimes involute; rachis terete, glabrous; pinna-rachis hairy on upper surface, costules winged throughout, hairy; veins and surfaces hairy with unicellular or multicellular hairs; texture herbaceous to softly papyraceous, green but often brownish when dried. **Sori** round.

Thailand.— NORTHERN: Chiang Rai, Chiang Mai (Doi Chiang Dao, Bo Luang, Doi Saket, Mae Klang, Pha Mon), Lampang, Lamphun (Doi Khun Tan), Tak (Ban Musoe); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Trat (Ko Chang); SOUTH-WESTERN: Kanchanaburi (Sai Yok); PENINSULAR: Chumphon, Surat Thani (Ban Don), Nakhon Si Thammarat (Khao Luang), Satun, Yala (Betong).

Distribution.— Mascarene Islands, throughout tropical Asia (type from Mariana Islands), Polynesia, Hawaii, north to Japan and south to Australia also naturalized in the World.

Ecology.— Terrestrial on mountain slope in tropical rain forest about 700-900 m alt.

Specimens examined.— W. Khwaiphan 001, 033, 022, 050,181, Y. Yuyen 41, P. Ratchata 237 [BCU]; M. Tagawa et al. 9336, S. Tsugaru 61695 [BKF].

4. PNEUMATOPTERIS

Nakai Bot. Mag. (Tokyo) 47(555): 179. 1933; Holttum, Blumea 19: 42. 1973, excl. *Pseudocyclosorus* Ching; in Fl. Males., Ser. II. 1: 414. f. 11. 1981.— *Thelypteris* subg. *Pneumatopteris* K.Iwats., Mem. Coll. Sci. Univ. Kyoto B. 31: 33. 1964, excl. sect. *Macrocyclosorus.*— *Cyclosorus* sensu Ching, Bull. An Mem. Inst. Biol. Bot. 8: 230. 1938, p.p.; sensu Holttum, Rev. Fl. Malaya 2: 255. 1954, p.p.

Rhizome usually short, erect, decumbent or long-creeping. Stipes not conspicuously hairy, scales thin, bearing few marginal acicular hairs. Fronds usually large with many pinnae, reduced basal pinnae, areophores at bases of costa; pinnae lobed, veins free or the basal veins at least anastomosing; lower surface of rachis and costae not densely hairy. Sori usually covered with thin indusia.

Pneumatopteris truncata (Poir.) Holttum, Blumea 21: 314. 1973; in Fl. Males., Ser. II. 1 : 429. f. 11. d-f. 1981.— *Polypodium truncatum* Poir., Encycl. Meth. 5: 534. 1804.—*Nephrodium truncatum* (Poir.) C.Presl, Tent. Pterid.: 81. 1836.— *Dryopteris truncata* (Poir.) C.Chr. Ind. Fil. 299. 1905, excl. *Polystichum truncatum* Gaudich— *Cyclosorus truncatus* (Poir.) Tardieu ex Tardieu & C.Chr., Notul. Syst. 7: 78. 1938; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 394. 1939; Holttom, Rev. Fl. Malaya 2: 266. f. 152. 1954.— *Thelypteris truncata* (Poir.) K.Iwats., Mem. Coll. Sci. Univ. Kyoto B. 31: 33. 1964; Tagawa & K.Iwats., Fl. Thailand 3(3) : 420. 1988. Fig. 5.117-5.118.

Rhizome short, erect; scales brown, thin, up to 1.5 by 4 mm, consisting of large cells, hairy. **Stipes** usually more than 50 cm long, pale, dark and scaly at base, pubescent, bearing reduced pinnae in upper part. **Fronds** oblong-lanceolate, up to 100 cm long, 50 cm wide; lower pinnae suddenly reduced to mere auricles, middle pinnae larger, straight, ascending, up to 20 by 2.5 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, persisent.

Thailand.— NORETHRN: 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, Myanmar, Indochina, Ryukyu Is., Taiwan, W. Malesia to Philippines.

Ecology.— Terrestrial on wet ground by stream in light shade in tropical rain forest about 700-800 m alt.

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

Specimens examined.— W. Khwaiphan 100, P. Ratchata 8, 133, 138, 218 [BCU]; T. Santisuk & B N 357, 409 [BKF].

5. PRONEPHRIUM

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

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

KEY TO THE SPECIES

1. Rhizome stout; fronds imparipinnate.....**1. P. nudatum**
1. Rhizome slender; fronds trifoliate.....**2. P. triphyllum**

1. Pronephrium nudatum (Roxb.) Holttum, Blumea 20(1): 111. 1972.— *Polypodium nudatum* Roxb., Calc. J. Nat. Hist. 4: 491. 1844.— *Polypodium multilineatum* Wall. ex Hook., Sp. Fil. 5: 11. 1863.— *Nephrodium moulmeinense* Bedd., Ferns Br. Ind. Suppl.: 18. 1876.— *Nephrodium multilineatum* (Wall. ex Hook.) Bedd., Handb. Suppl.: 80. 1892.— *Dryopteris moulmeinense* (Bedd.) C.Chr., Ind. Fil.: 278. 1905.— *Dryopteris urophyllum* auct. non (Mett.) C.Chr.: Bonap., Not. Pterid. 14: 49. 1923.— *Nephrodium urophyllum* auct. non (Mett.) Keys.: J. Sm., J. Siam. Soc. Nat. Hist. Suppl. 8: 5. 1929.— *Abacopteris multilineata* (Wall. ex Hook.) Ching, Bull. Fan Mem. Inst. Biol. 8: 253. 1938.—*Cyclosorus multilineatus* (Wall. ex Hook.) Tardieu & C.Chr. in Fl. Gén. I.-C.7(2): 358. 1939.— *Thelypteris multilineata* (Wall. ex Hook.) C.V.Morton, Amer. Fern J. 49: 113. 1959.— *Thelypteris nudata* (Roxb.) C.V.Morton, Contr. U.S. Nat. Herb. 38 : 352. 1974; Tagawa & K.Iwats., Fl. Thailand 3(3): 412. f. 41. 1, 42. 2-3. 1988. Fig. 5.119-5.120.

Rhizome creeping, stout, about 5 mm in diameter; scales caducous, dark brown, hairy, up to 5 by 1.5 mm. **Stipes** about 70 cm long, scaly at base. **Fronds** oblong, up to 74 by 30 cm; lateral pinnae lanceolate, sessile, ascending, gradually narrowing towards long-acuminate apex, rounded to narrowly cuneate at base, subentire or crenate,up to 29 by 3 cm; terminal pinnae like lateral ones, rounded to subtruncate at base; marginal lobes acute at apex, with cartilaginous margin; chartaceous, green, verrucose on lower surface; venation meniscioid. **Sori** rather close to excurrent veinlets or medial in two rows between costules; indusia setose.

Thailand.— NORETHERN: Chiang Rai (Mae Kok, Doi Tung, Doi Phacho), Chang Mai (Doi Phahom Pok, 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 (Mae 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 (Bannang Sta).

Distribution.— Himalaya (type), Myanmar, China and N. Vietnam.

Ecology.— Terrestrial by stream in light shade in tropical rain forest about 700-800 m alt.

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

Specimens examined.— W. Khwaiphan 167, P. Ratchata 193, 284, T. Boonkerd 502 [BCU]; K. Larsen & T. Smitinand 567, K. Iwatsuki T 7426 [BKF].

2. Pronephrium triphyllum (Sw.) Holttum, Blumea 20: 122. 1972; in Fl. Males., Ser. II. 1: 534. f. 16, k-1. 1981.— *Meniscium triphyllum* Sw., Schrad. J. Bot. 1800(2): 16. 1801.— *Dryopteris triphylla* (Sw.) C.Chr., Ind. Fil.: 298. 1905; Seidenf., Nat. Hist. Bull. Siam Soc. 19: 87. 1958.— *Cyclosorus triphyllus* (Sw.) Tardieu ex Tardieu & C.Chr., Notul. Syst. 7: 77. 1938; in Fl. Gén. I.-C. 7(2): 386. 1939.— *Abacopteris triphylla* (Sw.) Ching, Bull. Fan Mem. Inst. Biol. 8: 241. 1938; Holttum, Rev. Fl. Malaya 2: 287. f. 166. 1954.— *Thelypteris triphylla* (Sw.) K.Iwats., Mem. Coll. Sci. Univ. Kyoto B. 31: 190. 1965; Tagawa & K.Iwats., Fl. Thailand 3(3): 414. 1988. Fig. 5.121.

Rhizome long-creeping, slender, about 4 mm in diameter; scales narrow, up to 5 by 1 mm, brown, hairy. **Stipes** remote, about 45 cm long, stramineous with dark scaly base, hairy. **Fronds** trilobed; terminal pinnae larger, oblong-lanceolate, caudate-acuminate at apex, rounded to cuneate at base, up to 25 by 5 cm, subentire or irregularly undulate; lateral pinnae in one opposite pair, more or less falcate, caudate at apex, cuneate to round at base, 5-15 by 1-3 cm; venation meniscioid, hairy; texture herbaceous to thinly papyraceous, deep green, often tinted red in dried specimens. **Sori** elongate along united veinlets, crescent-shaped, naked; sporangia setiferous.

Thailand.— NORTH-EASTERN: Loei (Huai Ya); CENTRAL: Nakhon Nayok (Khao Yai).

Distribution.— India, Myanmar (type), Indochina, Malaya, Taiwan and the Ryukyus.

Ecology.— Terrestrial by stream in light shade in tropical rain forest about 700-800 m alt.

Specimens examined.— W. Khwaiphan 105, 151; T. Boonkerd 211, 212, 1381 [BCU]; T. Smitinand 1313; K. Iwatsuki and N. Fukuoka 7382 [BKF].

6. TRIGONOSPORA

Holltum, Blumea 19: 29. 1971; in Fl. Males., Ser. II. 1: 373. f. 5 c-f. 1981.— *Pseudocyclosorus* Ching, Acta Phytotax. Sinica. 8: 322. 1963, p.p.

Rhizome short, erect. Fronds lacking reduced basal pinnae; areophores at bases of costa; veins free, unbranched, lowest acroscopic veins ending beside short sinus-membrane, basal basiscopic veins to edge above base of sinus; acicular unicellular hair variously developed on lower surface. Sori indusiate.

Trigonospora ciliata (Wall. ex Benth.) Holttum, Blumea 19: 29. 1971; in Fl. Males., Ser. II. 1: 375. f. 5, c-e. 1981.— *Lastrea ciliata* Hook, J. Bot. Kew. Misc. 9: 338. 1857.— *Aspidium ciliatum* Wall. ex Benth., Fl. Hongk.: 455. 1861.— *Lastrea calcarata* (Blume) Bedd. var. *ciliata* (Wall. ex Benth.) Bedd., Handb.: 235. f. 121. 1883, p.p.— *Dryopteris ciliata* (Wall. ex Benth.) C.Chr. ex Wu et al., Bull. Dept. Biol. Sunyatsen Univ. n. 3: 30. pl. 6. 1922.— *Thelypteris ciliata* (Wall. ex Benth.) Ching, Bull. Fan Mem. Inst. Biol. 6: 289. 1936; Tardieu & C.Chr. in Fl. Gen. I.-C. 7(2): 362. 1939; Holttum, Rev. Fl. Malaya 2: 250. f. 142. 1954; Tagawa & K.Iwats., Fl. Thailand 3(3): 401. 1988. Fig. 5.122-5.123.

Rhizome short, erect; scales up to 2 by 1 mm, membranous, appressed, brown, hairy. **Stipes** stramineous to greyish, hairy throughout, about 7 cm long. **Fertile fronds** usually taller and larger than sterile ones, oblong-lanceolate, acute at apex, 11-14 by 4-5 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 costae densely hirsute; segments falcate, oblique, rounded at apex, subentire, hairy at margin; chartaceous or 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.— Nepal to W. Malesia, north to Hong Kong (type).

Ecology.— Terrestrial by stream in tropical rain forest about 700-800 m alt.

Specimens examined.— W. Khwaiphan 037 [BCU]; E. Hennipman 3989, H. Koyama et al. 33831 [BKF].

ORDER DAVALLIALES

DAVALLIACEAE

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

Mostly epiphytes with long creeping scaly rhizomes; stipes articulate to rhizome. Fronds usually broadly deltoid and often finely dissected, but sometimes simple, venation free. Sori submarginal, terminal on veinlets; indusia tubular, scale-like, or linear and continuous, opening towards margin.

KEY TO THE GENERA

1. Rhizome scaly as well as hairy ..... **3. Leucostegia**
1. Rhizome scaly
   2. Indusia attached by base and sides ..... **1. Davallia**
   2. Indusia attached by base only, or rarely also by a little above the base ..... **2. Humata**

1. DAVALLIA

Sm., Mem. Acad. Turin. 5: 414. 1793; Tagawa & K.Iwats., Fl. Thailand 3(2): 162. 1985.

Rhizome long-creeping, usually thick, densely scaly with peltate or cordate scales. Stipes naked, articulated to rhizome. Fronds usually deltoid, coriaceous to chartaceous, green, glabrous. Sori round, terminal on vein, usually close to margin; indusia attached by base and sides, cup-shaped.

KEY TO THE SPECIES

1. Rhizome thick, more than 1 cm; scales gradually narrowing towards long-tailed apex ..... **1. D. embolostegia**
1. Rhizome slender, up to 0.5 cm; scales gradually narrowing from peltate base to acuminate apex ..... **2. D. trichomanoides var. trichomanoides**

1. Davallia embolostegia Copel. Philipp. J. Sci. 1 (Suppl. 2): 147, t. 3. 1906; Noot., Blumea. 39. 182. 1994; Noot. in Fl. Males., Ser. II. 3: 253. 1998. Fig. 5.124-5.125.

Rhizome about 1-1.3 cm in diameter, densely scaly throughout; scales linear-lanceolate, gradually narrowing towards long-tailed apex, up to 15 by 2 mm, ciliate, pale brown. **Stipes** castaneous, adaxially groove, up to 70 cm long. **Fronds** tripinnate, quadripinnatifid, deltoid and broadest towards the base, glabrous, 50-60 by 30-35 cm; basal pinnae the largest, deltoid, stalked, up to 20 by 15 cm wide; pinnules, deltoid, gradually narrowing from base to long acuminate apex, cuneate at moderately acute, lobe moderately acute, entire, glabrous; veins pinnate, without false veinlets. **Sori** terminal on veinlets; indusia cup-shaped, longer than wide, about 1 by 0.5 mm.

Thailand.— EASTERN: Nakhon Ratchasima (Pak Chong, Khao Yai National Park)

Distribution.— Malesia, Sumatra, Borneo, Philippines, Moluccas, Pacific

Ecology.— Terrestrial on dry slopes in hill evergreen forest about 900-1,300 m alt.

Specimens examined.— W. Khwaiphan 004, T. Boonkerd & R. Pollawatn 349 [BCU].

2. Davallia trichomanoides Blume, En. Pl. Jav.: 238. 1828; Holttum, Rev. Fl. Malaya 2: 361. 1954; Tagawa & K.Iwats., Fl. Thailand 3(2): 162. 1985.

var. trichomanoides.— *Davallia bullata* Wall. ex Hook. Sp. Fil. 1: 169. t. 50B. 1846; Tagawa & K.Iwats., Fl. Thailand 3(2): 163. 1985. Fig. 5.126.

Rhizome long-creeping, about 3-5 mm in diameter, densely scaly throughout; scales gradually narrowing from peltate base to acuminate apex, dark brown, short-hairy at margin. **Stipes** stramineous, about 13 cm long. **Fronds** deltoid or roundly pentagonous, gradually narrowed from base to apex, about 23 cm long and 25 cm wide, tripinnate to quadripinnatifid; basal pinnae the largest, gradually narrowed from base to apex, 12 by 8.6 cm, shortly stalked; upper pinnae gradually smaller upwards; pinnules very shortly stalked, moderately acute at apex, cuneate at base, ultimate segments lobed more than half-way towards midribs; lobes acute at apex, subcoriaceous, glabrescent, green, paler beneath; veins pinnate, hardly distinct. **Sori** terminal on veinlets; indusia cup-shaped, up to 1.5 mm long, 0.6 mm diam.

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

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

Ecology.— Epiphyte on mossy tree trunk in tropical forests on ridges at low to medium altitudes.

Specimens examined.— W. Khwaiphan 071, P. Ratchata 156 [BCU]; E. Smith 879, Tagawa et al. T-401 [BKF].

2. 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. Stipes articulated to rhizome, grooved above. Fronds simple to tripinnatifid,

coriaceous, glabrous. Sori round, terminal on veinlets, marginal; indusia attached only by base, or rarely by the sides a little above the base.

Humata repens (L.f.) Diels. in Pflanzenfam. 1(4): 209. 1899; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 111. f. 13, 1. 1939; Holttum, Rev. Fl. Malaya 2: 371. f. 216. 1954; Seidenf., Nat. Hist. Bull. Siam. Soc. 19: 86. 1958; Tagawa & K.Iwats., Fl. Thailand 3(2): 166. 1985.— *Adiantum repens* L.f., Suppl.: 446. 1781.— *Davallia repens* (L. f.) Kuhn, Fil. Deck.: 27. 1867.— *Humata pinnatifida* Bedd., Handb. Suppl.: 12. 1892.— *Pachypleuria repens* (L. f.) M. Kato, Fac. Sci. Univ. Tokyo, Sect. 3, Bot. 13(5): 573. 1985. Fig. 5.127.

