

ACB Field Guide Series No. 2

Field Guide to the Pteridophytes of Chiang Mai, Thailand

John Rey C. Callado • Bayu Adjie • Piyakaset Suksathan
Wenni Setyo Lestari • Dedy Darnaedi

Edwino S. Fernando, Hidetsugu Miwa & Filiberto A. Pollisco, Jr., *Editors*



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Contributing Authors

Dian Indah Pratiwi • Farhad Yozarius • Hj. Shahrin Hj. Md. Jaafar
Heng Sovanna • Kittiphong Kertsawang • Ling Shing Mang
Myint Myint San • Ng Zi Qiang Arthur
Nor Ezzawanis Abdullah Thani • Pichai Yadee
Zaharin Hj. Abdul Kahan • Pham Van Haan

Editors

Edwino S. Fernando • Hidetsugu Miwa • Filiberto A. Pollisco, Jr.

Japan-ASEAN Integration Fund

East and Southeast Asia Biodiversity Information Initiative
Biodiversity Center of Japan, Ministry of the Environment,
Government of Japan
Queen Sirikit Botanic Garden
ASEAN Centre for Biodiversity

2016

Cover

Cyclosorus ciliatus Panigrahi

Back Cover (From the top, left to right)

Asplenium normale D. Don, *Cibotium barometz* (L.) J. Sm.,
Cyathea gigantea (Wall. ex Hook.) Holttum
Microlepia platyphylla (D. Don) J. Sm., *Acrophorus nodosus*
C. Presl, *Dicranopteris linearis* (Burm. f.) Underw.
Didymochlaena truncatula (Sw.) J. Sm., *Huperzia*
hamiltonii (Spreng.) Trevis., *Adiantum hispidulum* Sw.
Colysis pentaphylla (Baker) Ching, *Microsorium musifolium*
Copel., *Lepisorus nudus* (Hook.) Ching
Pteris bella Tagawa, *Heterogonium alderwereltii* Holttum,
Cyclosorus ciliatus Panigrahi



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Publisher

ASEAN Centre for Biodiversity

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Citation

Callado, J.R.C., Adjie, B., Suksathan, P., Lestari, W.S. & Darnaedi, D. 2016. *Field Guide to the Pteridophytes of Chiang Mai, Thailand. ACB Field Guide Series No. 2* (Fernando E.S., Miwa, H., & Pollisco Jr., F.A., editors). ASEAN Centre for Biodiversity & Japan - ASEAN Integration Fund, Los Baños, Philippines. 174p.

Production Team

Rolando Inciong, Sahlee Bugna-Barrer, Rhia Galsim, Karen Lapitan, Eisen Bernard Bernardo, Nanie Gonzales

Photographs

John Rey C. Callado, Ng Zi Qiang Arthur

ISBN: 978-621-95038-9-1

Printed and Distributed

ASEAN Centre for Biodiversity
3F ERDB Bldg. Forestry Campus, UPLB
Los Baños, Laguna, Philippines 4031

FOREWORD

In the ASEAN region, the lack of trained human resources and inadequate capacities in taxonomy have been stressed as the obstacles in the implementation of commitments to the Convention on Biological Diversity (CBD). It is, therefore, one of the thematic concerns of the ASEAN Centre for Biodiversity (ACB), to strengthen biodiversity conservation in the region and facilitate compliance of the ASEAN Member States to the CBD and other environmental agreements.

ACB acknowledges the support of the Ministry of Environment of Japan, Japan-ASEAN Integration Fund, East and Southeast Asia Biodiversity Information Initiative, and Queen Sirikit Botanic Garden in its efforts to increase taxonomic efforts in the region. Their most recent collaboration on *Taxonomic Capacity Building on Bryophytes, Pteridophytes and their Allies* produced this *Field Guide to the Pteridophytes of Chiang Mai, Thailand*.

The field guide embodies the skills learned during the course of the project, and is a substantial addition to the growing knowledge of taxonomy of species in the region. Envisioned for the use of both scientists and plant enthusiasts, it is hoped that the publication will spur greater appreciation of the importance of taxonomy and perhaps plant the seeds for the next generation of taxonomists in ASEAN.

Atty. Roberto V. Oliva

Executive Director

ASEAN Centre for Biodiversity

FOREWORD

We would like to express to the authors of the various institutions and the staff at the ASEAN Centre for Biodiversity (ACB) our gratitude for their wonderful contributions to this field guidebook on Pteridophytes.

The ASEAN region is home to rich biological diversity. Despite its richness, it remains underexplored with many species still unidentified. This publication is the embodiment of special opportunities for capacity building in the ASEAN region, which are also anchored on the programme of work for the Global Taxonomy Initiative under the Convention on Biological Diversity.

We are glad that we were able to support the capacity building on Taxonomy through the East and Southeast Asia Biodiversity Information Initiative by Ministry of the Environment, Government of Japan, with the Japan-ASEAN Integration Fund by the Ministry of Foreign Affairs JAPAN.

We hope that we will be able to continue working with the authors and ACB, for Biodiversity and Taxonomy.

Hidetsugu Miwa, PhD

Senior Technical Officer
Biodiversity Center of Japan
Ministry of the Environment, Government of Japan

ACKNOWLEDGEMENTS

This guidebook would not have been possible without the support of the Ministry of Environment of Japan, Queen Sirikit Botanic Garden, and the ASEAN Centre for Biodiversity. The inputs of colleagues from the Pteridophyte group in the workshop on pteridophytes and bryophytes held in Chiang Mai, Thailand from 20-30 January 2015 also contributed significantly to this field guide.

The assistance of Dr Mitzi Pollisco in the technical editing of this guidebook is also highly appreciated.



Members of the Pteridophyte group are (left to right, first row, standing) Dr Hidetsugu Miwa, Mr Farhad Yozarius, Mr John Rey C. Callado, Mr Haji Shahrin Din Haji Md Jaafar, Dr Dedy Darnaedi, Dr Piyakaset Suksathan, Dr Bayu Adjie, (second row, sitting), Mr Pichal Yadee, Mr Zaharin Haji Abdul Kahan, Mr Kittiphong Kertsawang, Mr Pham Van Hoan, Mr Heng Sovanna, Ms Ling Shing Mang, Ms Nor Ezzawanis binti Abdullah Thani, Ms Dian Indah Pratiwi, Ms Wenni Setyo Lestari, and Ms Khin Myo Htwe.



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INTRODUCTION

Doi Inthanon National Park

Situated in Chiang Mai Province, Doi Inthanon National Park was declared Thailand's sixth national park in 1972. It covers roughly 48,200 hectares of mountainous terrain, foothills and marginal lowland areas. The park encompasses Doi Inthanon, a gneiss-granite massif and the highest mountain in Thailand at 2,565 meters.

Doi Inthanon is part of the Thanon Thongchai Range, a southern extension of the Shan hill of Myanmar. The second highest peak of this North-South oriented mountain range is Doi Hua Mod Luang (2,330 m). The predominant soils on the mountain are sandy loams.

The mountain is an important watershed area, forming the divide between the Ping River to the east and the Chaem River to the west. Doi Inthanon is the source of four major tributaries of the Ping River, which in turn, is one of the four major tributaries of the Chao Phraya River.

With terrain ranging from 500 to 2,565 meters above sea level (masl), the varied topography and land exposure of the national park resulted in a wide variety of vegetation types. These include mixed deciduous



forests, pine deciduous dipterocarp forests, dry evergreen forests, and montane forests.

Mixed deciduous forests are widely distributed below 800 masl and occupy flat areas, foothills and the lower and middle slopes, where soil moisture is more favorable than on the heavily leached gravelly or sandy soils in deciduous dipterocarp forests. The canopy of forests is evenly mixed, containing a wide range of deciduous tree species, without any single species being dominant. The floristic composition is very variable. Notable is the high presence of Leguminosae (e.g. *Albizia*, *Dalbergia*), Lamiaceae (e.g. *Vitex*), Combretaceae (e.g. *Terminalia*) and Lythraceae (*Lagerstroemia*).

Deciduous dipterocarp forests occupy the dry habitats on the slopes of the foothills, on hill sides and along the ridges. They occur up to altitudes of approximately 600–800 masl. These forests have an open canopy, and trees are usually less than 20 m tall. The most characteristic species are *Dipterocarpus intricatus*, *D. obtusifolius*, *D. tuberculatus*, *Shorea obtusa*, and *S. siamensis*.

Pine deciduous dipterocarp forests grow at elevations ranging from 800 to 1,200 masl. They are similar to deciduous dipterocarp forests but are distinguished by emergent pine trees and some montane components at higher altitudes. Pine deciduous dipterocarp forests are three-layered and of an open nature. The upper or emergent stratum is composed of *Pinus merkusii* (Pinaceae) and sporadic *P. kesiya* trees, while the main canopy consists of dipterocarps such as those found in deciduous dipterocarp forests. There is also a prominent graminoid layer.