Rhizome long creeping, about 2 mm in diameter, glabrous, densely scaly throughout; scales acuminate at basal edges, long-acuminate at apex, up to 7 by 1.2 mm, brown. **Stipes** stramineous, terete, up to 10 cm long, sparse scaly. **Fronds** oblong-subdeltoid or roundly pentagonous, 7.5 by 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 semicircular, entire and free except for the bases, to 1 mm broad.

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 Mio, trang (Khao Chong), Yala (Gunong Ina, Khao Kala Khiri).

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

Ecology.— Epiphytes on mossy tree-trunks or lithophytes in hill evergreen forest about 1000-1200 m alt.

Vernacular.— Kut hom bai yoi (กูดห้อมใบย่อย) (Northern); kut thong (กูดทอง) (North-eastern); nakkharat tua mia (นาคราชตัวเมีย) (South-eastern).

Specimens examined.— W. Khwaiphan 002, 057; T. Boonkerd 600, 1081, 1407 [BCU]; K. Larsen et al. 26, C. Phengklai et al. 13576 [BKF].

3. LEUCOSTEGIA

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

Rhizome creeping, bearing both hairs and scales, with hairy roots all over the surface; rhizome-scales broad, not distinctly bicoloured, entire. Stipes articulated to rhizome. Fronds pinately 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 and sides, reaching or surpassing the margin of segments.

Leucostegia immersa (Wall. ex Hook.) C.Presl, Tent. Pterid.: 95. t. 4. f. 11. 1836; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 113. 1939; Holttum, Rev. Fl. Malaya 2 : 352. 1954; Tagawa & K.Iwats., Fl. Thailand 3(2): 169. 1985.— *Davallia immersa* Wall. ex Hook., Sp. Fil. 1: 156. 1846. Fig. 5.128.

Rhizome wide-creeping, bearing fronds remotely; hairs rather dense, golden-yellow, multicellular, woolly; scales narrowly lanceolate, up to 5 by 0.5 mm, light brown, membranous, entire at margin. **Stipes** stramineous or brownish on lower surface, scaly at base, glabrescent upwards, up to 40 cm long. **Fronds** oblong, acuminate at apex, quadripinnatifid, up to 32 by 25 cm; pinnae more than 8 pairs, the lowest the largest, with distinct petioles, lower ones asymmetrically oblong-subdeltoid, acuminate at apex, broadly cuneate at base, up to 23 cm long and 12 cm 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, 2-3 mm broad, white to pale brown, glabrous.

Thailand.— NORTHERN: Chiang Rai (Doi Tung), 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 Kradung); SOUTH-WESTERN: Kanchanaburi (Bo Rae); PENINSULAR: Surat Thani (Ban Don)

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

Ecology.— Terrestrial on mountain-slopes or epiphyte on mossy tree-trunks, in hill evergreen forest 1,100 -1,300 m alt.

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

Specimens examined.— W. Khwaiphan 139, 160, P. Ratchata 310, T. Boonkerd 1039, 1235 [BCU]; M. Tagawa and N. Fukuoka T-3186, Larsen et al. 34458 [BKF].

OLEANDRACEAE

Ching ex Pic.Serm., Webbia 20(2): 745. 1965; Devol & Kuo, Fl. Taiwan vol. 1. 2nd ed.: 320. 1980.

Rhizome scandent, or long-creeping scaly, fronds distant, articulate to phyllopodia; or the caudex short, erect, sending out a mass of fibrous roots and long, slender stolons. Stipes tufted, stout, non-articulated. Fronds simple or pinnate, pinnae articulate or rachis, often caducous; venation free, once or twice forked. Sori round, dorsal or submarginal, borne on the end of a veinlet; indusia round or rentiform, sinus usually narrow.

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. Stipes with distinct articulation, leaving phyllopode of various heights. Lamina simple, entire, linear-lanceolate; veins usually once or twice forked near midribs, parallel and all free, close, ending in distinct hydathode. Sori dorsal on anterior branches of veins, close to midribs; indusia reniform.

Oleandra musifolia (Blume) C.Presl, Epim.: 42. 1849; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 284. 1939; Tagawa & K.Iwats., Fl. Thailand 3(2): 181. 1985.— *Aspidium musifolium* Blume, En. Pl. Jav.: 141. 1828. Fig. 5.129.

Rhizome long-creeping, up to 4 mm in diameter, bearing a few fronds in scattered tufts, densely scaly throughout; scales appressed, lanceolate, moderately acute at basal edge, gradually narrowing from the broadest attached portion to tailed apex, about 7 by 1.1 mm, brown with dark attached point, paler and hairy at margin of apical portion. **Stipes** usually short, up to 2 cm including low phyllopode less than 0.5 cm tall, bearing both scales and hairs. **Fronds** linear-lanceolate, caudately acuminate at apex, gradually narrowing towards narrow and cuneate base, up to 50 by 3 cm, the margin entire and usually plane; midribs raised below, scaly with peltate, lanceolate, pale brown scales of up to 3 mm long, herbaceous, light green; veins once or twice forked near midrib, all free, ending just inside narrow cartilaginous margin. **Sori** irregular row near midrib; indusia up to 1.5 mm in breadth, glabrous.

Thailand.— NORTHERN: Chiang Mai (Doi Chiang Dao, Doi Inthanon), Lamphun (Doi Khun Tan), Phrae (Mae Sai), Phetchabun (Phu Miang), Tak (Ban Musoe); NORTH-EASTERN: Loei (Phu Luang, Phu Kradung); 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.— Epiphyte on tree-trunks or Lithophyte in rock crevices at 1,000-1,300 m alt.

Vernacular.— Thao nakkharat (เถานาคราช).

Specimens examined.— W. Khwaiphan 133, Y. Yuyen 148, T. Boonkerd 1092, 1340/1 [BCU]; E. Hennipman 3655, T. Smitinand 1915 [BKF].

POLYPODIACEAE

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

Usually epiphyte, growing on tree trunks, or mossy rocks, some terrestrial. Rhizome dictyostelic, usually creeping; scales peltate, often clathrate. Fronds often simple, pinnate or rarely digitately lobed; stipes usually articulate to rhizome; veins anastomosing with included veinlets. Sori usually round, oval or linear, and in some genera acrostichoid; exindusiate; peltate, clathrate paraphyses often present.

KEY TO THE GENERA

1. Fronds simple or pinnate with pinnae not articulate to rachis
   2. Nest leaves present ..... **4. Drynaria**
   2. Nest leaves absent
      3. Fronds simple
         4. Fronds covered with stellate hairs..... **10. Pyrrosia**
         4. Fronds not having stellate hairs
            5. Fronds bearing peltate scales on surface or in sori
               6. Sori round on lower surface of fronds ..... **6. Lepisorous**
               6. Sori acrostichoid on narrow apical part of fronds ..... **2. Belvisia**
            5. Fronds not bearing any peltate scales
               7. Sori forming continous or broken lines oblique to the midribs of frond ..... **7. Loxogramme**
               7. Sori round or nearly so ..... **8. Microsorum**
      3. Fronds pinnate or pinnately lobed
         8. Fronds sessile, larger, basal portion like nest leaves..... **1. Aglaomorpha**
         8. Fronds with stipes
            9. Scale clathrate
               10. Sori sunk in cavities, large, one row on each side of the midrib of the fronds ..... **9. Phymatosorus**
               10. Sori not sunk in cavities, small, scattered on the whole under surface of fronds..... **7. Microsorum**

9. Scale not clathrate; sori a single row at each side of costa scattered on the under surface of fronds.....**3. Crypsinus**

1. Fronds pinnate with pinnae articulate to rachis.....**5. Goniophlebium**

1. AGLAOMORPHA

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

Large epiphytes; rhizome fleshy, covered with thin narrow scales. Fronds subcoriaceous, usually with a large humus-collecting base, median portion deeply pinnatifid or pinnate, terminal portion usually fertile and with much contracted pinnae, sessile; venation anastomosing, forming regularly spaced areolae with included veinlets, costae and main veins of each pinna prominently raised on both surfaces.

Aglaomorpha coronans (Wall. ex Mett.) Copel., Univ. Calif. Publ. Bot. 16: 117. 1929 ; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 488. f. 57. 3-4. 1939; Tagawa & K.Iwats., Fl. Thailand 3(4) : 551. f. 55. 4-5. 1989 ; Hovenkamp et al. in Fl. Males., Ser. II. 3: 15. f. 1 h. 1998.— *Drynaria coronans* (Wall. ex Mett.) J. Sm. ex T.Moore , J. Bot. 4: 61. 1841.— *Polypodium coronans* Wall. ex Mett., Abh. Senck. Naturf. Ges. 2: 121. t. 3. f. 40-41. 1857.— *Polypodium conjugatum* Baker, Syn. Fil.: 366. 1868.— *Drynaria conjugata* (Baker) Bedd., Ferns Brit. India correct. Pl. 13. 1870.— *Pseudodrynaria coronans* (Wall. ex Mett.) Ching, Sunyatsenia 5: 262. 1940.— *Aglaomorpha heraclea* (Kunze) Copel. sensu Holttum, Dansk Bot. Ark. 20: 21. 1961. Fig. 5.130.

Rhizome creeping, thick, usually more than 1.5 cm in diameter, densely scaly throughout; scales brown, linear, 10 by 0.5 mm, sharply toothed at margin. **Fronds** sessile, usually more than 1 m long, about 30 cm wide, lobed almost to rachis; lobes continuing with wings less than 2 cm broad; the base of fronds broadly rounded to cordate, up to 20 cm broad, subentire or shallowly lobed, brown, like the nest-leaves of the upper part of fronds ascending, usually more than 12 pairs, linear-subtriangular, attenuately acuminate at apex, entire at margin, up to 27 by 4.5 cm; veins raised on both surfaces, venation drynarioid, or with complicatedly reticulate, main areoles

quadrangular, smaller areoles with free included veinlets; coriaceous, green, glabrous. **Sori** one row between main veins, more or less elongate.

Thailand.— NORTHERN: Chiang Rai (Doi Tung), Chiang Mai (Doi Hua Mot, Doi Suthep, Huai Tong, Doi Inthanon), Lampang (Mae Tia), Phrae (Mae Sai), Tak (Huai Krasa, Doi Musoe), Phitsanulok (Thung Salaeng Luang); EASTERN: Chaiyaphum (Thung kamang, Nam Phrom); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao), Prachin Buri (Khao Yai); 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; Khao Chong is the southernmost record of this species.

Ecology.— Epiphyte on tree-trunks in open places in tropical rain forests and hill evergreen forest about 700-1,300 m alt.

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

Specimens examined.— W. Khwaiphan 008, Y. Yuyen 54, T. Seelanan 22, T. Boonkerd 615 [BCU]; M. Tagawa, K. Iwatsuki and N. Fukuoka 6817, E. Hennipman 3838 [BKF].

2. BELVISIA

Mirb., Hist. Nat. Veg. 5: 111. 1803; Tagawa & K.Iwats., Fl. Thailand 3(4): 519. 1989.

Rhizome short-creeping, bearing stipes usually close together, densely scaly; scales peltate, usually dark, ovate to lanceolate. Fronds jointed to rhizome, with short indistinct stipes, simple, entire, papyraceous to coriaceous, peltate scaly or glabrescent; veins copiously anastomosing, visible or hardly so; fertile portion on narrow apical part of fronds, usually wholly covered by sporangia on the lower surface, sometime separated from the vegetative part by construction. Sporangia mixed with stalked peltate paraphyses and protected also by the narrow reflexed edge of fronds.

KEY TO THE SPECIES

1. Fronds constricted at base of the apical fertile portion ..... **3. B. mucronata**
1. Fronds not constricted at base of the apical fertile portion
   2. Rhizome-scales oblong-ovate; stipes distinct; the apical fertile portion with marginal sterile portion..... **1. B. annamensis**
   2. Rhizome-scales narrowly lanceolate; stipes hardly distinct; the apical fertile portion wholely covered with the sporangia on the underside ..... **2. B. henryi**

1. Belvisia annamensis (C.Chr.) Tagawa, Acta Phytotax. Geobot. 22: 107. 1967; Tagawa & K.Iwats., Fl. Thailand 3(4): 521. 1989.— *Hymenolepis annamensis* C.Chr., Dansk Bot. Ark. 6(3): 68. f. 1. 1929; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 452. f. 53, 1-2. 1939.— *Belvisia callifolia* (C.Chr.) Copel. sensu Holttum, Dansk Bot. Ark. 20: 19. 1961. Fig. 5.131.

Rhizome short-creeping, about 2 in diameter, bearing fronds closely, densely scaly throughout; scales oblong-ovate, acuminate at apex, round at base, up to 1 by 0.8 mm, brown, clathrate, toothed at margin. **Stipes** up to 2.5-4 cm long, narrowly winged on upper portion, scaly at base, stramineous to pale castaneous. **Fronds** lanceolate, broadest at 1/3 way from base, gradually narrowing upwards, cuneate at base, plane at margin, about 16-25 cm long excluding the fertile apical portion, 1.8-2.6 cm broad; thin chartaceous; lateral main veins more or less distinct, the other veins hardly visible, copiously anastomosing; fertile portion continuously narrowing from the narrow apices of the sterile portion, about 5 by 0.3 cm, bearing a pair of medial linear sori.

Thailand.— NORTHERN: Tak (Ban Musoe); CENTRAL; Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Trat (Khao Saming); PENINSULAR: Chumphon (Tha San), Ranong (Khlong Nakha), Trang (Khao Chong).

Distribution.— Laos and Vietnam (type).

Ecology.— Epiphyte on mossy tree-trunks in hill evergreen forest about 1,000-1,300 m alt.

Specimens examined.— W. Khwaiphan 171, T. Boonkerd 1333, 1509 [BCU]; T. Smitinand et al 364, K. Larsen et al 59 [BKF].

2. Belvisia henryi (Hieron. ex C.Chr.) Tagawa in Hara, 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; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 451. 1939. Fig. 5.132.

Rhizome short-creeping, up to 3 mm in diameter, bearing fronds closely, densely scaly; scales narrowly subtriangular, gradually narrowing from base towards apex, long-attenuate and tailed at apex, up to 3 by 1 mm, broadest at basal portion, concolorously brown, clathrate, toothed at margin. **Stipes** short, castaneous, narrowing winged, scaly at base. **Fronds** narrowing oblong, rather suddenly narrowing at apex, bearing linear fertile portion, narrowly cuneate at base, the sterile portion about 23 by 3 cm; papyraceous to thin chartaceous, vein hardly visible, the margin of fronds usually plane; fertile portion linear, not constricted at base, up to 7 by 3 cm; sporangia occupying the whole under surface except the midrib and margin, the margin hardly revolute.

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

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

Ecology.— Epiphyte on mossy tree-trunks in hill evergreen forest about 1,000-1,200 m alt.

Specimens examined.— W. Khwaiphan 119, P. Ratchata 329, K. Sridith 156 [BCU]; M. Tagawa, K. Iwatsuki, N. Fukuoka 1832 [BKF].

3. Belvisia mucronata (Fée) Copel., Gen. Fil.: 192. 1947; Holttum, Rev. Fl. Malaya 2: 155. 1954; Tagawa & K.Iwats., Fl. Thailand 3(4): 520. f. 52. 4-6. 1989.— *Hymenolepis mucronata* Fée, Gen. Fil.: 82. pl. 6 B. f. 1. 1852. Fig. 5.133.

Rhizome creeping, about 3 mm in diameter, bearing fronds rather closely, scaly; scales narrow, gradually narrowing from base towards long-attenuate apex, up to 2 by 1 mm, broadest at basal portion, dark brown, clathrate, toothed at margin. **Stipes** short, not distinct from lower part of midribs of fronds, narrowly winged,

castaneous to dark, scaly at base. **Fronds** linear-lanceolate, gradually narrowing towards both ends, attenuate at both apex and base, entire or a little revoluted at margin, up to 12 by 0.5 cm; subcoriaceous, veins hardly visible, copiously anastomosing; fertile portion of fronds at apex usually constricted at junction with sterile portion, linear, up to 4 by 0.15 cm, wholly covered by sporangia except the very margin enrolled to protect the young sori.

Thailand.— SOUTH-EASTERN: Chanthaburi (Takhamao Falls); PENINSULAR: Nakhon Si Thammarat (Khiriwong, Khao Luang), Yala (Betong).

Distribution.— Tropics of Asia (type from Malay Isl.) from Sri Lanka to Polynesia, north to Vietnam.

Ecology.— Epiphyte on tree-trunks in tropical rain forest and hill evergreen forest about 1,000-1,200 m alt.

Specimens examined.— W. Khwaiphan 072, Y. Yuyen 174, T. Boonkerd 320, T. Boonkerd & R. Pollawatn 70 [BCU]; M. Tagawa, K. Iwatsuki, N. Fukuoka 4684 [BKF].

3. CRYPSINUS

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

Epiphyte plants; rhizome long-creeping, scaly; scales gradually narrowing from peltate base to hairy apex, not or hardly clathrate. Stipes jointed to rhizome. Fronds 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, ones between adjacent main veins, in a single row at each side of costa, or scattered on the under surface of fronds, sometime sunk in deep cavities; paraphyses only in some species, simple.

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) C.Presl ex Ching, Contr. Inst. Bot. Nat. Acad. Peiping 2: 67. 1933; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 474. 1939.— *Pleopeltis hastata* (Thunb.) Bedd., Handb.: 362. f. 205. 1883.— *Pleopeltis trifida* (D.Don) Bedd., Handb. Suppl.: 96. 1892.—

Crypsinus taeniatus (Sw.) Copel. var. *palmatus* (Blume) C.Chr. sensu Holttum, Dansk Bot. Ark. 23: 231. 1965. Fig. 5.134.

Rhizome long-creeping, about 3 mm in diameter, densely scaly throughout; scales gradually narrowing from round peltate base to long-tailed apex, about 5 by 1.3 mm, brown in broader basal portion, paler in narrow tails, toothed at margin. **Stipes** stramineous or brown, jointed to rhizome at low scaly phyllopodes, glabrous upwards, 15-26 cm long. **Fronds** lobed, with 3-6 pairs of lateral lobes and a terminal ones, up to 30 by 24 cm; rachis brown beneath, paler on upper surface, winged with lobes 6-8 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 1.3-2.5 cm, entire, terminal lobes longer; midribs raised on both surfaces, main veins distinct, ascending, more or less zigzag, the other vein obscure, reticulate, forming irregular areoles with includes veinlets; papyraceous, deep green to paler, paler on lower surface, glabrous. **Sori** one between adjacent main veins, in a single row along both sides of midribs, subcostular or medial, round, 2-3 mm diam., hardly raised on upper surface.

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 Kradung); SOUTH-EASTERN: Prachin Buri (Khao Yai) ; SOUTH-WESTERN: Ratchaburi (Khao Luang).

Distribution.— N. India (type), Upper Myanmar, Sw. China (Yunan & Szechuwan) and Indochina.

Ecology.— Epiphyte on mossy tree-trunks or terrestrial in hill evergreen forests about 1,000-1,300 m alt.

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

Specimens examined.— W. Khwaiphan 159, Y. Yuyen 151, P. Ratchata 300, 319 [BCU]; Tagawa et al. T 9232, K. Iwatsuki et al. 9647 [BKF].

4. DRYNARIA

(Bory) J.Sm., J. Bot. 4: 60. 1841; Tagawa & K.Iwats., Fl. Thailand 3(4): 543. 1989.

Rhizome creeping, scaly. Leaves in two kinds: nest-leaves (or scaly leaves) sessile, sterile, small, usually placed to cover the rhizome, becoming brown but persistent, usually humus-collecting; foliage-leaves pinnatifid to pinnate, stipes not distinctly jointed to rhizome but all pinnae jointed to rachis, in pinnatifid leaves abscission distinct at base and each side of lobes, veins anastomosing to form drynariod veneation. Sori round or elongate.

KEY TO THE SPECIES

1. Foliage-leaves pinnate; sori one row along each side of costa .....**1. D. rigidula**
1. Foliage-leaves lobed, pinnatifid; sori irregularly placed on lower surface of fronds.....**2. D. sparsisora**

1. Drynaria rigidula (Sw.) Bedd., Ferns Brit. India: t. 314. 1869; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 512. 1939; Holttum, Rev. Fl. Malaya 2: 183. f. 90. 1954; Tagawa & K.Iwats., Fl. Thailand 3(4): 550. 1989.— *Polypodium rigidulum* Sw., Schrad. J. Bot. 1800 (2): 26. 1801. Fig. 5.135.

Rhizome creeping, about 4 mm in diameter, densely scaly throughout; scales gradually narrowing from peltate rounded base to apex, pale brown with dark basal point, up to 9 by 1 mm, sparsely hairs at margin with pale long downy hairs. **Nest-leaves** sessile, narrowly oblong-subdeltoid, round at base, acute at apex, up to 17 by 6 cm, lobed to 1/3 way towards midribs; lobes subtriangular, round at apex, entire, up to 2 by 0.6 cm. **Foliage-leaves**: stipes pale castaneous to purple, more or less densely downy hairy, usually very short, often bearing undeveloped pinnae at both side of stipes; Fronds pinnate, oblong-lanceolate, up to 35 by 17 cm; rachis pale purple, downy-hairy; lateral pinnae about 25 pairs, linear-lanceolate, up to 11 by 1 cm, sessile, subentire or serrate at margin, caudately acuminate at apex, unequally cuneate at base; costae pale stramineous, jointed to rachis; veins raised on both surfaces, anastomosing. **Sori** round, close to costa, one row along each side of costa, one between main veins, raised on upper surface.

Thailand.— NORTHERN: Chiang Rai (Mae Kok), Chiang Mai (Mae HO, Kong Kat, Ping Khong, Doi Suthep, Sop Aep, Doi Inthanon, Bo Luang), Phitsanulok (Thung Salaeng Luang), Tak; NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi (Khao Sabap); SOUTH-WESTERN: Kanchanaburi (Wangka, Thung Kang Yang); PENINSULAR: Krabi (Ao Luek), Surat Thani (Ban Don), Yala (Betong).

Distribution.— Indochina, Malesia, Polynesia and tropical Australia, also in Myanmar

Ecology.— Epiphyte on tree-trunks in open places in tropical rain forest about 700-800 m alt.

Vernacular.— Kra prok lek (กระปรอกเล็ก), kra prok hua hin (กระปรอกหัวหิน), kut thang (กุดถั่ง), kut fuei (กูดเฟือย), kut mai (กูดไม้), kut om (กูดอ้อม), kut hang ma (กูดหางม้า) (Northern)

Specimens examined.— W. Khwaiphan 042, T. Boonkerd 19, 37 [BCU]; C. Phengklai et al 12840, Tagawa et al. 586 [BKF].

2. Drynaria sparsisora (Desv.) T.Moore, Ind. Fil.: 348. 1862; Holttum, Rev. Fl. Malaya 2: 183. f. 89. 1954; Tagawa & K.Iwats., Fl. Thailand 3(4): 544. 1989.— *Polypodium sparsisorum* Desv., Berl. Mag. 5: 315. 1811.— *Polypodium linnei* Bory, Ann. Sci. Nat. 5: 464. t. 12. 1825.— *Drynaria linnei* (Bory) Bedd., Ferns Brit. India: t. 315. 1869. Fig. 5.136.

Rhizome creeping, about 1.2 cm in diameter, densely covered with scales; scales oblong-ovate, acute at apex, round at base, peltate, toothed to fimbriate at margin, up 3 by 2 mm, bi-coloured with black-brown central portion and brown margin, not so stiff. **Nest-leaves:** sessile, oval to ovate-oblong, 17 by 20, lobed to a half-way between midrib and margin; lobes round at apex, entire, oblong-subdeltoid, up to 3 by 2.5 cm. **Foliage-leaves:** stipes 17-22 cm long, narrowly winged almost to the base; Fronds pinnatifid, oblong, acute at apex, 53.4 by 18.2 cm; lobes oblique, adnate to the neighbourings with Fronds of less than 1 cm in breath, oblong-lanceolate, caudately acuminate at apex, entire , up to 13 by 3 cm; veins raised on both surfaces, copiously anastomosing, 5-6 rows of areoles between the main veins,

no included free veinlets; coriaceous; pale green, glabrous. **Sori** round or punctiform, on veins, irregularly placed on the lower surface of lobes.

Thailand.— EASTERN: Chaiyaphum (Chulaphorn Dam); SOUTH-EASTERN: Prachin Buri (Khao Yai), Chanthaburi (Nong Bon), Trat (Ko Rang Yai, Ko Chang, Huai Raeng); PENINSULAR: Ranong (Ko Kut), Phangnga (Khao Phota Luang Kaeo), Phuket (Ko Pu), Trang (Khao Chong), Satun, Narathiwat (Sungai Padi).

Distribution.— Malesia and Polynesia to tropical Australia.

Ecology.— Epiphyte on tree-trunks in light shade in tropical rain forest about 700-800 m alt.

Vernacular.— Kut hok (กูดฮอก) (Northern); phang-nga (พังงา) (Malay/Peninsular); wan ngu kwak (ว่านงูกวัก), wao (ว่าว) (Peninsular).

Specimens examined.— W. Khwaiphan 035 [BCU]; M. Tagawa, K. Iwatsuki & N. Fukuoka T-6972, E. Hennipman 3949 [BKF].

5. GONIOPHLEBIUM

C.Presl, Tent. Pterid. 185. pl. 7. f.13-14. 1836; Hovenkamp et al. in Fl. Males., Ser. II. 3: 44. f. 7, 8. 1998.— *Polypodium* subg. *Goniophlebium* Blume, Fl. Java Fil. 132. 1829.— *Polypodium* subg. *Goniophlebium* C.Chr., Contr. U. S. Nat. Herb. 26: 315. 1931.

Epiphytes or epilithic, occasionally terrestrial. Rhizome long-creeping; scales mostly clathrate, appressed to erect, margin dentate, apex acuminate to filiform, often with superficial hairs. Fronds pinnate to pinnatifid, margin crenate to serrate; venation with 1-several rows of areoles, each with 1 included, excurrent, free veinlet; marginal row of excurrent veinlets present. Sori round, 1-3 rows between pinna-midrib and margin, superficial to deeply sunken.

KEY TO THE SPECIES

1. Fronds chartaceous; epiphyte plants ..... **1. G. subauriculatum**
1. Fronds subcoriaceous; terrestrial plants ..... **2. G. sp.**

1. Goniophlebium subauriculatum (Blume) C.Presl, Tent. Pterid. 186. 1836; Rödl-Linder, Blumea 34: 400. 1990.— *Polypodium subauriculatum* Blume, Enum. Pl. Javae 133. 1828; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 538. 1939; Holttum, Rev. Fl. Malaya 2: 207. f. 108. 1954; Tagawa & K.Iwats., Fl. Thailand 3(4): 573. 1989. Fig. 5.137-5.138.

Rhizome long-creeping, about 5 mm in diameter, distinctly glaucous, densely scaly; scales linear, about 7 by 1.5 mm, brown, clathrate, toothed at margin. **Stipes** stramineous or brown, 12-25 cm long, densely scaly at base, minutely scaly upwards or glabrecent. **Fronds** imparipinnate, lanceolate, 23-30 by up to 15-18 cm; rachis pale brown, minutely scaly throughout; lateral pinnae up to 30 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 or a little falcate, up to 20 by 8-15 mm, upper pinnae gradually becoming smaller; terminal pinna not so larger, 3-8 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; chartaceous, deep green, glabrous. **Sori** teminal on simple included veinlets in costal areoles, in one row at each side of costa, costular about 1.5 mm in diameter, distinctly immersed and raised on the upper surface.

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

Distribution.— NE. India, Sw. China, Laos, Vietnam, Malesia throughout (type from Java) to Australia (Queensland); also in the Tenasserim.

Ecology.— Epiphyte on tree-trunks in hill evergreen forests about 1,000-1,300 m alt.

Specimens examined.— W. Khwaiphan 089, 142, O. Vannasri 24, Y. Yuyen 66 [BCU]; M. Tagawa, K. Iwatsuki and N. Fukuoka 787, T. Smitinand & C. Phengklai 8841 [BKF].

2. Goniophlebium sp. Fig. 5.139.

Rhizome long-creeping, about 4 mm diam., glaucous, densely scaly throughout; scales linear, toothed at margin, brown, clathrate about 7 by 0.5 mm. **Stipes** 25-30 cm long, stramineous, scaly upwards. **Fronds** lanceolate, 50 by 18 cm; rachis pale brown, minutely scaly throughout; lateral pinnae 23-30 pairs, a few basal pinnae reduced, sessile, linear, subtruncate at base, serrate at margin, slightly ascending, up to 9 by 0.8 cm, gradually narrowing from base to attenuate apex, upper pinnae gradually becoming smaller; irregularly lobed at basal portion; vein anastomosing to form 1-2 rows of areoles at each side of costa, more visible subcoriaceous, pale green, glabrous. **Sori** terminal on simple included veinlets in costal areoles, in a single row at each side of costae, costular up to 2 mm diam., sunk in cavities which raised distinctly on upper surface.

Thailand.— SOUTH-EASTERN: Prachin Buri (Khao Yai).

Distribution.—

Ecology.— Terrestrial in light shade in hill evergreen forests about 1,000-1,300 m alt.

Specimens examined.— W. Khwaiphan 089, 142 [BCU].

Note.— *Goniophlebium* sp. is a terrestrial plant in exposed places of hill evergreen forest. It is closely related to *Goniophlebium subauriculatum* (Blume) C.Presl, but differs in having a terrestrial habit and a different lamina shape.

6. LEPISORUS

(J. Sm.) Ching, Bull. Fan Mem. Inst. Biol. 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 clarhrate. Stipes articulate to rhizome, sometimes indistinct from Fronds, scaly at least at base. Fronds simple, entire, usually leatherly, bearing peltate scales or glabrescent; veins usually invisible, copiously anastomosing with included free veinlets in areoles. Sori usually at junction of veins, round or rarely elongate, in some species fusing to

form linear submarginal lines, superficial or sunk in cavities, exindusiate but covered when young with umbrella-shaped peltate scales.

Lepisorus scolopendrium (Buch.-Ham. ex D.Don) Tagawa in Hara, Fl. East. Himal. 494. 1966; Tagawa & K.Iwats., Fl. Thailand 3(4): 511. f. 51. 6. 1989.— *Polypodium scolopendrium* Buch-Ham. ex D.Don, Prodr. Fl. Nepal.: 1. 1825.— *Lepisorus excavatus* var. *scolopendrium* (Buch-Ham. ex D. Don) Ching, Bull. Fan Mem. Inst. Biol. 4: 69. 1933; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 456. 1939.— *Pleopeltis scolopendrium* (Buch.-Ham. ex D.Don) Alst. & Bonn., Candollea 15: 207. 1956.— *Polypodium excavatum* Bory ex Willd., Sp. Pl. 5: 158. 1810. Fig. 5.140.

Rhizome creeping, bearing a few fronds closely, dark brown on upper surface, scaly; scales dense, thin, gradually narrowing towards acuminate apex, up to 5 by 2 mm, concolorously light brown, clathrate, rather irregular at paler margin. **Stipes** short, indistinct, usually 1 cm long. **Fronds** variable in size and form, linear-lanceolate, often broadest at 1/3 part from base, up to 33 by 4 cm, gradually narrowing towards both ends, entire but variously waved at margin; midribs raised on both surfaces; 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, never fused to the next ones, the receptacles raised with hollows on upper surface.

Thailand.— NORTHERN: Chiang Rai (Doi Tung), Ching 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 Miang); NORTH-EASTERN: Loei (Phu Luang); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); PENINSULAR: Surat Thani (Ban Don).

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

Ecology.— Epiphyte on branches of mossy trees in light shade in hill evergreen forest about 1,000-1,300 m alt.

Vernacular.— Kut chak khep (กูดจักเข็บ) (Northern).

Specimens examined.— W. Khwaiphan 140; T. Boonkerd 31, 77, 1399 [BCU]; K. Iwatsuki, N. Fukuoka, M. Hutoh & D. Chaiglom T-11095, T-11025 [BKF].

7. LOXOGRAMME

(Blume) C.Presl, Tent. Pterid.: 214. pl. 9. f. 8. 1836.; Tagawa & K.Iwats., Fl. Thailand 3(4): 575. 1989.

Rhizome short or long-creeping, scaly; scales entire, thin, concolorous, clathrate. Fronds not distinctly articulate, monomorphic to dimorphic, simple and entire, usually oblanceolate in outline, coriaceous to fleshy, glabrous; main veins hardly distinct, veins all invisible, reticulate to form areoles without, or rarely with, included free veinlets. Sori elongate, usually oblique to midribs, superficial or slightly immersed, naked.

Loxogramme involuta (D.Don) C.Presl, Tent. Pterid.: 215. 1836; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 464. 1939; Tagawa & K.Iwats., Fl. Thailand 3(4): 577. 1989.— *Grammitis involuta* D.Don, Prodr. Fl. Nepal.: 14. 1825. Fig. 5.141-5.142.

Rhizome short, ascending to creeping, about 1.5 mm in diameter, bearing a tuft of fronds near apex, densely covered with scales or dark on older portion; scales subdeltoid with acuminate apex, up to 5 by 1 mm, thin but stiff, entire, greyish-brown, clathrate. **Stipes** indistinct, or very short with wings. **Fronds** caudately long-acuminate at apex, attenuate at base and decurrent to narrow wings of stipes nearly to the base, lanceolate, up to 45 by 5 cm, deep green on upper sueface, paler beneath; midribs more or less raised beneath, usually flat on upper surface, stramineous or pale green; veins all obscure, anastomosing with free included veinlets; thick and fleshy, glabrous on both surfaces. **Sori** linear, to form angles of about 80^{o} to midribs, continuous from near margin to near midrib, up to 5 cm long, about 2 mm broad, superficial.

Thailand.— NORTHERN: Chiang Mai (Doi Inthanon, Doi Chiang Dao, Khun Kong San, Doi Hua Mot), Tak (Khao Phra Wo, Mae Sot); NORTH-EASTERN: Loei (Phu Luang, Phu Kradung); EASTERN: Nakhon Ratchasima (Khao Yai).

Distribution.— India (type from Nepal), Upper Myanmar and Indochina.

Ecology.— Epiphyte on mossy tree-trunks in tropical rain forest about 700-800 m alt.

Specimens examined.— W. Khwaiphan 190 [BCU]; T. Smitinand et al 7747, T. Smitinand 541 [BKF].

8. MICROSORUM

Link, Hort. Berol. 2: 110. 1833; Tagawa & K.Iwats., Fl. Thailand 3(4): 523. 1989.

Rhizome creeping, densely scaly in apical portion; scales peltate, usually thin, brown to darker, distinctly clathrate. Stipes articulate to rhizome, somtimes indistinct from the attenuate base of fronds. Fronds simple and entire, lobed, hastate, or pinnate, the margin of fronds or lobes not toothed; venation copiously anastomosing with free included veinlets in areoles. Sori round to oblong, usually small and scattered, rarely fused, without peltate paraphyses.