Pine trees may reach up to 40 m height, but 25–30 m tall trees are more common. The main middle canopy consists of large to medium-sized trees, dominated by Dipterocarpaceae (mainly *Dipterocarpus obtusifolius*, *D. tuberculatus* and *Shorea obtusa*).

Dry evergreen forests, green all year round in spite of the marked alteration between wet and dry seasonal periods in the area, occur in sheltered, moist valleys of the low hill ranges up to approximately 900 masl. They are also found on gentle to moderate moist slopes, along mountain ravines, or on moist foothills. Along larger watercourses dry evergreen forests often form a narrow strip of gallery forest.

Dry evergreen forests are structurally three-layered, and emergent trees are rare. About two thirds of the main canopy trees are evergreen. Typical tree taxa include various members of Meliaceae (e.g. *Aglaiia* spp, *Aphanomixis polystachya*, or *Dysoxylum andamanicum*), Leguminosae (*Acrocarpus fraxinifolius*, *Erythrina* or *Adenanthera pavonina*), Myrtaceae (*Syzygium*), Anacardiaceae (*Choerorandias axillaris*, *Dracontomelon dao*), Sapindaceae (*Dimocarpus longan*, *Nephelium hypoleucum*), and many others.

Montane forests gradually commence at an elevation of approximately 700 masl but more typically, lower montane vegetation starts dominating from about 1,000 masl upwards. The transition from lowland vegetation (dry evergreen forests, deciduous vegetation types) is often gradual and local environmental conditions obviously play an important role. Lower montane vegetation is replaced by upper montane vegetation at around 1,700–1,800 masl. An interesting upper montane peat bog is found in the summit area of Doi Inthanon at about 2,500 masl. The bog, dominated by the peat moss *Sphagnum* (Sphagnaceae), is surrounded by dense, rather stunted upper montane rain forests with a closed canopy, which leaves little light for undergrowth. The many trees of *Rhododendron arboreum* subsp. *delavayi* (Ericaceae) along the periphery of the bog are particularly conspicuous. Because of the permanent cloud or mist cover, tree trunks and branches are densely packed with epiphytes such as lichens, mosses, ferns, orchids, and others (This portion on the Doi Inthanon National Park is taken from Chayamarit & Puff [2007]).

Queen Sirikit Botanic Garden

The Queen Sirikit Botanic Garden (QSBG) is contoured into the foothills of the mist-shrouded Doi-Suthep-Pui Mountain in Chiang Mai, Thailand. It is Thailand's oldest and foremost botanic garden and major center for scientific research. Dedicated to the conservation of Thai flora, it holds collections of, and carries out research on rare, endemic and endangered species.

Although the main focus is on Northern Thai flora and surrounding regions, QSBG has an integrated programme of research and education with a global perspective. The QSBG has an extensive research facility housing the herbarium, micro propagation laboratories, and library. Research work covers a wide spectrum of morphological, entomological, biochemical, and molecular studies. Species recovery and *ex situ* conservation projects include work with endangered native Thai orchids, cycads, and palms. In addition, QSBG protects a large area of unique tropical deciduous forest with its associated wildlife as a conservation zone.



Covering an area of about 1,000 hectares, the topography of QSBG consists of small plains alternating with interposing mountains with the highest point at approximately 1,200 meters. QSBG is situated within an important center for biodiversity, as well as, serving as a watershed for the Ping River tributaries and the Chaopraya region of Thailand. Three streams flow down to join the Mae Sa stream that runs through the Garden. A combination of complex topography and high mountains composed of many ridge systems alternating with plains, combined with the seasonal climate, has resulted in an intricate mosaic of evergreen and deciduous forest.



QSBG Fern Garden. Photo by ES Fernando

The deciduous forest occurs below 1,000 meters, with evergreen hill forests at 1,000 meters upwards. The deciduous forest is further divided into two types: deciduous dipterocarp-oak (*Dipterocarpus*, *Shorea*, *Quercus* and *Lithocarpus*) in the driest areas, and mixed evergreen forest (usually Fagaceae) along streams and gullies. Found between 600–1,620 meters on upper ridges is hill pine forest, which occurs in less than 1 percent of Thailand. *Pinus kesiya* occurs at higher altitudes and *Pinus merkusii* at lower altitudes. On the plains at the foothills below dry dipterocarp is mixed deciduous forest, which is characterized by stands of bamboo and three important timber trees: *Tectona grandis* (teak), *Xylia xylocarpa* (redwood), and *Pterocarpus macrocarpus*.

Fauna is also rich with over 360 species of birds, over 500 species of butterflies, 31 species of mammals, and numerous reptiles including the rare Doi Suthep green frog.

With such important natural assets, QSBG has kept 70 percent of its 1,000 hectares for conservation to fulfill its vital role as a watershed. This area of forest is an important research area and is of tremendous value to QSBG taxonomists, as well as, visiting researchers. The forest is regularly monitored and rare species identified to date include *Aquilaria rugosa*, *Sapria himalayana*, *Passiflora siamica* and wild rice (*Oryza granulata*).

Why publish the guidebook?

The ASEAN Centre for Biodiversity (ACB) has been working with a number of partners to further research and knowledge in taxonomy in ASEAN to strengthen biodiversity conservation efforts in the region. Increasing taxonomic capabilities allows ASEAN Member States (AMS) to identify species and thus prioritize conservation action and management. ACB programmes in taxonomy include the conduct of various training workshops, field and laboratory work, as well as the publication of workshop reports and field guides on various species.

The development of information materials is particularly important as knowledge in taxonomy extends beyond project participants, and adds to a better understanding of the significance of the region's rich biodiversity.

The guidebook is a major output of the Internship Programme for *Taxonomic Capacity Building for Bryophytes and Pteridophytes*, which was jointly conducted by ACB and QSBG in Chiang Mai, Thailand on 20–30 January 2015. The internship programme included lectures, hands-on experience in identification and collections management, and sharing of experiences with experts with the aim of capacitating participants in the rigors of taxonomy, particularly on bryophytes and pteridophytes.

Research work on pteridophytes were conducted in Doi Inthanon National Park and Queen Sirikit Botanic Garden. Created by participants from AMS, the guidebook reflects the skills developed during the programme, as well as, a collective effort to conserve ASEAN's shared natural heritage. The guidebook aims not only to add to the body of knowledge of taxonomy in the region, but also hopes to stimulate further research, and strengthen collaboration among AMS in regional research and conservation of biodiversity.

What are pteridophytes?

Pteridophytes is a term informally used to refer to two separate evolutionary classes: lycophytes or Lycopodiopsida (e.g. Lycopodiaceae and Selaginellaceae); and ferns or Polypodiopsida (e.g. Marattiaceae, Dryopteridaceae and Polypodiaceae). The term pteridophytes is broadly interpreted as vascular plants (with xylem and phloem) similar to angiosperms and gymnosperms but don't produce flowers, fruits, or seeds. They produce spores similar to bryophytes.

Pteridophytes are different from other plant groups because of their unique life cycle known as alternation

of generations. The sporophyte stage (diploid generation) produces spores and the gametophyte stage (haploid generation), also known as prothallus, produces gametes. The two generations survive independently. In the gametophyte stage, the prothallus has antheridia (produces sperm) and archegonia (produces egg cells), which when fertilized will produce young sporophytes.

In current classifications depending on some authors, there are about 35–45 families, 300–350 genera, and more than 12,000 species, and most of the species are found in tropical areas. The pteridophyte habit varies from grass-like (*Isoetes* sp. and *Schizaea* sp.), moss-like (*Lycopodium* sp. and *Huperzia* sp.), vine-like (*Lygodium* sp.), herb-like (*Diplazium* sp.), and palm-like (*Dicksonia* sp. and *Cyathea* sp.). Pteridophytes grow in various habitat types such as deserts, savanna, swamps, estuarine mangroves, and sub-tropical to tropical montane forest as terrestrial, epiphytes (on trees), lithophytes (on rocks), rheophytes (on river banks), and floating aquatic plants.

Economic and ecological importance, and potential uses of pteridophytes

Pteridophytes are ecologically important components of a forest ecosystem, particularly in water and biochemical (e.g. nitrogen and carbon) cycling. *Azolla*, for instance, has a symbiotic relationship with nitrogen-fixing cyanobacteria, which convert nitrogen to nitrate. Metallophytic pteridophyte species, which can absorb heavy metals, can be used in bioremediation in mined-out areas. Pteridophytes are also important in ecological succession where they act as pioneering plant species growing in burnt-out areas. Pteridophytes are good biological indicators as they respond to ecosystem and climatic changes brought by anthropogenic activities.

Economically, pteridophytes are sought for their horticultural importance. Species such as *Asplenium*, *Cyathea*, *Nephrolepis*, and *Platynerium* are commonly used as ornamental plants in tropical gardens. There

are already myriad horticultural hybrids with showy and complex dissected fronds, which usually fetch a higher price. However, several species of ferns that have been introduced as ornamental plants, such as *Salvinia*, have become noxious invasive weeds in countries outside their natural range. *Lygodium* and *Cyathea* are commonly used in making ornaments, handicrafts, and light building materials. In the tropics, young fiddleheads of *Asplenium nidus* and *Diplazium esculentum* are used in salads and stewed vegetables. Unknowingly, the fossil fuels used today come from ancient giant ferns and lycophytes during the Carboniferous period. The pharmaceutical potential of some fern species have yet to be realized and used in the development of new medicines.

For researchers, pteridophytes are good subjects for phylogenetic, island biogeography, and evolutionary studies. Rare and unique species are planted and maintained as the main attraction in many botanical and private gardens. In some countries, threatened pteridophytes have become flagship species for conservation leading to the development and formulation of relevant biodiversity conservation legislation and establishment of protected areas.

Morphology

Taxonomically, pteridophyte species, genera and families are classified and named based mainly on the morphology of the mature sporophyte structures. Unlike bryophytes, the sporophyte of pteridophytes is the most conspicuous form or stage of the pteridophyte life-cycle. At this stage it is large, easily collected and preserved, and provides a vast array of complex and distinctive characters for identification composed of roots, stems, and leaves. The habit, life-form, and habitat preferences of pteridophytes are also needed to determine taxa to species, genera and families.

Pteridophytes can be aquatic in form, and a much greater number are subaquatic or **rheophytic**.

They can be free-floating on the surface of the water such as *Azolla* and *Salvinia*, completely submerged and rooted in the sediment (*Isoetes*), rooted and emergent (*Marsilea*), or combination of all three habits (*Ceratopteris*). It can also be terrestrial in form with erect or creeping stems, branched or unbranched, or growing directly on rocks (lithophytes). Some forms of pteridophytes are epiphytes, which are commonly diverse in forms in the tropical montane forest.

Fern stems are often called **rhizomes**, which bear the roots or root-like structures that attach the plant to the substrate, and serve as passage of water and nutrients for the leaves, which are regularly produced in the apical meristems. It varies in form from erect and tree-like stems (**caudex**) such as in tree ferns (*Cyathea*, *Dicksonia*), which can reach 20 meters; massive-globose rhizome (*Angiopteris*); or short-erect; long-creeping or short-creeping. In different families, rhizomes, particularly the young parts, are protected by either scales or hairs. The rhizomes can be **radial** or radially symmetric, or **dorsiventral** with leaves or fronds produced on the dorsal or upper side, and roots produced on ventral or lower side. In some genera, the difference in the structure of scales could be determined between species. Vascular tissue in the internal structure of the rhizome can also verify the family of a particular fern.

The leaves of typical and true ferns are usually called **fronds**. The bewildering variety of frond forms or arrangements provide many of the most useful characters of pteridophyte taxonomy. The expanded green portion of a frond is called the **lamina**. A frond where the lamina arises directly from the stem is described as **sessile**, while the petiole or stalk of a fern frond is generally called the **stipe**. The stipe of a fern can be glabrous or covered with hairs, scales, or both, which are characters to distinguish species. The main axis consists of stipe and its continuation into the lamina of the frond. In simple fronds these are called midrib or **costa**, and **rachis** in compound fronds. The lamina varies with myriad shapes, sizes and

dissections from simple, pinnatifid, pinnatisect, bipinnate, tripinnate to quadripinnate fronds. Frond dimorphism can be present in some species that may exist between sterile and fertile fronds, and juvenile fronds are sometimes different from mature fronds. **Bulbils** (plantlets) may also occur in the lamina of some species. Venation in the lamina are also good diagnostic characters in some groups, where veins vary from simple, forked, dichotomously branching to reticulate/anastomosing veins. Fertile lamina of ferns bear **sori** (clustered sporangia) while lycophytes bear a special structure of sporangia called **sporophylls**. Sori vary in shape, size and relative position in the lamina. These are very important diagnostic characters in determining the family of species. The sori range from acrostichoid (covering the entire lamina), synangium, sori with false indusia, exindusiate (without indusia), and indusiate (with indusia), which vary from round, peltate, reniform (kidney shape), bivalvate, conical, cup-shape, and linear.

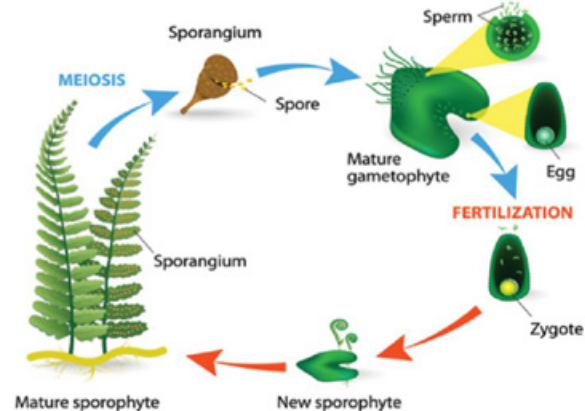
The fern life cycle

Unlike bryophytes, the life cycle of pteridophytes involves two distinct and separate phases known as the **gametophyte** (haploid stage) and **sporophyte** (diploid stage). The sporophyte is the conspicuous, dominant form of pteridophytes, and is so-named because this is the stage that produces the spores. At maturity, the sporophyte develops structures of varying complexity, form, shapes and position on the lamina called **sporangia**, in which **spores** are produced. Forms, shapes and positions vary within families, genera and species, and this clustered or aggregated sporangia is called **sorus**. At certain environmental conditions and maturity of sporangia, spores are released and dispersed by dehiscing sporangia with the assistance of wind, which will later develop into gametophytes. In this stage the spores develop into **prothallus**, which are nearly always short-lived and inconspicuous.

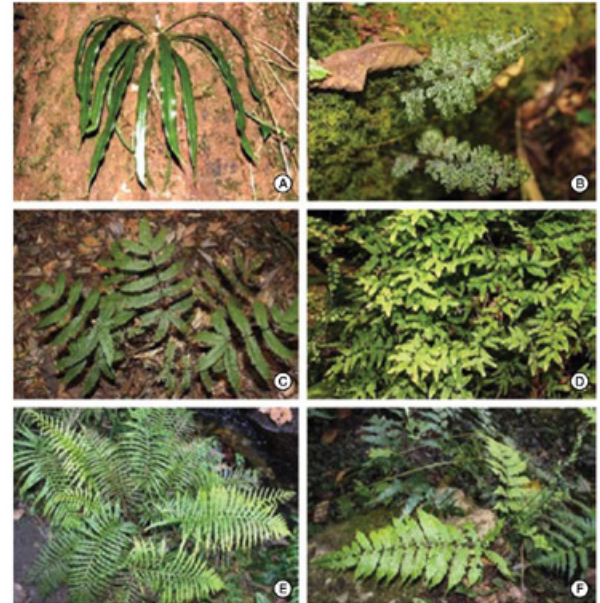
The prothallus is only few millimeters across, photosynthetic, generally simple in structure, without

vascular tissues, often only one-celled, thick in most parts, and attached to the substrate by fine multicellular root hairs called rhizoids. The prothallus is the sexual part of the life cycle where sexual organs are microscopic and have a single set of chromosomes. The male organs are called **antheridia**, which produce and shed numerous motile sperm. The female organ develops flask-like structures called **archegonia**, which produce an embedded single egg cell. Antheridia and archegonia may be borne on the same prothallus (**monoecious**), or on separate male and female prothallia (**dioecious**). With the aid and presence of water, sperm from the antheridia will find its way to the archegonia and fertilize the egg cell. The union of sperm and egg cell will form a zygote containing a double set of chromosomes, and is thus diploid. It repeatedly divides and develops into an embryo and then into a juvenile plant, with gradually developing roots and lamina, which become independent from the gametophyte. Later on, the gametophyte withers and dies while the new plant will eventually mature into a spore-bearing sporophyte.