KEY TO THE SPECIES

1. Fronds simple
   2. Rhizome long-creeping; sori one row between midrib ..... **2. M. pteropus**
   2. Rhizome short-creeping; sori scattered on the whole under surface of fronds. ....**3. M. punctatum**
1. Fronds pinnatifid; sori irregularly scattered on the lower surface of fronds..... ..... **1. M. insigne**

1. Microsorum insigne (Blume) Copel., Univ. Calif. Publ. Bot. 16(2): 112. 1929.— *Polypodium insigne* Blume, En. Pl. Javae. 127. 1828. Fig. 5.143.

Rhizome short-creeping, about 8 mm in diameter, dark, bearing fronds rather closely, scaly; scales oblong-lanceolate, round at base, up to 6 by 1.5 mm, brown to dark brown, clathrate. **Stipes** usually very short, up to 1 cm long, winged on upper portion. **Fronds** pinnatifid with 1-2 pairs of lateral pinnae and winged rachis, up to 46 by 22 cm, the lower lateral pinnae or lobed adnate at base, oblong-lanceolate, acuminate at apex, entire, up to 15 by 3 cm, the upper ones gradually becoming

smaller, the terminal lobes oblong-lanceolate; midribs and costae raised on both surfaces, main lateral veins distinct, the other veins visible, copiously anastomosing, veinlets; papyraceous, green. **Sori** round, smaller, irregularly scattered on the lower surface, about 1 mm in diameter.

Thailand.— NORTHERN: Phitsanulok (Phu Hin Rong Kla National Park); SOUTH-EASTERN: Prachin Buri (Khao Yai).

Distribution.— Himalayas to Indochina, Taiwan, Japan, Sumatra, Peninsular Malaysia, Java, Lesser Sunda Islands (Flores), Borneo, Philippines.

Ecology.— Epiphyte or on rock in tropical rain forest about 700-900 m alt.

Specimens examined.— W. Khwaiphan 108; T. Boonkerd 1732 [BCU].

2. Microsorum pteropus (Blume) Copel., Univ. Calif. Publ. Bot. 16: 112. 1929; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 484. 1939; Holttum, Rev. Fl. Malaya 2: 172. f. 80. 1954; Tagawa & K.Iwats., Fl. Thailand 3(4): 529. 1989.— *Polypodium pteropus* Blume, En. Pl. Jav. 2: ad. 3. 1828 ; Fl. Jav. Fil.: 168. t. 76. 1829.— *Pleopeltis pteropus* (Blume) Bedd., Handb.: 359. f. 203. 1883. Fig. 5.144.

Rhizome long-creeping, about 2 mm in diameter, bearing fronds rather closely, densely scaly; scales oblong-lanceolate, gradually narrowing toward apex, round at base, brown, clathrate, the margin entire, up to 2 by 0.5 mm. **Stipes** up to 1 cm long, 0.5 mm broad, stramineous, with the scales like those on rhizome but smaller in size, winged on upper portion. **Fronds** simple, broadestat lower 1/3 portion, narrowing towards attenuately base, decurrent downwards as wings of stipes, narrowing towards attenuately very long-acuminate apex, entire, up to 12 by 0.7 cm, midrib raised on both surfaces, more or less minutely scaly; lateral main vein distinct beneath, the other vein hardly visible or distinct, anastomosing with a row of main areoles along both side of midriband many smaller areoles in irregular arrangement; thinly papyraceous to herbaceous, dark green to blackish in color. **Sori** round to more or less elongate, many, one row between midrib.

Thailand.— NORTHERN: Chinag 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 Rum (Bu Khanun), Chaiyaphum;

CENTRAL: Nakhon Nayok (Khao Yai), Saraburi (Muak Lek); SOUTH-EASTERN: Chanthaburi (Pong Nam Ron); SOUTH-WESTERN: Ratchaburi Kanchanaburi (Khao Ri Yai), Prachuap Khiri Khan (Huai Yang); PENINSULAR: Chumphon (Ban Tha Ngo), Ranong (Mueang Laen), Surat Thani (Ko Samui, Ban Don), Nakhon Si Thammarat (Khao Lunag, Thap Chang, Khiriwong), Trang (Khao Chong), Satun (Bukit Racha Wang), Yala (Bannang Sta).

Distribution.— India to Malesia (type from Java), north to S. China and the Ryukyus.

Ecology.— Lithophytes on wet and muddy rocks by stream in tropical rain forest about 700-800 m alt.

Vernacular.— Kut hang nok kaling (กูดหางนกกะลิง) (Peninsular)

Specimens examined.— W. Khwaiphan 038, 061 [BCU]; M. Tagawa, K. Iwatsuki and N. Fukuoka 1090, T. Smitinand 948 [BKF].

3. Microrum punctatum (L.) Copel., Univ. Calif. Publ. Bot. 16: 111. 1929; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 483. 1939; Holttum, Rev. Fl. Malaya 2: 179. 1954; Seidenf., Nat. Hist. Bull. Siam Soc. 19 86. 1958; Tagawa & K.Iwats., Fl. Thailand 3(4): 528. 1989.— *Acrostichum punctatum* L., Sp. Pl. ed. 2: 1524. 1763.— *Pleopeltis punctata* (L.) Bedd., Fern Brit. Ind. Suppl.: 22. 1876.— *Polypodium punctatum* (L.) Sw., Schrad. J. Bot. 1800 (2): 21. 1801. Fig. 5.145.

Rhizome short-creeping, 4-5 mm in diameter, dark or glaucous on surface, bearing fronds closely, scaly; scales narrowly oblong-subtriangular, gradually narrowing from ovate basal portion towards long-attenuate apex, concolorously dark greyish-brown, clathrate, margin distinctly toothed, up to 2 by 1.5 mm. **Stipes** not distinct from Fronds, scaly at base, stramineous to greenish. **Fronds** narrowly oblong to lanceolate, gradually narrowing towards acute apex or moderately acute with not pointed apex, narrowing towards attenuate base, 35-50 cm long including stipes, 4-5 mm broad; midribs raised on both surfaces, other veins obscure, finely anastomosing to form copious areoles; subcoriaceous, the margin of fronds sometime revoluted. **Sori** small, round, many, scattered on the whole under surface of fronds.

Thailand.— NORTHERN: Chiang Rai (Mae Kok), Chiang Mai (Fang Doi, Chiang Dao, Tin Tok, Mae Rim, Doi Inthanon), Lampang (Mae Ngao), Tak (Lan Sang, Doi Musoe), Phitsanulok (Salaeng Haeng, Thung Salaeng Luang); NORTH-EASTERN: Phetchabun (Phu Miang), Loei (Phu Luang, Phu Kradueng); EASTERN: Chiyaphum (Phu Khieo); SOUTH-EASTERN: Prachin Buri (Khao Yai), Chon Buri (Si Racha, Hup Bon), Nakhon Ratchasima (Pak Thong Chai, Pak Chong), Chanthaburi (Takhamao Falls, Makham, Khao Kluea), Trat (Ban Saphan Hin, Ko Chang, Ko Kut); SOUTH-WESTERN: Kanchanaburi (Khao Ri Yi, Wangka, Sai Yok), Prachuap Khiri Khan (Bang Saphan); PENINSULAR: Ranong (Kra Buri, Khlong Nakha), Surat Thani (Bna Don), Phangnga (Khlong Nang Yon), Phuket, Nakhon Si Thammarat (Khao Luang, Thung Song), Trang (Khao Chong), Yala (Khao Khalakhiri, Bannang Sta).

Distribution.— Throughout the tropics of the world, W. Africa to Tahiti.

Ecology.— Epiphyte tree-trunks usually in dry open places or in light shade in tropical rain forest about 600-900 m alt.

Vernacular.— Kraprok hang sing (กระปรอกหางสิงห์) (South-eastern); prue mai (ปรือไม้) (South-westren); lin phi mai (ลิ้นผีไม้), hang nok wa (หางนกหว้า) (Peninsular); ai-ka bu-kong ka-waeng (ไอกาบุกงกะแวง) (Malay/Peninsular); Crested Fern.

Specimens examined.— W. Khwaiphan 067 [BCU]; M. Tagawa & I. Yamada T-140, K. Iwatsuki 6854 [BKF].

9. PHYMATOSORUS

Pic.Serm., Webbia 28(2): 457. 1973; B.Øllg., The families and genera of vascular plants vol. I. 221. 1990.

Rhizome usually long-creeping, bearing fronds jointed to the apices of short erect bases; scales peltate, at least the middle part clathrate, with raised and thickened lateral cell walls, clathrate. Fronds glabrous, simple or deeply pinnatifid, thinly leathery, the veins clearly visible or not the edge slightly thickened but not notched; veins forming irregular areoles between the main lateral veins, each areole with included free veinlets pointing in all directions. Sori rather larger, sunk in distinct cavities which appear as prominences on the upper surface, in one row on each side of

the midrib of the fronds or of its lobes, a very distinct acroscopic veinlet always passing from the base (or near the base) of a main lateral vein to the sorus; paraphyses sometimes with enlarged apices, no peltate paraphyses.

Phymatosorus nigrescens (Blume) Pic.Serm., Webbia 28(2): 459. 1973.— *Polypodium nigrescens* Blume, En. Pl. Jav.: 126. 1828.— *Pleopeltis nigrescens* (Blume) Carr. in Seem., Fl. Vit.: 368. 1873; Bedd., Handb.: 367. f. 208. 1883.— *Phymatodes nigrescens* (Blume) J. Sm.; Ferns Br. For.: 94. 1866; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 473. 1939; Holttum, Rev. Fl. Malaya 2: 193. f. 95. 1954; Seidenf., Nat. Hist. Bull. Siam Soc. 19 86. 1958.— *Microsorum nigrescens* (Blume) Copel., Occ. Pap. B. P. Bishop Mus. 14: 74. 1938; Tagawa & K.Iwats., Fl. Thailand 3(4): 532. 1989.— *Microsorum alternifolium* (Willd.) Copel., Gen. Fil.: 197. 1947.— *Polypodium alternifolium* Willd., Sp. Pl. 5: 168. 1810. Fig. 5.146-5.147.

Rhizome creeping, thick, about 1.3 cm in diameter scaly; scales circular to oblong, round to moderately acute at apex, round at base, attached near the center, minutely hairy at margin, about 4 mm in both directions, brown, more or less clathrate with thick internal cell-walls and transparent surface walls, the internal wall gradually becoming thinner outwards. **Stipes** up to 40 cm long, stramineous to pale castaneous. **Fronds** oblong-ovate to subdeltoid, pinnatifid with broadly winged rachis, up to 70 by 40 cm; lateral pinnae up to 10 pairs, the basal ones the largest, up to 30 by 3 cm in fertile and 5 cm broad in sterile ones, gradually narrowing towards apex, entire at margin, the upper ones gradually becoming smaller, the wings of rachis about the same as the pinnae in breath; costae raised on both surfaces, veins hardly visible, anastomosing, with many included veinlets ending in raised point; coriaceous. **Sori** in two rather irregular rows at each side of midribs, round or elongate in deep hollows, about 4 mm in breadth, raised on upper surface.

Thailand.— EASTERN: Chaiyaphum (Nam Phrom, Phu Khieo), Nakhon Ratchasima (Pak Thong Chai); SOUTH-EASTERN: Prachin Buri (Khao Yai), Chanthaburi (Takhaomao Falls, Khao Sabap, Khao Soi Dao), Trat (Ko Chang); SOUTH-WESTERN: Uthai Thani (Ban Rai), Kanchanaburi (Khao Ri Yai, Ban Ti Li), Prachuap Khiri Khan (Ban Huai Ta, Ban Huai Ta, Ban Sai Khao); PENINSULAR: Chumphon (Tha Ngo), Phangnga (Khao Katha Khwam, Khao Phra Mi), Nakhon Si

Thammarat (Chawang, Khao Luang, Khiriwong), Trang (Khao Chong), Satun, Pattani, Narathiwat (Waeng, Bacho, Sungai Padi, Bacho Falls), Yala (Bannang Sta).

Distribution.— Sri Lanka, S. India, Vietnam, Cambodia, throughout Malesia (type from Java) and Polynesia.

Ecology.— Terrestrial or epiphyte in light shade in tropical rain forest about 700-900 m alt.

Vernacular.— Ka-lo ra-wa (กาโลระวา) (Malay/Peninsular).

Specimens examined.— W. Khwaiphan 203, O. Neamsuvan 69, T. Boonkerd 6, 14 [BCU]; M. Tagawa, K. Iwatsuki and N. Fukuoka 5293, K. Iwatsuki, N. Fukuoka 7319 [BKF].

10. PYRROSIA

Mirbel, Hist. Nat. Veg. 5: 91. 1803; Tagawa & K.Iwats., Fl. Thailand 3(4): 491. 1989.

Rhizome long-creeping, usually slender, scaly; scales peltate, fringed with hairs or entire, not clathrate. Fronds simple to palmately lobed, entire, fleshy, rarely dimorphic; venation anastomosing, completely hidden; surfaces more or less entirely covered with stellate hairs, generally caduceus on upper surface. Sori round, larger, 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 stellate hairs.

KEY TO THE SPECIES

1. Fronds dimorphic with longer fertile fronds; sori elongate along margin of fronds... ..... **2. P. piloselloides**
1. Fronds not dimorphic; sori scattered on the lower surface of fronds..... ..... **1. P. lingua var. heteractis**

1. Pyrrosia lingua (Thunb.) Farw., Amer. Midl. Naturalist 12(8): 302. 1931.

var. heteractis (Mett. ex Kuhn) Hovenkamp, Blumea 30: 208. 1984.— *Cyclophorus eberhardtii* Christ, J. Bot. France 21: 237, 270. 1908.— *Pyrrosia eberhardtii* (Christ) Ching, Bull. Chin. Bot. Soc. 1: 59. 1935; Tardieu & C.Chr. in Fl. Gén. I.-C. 7(2): 507.

1939; Tagawa & K.Iwats., Fl. Thailand 3(4): 505. f. 50. 9-10. 1989.— *Pyrrosia mannii* (Giesenh.) Ching et *Pyrrosia stigmosa* (Sw.) Ching sensu Holttum, Dansk Bot. Ark. 20: 19. 1961, p.p. Fig. 5.148-5.149.

Rhizome long-creeping, 2.5 mm in diameter, bearing fronds 3.5-4 cm apart, scaly throughtout; scales appressed or patent at least in the upper part especially in younger portion, narrowly subtriangular, gradually narrowing from broadest peltate portion towards attenuate apex, up to 7 by 1.5 mm, usually bi-colored with nearly black basal portion and brown marginal portions, entire at margin, bearing long downy hairs at margin of apical portion. **Stipes** up to 25 cm long, scaly at base with those like rhizome-scales, densely hairy throughout, brown. **Fronds** oblong-lanceolate to oblong, acute to acuminate at apex, caudate or very shortly decurrent at base, 14-18 by 4-5 cm, sterile fronds usually shorter 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 dense mat of stellate hairs grayish in color. **Sori** round, distinct, scattered on all the lower surface or in upper part of it, embedded in stellate hairs, not confluent.

Thailand.— NORTHERN: Chiang Rai (Doi Tung), Chiang Mai (Doi Pha Hom Pok, Doi Chiang Dao, Doi Inthanon, Doi Suthep, Pha Mon), Phitsanulok (Phu Miang, Thung Salaeng Luang); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng, Phu Paek); 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.— Terrestrial or epiphyte on tree-trunks in light shade in hill evergreen forest about 1,000-1,300 m alt.

Vernacular.— Lin kuram (ลิ้นกุรัม) (Eastern).

Specimens examined.— W. Khwaiphan 019, T. Boonkerd 139, 1263, 1264, 1401 [BCU]; M. Tagawa et al. 4779, E. Hennipman 3831 [BKF].

2. Pyrrosia piloselloides (L.) M.G.Price, Kalikasan 3: 176. 1975.— *Drymoglossum piloselloides* (L.) C.Presl, Tent. Pterid. 227, pl. 10, f. 5-6. 1836; Seidenf., Nat. Hist. Bull. Siam Soc. 19: 86. 1958. Fig. 5.150.

Rhizome long-creeping, about 1 mm in diameter, densely scaly throughout; scales peltate, up to 1 by 0.5 mm, pale brown with deep brown center, hairy at margin. **Fronds** distinctly dimorphic. **Sterile fronds**: stipes very short, up to 2 mm long, scaly at base; Fronds almost circular to broaly oblong, round at apex, 1.5-2.7 cm long , 1.2-1.5 cm wide, veins not distinct; fleshy, both surfaces stellate hairy. **Fertile fronds**; stipes 0.2-0.5 cm long, slender; Fronds lanceolate, up to 3.5-5.5 cm, round at apex, gradually narrowing toward base. **Sori** elongate along margin of fronds.

Thailand.— NORTH-EASTERN: Nong Khai, Chaiyaphum, Nakhon Ratchasima; CENTRAL: Nakhon Nayok, Krung Thep; SOUTH-EASTERN: Chon Buri, Chanthaburi, Trat; SOUTH-WESTERN: Kanchanaburi; PENINSULAR: Chumphon, Ranong, Surat Thani, Phangnga, Krabi, Nakhon Si Thammarat, Trang, Satun, Songkhla, Yala, Narathiwat

Distribution.— Northeast India to Hainan. Throughout Malesia.

Ecology.— Epiphyte on tree trunks in light shade in secondary forest about 700-800 m alt.

Vernacular.— Klet nakkharat (เกล็ดนาคราช), kip ma lom (กีบม้าลม), Man hia (มันเหี้ย).

Specimens examined.— W. Khwaiphan 003 [BCU]; David J. Middleton et al. 2123 [BKF].

GRAMMITIDACEAE

Newman, Hist. Brit. Ferns 7. 1-5 Feb 1840; Devol, Fl. Taiwan vol. 1. 2nd ed.: 216. 1980.