LIFE CYCLE OF THE FERN

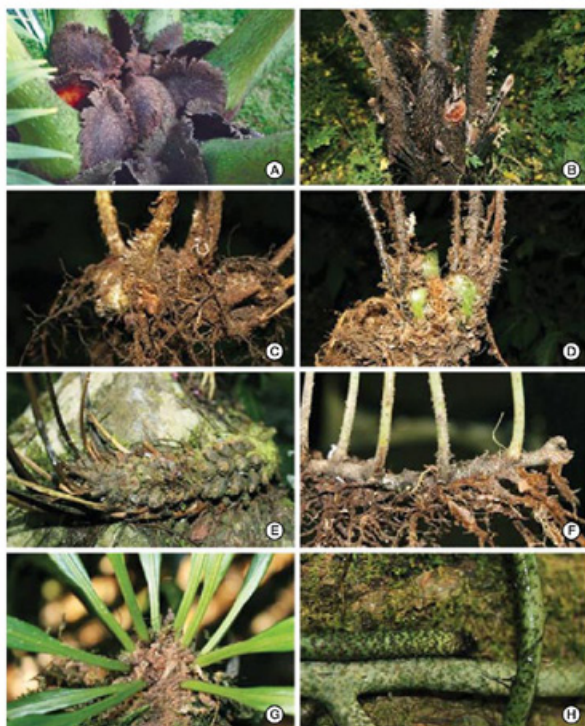


Source: commons.wikimedia.org



Fern Growth Habits

- A. Epiphytic on tree trunks (*Asplenium ensiforme*);
- B. Growing along with moss (*Hymenophyllum polyanthos*);
- C. Terrestrial on forest floor (*Pteris bella*);
- D. Scrambling habit (*Lygodium microphyllum*);
- E. Rheophytic habit (*Cyclosorus falcilobus*);
- F. Lithophytic habit (*Bolbitis sinensis*)



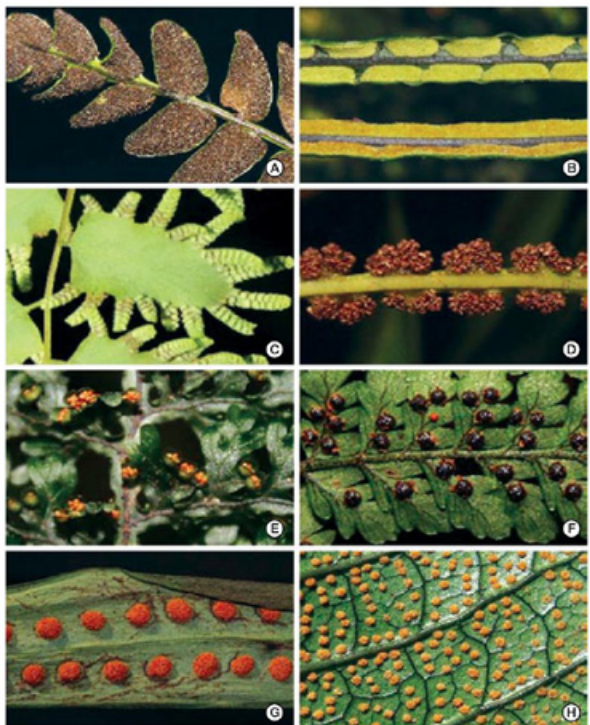
Types of Rhizomes

A. Massive, globose, short-erect rhizome with stipules (*Angiopteris evecta*); **B.** Massive, long-erect (*Cyathea gigantea*); **C.** Small, short-creeping (*Arachniodes spectabilis*); **D.** Small, short-erect (*Diacalpe aspidioides*); **E.** Lithophytic, long-creeping with close interval of stipes (*Bolbitis sinensis*); **F.** Terrestrial, long-creeping with wide interval of stipes (*Leptochilus decurrens*); **G.** Epiphytic, short-erect rhizome (*Asplenium ensiforme*); **H.** Epiphytic, long-creeping rhizome (*Phymatosorus scolopendria*)



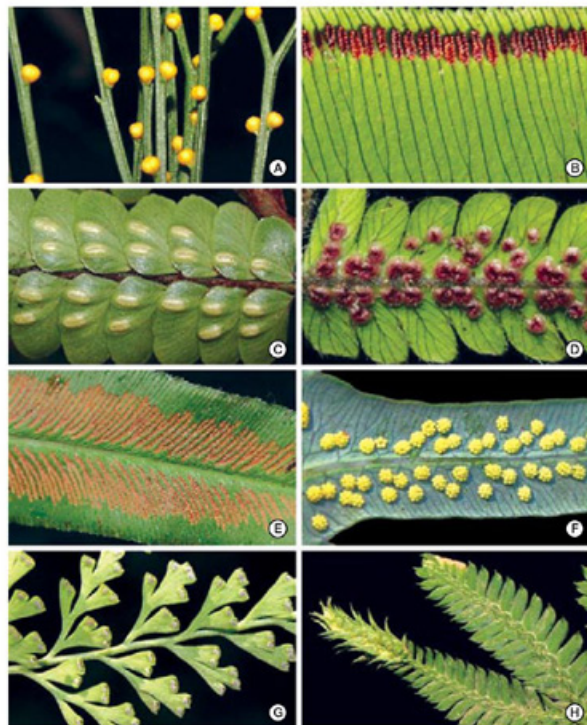
Types of Sori

A. Exindusiate linear sori (*Colysis pentaphylla*); **B.** Linear sori with indusia (*Asplenium ensiforme*); **C.** Marginal sori with false indusia (*Pteris bella*); **D.** Sori with false indusia (*Adiantum hispidulum*); **E.** Continuous sori along the costa (*Blechnum orientale*); **F.** Short, linear sori discontinuous along the costa (*Woodwardia orientalis*); **G.** Marginal bivalvate (clam-like) sori (*Cibotium barometz*); **H.** Marginal cup-shape sori (*Microlepia platyphylla*)



Types of Sori

A. Acrosticoid sori in pinnate lamina (*Bolbitis sinensis*);
B. Acrosticoid sori in simple lamina (*Leptochilus decurrens*); **C.** Fertile leaf segment bearing rows of sori (*Lygodium microphyllum*); **D.** Naked sporangia directly attached to fertile lamina (*Osmunda angustifolia*);
E. Sori with bivalvate indusia (*Hymenophyllum polyanthos*); **F.** Round sori with indusia (*Diacalpe aspidioides*); **G.** Large round exindusiate sori (*Lepisorus sublinearis*); **H.** Randomly scattered small exindusiate sori (*Microsorium musifolium*)



Types of Sori

A. 3-lobed synangium subtended by bifid appendage (*Psilotum nudum*); **B.** Submarginal clustered synangium (*Angiopteris evecta*); **C.** Embedded elliptic-oblong sori (*Didymochlaena truncatula*); **D.** Round to kidney-shaped sori (*Cyclosorus ciliatus*); **E.** Reticulated sori along veins (*Coniogramme fraxinea*); **F.** Round clustered naked sori (*Dicranopteris splendida*); **G.** Terminal sori at the tip of the lobe (*Odontosoria chinensis*); **H.** Strobilus (*Selaginella helferi*)

How to collect and maintain pteridophytes for scientific study

There are several ways to collect, preserve, and store pteridophyte specimens for museum deposition and scientific study. In herbaria all over the world, pteridophyte specimens are dried mounted on a 29.21 x 41.91 centimeters standard size Bristol board/ mounting sheet.

The tools and materials needed in collecting pteridophyte specimens include old newspapers, pocket papers, tea bags, transparent plastic bags (50.8 x 76.2 centimeters), small plastic tubes with lid, number tags, denatured/ethyl alcohol, silica gels, telescopic pruning shears, pruning shears, cutter, measuring tapes, hand lens, field notes, pencil/ permanent marker, and camera. A botanical specimen is worthless without any accompanying information such as collector's name, field numbers, locality, local name (local dialect), habitat, elevation, short plant descriptions, special notes, economic uses, and date of collection. If necessary, take some photographs of habitat, plant habit, and plant parts prior to gathering of plant samples for future reference, since color will fade as the specimens are dried.

There are two types of collection: dry (without alcohol for short-term fieldwork) and wet (with alcohol for long-term fieldwork). During collection, select plant specimens with sterile and fertile fronds, stipes and rhizomes. There should be multiple duplicates with corresponding collection field numbers for future specimen sharing with other herbaria. Lamina samples are gathered and placed in tea bags with silica gel for future phylogenetic studies. For small specimens such as *Selaginella* sp., the whole plant can be collected and placed in paper pockets. In collecting large ferns such as tree ferns (*Dicksonia* sp. and *Cyathea* sp.), all the morphometric data should be gathered first before cutting the specimens into pieces. Usually the tip,

middle, and basal parts are obtained. A small portion of fertile lamina with sori can be preserved in small plastic tubes with alcohol for future reference of soral structure.

The specimens collected should be arranged neatly in old newspapers and piled tightly in plastic bags with alcohol for long-term storage. Preferably, collected specimens should be dried right after collection to maintain some pigment color. However, because of inaccessibility to proper drying facilities, the wet method is carried out for long-term storage. Prior to drying, specimens in wet collections should be transferred in fresh newspaper sheets, arranged neatly in between corrugated boards, and tightly compacted with a plant press, and placed in the dryer. Drying should be checked regularly, as it depends on the thickness of the stipe lamina and stipe of pteridophyte specimens. Too much drying will lead to the brittleness of the specimen. On the other hand, specimen with moisture is favorable to fungal infection.

Properly dried specimens should be mounted on a standard mounting sheet with associated field notes. Duplicate specimens should be sent to partner herbaria for further taxonomic study and safe keeping. Specimens are filed in folders and alphabetically arranged from Family, Genera and Species in herbarium cabinets. New specimens entered in the herbarium should be accessioned and properly documented. Unknown specimens can be identified using taxonomic keys; compared with current herbarium materials, online flora and plant photos, and databases; and in consultation with experts. Specimens should be regularly maintained to check for damage and pest infestation.

FERN FACTS

Do you know that...