Mostly small epiphytes growing on mossy tree trunks or on rocks; rhizome short-creeping or suberect; scales usually opaque or sometimes clathrate. Stipes tufted, usually not articulate to rhizome. Fronds simple, pinnate or rarely bipinnate, veins free; patent hasirs usually borne on stipes, rachis and one or both surfaces of

frond. Sori round, oval or linear, dorsal or marginal, superficial or immersed; sporangia often setose.

KEY TO THE GENERA

1. Fronds simple; sori superficial ..... **1. Grammitis**
1. Fronds deeply lobe; sori immersed in soral cavities ..... **2. Prosaptia**

1. GRAMMITIS

Sw., Schrad. J. Bot. 2: 3, 17. 1800; Tagawa & K.Iwats., Fl. Thailand 3(4): 581. 1989.

Small epiphytic ferns. Rhizome short, creeping or suberect, bearing scales. Stipes short or indistinct, usually setose hairy. Fronds simple, entire or crenate to shallowly lobed, narrow, usually setose hairy; veins simple or forked, usually ending by hydathodes on upper surface. Sori typically dorsal on the lowest acroscopic branches of forked veins, usually in a single row along both sides of midribs, round or elliptic, superficial or impressed.

Grammitis dorsipila (Christ) C.Chr. & Tardieu, in Fl. Gén. I.-C. 7(2): 524. 1939; Tagawa & K.Iwats., Fl. Thailand 3(4): 582. 1989.— *Polypodium dorsipilum* Christ in Warb., Monsunia 1: 59. 1900. Fig. 5.151.

Rhizome short, creeping or ascending, slender, bearing several fronds in tuft, densely scaly; scales lanceolate, acute at apex, about 2 by 0.5 mm, entire, membranous, pale brown. **Stipes** short, hardly distinct from the base of fronds, winged, sparsely scaly, hairy with shining brown setose patent hairs, about 1 mm in length. **Fronds** simple, linear, moderately acute at apex, entire or slightly waved at margin, 3-6 cm by 2-5 mm, veins hardly visible, forked, the acroscopic branches short, ending in distinct hydathodes on upper surface; coarsely leathery, hairy throughout. **Sori** dorsal on short acroscopic branches of veins, costal to submarginal, round or oblong, not fusing to the neighbourings.

Thailand.— CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-WESTERN: Prachuap Khiri Khan (Khao Luang); PENINSULAR: Phangnga (Khao Phota Luang Kaeo, Khao Katha Khwam).

Distribution.— S. Japan, Ryukyus, S. China (type) and Indochina.

Ecology.— Epiphyte on mossy tree-trunks in hill evergreen forest about 1,000-1,100 m alt.

Specimens examined.— W. Khwaiphan 082, 083, 158, Y. Yuyen 142, T. Boonkerd 1499 [BCU]; Larsen et al. 33507, FTP 976 [BKF].

2. PROSAPTIA

C.Presl, Tent. Pterid.: 165. 1836; Tagawa & K.Iwats., Fl. Thailand 3(4): 591. 1989.

Rhizome short-creeping or ascending, scaly. Fronds in tuft, pinnatifid with free venation. Sori round to elliptic, more or less sunk in cavities at margin or on lower surface of fronds.

Prosaptia khasyana (Hook.) C.Chr. & Tardieu., Not., Syst. 8: 180. 1939; in Fl. Gén. I.-C. 7(2): 531. 1939; Tagawa & K.Iwats., Fl. Thailand 3(4): 591. 1989.— *Polypodium khasynum* Hook., Ic. Pl.: t. 949. 1854.— *Ctenopteris khasyana* (Hook.) Holttum, Rev. Fl. Malaya 2: 233. f. 134. 1955. Fig. 5.152.

Rhizome short, ascending, bearing a tuft of fronds at apex, scaly; scales oblong-subdeltoid, pale brown, pubescent at margin. **Stipes** very short, castaneous, densely pubescent. **Fronds** narrowly lanceolate, graduall narrowing towards both ends, 20-40 by up to 2 cm, deeply lobed to midrib with a wing; lobes oblique, oblong-subtriangular, moderately acute at a apex, entire, the lower ones gradually becoming smaller upwards; thinly leathery, veins simple, the lowest basiscopic one usually running direct from midribs, 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 carvities withpout prominent edges.

Thailand.— NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng, 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.— Epiphyte on mossy tree-trunks in hill evergreen forest about 1,000-1,100 m alt.

Specimens examined.— W. Khwaiphan 058, T. Boonkerd 564, 586 [BCU]; M. Tagawa, K. Iwatsuki and N. Fukuoka T-598, T-1305 [BKF].

Fig. 5.1 ***Huperzia hamiltonii*** **(Spreng.) Trevis., habitat**

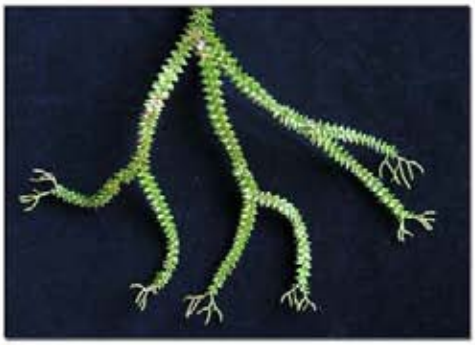

Fig. 5.2 ***Huperzia phlegmaria*** **(L.) Rothm., sporophyll**

Fig. 5.3 ***Huperzia squarrosa*** **(G.Forst.) Trevis., habitat**

Fig. 5.4 ***Lycopodiella cernua*** **(L.) Pic.Serm., sporophyll**

Fig. 5.5 ***Selaginella biformis*** **A.Braun ex Kuhn, habitat**

Fig. 5.6 ***Selaginella roxburghii*** **(Hook. & Grev.) Spring, habitat**

Fig. 5.7 ***Selaginella siamensis*** **Hieron., habitat**

Fig. 5.8 ***Psilotum nudum*** **(L.) P.Beauv., habitat**

Fig. 5.9 ***Angiopteris evecta*** **(G.Forst.) Hoffm., frond**

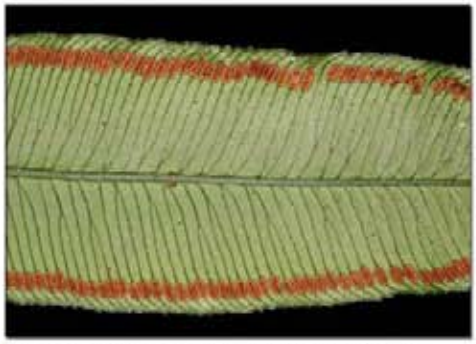

Fig. 5.10 ***Angiopteris evecta*** **(G.Forst.) Hoffm., sori**

Fig. 5.11 ***Helminthostachys zeylanica*** **(L.) Hook., fertile frond**

Fig. 5.12 ***Ophioglossum gramineum*** **Willd., habitat**

Fig. 5.13 ***Ophioglossum petiolatum*** **Hook., habitat**

Fig. 5.14 ***Crepidomanes latealatum*** **(Bosch) Copel., habitat**

Fig. 5.15 ***Crepidomanes latemarginale*** **(Eaton) Copel., habitat**

Fig. 5.16 ***Crepidomanes maximum*** **(Blume) K.Iwats., habitat**

Fig. 5.17 *Crepidomanes minutum* (Blume) K.Iwats., fertile frond

Fig. 5.18 *Hymenophyllum barbatum* (Bosch) Baker, fertile frond

Fig. 5.19 *Hymenophyllum exsertum* Wall. ex Hook., fertile frond

Fig. 5.20 *Hymenophyllum polyanthos* (Sw.) Sw., habitat

Fig. 5.21 *Trichomanes motleyi* Bosch, habitat

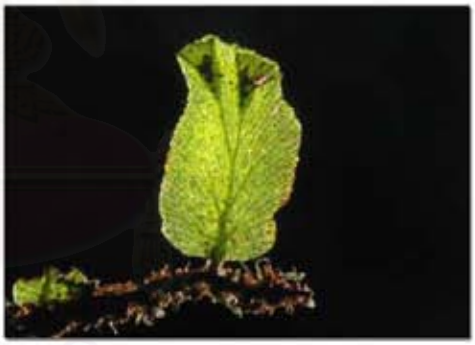

Fig. 5.22 *Trichomanes motleyi* Bosch, fertile frond

Fig. 5.23 *Dicranopteris linearis* (Burm.f.) Underw. var. *linearis*, branching frond

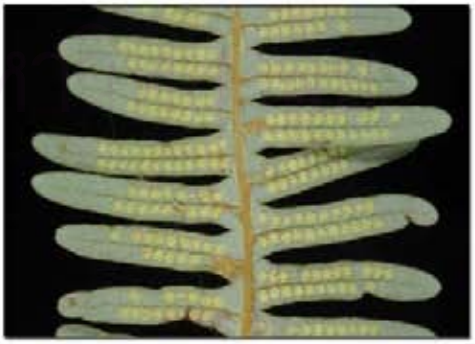

Fig. 5.24 *Dicranopteris linearis* (Burm.f.) Underw. var. *linearis*, sori

Fig. 5.25 *Dicranopteris splendida* **(Hand.-Mazz.) Tagawa, branching frond**

Fig. 5.26 *Dicranopteris splendida* **(Hand.-Mazz.) Tagawa, sori**

Fig. 5.27 *Gleichenia norrisii* **Mett. ex Kuhn, fronds**

Fig. 5.28 *Gleichenia norrisii* **Mett. ex Kuhn, sori**

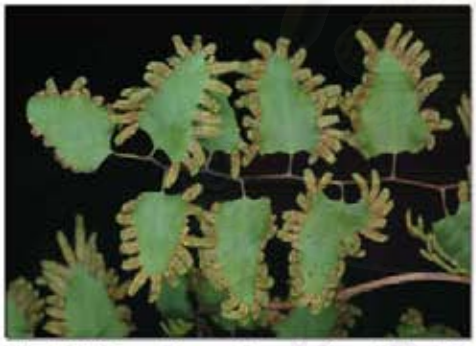

Fig. 5.29 *Lygodium microphyllum* **(Cav.) R.Br., sorophores**

Fig. 5.30 *Lygodium polystachyum* **Wall. ex T.Moore, fronds**

Fig. 5.31 *Lygodium salicifolium* **C.Presl, fronds**

Fig. 5.32 *Lygodium salicifolium* **C.Presl, sorophores**

Fig. 5.33 *Microlepia herbacea* Ching & C.Chr. ex Tardieu & C.Chr., habitat

Fig. 5.34 *Microlepia herbacea* Ching & C.Chr. ex Tardieu & C.Chr., sori

Fig. 5.35 *Pteridium aquilinum* (L.) Kuhn subsp. *caudatum* (L.) R.M. Tryon var. *yarrabense* Domin, fronds

Fig. 5.36 *Pteridium aquilinum* (L.) Kuhn subsp. *caudatum* (L.) R.M. Tryon var. *yarrabense* Domin, sori

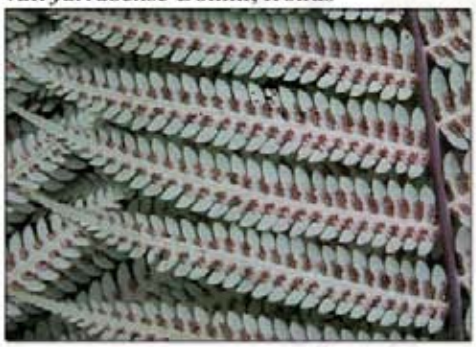

Fig. 5.37 *Cibotium barometz* (L.) J.Sm., sori

Fig. 5.38 *Lindsaea chienii* Ching, habitat

Fig. 5.39 *Lindsaea ensifolia* Sw., fronds

Fig. 5.40 *Lindsaea heterophylla* Dryand., fronds

Fig. 5.41 *Lindsaea lucida* Blume, habitat

Fig. 5.42 *Lindsaea lucida* Blume, sori

Fig. 5.43 *Cyathea gigantea* (Wall. ex Hook.) Holttum, habitat

Fig. 5.44 *Cyathea gigantea* (Wall. ex Hook.) Holttum, sori

Fig. 5.45 *Cyathea latebrosa* (Wall. ex Hook.) Copel., habitat

Fig. 5.46 *Cyathea latebrosa* (Wall. ex Hook.) Copel., sori

Fig. 5.47 *Adiantum philippense* L., habitat

Fig. 5.48 *Adiantum philippense* L., sori

Fig. 5.49 *Cheilanthes pseudofarinosa* **(Ching & S.K.Wu) K.Iwats., habitat**

Fig. 5.50 *Cheilanthes pseudofarinosa* **(Ching & S.K.Wu) K.Iwats., sori**

Fig. 5.51 *Cheilanthes tenuifolia* **(Burm.f.) Sw., habitat**

Fig. 5.52 *Cheilanthes tenuifolia* **(Burm.f.) Sw., sori**

Fig. 5.53 *Pityrogramma calomelanos* **(L.) Link, habitat**

Fig. 5.54 *Pityrogramma calomelanos* **(L.) Link, sori**

Fig. 5.55 *Taenitis blechnoides* **(Willd.) Sw., elongate sori**

Fig. 5.56 *Pteris aspericaulis* **Wall. ex J.Agardh, fronds**

Fig. 5.57 *Pteris biaurita* **L., sori**

Fig. 5.58 *Pteris grevilleana* **Wall. ex J.Agardh, habitat**

Fig. 5.59 *Pteris vittata* **L., habitat**

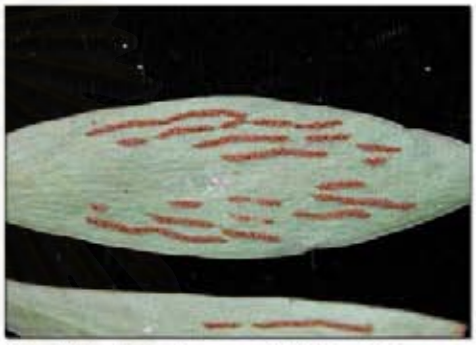

Fig. 5.60 *Antrophyum callifolium* **Blume, sori**

Fig. 5.61 *Vittaria angustifolia* **Blume, sori**

Fig. 5.62 *Vittaria elongata* **Sw., habitat**

Fig. 5.63 *Vittaria elongata* **Sw., sori**

Fig. 5.64 *Vittaria flexuosa* **Fée, sori**

Fig. 5.65 *Asplenium apogamum* N.Murak. & Hatan., habitat

Fig. 5.66 *Asplenium crinicaule* Hance, habitat

Fig. 5.67 *Asplenium crinicaule* Hance, sori

Fig. 5.68 *Asplenium nidus* L. var. *nidus*, habitat

Fig. 5.69 *Asplenium normale* D.Don, habitat

Fig. 5.70 *Asplenium yoshinagae* Makino, sori

Fig. 5.71 *Asplenium* sp., habitat

Fig. 5.72 *Asplenium* sp., sori

Fig. 5.73 ***Blechnum orientale*** **L., habitat**

Fig. 5.74 ***Blechnum orientale*** **L., sori**

Fig. 5.75 ***Bolbitis appendiculata*** **(Willd.) K.Iwats., habitat**

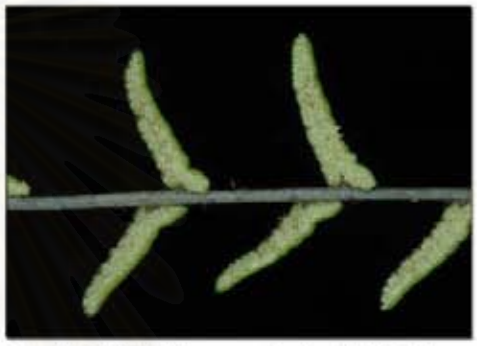

Fig. 5.76 ***Bolbitis appendiculata*** **(Willd.) K.Iwats., fertile frond**

Fig. 5.77 ***Bolbitis heteroclita*** **(C.Presl) Ching ex C.Chr, habitat**

Fig. 5.78 ***Bolbitis heteroclita*** **(C.Presl) Ching ex C.Chr, fertile frond**

Fig. 5.79 ***Bolbitis sinensis*** **(Baker) K.Iwats var.** ***sinensis*****, habitat**

Fig. 5.80 ***Bolbitis virens*** **(Wall. ex Hook. & Grev.) Schott var.** ***virens*****, habitat**

Fig. 5.81 ***Bolbitis virens*** **(Wall. ex Hook. & Grev.) Schott var.** ***compacta*** **Hennipman, habitat**