- Pteridophytes are the third largest plant group after mosses and flowering plants. Currently, there are more than 12,000 species around the world.
- Sori are structures of various shapes and sizes found underneath the lamina, which are composed of aggregate sporangia. Sporangia are special pouch-like structures that produce and disperse spores. Spores vary in shape, size and color from red, orange, brown, yellow, and black depending on species and families.
- Pteridophytes range in size from the smallest, which measure only a few centimeters, to giant tree ferns (*Cyathea* species), which grow up to 20 meters tall.
- Pteridophytes survive in any kind of ecosystem, including deserts, savanna, swamps, mangrove, and montane areas. Most of the species are found in montane tropical areas.
- Ferns are unique among other plants because of their life cycle. They occur in two morphologically different phases known as sporophyte and gametophyte, which live independently.
- Some species of ferns reproduce plantlets (bulbils) in rhizome and leaves such as *Asplenium* and *Woodwardia*.
- Ferns play a major role in the ecosystem as they are eaten by primary consumers such as insects.
- Ferns and lycophytes were the dominant plant life during the Carboniferous Period, nearly 300–400 million years ago.
- Some species of ferns are used for food such as *Diplazium esculentum*.
- Pteridophytes are sought for their horticultural beauty because of the array of forms and arrangements of fronds.
- Some ferns are good biological indicators as they respond to ecosystem and climatic changes. Certain species are site endemic to special types of substrates such as limestone/karst and ultramafic soil.
- *Azolla* species have a symbiotic relationship with nitrogen-fixing cyanobacteria, which convert nitrogen into nitrates that are useful to other plants. As such, farmers use these water ferns as natural fertilizers in rice fields.
- Certain species of tree ferns are used for handicrafts and building materials.
- *Lygodium* species have very long flexible stipe and rachises that are used to make baskets, mats, and other handicrafts.
- The lifespan of ferns and lycophytes depends on the species. Some species of tree ferns (*Cyathea* sp.) can live up to 100 years.
- Ferns can absorb heavy metals from the soil in mining areas, which are called metallophytes. They are very useful plants for bioremediation in open pit areas.

LIST OF FERNS OF DOI INTHANON NATIONAL PARK

ASPENIACEAE

1. *Asplenium ensiforme* Wall. ex Hook. & Grev.
2. *Asplenium normale* D.Don
3. *Asplenium tenuifolium* D.Don
4. *Hymenasplenium obscurum* (Blume) Tagawa
5. *Hymenasplenium unilaterale* (Lam.) Hayata

ATHYRIACEAE

6. *Athyrium mackinnoni* (C.Hope) C.Chr.
7. *Athyrium setiferum* C.Chr.

BLECHNACEAE

8. *Blechnum orientale* L.

DENNSTAEDTIACEAE

9. *Microlepia platyphylla* (D.Don) J.Sm.
10. *Microlepia spelunca* (L.) T.Moore
11. *Pteridium aquilinum* (L.) Kuhn subsp. *wightianum* (J.Agardh) W.C.Shieh

DRYOPTERIDACEAE

12. *Acrophorus nodosus* C.Presl
13. *Arachnioides spectabilis* (Ching) Ching
14. *Bolbitis sinensis* (Baker) K.Iwats.
15. *Diacalpe aspidioides* Blume
16. *Dryopteris sparsa* (D.Don) Kuntze
17. *Polystichum semifertile* (Clarke) Ching

GLEICHENIACEAE

18. *Dicranopteris linearis* (Burm.f.) Underw.
19. *Dicranopteris splendida* (Hand.-Mazz.) Ching

HYMENOPHYLLACEAE

20. *Hymenophyllum polyanthos* (Sw.) Sw.

LINDSAEACEAE

21. *Odontosoria chinensis* (L.) J.Sm.

LYCOPODIACEAE

22. *Lycopodium clavatum* L.
23. *Huperzia hamiltonii* (Spreng.) Trevis.

MARATTIACEAE

24. *Angiopteris evecta* (G.Forst.) Hoffm.

POLYPODIACEAE

25. *Crypsinus rhynchophyllus* (Hook.) Copel.
26. *Drynaria quercifolia* (L.) J.Sm.
27. *Lepisorus nudus* (Hook.) Ching
28. *Lepisorus sublinearis* (Baker ex Takeda) Ching
29. *Leptochilus ellipticus* (Thunb.) Noot.
30. *Neocheiropteris normalis* (D.Don) Tagawa

PTERIDACEAE

31. *Coniogramme fraxinea* (D.Don) Diels var. *serrulata* (Blume) Hieron
32. *Pteris bella* Tagawa
33. *Pteris biaurita* L.
34. *Pteris nepalensis* H.Ito

TECTARIACEAE

35. *Tectaria remotipinna* Ching & Chu H.Wang

THELYPTERIDACEAE

36. *Cyclosorus ciliatus* (Wall. ex Benth.) Panigrahi
37. *Cyclosorus falculobus* (Hook.) Panigrahi

LIST OF FERNS OF QUEEN SIRIKIT BOTANIC GARDEN

ANEMIACEAE

1. *Anemia mexicana* Klotzsch

ASPLENIACEAE

2. *Asplenium thunbergii* Kunze

ATHYRIACEAE

3. *Diplazium polypodioides* Blume

BLECHNACEAE

4. *Blechnum orientale* L.
5. *Woodwardia orientales* Sw.

CIBOTIACEAE

6. *Cibotium barometz* (L.) J.Sm.

CYATHEACEAE

7. *Cyathea gigantea* (Wall. ex Hook.) Holttum

DENNSTAEDTIACEAE

8. *Microlepia speluncae* (L.) T.Moore
9. *Pteridium aquilinum* (L.) Kuhn subsp. *wightianum* (J.Agardh) W.C.Shieh

DRYOPTERIDACEAE

10. *Bolbitis heteroclita* (C.Presl) Ching
11. *Polystichum biaristatum* (Blume) T.Moore

LYGODIACEAE

12. *Lygodium flexuosum* (L.) Sw.
13. *Lygodium microphyllum* (Cav.) R.Br.

MARRATIACEAE

14. *Angiopteris evecta* (G.Forst.) Hoffm.

OSMUNDACEAE

15. *Osmunda angustifolia* Ching

POLYPODIACEAE

16. *Drynaria bonii* Christ
17. *Drynaria quercifolia* (L.) J.Sm.
18. *Leptochilus decurrens* Blume
19. *Microsorium musifolium* Copel.
20. *Phymatosorus scolopendria* (Burm.f.) Pic.Serm.
21. *Pyrrosia lanceolata* (L.) Farw.

PSILOTACEAE

22. *Psilotum nudum* (L.) P.Beauv.

PTERIDACEAE

23. *Adiantum caudatum* L.
24. *Adiantum hispidulum* Sw.
25. *Adiantum macrophyllum* Sw.
26. *Adiantum tenerum* Sw.
27. *Pteris biaurita* L.

SELAGINELLACEAE

28. *Selaginella helferi* Warb.

TECTARIACEAE

29. *Heteronium alderwereltii* Holttum

THELYPTERIDACEAE

30. *Macrothelypteris torresiana* (Gaudich.) Ching
31. *Thelypteris crinipes* (Hook.) K.Iwats.

Anemia mexicana Klotzsch

Synonym *Anemia mexicana* Klotzsch var. *paucifolia* Hook.

Description Rhizome erect, densely hairy with brown colored hairs. Stipe hairy. Frond dimorphic, fertile pinnae usually taller than sterile pinnae; sterile pinnae pinnate, deltoid-lanceolate with truncate base, hairy, the terminal portion of sterile pinnae asymmetric, one slightly reduced, margin serrulate, apex obtuse-acute; fertile pinnae oblong-linear, filled up with sori, becomes curly. Sori many, next to each other covering the fertile pinnae; sporangia green when young and becoming reddish brown when mature.

Habitat Terrestrial endemic fern from Mexico, one of the ferns showcased in QSBG's fern garden (IUCN: LC).

Author: Dian Indah Pratiwi



sori



under surface of frond



rhizome and stipe



habit

Asplenium ensiforme

Wall. ex Hook. & Grev.

Description Rhizome short, erect, brown to dark brown, with very short brown scale at apex. Stipe short, indistinct, green (sometimes black on one side of the base), densely scaly at the base; scales dark brown. Lamina simple, oblong, acuminate at the apex; rachis grooved on upper surface, rarely scaly at the lower surface. Sori linear, elongate along acroscopic branches of veins, up to 3 cm long, covered with thin linear indusia.

Distribution and habitat Sri Lanka, India, Southwest China and Indochina, extending north to southern edge of Japan. Epiphytic on tree trunks in the montane forest of Doi Inthanon National Park (DINP) (IUCN: LC).

Author: Wenni Setyo Lestari



sori



upper surface of frond



rhizome and stipe



habit

Asplenium normale D. Don

Description Rhizome short, erect, brown, covered with brown scales. Stipe up to 7 cm long, dark brown, more or less polished, scaly; scales dark brown. Lamina pinnate; rachis brown, vein at the upper surface whitish at the apex. Sori up to 3 mm long, covered with thin linear indusia.