Fig. 5.82 ***Elaphoglossum malayense*** **Holttum, habitat**

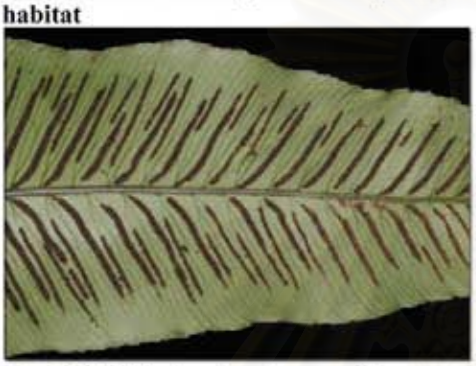

Fig. 5.83 ***Diplazium bantamense*** **Blume, sori**

Fig. 5.84 ***Diplazium donianum*** **(Mett.) Tardieu, habitat**

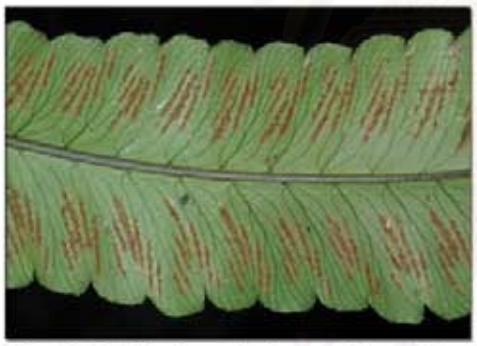

Fig. 5.85 ***Diplazium donianum*** **(Mett.) Tardieu, sori**

Fig. 5.86 ***Diplazium esculentum*** **(Retz.) Sw., habitat**

Fig. 5.87 ***Diplazium esculentum*** **(Retz.) Sw., sori**

Fig. 5.88 ***Diplazium simplicivenium*** **Holttum, sori**

Fig. 5.89 *Arachniodes cavalerii* (Christ) Ohwi, habitat

Fig. 5.90 *Arachniodes cavalerii* (Christ) Ohwi, sori

Fig. 5.91 *Diacalpe aspidioides* Blume, habitat

Fig. 5.92 *Dryopteris polita* Rosenst., sori

Fig. 5.93 *Dryopteris sparsa* (D.Don) Kuntze, sori

Fig. 5.94 *Dryopteris subtriangularis* (C.Hope) C.Chr., fronds

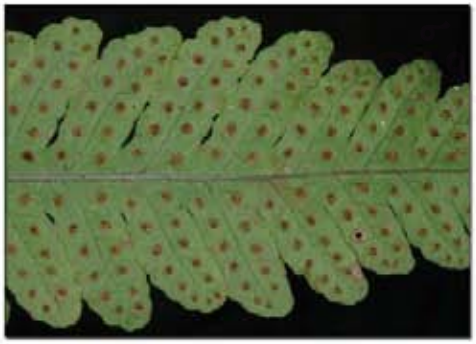

Fig. 5.95 *Heterogonium gurupahense* (C.Chr.) Holttum, sori

Fig. 5.96 *Pleocnemia irregularis* (C.Presl) Holttum, habitat

Fig. 5.97 *Pleocnemia irregularis* **(C.Presl) Holttum, sori**

Fig. 5.98 *Polystichum biaristatum* **(Blume) T.Moore, habitat**

Fig. 5.99 *Polystichum biaristatum* **(Blume) T.Moore, sori**

Fig. 5.100 *Tectaria griffithii* **(Baker) C.Chr., habitat**

Fig. 5.101 *Tectaria maingayi* **(Baker) C.Chr., habitat**

Fig. 5.102 *Tectaria* **sp. 1, habitat**

Fig. 5.103 *Tectaria* **sp.1, habitat**

Fig. 5.104 *Tectaria* **sp. 2, fronds**

Fig. 5.105 ***Amphineuron immersum*** **(Blume) Holttum, sori**

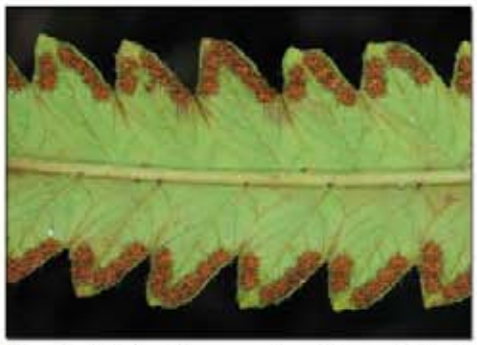

Fig. 5.106 ***Amphineuron terminans*** **(J.Sm.) Holttum, sori**

Fig. 5.107 ***Christella appendiculata*** **(C.Presl) Holttum, habitat**

Fig. 5.108 ***Christella hispidula*** **(Decne) Holttum, sori**

Fig. 5.109 ***Christella papilio*** **(C.Hope) Holttum, habitat**

Fig. 5.110 ***Christella papilio*** **(C.Hope) Holttum, sori**

Fig. 5.111 ***Christella parasitica*** **(L.) H.Lév., habitat**

Fig. 5.112 ***Christella subelata*** **(Baker) Holttum, habitat**

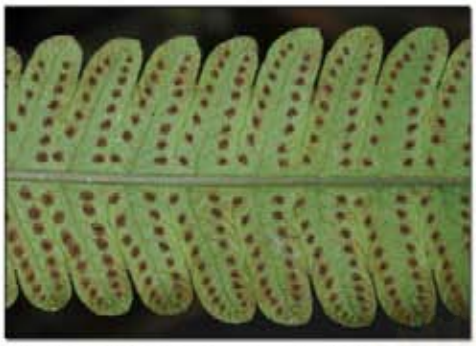

Fig. 5.113 *Christella subelata* **(Baker) Holttum, sori**

Fig. 5.114 *Christella subpubescens* **(Blume) Holttum, sori**

Fig. 5.115 *Macrothelypteris torresiana* **(Gaudich.) Ching, habitat**

Fig. 5.116 *Macrothelypteris torresiana* **(Gaudich.) Ching, sori**

Fig. 5.117 *Pneumatopteris truncata* **(Poir.) Holttum, habitat**

Fig. 5.118 *Pneumatopteris truncata* **(Poir.) Holttum, sori**

Fig. 5.119 *Pronephrium nudatum* **(Roxb.) Holttum, habitat**

Fig. 5.120 *Pronephrium nudatum* **(Roxb.) Holttum, sori**

Fig. 5.121 *Pronephrium triphyllum* **(Sw.) Holttum, habitat**

Fig. 5.122 *Trigonospora ciliata* **(Wall. ex Benth.) Holttum, habitat**

Fig. 5.123 *Trigonospora ciliata* **(Wall. ex Benth.) Holttum, sori**

Fig. 5.124 *Davallia embolostegia* **Copel., habitat**

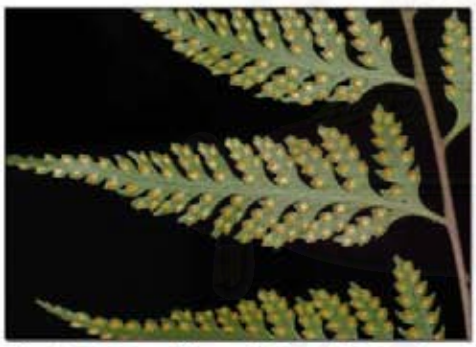

Fig. 5.125 *Davallia embolostegia* **Copel., sori**

Fig. 5.126 *Davallia trichomanoides* **Blume var.** *trichomanoides***, habitat**

Fig. 5.127 *Humata repens* **(L.f.) Diels, sori**

Fig. 5.128 *Leucostegia immersa* **(Wall. ex Hook.) C.Presl, sori**

Fig. 5.129 *Oleandra musifolia* (Blume) C.Presl, sori

Fig. 5.130 *Aglaomorpha coronans* (Wall. ex Mett.) Copel., habitat

Fig. 5.131 *Belvisia annamensis* (C.Chr.) Tagawa, sori

Fig. 5.132 *Belvisia henryi* (Hieron. ex C.Chr.) Tagawa, habitat

Fig. 5.133 *Belvisia mucronata* (Fée) Copel., habitat

Fig. 5.134 *Crypsinus oxylobus* (Wall. ex Kunze) Sledge, habitat

Fig. 5.135 *Drynaria rigidula* (Sw.) Bedd., habitat

Fig. 5.136 *Drynaria sparsisora* (Desv.) T.Moore, habitat

Fig. 5.137 ***Goniophlebium subauriculatum*** **(Blume) C.Presl, habitat**

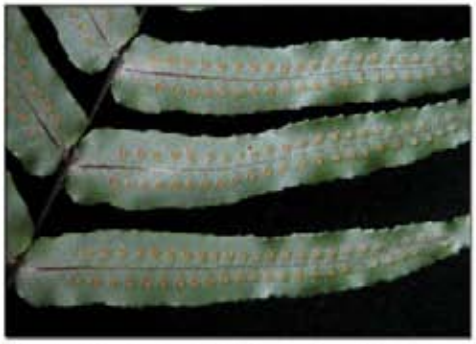

Fig. 5.138 ***Goniophlebium subauriculatum*** **(Blume) C.Presl, sori**

Fig. 5.139 ***Goniophlebium*** **sp., habitat**

Fig. 5.140 ***Lepisorus scolopendrium*** **(Buch.-Ham. ex D.Don) Tagawa, habitat**

Fig. 5.141 ***Loxogramme involuta*** **(D.Don) C.Presl, habitat**

Fig. 5.142 ***Loxogramme involuta*** **(D.Don) C.Presl, sori**

Fig. 5.143 ***Microsorum insigne*** **(Blume) Copel., habitat**

Fig. 5.144 ***Microsorum pteropus*** **(Blume) Copel., habitat**

Fig. 5.145 *Microsorum punctatum* **(L.) Copel., habitat**

Fig. 5.146 *Phymatosorus nigrescens* **(Blume) Pic.Serm., habitat**

Fig. 5.147 *Phymatosorus nigrescens* **(Blume) Pic.Serm., sori**

Fig. 5.148 *Pyrrosia lingua* **(Thunb.) Farw. var.** *heteractis* **(Mett. ex Kuhn) Hovenkamp, habitat**

Fig. 5.149 *Pyrrosia lingua* **(Thunb.) Farw. var.** *heteractis* **(Mett. ex Kuhn) Hovenkamp, sori**

Fig. 5.150 *Pyrrosia piloselloides* **(L.) M.G.Price, habitat**

Fig. 5.151 *Grammitis dorsipila* **(Christ) C.Chr. & Tardieu, habitat**

Fig. 5.152 *Prosaptia khasyana* **(Hook.) C.Chr. & Tardieu, habitat**

CHAPTER VI

DISCUSSION AND CONCLUSION

Diversity of ferns and fern allies at Khao Khiao area in Khao Yai National Park were explored from December 2003 to May 2005. A total of 219 specimens were collected and subsequently determined into 113 species and 2 varieties, in 59 genera within 25 families. Among these, 22 families, 55 genera, 105 species and 2 varieties were ferns, while 3 families, 4 genera and 8 species were fern allies. Three families of ferns namely Polypodiaceae, Thelypteridaceae, Dryopteridaceae were among the common families. Polypodiaceae included 17 species in 10 genera while Thelypteridaceae and Dryopteridaceae included 13 species in 6 genera, and 12 species in 7 genera, respectively. With regard to habitats, there were 58 species of terrestrials, 30 species of epiphytes, 7 species and 2 varieties of lithophytes. However, 18 species of ferns and fern allies could be found in more than one habitats. Furthermore, it can be concluded that 53 species and 2 varieties were found in tropical rain forest, while 34 species were found in hill evergreen forest. Six species were commonly found in grassland and secondary forest. Twenty species may be found in more than one vegetation.

6.1 Diversity of ferns and fern allies in relation to habitat

Various habitats of ferns and fern allies at Khao Khiao area in Khao Yai National Park were found, such as on forest floor (terrestrial), on tree trunks or branches (epiphyte) and on rocks (lithophyte). Furthermore, some species of ferns and fern allies can be found in more than one habitat. (Fig. 6.1)

6.1.1 Terrestrials

Terrestrial ferns and fern allies grew on forest floor. It was found that 58 species of ferns and fern allies thrive in this habitat (Fig. 6.1). Common species were member of Thelypteridaceae, Dryopteridaceae, Lindsaeaceae, and Woodsiaceae. Terrestrial habitat included exposed areas, shady areas, stream banks, and hill slopes. Most species were found in shady areas which were shaded by tree or shrub canopy. Examples included *Amphineuron terminans* (J.Sm.) Holttum, *Dryopteris subtriangularis* (C.Hope) C.Chr., *Lindsaea heterophylla* Dryand., *Diplazium*

donianum (Mett.) Tardieu. The exposed areas are found along margin of the forests, along stream banks or the disturbed areas from log cutting or road construction. Examples of terrestrial exposed plants included *Lycopodiella cernua* (L.) Pic.Serm. *Dicranopteris linearis* (Burm.f.) Underw. var. *linearis*, *Blechnum orientale* L. These pteridophytes usually occur on hill slopes, they more or less protect soil erosion by using their penetrating roots. *Pteridium aquilinum* (L.) Kuhn subsp. *caudatum* (L.) R.M.Tryon var. *yarrabense* Domin usually grew on exposed grounds or mountain ridges. This bracken fern has long creeping rhizome below the grounds, during dry season (January-March) there occur some forest fire. The fire burn all the above ground parts, but the underneath rhizomes still survive, after some shower of rain in early April this fern can produce some new frond above ground again. (Winter and Amoroso, 2003)

Some ferns, such as *Dicranopteris linearis* (Burm.f.) Underw. var. *linearis*, *Helminthostachys zeylanica* (L.) Hook. and *Lygodium microphyllum* (Cav.) R.Br. can successfully thrive in fully exposed areas of grassland where grasses are dominant. Since they have rhizomes below the ground surface, their above ground plant-parts are still protected from strong sun-light from the shade of grasses and some pioneer tree species.

Along stream banks where sunlight can penetrate to the forest floors, some ferns grow best in this humid air and moist fertile soil. Some large fern, e.g. *Angiopteris evecta* (G.Forst.) Hoffm., *Pleconemia irregularis* (C.Presl) Holttum can be observed here. Nearby areas some species of Thelypteridaceae are commonly found, viz. *Pneumatopteris truncata* (Poir.) Holttum.

On shady mountain slopes, high air humidity is frequently observed during rainy season. It is usually cloudy and foggy in the morning up to midday. Some terrestrial mountain ferns can be found in hill evergreen forest, such as *Asplenium normale* D.Don, *Diacalpe aspidioides* Blume. They usually occupy humus rich grounds or rocks. These two species are common in hill evergreen forest or lower montane forest in Thailand and tend to be indicator of this vegetation type.

1.2 Epiphytes

It was found that 30 species of ferns and fern allies are epiphytes (Fig. 6.1). Common species are member of family: Polypodiaceae, Hymenophyllaceae, Aspleniaceae, Vittariaceae and Davalliaceae. In hill evergreen forest, tree-trunks and branches usually cover with mosses and leafy liverworts. Common epiphytic species included *Huperzia hamiltonii* (Spreng.) Trevis., *Lepisorus scolopendrium* (Buch.-Ham. ex D.Don) Tagawa, *Hymenophyllum polyanthos* (Sw.) Sw., *Elaphoglossum malayense* Holttum, *Humata repens* (L.f.) Diels and *Pyrrosia lingua* var. *heteractis* (Mett. ex Kuhn) Hovenkamp. They normally grow together with some orchids, e.g. *Bulbophyllum siamense* Rchb.f., *Otochilus fuscus* Lindl., *Eria siamensis* Schltr. *Gastrochilus calceolaris* (Buch.-Ham. ex J.Sm.) D.Don and *Aeschynanthus hildebrandii* Hemsl. (Gesneriaceae). In some spots where sun light can penetrate to tree-trunks, a large epiphyte i.e. *Aglaomorpha coronans* (Wall. ex Mett.) Copel. can be noticed. This species has frond of one kind instead of two that are seen in its related genus *Drynaria*. It has leathery and glossy fronds as well as a succulent rhizome. These characters give rise to its drought resistance during dry season. This fern species can collect humus in the same way as *Drynaria* spp. and bird's nest fern, *Asplenium nidus* L. did. It is frequently found in both tropical rain forest and hill evergreen forest. In contrast, some small ferns member of the Grammitidaceae, i.e. *Grammitis dorsipila* (Christ) C.Chr. & Tardieu and *Prosaptia khasyana* (Hook.) C.Chr. are restricted in hill evergreen forest. These two species are uncommon. Likewise, *Davallia trichomanoides* Blume var. *trichomanoides* is also uncommon species at Khao Khiao (Table 5.1) though this epiphytic species can be observed in both tropical rain forest and hill evergreen forest. The other uncommon species included *Belvisia* spp., *Drynaria rigidula* (Sw.) Bedd., *Pyrrosia piloselloides* (L.) Copel. (Table 5.1). In some moist and shady places, such as nearby waterfall or streamlets in tropical rain forest, there are small or medium-sized epiphytes on shrubs or small trees, e.g. *Asplenium apogamum* N. Murak. & Hatan., *Antrophyum callifolium* Blume. and *Loxogramme involuta* (D.Don) C.Presl. These ferns avoid desiccation during dry season by shriveling resulted in reducing transpiration. After having some rains at the beginning of the rainy season they have their fronds fully expand again.

1.3 Lithophytes

At Khao Khiao lithophytes usually occupied bare or humus-rich rocks in shady area. Seven species and 2 varieties were found as lithophytes (Fig. 6.1). In hill evergreen forest ferns and fern allies usually occur in rock crevices or mossy cliffs. They usually have long-creeping rhizome for creeping on rock surface or in rock crevices. Examples included *Humata repens* (L.f.) Diels, *Leucostegia immersa* (Wall. ex Hook.) C.Presl., *Oleandra musifolia* (Blume) C.Presl. Among the three species, *Oleandra musifolia* has drought avoidance property. This species usually shed their fronds to prevent transpiration. In addition, it also has appressed scales covered rhizome to avoid desiccation. In tropical rain forest, lithophytes can be found in high humidity area such as along stream banks or on muddy rocks in streamlets. Examples included *Bolbitis virens* (Hook. & Grev.) Schott var. *virens, Bolbitis virens* (Hook. & Grev.) Schott var. *compacta* Hennipman, *Bolbitis sinensis* (Baker) K. Iwats var. *sinensis*, *Crepidomanes latealatum* (Bosch) Copel. and *Trichomanes motleyi* Bosch. While *Microsorum pteropus* (Blume) Copel. is usually found on muddy rocks near waterfall. It can withstand flood for a consideration periods and it is a member of rheophyte (Boonkerd, 1996). In some moist spot where sun-light can penetrate to the forest floor, *Adiantum philippense* L. can be observed in clump on moist rocks.