Distribution and habitat Old World tropics throughout, north to the Himalayas and Japan. Terrestrial on shaded montane forest in DINP (UCN: LC).

Author: Wenni Setyo Lestari



habit



sori



upper surface of frond



rhizome and stipe

Asplenium tenuifolium D. Don

Description Rhizome short, erect, brown to dark brown with very short brown scales. Stipe up to 10 cm long, green (sometimes black on one site of the base), scaly. Lamina bipinnate-tripinnatifid, rachis grooved on upper surface, rarely scaly at the lower and upper surface. Sori linear, covered with thin indusia, one on each lobe.

Distribution and habitat Sri Lanka, South India, East Himalayas from Nepal to India (Assam), Southwest China, Indochina, and Taiwan. Terrestrial or lithophytic along shaded small streams in the montane forest of DINP (IUCN: NT).

Author: Wenni Setyo Lestari



habit



sori



under surface of frond



rhizome and stipe

Asplenium thunbergii Kunze

Synonyms *Asplenium decorum* Kunze, *Darea belangeri* Bory, *Asplenium belangeri* (Bory) Kunze

Description Rhizome short, suberect; scales subdeltoid with acuminate apex, 3 mm by 1 mm, brown to nearly black in central position, light brown thin-walled at edges and with irregular small projection at margin. Stipe 10 cm in length, green to brownish, scaly near base. Lamina bipinnate-tripinnatifid, elliptic in outline, acute at apex, base subtruncate, 18 by 6 cm, lateral pinnae 12 pairs; rachis curved upward continuously to blade, apex rounded, 6 by 1.2 mm. Sori linear along the vein, with thin indusia continuously reaching the margin of segment.

Distribution and habitat Indochina and West Malasia. Terrestrial or epiphytic in mid-montane forest, plants were observed in QSBG (IUCN: NT).

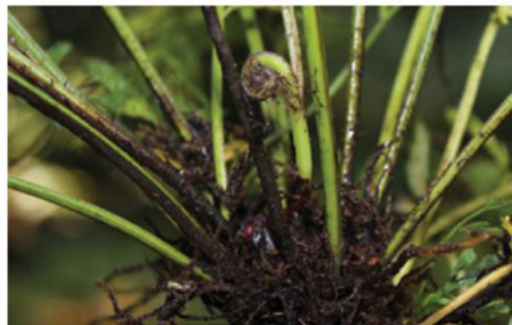
Author: Zaharin Hj. Abdul Kahan



sori



upper surface of frond with bulbils



rhizome and stipe



habit

Hymenasplenium obscurum (Blume) Tagawa

Synonym *Asplenium obscurum* Blume

Description Rhizome creeping, not so long, brown, covered with brown scales. Stipe up to 15 cm long, dull greenish-brown, never polished, scaly at the base; scale brown. Lamina pinnate; pinnae up to 21 pairs; rachis green to dark brown. Sori short, up to 3 mm long, covered with thin linear indusia.

Distribution and habitat Madagascar, Sri Lanka, South India and East Himalayas, Myanmar, Indochina, South China, Taiwan, and throughout Malesia. Terrestrial along shaded small streams from lower to mid-montane forest of DINP (IUCN: LC).

Author: Wenni Setyo Lestari



sori



upper surface of frond



rhizome and stipe



habit

Hymenasplenium unilaterale (Lam.) Hayata

Synonym *Asplenium unilaterale* Lam.

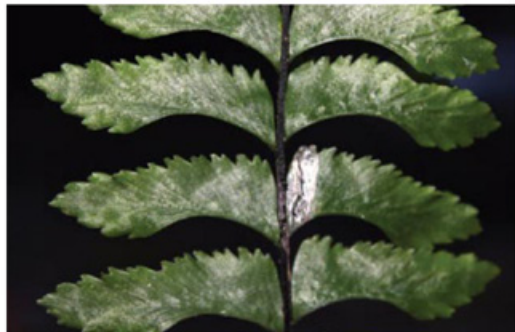
Description Rhizome long, creeping, brown, covered with brown scales. Stipe up to 13 cm long, brown, polished, densely scaly at the base; scale brown. Lamina pinnate; rachis brown, scaly. Sori 4–6 mm long, close to pinnae base, covered with thin linear indusia; indusia opening towards anterior side.

Distribution and habitat Widespread in Old World tropics. Terrestrial along small streams in montane forest of DINP (IUCN: LC).

Author: Wenni Setyo Lestari



sori



upper surface of frond



rhizome and stipe



habit

Athyrium mackinnoni (C.Hope) C.Chr.

Synonym *Asplenium mackinnoni* C.Hope

Description Rhizome erect, with a few fronds at apex, scaly; scales narrow with long-tailed apex, up to 6 by 0.8 mm, dark brown. Stipe up to 25 cm long, stramineous, dark brown, scaly at base. Frond broadly oblong, acute at apex, bipinnate-tripinatifid; pinnae 10 pairs, each oblong lanceolate, up to 20 by 7.5 cm; pinnules short stalk, oblong, moderately toward the apex; veins pinnate, veinlet simple uniting to the margin of segments. Sori oblong, located close to costules; indusia opening anteriorly.

Distribution and habitat India, Southwest China and Indochina. Terrestrial on shaded dry montane forest of DINP (IUCN: LC).

Author: Zaharin Hj. Abdul Kahan



sori



upper surface of frond



rhizome and stipe



habit

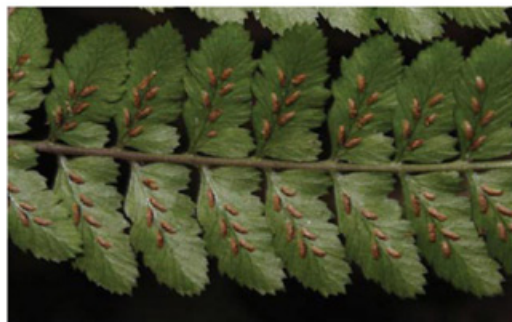
Athyrium setiferum C.Chr.

Synonym *Asplenium tenerum* C.Hope

Description Rhizome short; scale narrow, brown, entire. Stipe 35 cm long, stramineous, dark, scaly at base. Lamina narrowly oblong, apex acuminate, bipinnate-tripinnatifid, pinnae 3–5 cm, patent or slightly deflexed; upper pinnae smaller, ascending; pinnule oblong, auricled cuneate at anterior and narrowly cuneate at posterior base, short stalk, deeply lobed, lobe oblong, veinlets ending in teeth, a unicellular hair present at each junction between costa and costule. Sori round to oblong; indusia thin, crenate at margin.

Distribution and habitat Himalayas to Yunnan. Terrestrial on shaded montane forest of DINP (IUCN: LC).

Author: Ling Shing Mang



sori



upper surface of pinna with spine



rhizome and stipe



habit

Diplazium polypodioides Blume

Synonyms *Diplazium asperum* Blume, *Athyrium asperum* (Blume) Milde

Description Rhizome erect, massive; with narrow scale of about 30 by 1.8 mm, medium brown and black-margined with toothed edges. Stipe large, c. 1.5 cm in diameter, up to 1 m long, with a scaly to prickly surface near the base. Lamina bipinnate to tripinnatifid, consists of 50 to 20 cm lateral pinnae, acute at apex and subtruncate at the base. Sori 2 mm long, located near the costules.

Distribution and habitat Sri Lanka, South India, Himalayas, Indochina, throughout Malesia, north to Taiwan. Terrestrial on humus-rich forest to forest edge from lowland to montane forest (IUCN: LC).

Author: Hj. Shahrin Hj. Md. Jaafar



sori



upper surface of frond



rhizome and stipe



habit

***Blechnum orientale* L.**

Description Rhizome thick and covered with linear, dark brown scales, sub-erect. Stipe is usually dark purplish-red when young, can be up to 50–60 cm long, having scales at the base and usually bearing reduced pinnae. Lamina pinnate, measuring up to 1.5–2 m long and 50 cm wide; pinnae many, 20–30 cm long and 1–2 cm wide, linear and narrowing towards apex. Sori linear, along the costa on the underside of pinnae.

Distribution and habitat Tropics of Asia, Australia and the Pacific, India to Polynesia, north to southern edge of Japan (Yakushima). Terrestrial in open areas from lowland to lower montane forest in DINP and QSBG (IUCN: LC).

Author: Ng Zi Qiang Arthur



habit



sori



upper surface of frond



base of stipe

Woodwardia orientalis Sw.

Synonym *Woodwardia radicans* (L.) Smith var. *orientalis* (Sw.) Sw.

Description Rhizome erect, stout, densely scaly; scales dark brown lanceolate. Stipe 20–55 cm long, densely scaly at the base. Lamina deeply bipinnatifid, the basiscopic pinnae missing or reduced to 2–4 pinnules, margin serrate, apex acute to acuminate, veins distinct, anastomosing; small bulbils present on adaxial surfaces of pinnae. Sori crescent or elliptic; indusia dark brown, sunken in rimmed depressions, occupying costular areoles.

Distribution and habitat China, Japan, Taiwan, and the Philippines. Terrestrial, one of the ferns showcased in QSBG's fern garden (IUCN: LC).

Author: Farhad Yozarius



sori



upper surface of frond with bulbils



fiddlehead of fronds



habit

Cibotium barometz (L.) J.Sm.

Synonym *Polypodium barometz* L.

Description Rhizome massive, covered with woolly yellow hairs. Lamina 2-pinnate-pinnatifid, can grow up to 1.5–2 m long and 1 m wide; pinnae many, up to 80 cm long and 25 cm wide; pinnules deeply pinnatifid, linear-lanceolate, measuring 10–15 cm long and 1–3 cm wide. Sori 4–6, usually on lower segments of pinnules and parallel to the edge, covered by an outer and inner indusia.

Distribution and habitat Himalayas to South China and Taiwan, south to West Malesia, north to the Ryukyus. Terrestrial in open to shaded mid-montane forest. Terrestrial, one of the ferns showcased in QSBG's fern garden (IUCN: LC).

Author: Ng Zi Qiang Arthur



sori



upper surface of frond



stipe with hairs



habit

Cyathea gigantea (Wall. ex Hook.) Holttum

Synonym *Alsophila gigantea* Wall. ex Hook.

Description Rhizome erect, scaly. Stipe up to 18 cm long and 8 cm wide, groove shaped in middle, densely covered with spreading scales; scale erect, dark brown to nearly black, stiff, single row. Lamina pinnate, 150 cm long and 95 cm wide, lanceolate, hairy, 13 to 15 pairs; basal first pinnae shorter than others, longest pinnae upright. Sori round, near costule.

Distribution and habitat East Himalayas, South India, Sri Lanka, Myanmar, South China, Indochina, Peninsular Malaysia, Sumatra, and West Java. Terrestrial in montane forests, one of the ferns showcased in QSBG's fern garden (IUCN: LC).

Author: Farhad Yozarius



sori



upper surface of frond



rhizome and stipe



habit

Microlepia platyphylla (D. Don) J. Sm.

Synonyms *Davallia platyphylla* D. Don, *Humata grandissima* Hayata, *Microlepia grandissima* Hayata

Description Rhizome thick, densely covered with hairs at the apex; hairs brown with black-margined and toothed edges. Stipe thick, glabrous surface, more than 1 m long. Lamina very large, bipinnate, 80–130 cm long, subrectangular in outline; pinnae acuminate at apex and unequally cuneate at the base, with stipe more than 1.5 cm long; costules can be seen clearly at the lower side compared to the upper side, which is densely hairy. Sori terminal on veinlets; indusia cup-shaped, glabrous.

Distribution and habitat Sri Lanka, Himalayas to Southwest China, Taiwan, Indochina and Philippines. Terrestrial along small streams in montane forest of DINP (IUCN: LC).

Author: Hj. Shahrin Hj. Md. Jaafar



sori



upper surface of frond



rhizome and stipe



habit

Microlepia speluncae (L.) T.Moore

Synonyms *Polypodium speluncae* L., *Microlepia hancei* Prantl, *Microlepia speluncae* (L.) T.Moore var. *hancei* (Prantl) C.Chr. & Tard., *Microlepia speluncae* (L.) T.Moore var. *villosissima* C.Chr.

Description Rhizome short-creeping, bearing fronds 8–10 mm apart; scales 2–4 mm long, reddish brown, lanceolate. Stipe c. 0.5 m long, the base scaly with similar scales as on rhizome, pubescent or glabrescent. Lamina c. 0.6 × 0.5 m, tripinnate, deltoid; pinnae c. 18 pairs, basal pinnae longest, distinctly stalked, c. 20 mm long; rachis grooved on the upper side, more or less hairy; segments lobed to pinnatisect, oblong to subquadrangular. Sori 1–4 per lobe, located at sinuses; indusia cup-shaped, hairy.

Distribution and habitat Pantropical. Terrestrial in open to light-shaded areas from lowland to montane forest of DINP and QSBG (IUCN: LC).

Author: Nor Ezzawanis Abdullah Thani



sori



upper surface of frond



rhizome and stipe



habit

Pteridium aquilinum (L.) Kuhn
 subsp. ***wightianum*** (J.Agardh)
 W.C.Shieh

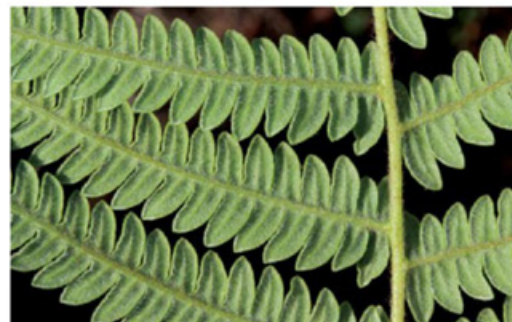
Synonym *Pteris recurvata* Wall. ex Ag. var. *wightiana* J.Agardh

Description Rhizome long, creeping, covered with pale brown hairs. Stipe more than 1 m long, 0.5 m wide, thick, densely covered with pale brown hairs, dark brown. Lamina tripinnate to quadripinnatifid, 70 cm long by 40 cm wide; basal pinnae larger; pinnules sessile; rachis hairy in the groove above, greenish white. Sori linear, submarginal; indusia thin.

Distribution and habitat Cosmopolitan. Common terrestrial fern in open areas (IUCN: LC).



habit



under surface of frond



upper surface of frond showing apical part



base of stipe

Didymochlaena truncatula
(Sw.) J.Sm.

Synonyms *Aspidium truncatum* Sw., *Didymochlaena lunulata* Desv.

Description Rhizome massive bearing a group of fronds, more than 10 cm long, scale up to 20 by 5 mm, color brown or sometimes black brown. Stipe stramineous or dark covered with the scales and downy hair up to 70 cm long, grooved on adaxial surface. Lamina pinnate and narrower up to 100 by 40 cm; pinnae 20 or more pairs; rachis grooved. Sori terminal on anterior branch of vein somewhat hollowed; indusia glabrous; about 2 mm long.

Distribution and habitat Pantropical. Terrestrial in humus-rich montane forest, one of the ferns showcased in QSBG's fern garden (IUCN: LC).

Author: Heng Sovanna



sori



upper surface of frond



stipe



habit

Acrophorus nodosus C.Presl

Synonym *Peranema nodosa* (C.Presl) Fraser-Jenk.

Description Rhizome erect, scaly. Stipe stramineous up to 90 cm, scaly at the base, reddish brown, rough by fallen scars of scales. Lamina quadripinnate-quadripinnatifid up to 100 cm by 80 cm; lateral pinnae opposite, the lowest the largest; pinnules deeply lobed, with light green to white hairs on upper surface of veins. Sori subterminal at the veinlets, rounded; indusia reniform.

Distribution and habitat Himalayas to South China and Taiwan, north to southern edge of Japan (Yakushima). Terrestrial on humus-rich montane forest of DINP (IUCN: LC).

Author: Dian Indah Pratiwi



sori



upper surface of frond



base of stipe



habit

Arachnioides spectabilis
(Ching) Ching

Synonym *Rumohra spectabilis* Ching

Description Rhizome short, erect; scales dense, brown. Stipe stramineous, scaly at base, glabrescent upwards. Lamina oblong-subtriangular, tripinnate; lateral pinnae more than 10 pairs, the lowest the largest, with large basal acroscopic pinnules, lobes serrate at margin, vein indistinct forked; rachis glabrous, grooved at upper surface. Sori dorsal in veinlet near midrib; indusia round, entirely covered the sori when young, breaking down irregularly.

Distribution and habitat East Himalayas and Southwest China. Terrestrial on humus-rich montane forest of DINP (IUCN: LC).

Author: Farhad Yozarius



sori



upper surface of frond



rhizome and stipe



habit

Bolbitis heteroclita (C.Presl)

Ching

Synonyms *Bolbitis cuspidata* (C.Presl) Ching, *B. psuedoscalpturata* (Copel.) Ching, *B. foxworthyi* (Copel.) Ching, *B. tenuissima* (Copel.) Copel., *B. membranacea* (Copel.) C.Chr., *B. edanyoi* Copel., *Edanyoa difformis* Copel.

Description Rhizome long creeping, scaly, scale brown, linear, up to 5 by 1 mm. Stipe of sterile shorter than fertile, 5–15 cm long, scaly at base with brown scales, lamina of sterile strongly dimorphic, from simple to pinnate, bipinnatifid (specimens in QSBG), free veins, herbaceous, softly papyrous, glabrous, deep green, irregularly pinnatifid pinnae with denticulate margin, fertile lamina contracted simple pinnate. Sori acrostichoid, dispersed and covered whole lower surface, naked.

Distribution and habitat Northern India, Myanmar, South and Southwest China, Taiwan, Indochina, Ryukyu, throughout Malesia to New Guinea. Terrestrial, lithophytic, sometimes epiphytic near streams in lower to mid-montane forest. Plant specimens observed in the fern garden of QSBG might come from typical miniscule form from the Philippines (IUCN: LC).