Some species of ferns and fern allies were found in more than one habitats. It was found that *Asplenium normale* D.Don, *Bolbitis heteroclita* (C. Presl.) Ching ex C.Chr. and *Phymatosorus nigrescens* (Blume) Pic.Serm. can be terrestrials or epiphytes. While *Selaginella roxburghii* (Hook. & Grev.) Spring, *Pityrogramma calomelanos* (L.) Link., *Trigonospora ciliata* (Wall. ex Benth.) Holttum and *Arachniodes cavalerii* (Christ) Ohwi can be terrestrials or lithophytes. Some species can be epiphytes or lithophytes such as, *Asplenium yoshinagae* Makino, *Microsorum insigne* (Blume) Copel. and *Oleandra musifolia* (Blume) C.Presl.

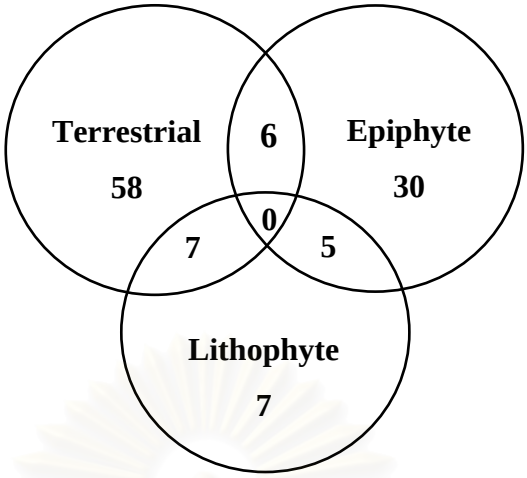

Fig. 6.1 Diversity of ferns and fern allies in each habitat

6.2 Diversity of ferns and fern allies and vegetation

The vegetation of Khao Khiao area in Khao Yai National Park included tropical rain forest, hill evergreen forest, grassland and secondary forest. Each species of ferns and fern allies may be restricted to only one forest type or can be found in the others. (Fig. 6.2)

6.2.1 Tropical rain forest

At Khao Khiao, tropical rain forest was found between 600-1,000 m elevations. This forest type usually has humid air and soil throughout the year. There are some streamlets and many fern species were observed on forest floor. It was found that 73 species and 2 varieties of ferns and fern allies in tropical rain forest, of these 53 species and 2 varieties are confined to this forest. Tropical rain forest has the highest number of ferns and fern allies as compared with the others. The high diversity probably due to the biggest areas among the three forest types and may be due in part to the favourable physical factors of this forest type. Moisture and temperatures were rather stable during day and night. Sun light has been shaded by tree canopy and light intensity and quality were suitable for most ferns and fern allies. In addition wind also has been shielded from trees or shrubs at the margin of the forest. So these physical environments promote growth of most ferns and fern allies, especially terrestrials. The common families included Dryopteridaceae, Pteridaceae,

Thelypteridaceae and Lomariopsidaceae. The characteristic species of this type of forest included large ferns: *Angiopteris evecta* (G.Forst.) Hoffm. and *Pleocnemia irregularis* (C.Presl) Holttum; medium-sized ferns: *Christella papilio* (C.Hope) Holttum, *Pronephrium nudatum* (Roxb.) Holttum and *Pronephrium triphyllum* (Sw.) Holttum, *Pteris aspericaulis* Wall. ex J.Agardh and *Microlepia herbacea* Ching & C.Chr. ex Tardieu. They usually grow nearby moist spots, e.g. stream banks. The common epiphytes comprised *Huperzia phelgmaria* (L.) Rothm., *Drynaria sparsisora* (Desv.) T.Moore and *Microsorum punctatum* (L.) Copel. They normally occur on tree trunks or branches where some light can be attained.

6.2.2 Hill evergreen forest

This forest type is found from 1,000 m elevation to the summit of Khao Khiao (1,292 m). This forest has rich in number of individuals, but hill evergreen forest has less diversity of ferns and fern allies than tropical rain forest. Since this forest type mainly found on mountain ridge and has smaller areas than the tropical rain forest. Fifty two species of ferns and fern allies were noticed in this forest. Among these, 34 species were restricted to hill evergreen forest. Most ferns and fern allies were epiphytes, some species are well adapted to thrive in dry condition during dry season, for example, filmy ferns have contracted lamina for reducing transpiration areas. Polypodiaceae, Hymenophyllaceae and Dryopteridaceae were among the common families.

6.2.3 Grassland and secondary forest

Grassland and secondary forest were found along highway number 3182. Common pioneer species in grassland comprised *Imperata cylindrica* Beauv., *Saccharum spontaneum* L. whereas *Mallotus paniculatus* (Lam.) Muell.-Arg. and *Melia azedarach* L. can be found in the secondary forest. This vegetation have open area which rather low air and soil humidity. Therefore, these conditions are not suitable for most ferns and fern allies. Eleven species of ferns and fern allies were observed, of these 6 species were confined to this vegetation. However, it is surprised to observe *Helminthostachys zeylanica* (L.) Hook., *Ophioglossum gramineum* Willd. and *Ophioglossum petiolatum* Hook. in grassland. These species are terrestrials of semi-exposed areas, they often occur near the margin of tropical rain forest. So these ferns may be the remnant of tropical rain forest in the past. In the secondary forest

the following species: *Pyrrosia piloselloides* (L.) M.G.Price, *Cheilanthes tenuifolia* (Burm.f.) Sw. and *Lygodium microphyllum* (Cav.) R.Br. can be observed. In addition, some species can be found in both grassland and secondary forest: *Pteridium aquilinum* (L.) Kuhn var. *yarrabense* Domin, *Lygodium salicifolium* C.Presl.

Some species of ferns and fern allies can be found in more than one vegetation. Fourteen species can be found in both tropical rain forest and hill evergreen forest such as, *Huperzia squarrosa* (G.Forst.) Trevis., *Cyathea gigantea* (Wall. ex Hook.) Holttum, *Davallia trichomanoides* Blume var. *trichomanoides*, *Aglaomorpha coronans* (Wall. ex Mett.) Copel. and *Christella parasitica* (L.) H.Lév. While *Lygodium salicifolium* C.Presl. can be found in tropical rain forest, grassland and secondary forest. *Lindsaea ensifolia* Sw. can be found in both hill evergreen forest and secondary forest. It was found that 4 species can be found in all forest types, viz. *Dicranopteris linearis* (Burm.f.) Underw. var. *linearis*., *Lycopodiella cernua* (L.) Pic.Serm., *Pteridium aquilinum* (L.) Kuhn subsp. *caudatum* (L.) R.M.Tryon var. *yarrabense* Domin and *Selaginella siamensis* Hieron. These species also have wide distribution throughout Thailand (Tagawa and Iwatsuki, 1979).

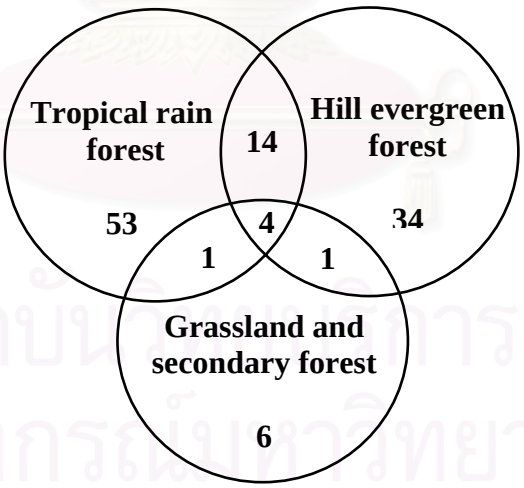

Fig. 6.2 Diversity of ferns and fern allies in each vegetation

6.3 Rare species

Some species of ferns and fern allies can be found in small number, for example *Bolbitis virens* (Hook. & Grev.) Schott var. *virens* and *Microsorum insigne* (Blume) Copel. can be found in tropical rain forest whearas *Lindsaea hetrophylla* Dryand. and *Taenitis blechnoides* (Willd) Sw. can be found in hill evergreen forest. While some species can be found only once e.g. *Amphineuron immersum* (Blume) Holttum, *Bolbitis virens* (Hook. & Grev.) Schott var. *compacta* Hennipman, *Crepidomanes maximum* (Blume) K.Iwats., *Diplazium esculentum* (Retz.) Sw., *Dryopteris polita* Rosenst, *Dryopteris sparsa* (D.Don) Kuntze, *Tectaria* sp. 2. *Amphineuron immersum Diplazium esculentum*, and *Dryopteris polita* have rather wide distribution in Thailand. Their rare status at Khao Khiao area is worth investigating. It is surprised to find *Crepidomanes maximum* (Blume) K.Iwats. at Khao Khiao area since this species has distribution mainly in peninsular Thailand and tropic of east asia (Tagawa and Iwatsuki, 1979). Likewise, *Bolbitis virens* (Wall. ex Hook. & Grev.) Schott var. *compacta* also has its distribution in peninsular Thailand and Malaysia. If the determination of these species is right, Khao Khiao area will be the northernmost station of these two species.

6.4 Dubious species

In this study, there were 4 species of ferns that cannot be determined to species. Although attempts have been made to use keys from the Flora of Thailand as well as the other Flora. They also do not match with the voucher herbarium specimens deposited at BCU, BK and BKF.

1. *Asplenium* sp. is a terrestrial plant and found nearby stream in tropical rain forest at about 700-800 m alt. *Asplenium* sp. is a terrestrial plant and found by stream in tropical rain forest. It has an affinity with *Asplenium macrophyllum*, but differs by the scales of rhizome and the shape of pinnae.

2. *Tectaria* sp.1 is a terrestrial plant on humus-rich slopes in hill evergreen forest at 1,000-1,100 m alt. It is closely related to *Tectaria impressa* (Fée) Holttum but differs in having shallowly lobed at margin of pinnae rather than deeply lobed to pinnatifid of pinnae.

3. *Tectaria* sp.2 is a terrestrial plant, grows nearby stream in tropical rain forest at about 700-800 m alt. It is closely related to *Tectaria fuscipes* (Wall. ex

Bedd.) C.Chr. but differs from that species in having free veins in both fertile and sterile fronds.

4. *Goniophlebium* sp. is a terrestrial plant in exposed places of hill evergreen forest at altitudes ranging from 1,200-1,300 m. It was closed to *Goniophlebium subauriculatum* (Blume) C.Presl which is epiphyte. But *Goniophlebium* sp. is terrestrial. Another difference is that the shape and size of pinnae.

6.5 Distribution of ferns and fern allies

6.5.1 The Indo-Burmese element

The Indo-Burmese elements have their distribution from the eastern Himalayas and Guinghai-Tibetan plateau and the subtropics of South China, the Ganges plain, Eastern India, Bangladesh, Upper Myanmar and Thailand (Boonkerd, 1996). According to Flora of Thailand (Tagawa and Iwatsuki, 1979, 1985, 1988, 1989) one species of fern is a member of the Indo-Burmese element.

Pteris aspericaulis Wall. ex J.Agardh is a terrestrial fern, it was found on humus-rich floor in tropical rain forest or on muddy rocks near streams at high altitudes above 1,500 m. It was reported from N. India, Upper Myanmar and Yunnan and North Thailand (Chiang Mai Province). This species was found in tropical rain forest at 700-800 m elevations from this study.

6.5.2 The Indo-Chinese element

The Indo-Chinese elements have their distribution from Southern China to Indochina (Boonkerd, 1996). According to Flora of Thailand (Tagawa and Iwatsuki, 1979, 1985, 1988, 1989), 5 species seem to be members of the Indo-Chinese elements.

Arachniodes cavalerii (Christ) Ohwi is a terrestrial fern, found in evergreen forest at high altitude. Its distribution was recorded from S. China, N. Vietnam and south Japan and N.E. Thailand (Loei Province). This species is terrestrial or lithophyte fern in hill evergreen forest at 1,000-1,300 m elevations at Khao Khiao area.

Grammitis dorsipila (Christ) C.Chr. & Tardieu is an epiphytic fern, found on mossy tree-trunks in light shade along rivers at medium altitudes. It naturally occur in S. Japan, Ryukyus, S. China and Indochina. In Thailand, it was

found in Nakhon Nayok, Prachuap Khiri Khan and Phangnga. It was found in hill evergreen forest at 1,000-1,100 m elevations from this study.

Belvisia annamensis (C.Chr.) Tagawa is an epiphytic fern, found on mossy tree-trunks in light shade or in dense forests usually in moist places at medium altitudes. It was reported from Laos and Vietnam. In Thailand, it was found at Tak, Nakhon Nayok, Trat, Chumphon, Ranong, Trang. This species was reported from this study, found in hill evergreen forest at 1,000-1,300 m altitudes.

Pyrrosia lingua (Thunb) Farw. var. *heteractis* (Mett. ex Kuhn) Hovenkamp is a lithophyte or epiphyte on rocks or on tree-trunks in exposed places, in light shade or in rather dense forest at various elevations. It was reported from S. China, Vietnam and was rather common throughout Thailand. In this study, it was found that *Pyrrosia lingua* (Thunb) Farw. var. *heteractis*, terrestrial or epiphyte occurs in hill evergreen forest at 1,000-1,300 m elevations.

Microlepia herbacea Ching & C.Chr. ex Tardieu & C.Chr. is a terrestrial fern, found on rather dry humus rich slopes in tropical evergreen forest at high altitude. It was reported from Vietnam. In Thailand, it was found in Chiang Rai, Chiang Mai, Phetchabun, Loei, Nakhon Nayok Provinces. It was terrestrial fern in tropical rain forest at 700-800 m elevations about, in this site.

6.5.3 The Malesian element

The Malesian elements were found from Malay archipelago and Malay Islands to the Isthmus of Kra, in Ranong Province, Thailand (Boonkerd, 1996). According to Flora of Thailand (Tagawa and Iwatsuki, 1979, 1985, 1988, 1989), 6 species are members of the Malesian elements.

Crepidomanes maximum (Blume) K.Iwats. is a lithophyte or terrestrial fern, found on moist muddy rocks or on wet sandy ground near streams in hill evergreen forest. It occurs naturally in the tropics of E. Asia and Polynesia. In Thailand, it was found in Ranong, Surat Thani, Phanga, Nakhon Si Thammarat, Trang, Pattani, Yala. It was found in hill evergreen forest at 1,000-1,200 m elevation from this study.

Diplazium bantamense Blume is a terrestrial fern, occurs on mountain slopes near streams in dense evergreen forests at medium altitudes. It was reported from W. Malesia. In Thailand, it was found in Surat Thani, Nakhon Si Thammarat,

Trang, Yala Provinces. In this study, this species is found at 700-800 m elevations in tropical rain forest.

Gleichenia norrisii Mett. ex Kuhn is a terrestrial fern on mountain slope, along stream or at margin of dense forest about 1,100 m altitude. It was reported from Malaya, Sumatra and Borneo. In Thailand, it was found in Nakhon Nayok, Nakhon Si Thammarat Provinces. It was in hill evergreen forest at 800-1,100 m elevations in this study.

Tectaria maingayi (Baker) C.Chr. is a terrestrial fern, occurs on mountain slopes in dense evergreen forests at low and medium altitudes. It was reported from W. Malesia. In Thailand, it was found in Surat Thani, Phangnga, Phuket, Nakhon Si Thammarat, Trang, Narathiwat, Yala Provinces. It grows in tropical rain forest at 700-800 m elevation from this study

Trichomanes motleyi Bosch is an epiphyte on basal part of tree trunks in dense primary forest at low altitudes. It was reported from Malaya and Borneo. In Thailand, it was observed in Tak, Chumphon, Surat Thani, Phangnga, Phuket, Trang Provinces. This species occurs on moist humus-rich cliffs in hill evergreen forest at 1,000-1,100 m elevations at Khao Khiao area.

Vittaria angustifolia Blume is an epiphyte or lithophyte, found on tree-trunks, on old bark of trees or on muddy rocks in dense evergreen forests at medium to high altitudes. It was reported throughout Malesia, east to New Caledonia. In Thailand, it was found in Chanthaburi, Nakhon Si Thammarat, Trang, Krabi, Yala Provinces. This species is found on tree trunks in tropical rain forest and hill evergreen forest at 700-1,300 m elevations at Khao Khiao area.

6.6 Comparison of ferns and fern allies diversity

6.6.1 Comparison of ferns and fern allies diversity at Khao Khiao area in Khao Yai National Park and Flora of Thailand

Flora of Thailand (Vol. 3 Part 1-4)

The following Flora of Thailand Vol. 3 Part 1-4 were enumerated 34 families, 132 genera, 633 species of ferns and fern allies. Of these, there were 25 new species and 21 endemic species of Thailand. Among these 118 species were recorded from Khao Yai National Park (Tagawa and Iwatsuki, 1979, 1985, 1988, 1989). It was found that 64 species of ferns and fern allies were in common with this study. Among these,

3 species namely, *Hymenophyllum polyanthos* (Sw.) Sw., *Hymenophyllum exsertum* Wall. ex Hook., *Dryopteris subtriangularis* (C.Hope) C.Chr. were recorded from Khao Khiao area in Khao Yai National Park. These species were common in this area, *Hymenophyllum polyanthos* (Sw.) Sw. and *Hymenophyllum exsertum* Wall. ex Hook. were epiphytes in hill evergreen forest. While *Dryopteris subtriangularis* (C.Hope) C.Chr. was a terrestrial fern in hill evergreen.

This study revealed that intensive surveys of ferns and fern allies at Khao Khiao area have added more informations on pteridophyte for Flora of Thailand.

6.6.2 Comparison of ferns and fern allies diversity at Khao Khiao area in Khao Yai National Park and the other area

Previously, the study of ferns and fern allies in specific area were scarce data . The comparison of ferns and fern allies diversity at Khao Khiao area in Khao Yai National Park and the other area viz. The Sakaerat Environmental Research Station, Huaiyang Waterfall National Park, Phu Hin Rong Kla National Park

The Sakaerat Environmental Research Station

The Sakaerat Environmental Research Station, Nakhon Ratchasima Province was a protected area of about 80 km^2 north of Khao Yai National Park. It was ranging in elevations from 250 to 762 m above mean sea level. The mean relative humidity was about 75%, while annual rainfall was about 1,000-1,200 mm. The mean temperature was about 26 °C, while the maximum high temperature was 37 °C in March and the maximum low temperature was 8 °C in January. The vegetation of this area includes dry evergreen forest, mixed deciduous forest, dry deciduous dipterocarp forest and grassland.

Nineteen families, 29 genera, 52 species, 1 varieties of ferns and fern allies were listed, including 3 new records for Thailand viz. *Thelypteris heterocarpa* (Blume) Morton, *Thelypteris terminans* (Hook.) Tagawa & K. Iwats and *Lomariopsis cochinensis* Fée. (Boonkerd, 1975). Then, during 1975-1977, an additional survey of ferns and fern allies in this area were made. Seventeen species of ferns were collected. In all, 19 families, 32 genera, 66 species and 2 varieties were record from this protected area (ทวีศักดิ์ บุญเกิด, 2520). It was found that 25 species of ferns were in common with the ferns collection at Khao Yai National Park (Table 6.1).

Huaiyang Waterfall National Park

Huaiyang Waterfall National Park, Prachuap Khiri Khan Province, was a part of southwest Thailand. It covered an area of approximately 161 km^2 and ranges in elevations from 100 to 1,250 m above mean sea level. The vegetation of this park includes mixed deciduous forest, dry evergreen forest, tropical rain forest and hill evergreen forest. The average annual relative humidity was about 78%. The average rainfall was 1150 mm, while the highest rainfall about 300 mm in October and the lowest rainfall about 28 mm in December. The average temperate of 27.1°C, while the maximum high temperature was 33.2 °C in April and the maximum low temperature was 19.9 °C in December.

Twenty six families, 63 genera, 128 species were identified. (Yuyen and Boonkerd, 2002). It was found that 56 species of ferns and fern allies were in common with the ferns and fern allies collection at Khao Yai National Park (Table 6.1).

Phu Hin Rong Kla National Park

Phu Hin Rong Kla National Park, Phitsanulok Province was a part of Northern Thailand. It covers an area of approximately 307 km^2. Some specific moist area were explored, such as Man Daeng Waterfall, Rom Klao-Paradorn Waterfall and nearby site. The Waterfall was ranging in elevations form 1,200-1,600 m above mean sea level. The vegetation of this area consisted mixed deciduous forest, dry deciduous dipterocarp forest, dry evergreen forest and hill evergreen forest. The average maximum relative humidity was about 89%, while the average minimum relative humidity was about 51%. The average annual rainfall was 1051 mm average, while the highest average annual rainfall was 197.5 mm in August and the lowest annual rainfall was 4.5 mm in January. The average annual temperature was 26.8 °C, while the maximum high temperature of 36.4 °C and the maximum low temperature of 16.8 °C were observed in April and December, respectively.

Twenty three families, 55 genera, 112 species and 2 varieties of ferns and ferns allies were found in this area. Of these, *Acrorumohra diffracta* (Baker) H. Itô, was a new record of Thailand (Rattanathirakul, 2002). It was found that 48 species of ferns and fern allies were in common with the ferns and fern allies collection at Khao Yai National Park (Table 6.1).

Table 6.1 Comparison of ferns and fern allies from Khao Khiao area in Khao Yai National Park, The Sakaerat Environmental Research Station, Huaiyang Waterfall National Park, Phu Hin Rong Kla National Park

Taxon	The Sakaerat Environmental Research Station	Huaiyang Waterfall National Park	Phu Hin Rong Kla National Park
Lycopodiaceae			
Huperzia hamiltonii (Spreng.) Trevis.		✓	✓
Huperzia phlegmaria (L.) Rothm.			✓
Huperzia squarrosa (G.Forst.) Trevis.			
Lycopodiella cernua (L.) Pic.Serm.		✓	
Selaginellaceae			
Selaginella biformis A.Braun ex Kuhn			✓
Selaginella roxburghii (Hook. & Grev.) Spring		✓	
Selaginella siamensis Hieron.			✓
Psilotaceae			
Psilotum nudum (L.) P.Beauv.		✓	
Marattiaceae			
Angiopteris evecta (G.Forst.) Hoffm.	✓	✓	✓
Ophioglossaceae			
Helminthostachys zeylanica (L.) Hook.			
Ophioglossum gramineum Willd.			
Ophioglossum petiolatum Hook.		✓	✓
Hymenophyllaceae			
Crepidomanes latealatum (Bosch) Copel.			
Crepidomanes latemarginale (Eaton) Copel.			
Crepidomanes maximum (Blume) K.Iwats			
Crepidomanes minutum (Blume) K.Iwats		✓	✓
Hymenophyllum barbatum (Bosch) Baker		✓	✓
Hymenophyllum exsertum Wall. ex Hook.		✓	✓
Hymenophyllum polyanthos (Sw.) Sw.			✓
Trichomanes motleyi Bosch			
Gleicheniaceae			
Dicranopteris linearis (Burm.f.) Underw. var. *linearis*		✓	✓
Dicranopteris splendida (Hand.-Mazz.) Tagawa			
Gleichenia norrisii Mett. ex Kuhn			

Taxon	The Sakaerat Environmental Research Station	Huaiyang Waterfall National Park	Phu Hin Rong Kla National Park
Schizaeaceae			
Lygodium microphyllum (Cav.) R.Br.		✓	
Lygodium polystachyum Wall. ex T.Moore			
Lygodium salicifolium C.Presl.	✓	✓	
Dennstaedtiaceae			
Microlepia herbacea Ching & C.Chr. ex Tardieu & C.Chr.	✓		✓
Pteridium aquilinum (L.) Kuhn subsp. *caudatum* (L.) R.M.Tryon var. *yarrabense* Domin			
Dicksoniaceae			
Cibotium barometz (L.) J.Sm.		✓	✓
Lindsaeaceae			
Lindsaea chienii Ching			
Lindsaea ensifolia Sw.	✓	✓	✓
Lindsaea hetrophylla Dryand.			
Lindsaea lucida Blume			
Cyatheaceae			
Cyathea giganthea (Wall. ex Hook.) Holttum	✓		✓
Cyathea latebrosa (Wall. ex Hook.) Copel.	✓	✓	✓
Adiantaceae			
Adiantum philippense L.		✓	✓
Cheilanthes pseudofarinosa (Ching & S.K.Wu) K.Iwats.			
Cheilanthes tenuifolia (Burm.f.) Sw.			
Pityrogramma calomelanos (L.) Link		✓	
Taenitis blechnoides (Willd.) Sw.			
Pteridaceae			
Pteris aspericaulis Wall. ex J.Agardh			
Pteris biaurita L.		✓	
Pteris grevilleana Wall. ex J.Agardh			
Pteris vittata L.			✓
Vittariaceae			
Antrophyum callifolium Blume	✓	✓	✓
Vittaria angustifolia Blume			✓
Vittaria elongata Sw.	✓		
Vittaria flexuosa Fée			

Taxon	The Sakaerat Environmental Research Station	Huaiyang Waterfall National Park	Phu Hin Rong Kla National Park
Aspleniaceae			
Asplenium apogamum N. Murak. & Hatan.		✓	
Asplenium crinicaule Hance		✓	
Asplenium nidus L. var. *nidus*	✓	✓	✓
Asplenium normale D.Don		✓	✓
Asplenium yoshinagae Makino		✓	✓
Asplenium sp.			
Blechnaceae			
Blechum orientale L.		✓	✓
Lomariopsidaceae			
Bolbitis appendiculata (Willd.) K.Iwats	✓	✓	
Bolbitis heteroclita (C.Presl.) Ching ex C.Chr.		✓	✓
Bolbitis sinensis (Baker) K.Iwats var. *sinensis*		✓	✓
Bolbitis virens (Wall. ex Hook. & Grev.) Schott var. *compacta* Hennipman		✓	
Bolbitis virens (Wall. ex Hook.& Grev.) Schott var. *virens*			✓
Elaphoglossum malayense Holttum			✓
Woodsiaceae			
Diplazium bantamense Blume		✓	
Diplazium donianum (Mett.) Tardieu		✓	
Diplazium esculentum (Retz.) Sw.		✓	
Diplazium simplicivenium Holttum	✓	✓	✓
Dryopteridaceae			
Arachniodes cavalerii (Christ) Ohwi			
Diacalpe aspidioides Blume			
Dryopteris polita Rosenst.			✓
Dryopteris sparsa (D.Don) Kuntze.			
Dryopteis subtriangularis (C.Hope) C.Chr.			
Heterogonium gurupahense (C.Chr.) Holttum		✓	
Pleocnemia irregularis (C.Presl) Holttum	✓		
Polystichum biaristatum (Blume) T.Moore		✓	✓
Tectaria griffithii (Baker) C.Chr.		✓	
Tectaria maingayi (Baker) C.Chr.	✓		
Tectaria sp.1			
Tectaria sp.2			

Taxon	The Sakaerat Environmental Research Station	Huaiyang Waterfall National Park	Phu Hin Rong Kla National Park
Thelypteridaceae			
Amphineuron immersum (Blume) Holttum			
Amphineuron terminans (J.Sm.) Holttum	✓	✓	✓
Christella appendiculata (C.Presl) Holttum			
Christella hispidula (Decne) Holttum			
Christella papilio (C.Hope) Holttum		✓	
Christella parasitica (L.) H. Lév.	✓	✓	
Christella subelata (Baker) Holttum			
Christella subpubescens (Blume) Holttum	✓		✓
Macrothelypteris torresiana (Gaudich.) Ching		✓	
Pneumatopteris truncata (Poir.) Holttum			✓
Pronephrium nudatum (Roxb.) Holttum	✓		✓
Pronephrium triphyllum (Sw.) Holttum	✓	✓	
Trigonospora ciliata (Wall. ex Benth.) Holttum			✓
Davalliaceae			
Davallia embolostegia Copel.			
Davallia trichomanoides Blume var. *trichomanoides*	✓		✓
Humata repens (L.f.) Diels		✓	✓
Leucostegia immersa (Wall. ex Hook.) C.Presl.		✓	✓
Oleandraceae			
Oleandra musifolia (Blume) C.Presl.		✓	✓
Polypodiaceae			
Aglaomorpha coranans (Wall. ex Mett.) Coepl.	✓	✓	✓
Belvisia annamensis (C.Chr.) Tagawa			
Belvisia henryi (Hieron. ex. C.Chr.) Tagawa			✓
Belvisia mucronata (Fée) Copel.		✓	
Crypsinus oxylobus (Wall. ex Kunze) Sledge		✓	✓
Drynaria rigidula (Sw.) Bedd.	✓	✓	
Drynaria sparsisora (Desv.) T.Moore.		✓	
Goniophlebium subauriculatum (Blume) C.Presl		✓	✓
Goniophlebium sp.			
Lepisorus scolopendrium (Buch.-Ham. Ex D.Don) Tagawa		✓	✓
Loxogramme involuta (D.Don) C.Presl.			
Microsorum insigne (Blume) Copel.			
Microsorum pteropus (Blume) Copel.	✓	✓	✓
Microsorum punctatum (L.) Copel.	✓	✓	
Phymatororus nigrescens (Blume) Pic.Serm.	✓	✓	

Taxon	The Sakaerat Environmental Research Station	Huaiyang Waterfall National Park	Phu Hin Rong Kla National Park
Polypodiaceae (continued)			
Pyrrosia lingua (Thunb.) Farw. var. *heteractis* (Mett. ex Kuhn) Hovenkamp		✓	✓
Pyrrosia piloselloides (L.) M.G.Price	✓		
Grammitidaceae			
Grammitis dorsipila (Christ) C.Chr. & Tardieu		✓	
Prosaptia khasyana (Hook.) C.Chr. & Tardieu			✓

The result from this study indicated that Khao Khiao area has rather high diversity of pteridophytes in comparison with the other protected areas, though the total area of Khao Khiao is the most smallest (Table 6.2). However, it can be seen that there are different in vegetation among each site. Tropical rain forest and hill evergreen forest are among the two vegetation that rich in pteridophyte diversity (Yuyen and Boonkerd, 2002; Boonkerd and Ratchata, 2002). Khao Khiao has some disturbed areas in tropical rain forest and hill evergreen forest, but they are still small as compares with the other protected areas.

The high diversity of ferns and fern allies at Khao Khiao area in Khao Yai National Park may be in part supports the idea that Khao Yai National Park was a meeting place, as well as a cross-road of the plant species belonging to three floristic elements, viz. the Malesian elements, the Indo-Chinese elements and the Indo-Burmese elements (Smitinand, 1968) and also stress the important of Khao Khiao as a Mecca for fern lover (Boonkerd, 1996). Species composition of ferns and fern allies in each vegetation can be used as an indicator of forest type and also indicate the primary forest condition of this ferny site.

Table 6.2 Comparison of ferns and fern allies diversity among four protected areas.

Protected area	Total area (km^2)	Number of family	Number of genera	Number of species
Khao Khiao area in Khao Yai National Park	60	25	59	113
The Sakaerat Environmental Research Station	80	19	32	66
Huaiyang Waterfall National Park	161	26	63	128
Phu Hin Rong Kla National Park	307	23	55	112

6.7 Utilization of ferns and fern allies

Some species of ferns and fern allies are utilized as food, medicinal, and ornamental plants. They may be used as materials for handicraft.

6.7.1 Food plants

Some ferns and fern allies are used as food plants, especially using young frond as vegetables. (ทวีศักดิ์ บุญเกิด, 2523; Tagawa & Iwatsuki, 1979, 1985, 1988, 1989). This study found 3 species can be used this purpose, i.e. *Blechnum orientale* L., *Diplazium esculentum* Sw. and *Pteridium aquilinum* (L.) Kuhn subsp. *caudatum* (L.) R.M.Tryon var. *yarrabense* Domin.

6.7.2 Medicinal plants

Some ferns and fern allies have medicinal properties It was found that 12 species of ferns were previously recorded for medicinal properties (Table 6.3).

Table 6.3 Some medicinal ferns and fern allies (ทวีศักดิ์ บุญเกิด, 2524; Tagawa and Iwatsuki, 1979, 1985, 1988, 1989).

Species	Part use	Cure
1. *Angiopteris evecta* (G.Forst.) Hoffm.	Root, Rhizome	Fever
2. *Asplenium nidus* L.	Root, Rhizome	Allergies
3. *Blechnum orientale* L.	Root, Rhizome, Leaves	Uropathy
4. *Bolbitis appendiculata* (Willd.) K.Iwats.	Rhizome	Pneumania
5. *Cibotium barometz* (L.) J.Sm.	Hairs	Styptic for wound
6. *Cyathea gigantea* (Wall. ex Hook.) Holttum	Scales	Styptic for wound
7. *Dicranopteris linearis* (Burm.f.) Underw.	Root, Rhizome, Leaves	Wormicide
8. *Diplazium esculentum* (Retz.) Sw.	Root, Rhizome, Leaves	Fever
9. *Helminthostachys zeylanica* (L.) Hook.	Rhizome	Fever
10. *Lindsaea ensifolia* Sw.	Root, Rhizome	Wormicide
11. *Pyrrosia piloselloides* (L.) M.G.Price	Leaves	Allergies

6.7.3 Ornamental plants

Some ferns and fern allies have their beautiful characters and suitable for ornamentation (ทวีศักดิ์ บุญเกิด, 2523). The following 10 species of ferns at Khao Khiao area can be used as ornamental plants.

1. *Adiantum philippense* L.
2. *Aglaomorpha coronans* (Wall. ex Mett.) Copel.
3. *Asplenium nidus* L.
4. *Davallia trichomanoides* Blume
5. *Pyrrosia piloselloides* (L.) M.G.Price
6. *Drynaria rigidula* (Sw.) Bedd.
7. *Dicranopteris linearis* (Burm.f.) Underw.
8. *Lygodium microphyllum* (Cav.) R.Br.
9. *Microsorum punctatum* (L.) Copel.
10. *Pityrogramma calomelanos* (L.) Link

6.7.4 Material for handicraft

Some species of ferns can be used as material for handicraft, e.g. handbags, vase, fan and arm rings (ทวีศักดิ์ บุญเกิด, 2523; Tagawa and Iwatsuki, 1979). *Lygodium salicifolium* C.Presl and *L. microphyllum* (Cav.) R.Br. are found at Khao Khiao area and can be used for this purpose.

6.8 Problems encounter from this study

1. Khao Khiao area in Khao Yai National Park is still rich in wild animals, for example, elephants, snakes, tigers, bears etc. Therefore, it is need to have forest rangers accompany during surveys.

2. There are still some areas that are difficult to access due to high steep slope. So some species are still unseen at these difficult sites.

3. During rainy season, it usually rains most of the day. So it is difficult to take some pictures in the field. There were also some landslides occurred in this season, this natural accidents may wipe out some species and were obstructed by collapsed rocks.

6.9 Benefit of this research

1. The fundamental data of species diversity of ferns and fern allies at Khao Khiao area in Khao Yai National Park was known.

2. The information of this research can be used in conservation and tourism promotion programs.

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