Author: John Rey C. Callado



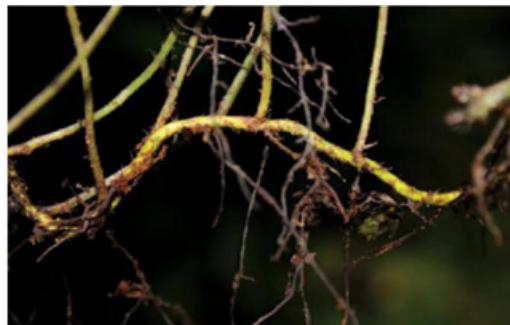
habit



sori



upper surface of frond



rhizome and stipe

Bolbitis sinensis (Baker) K.Iwats.

Synonyms *Acrostichum sinense* Baker, *Egelnoia sinensis* (Baker) Maxon

Description Rhizome creeping, scale greyish-brown, narrowly subtriangular with long acuminate apex, entire, up to 4 by 0.8 mm. Frond strongly dimorphic. Stipe of sterile frond 15–30 cm long, scaly at base with brown scales, bipinnatifid, lamina narrowly subtriangular, apex attenuately long tailed, often viviparous at apex, rachis sparsely scaly, winged in upper part, middle pinnae patent, lanceolate, shortly stalked, upper ones ascending oblong, moderately acute to rounded at apex; stipe of fertile frond 25–60 long, lamina narrower 15–25 by 5–7 cm; simply pinnate, lower lateral pinnae linear-lanceolate, gradually narrowing from base to apex, moderately acute at apex; vein pinnate, veinlet simple, all free. Sori dispersed and covers whole lower surface, naked.

Distribution and habitat North India, Myanmar, Southwest China, and Viet Nam. Terrestrial in lower montane forest of DINP (IUCN: LC).

Author: Farhad Yozarius



sori



under surface of frond



rhizome and stipe



habit

Diacalpe aspidioides Blume

Description Rhizome erect; scales c. 10 mm long, linear-subtriangular, base auriculate, apex acuminate, pale brown. Stipe c. 0.3 m long, the base densely covered with almost similar scales as on rhizome but sparsely distributed on the upper side. Lamina c. 30 × 30 cm, tripinnate, subdeltoid; rachis minutely scaly; basal pinnae largest, distinctly stalked, c. 5 mm long; pinnules oblong-subdeltoid, 2–4 cm long; segments oblong to spatulate, oblique. Sori round, dorsal on veinlets, with indusia; indusia about 0.7 mm diameter.

Distribution and habitat Sri Lanka, North India, South China, Indochina, and throughout Malesia. Terrestrial on humus-rich montane forest of DINP (IUCN: LC).

Author: Nor Ezzawanis Abdullah Thani



sori



under surface of frond



rhizome and stipe



habit

Dryopteris sparsa (D.Don) Kuntze

Synonyms *Nephrodium sparsum* D.Don, *Lastrea sparsa* (D.Don) Moore

Description Rhizome short, erect; scales 5–7 mm long, lanceolate, pale brown, apex long pointed. Fronds dimorphic, fertile laminae and pinnae much reduced in size than the sterile. Stipe 5–8 cm long, glabrous. Lamina 10–13 × 4–7 cm, bipinnatifid, subdeltoid, apex acuminate; pinnae 2–3.5 cm long, subtriangular-lanceolate, falcate, shortly stalked; segments oblong, oblique, apex rounded to acute, margin serrate. Sori round, located along costae or at the middle between costae and margin, with indusia; indusia above the sori, almost round, about 1 mm diameter.

Distribution and habitat India, China, Indochina, throughout Malesia to Polynesia, Taiwan, and Japan. Terrestrial in mid-montane to montane forest of DINP (IUCN: LC).

Author: Nor Ezzawanis Abdullah Thani



sori



upper surface of frond



rhizome and stipe



habit

Polystichum biaristatum
(Blume) T.Moore

Synonyms *Aspidium biaristatum* Blume, *Polystichum aculeatum* (L.) Roth ex Mert. var. *biaristatum* (Blume) Bedd., *Aspidium aculeatum* auct. non (L.) Sw.

Description Rhizome short, sub-erect, scaly; scale bicolored, black at the center and brown at the edge. Stipe scaly at the base, with two kinds of scales, some look like one on the rhizome, one narrower. Lamina oblong lanceolate with acuminate apex; rachis densely scaly throughout with linear black scales. Sori arranged in one row at submarginal or medial portion of pinnules; indusia pale brown.

Distribution and habitat Sri Lanka, North India, South China, Taiwan, and Java. Terrestrial on humus-rich montane forest, one the ferns showcased in QSBG (IUCN: LC).

Author: Dian Indah Pratiwi



habit



sori



upper surface of frond



rhizome and stipe

Polystichum semifertile
(C.B.Clarke) Ching

Synonyms *Aspidium aculeatum* (L.) Sw. var. *semifertile* (C.B.Clarke), *Polystichum aculeatum* (L.) Roth ex Mert. var. *semifertile* (C.B.Clarke) Bedd.

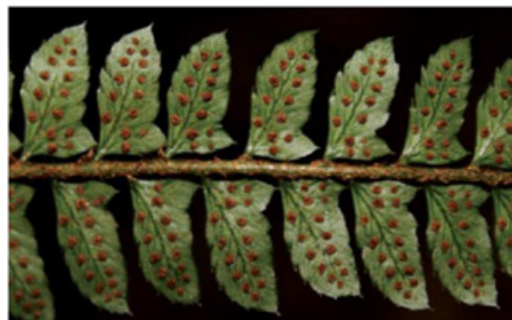
Description Rhizome massive, erect, covered with dense scales; scale oblong, bicolor (light brown to black brown). Stipe 40–60 cm long, covered with two kinds of scales, the larger one as in rhizome, the small one linear, toothed at margin, rachis covered with dense downy linear scales, grooved in abaxial surface. Lamina oblong, acuminate at apex, truncate at base, 50–70 by 25–30 cm, lowest pinnae opposite, reduced, patent, middle pinnae patent or slightly ascending, alternate, narrowly lanceolate, broadly cuneate at base, pinnules falcate, acute at apex, distinct areoles at acroscopic and dimidiate at basiscopic bases, sessile. Sori scattered on basal pinnae, from near rachis towards posterior portion, in one row, medial to costular, fertile pinnules smaller than sterile ones; indusia fugacious at maturity, dark in central portion, up to 1 mm.

Distribution and habitat Southwest China (Yunnan) and Viet Nam. Terrestrial on humus-rich montane forest of DINP (IUCN: LC).

Author: Farhad Yozarius



habit



sori



basal stipe with scale



rhizome and stipe

Dicranopteris linearis (Burm.f.) Underw.

Synonyms *Polypodium linearis* Burm.f., *Gleichenia linearis* (Burm.f.) C.B. Clarke

Description Rhizome creeping and hairy, forking. Frond compound, two ultimate leafy branches of equal length present at the end of the upward-growing forked frond, width between 9–12 cm, which are deeply, pinnately lobed and comb-like; the main rachis is divided dichotomously into two rachis branches, which also fork further about 3–4 times; the ultimate branches 15–30 cm long, 4–7 cm wide, ultimate segments linear, entire, round at apex with up to 4 mm broad. Lamina texture firm, hairy, glaucous below, veins more or less prominent on lower surface.

Distribution and habitat Old World tropical to subtropical regions. Terrestrial in open areas to forest edge of DNP (IUCN: LC).

Author: Hj. Shahrin Hj. Md. Jaafar



sori



upper surface with forking branch



rhizome and stipe



habit

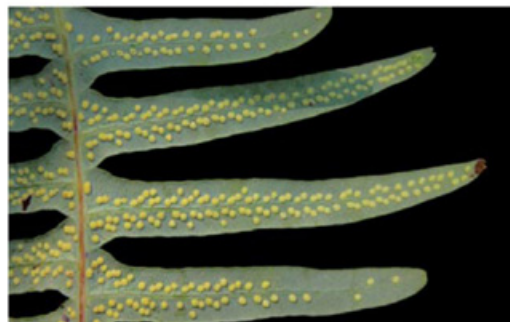
Dicranopteris splendida (Hand.-Mazz.) Ching

Synonym *Gleichenia splendida* Hand.-Mazz.
Dicranopteris ampla Ching & Chiu

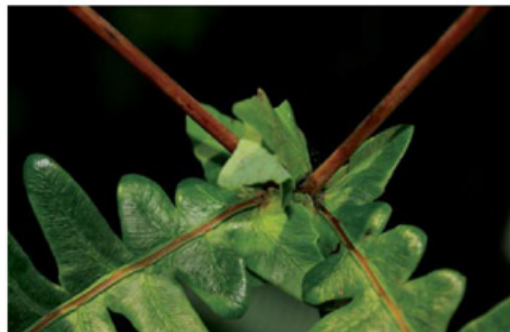
Description Rhizome long, creeping, densely hairy with shining brown stiff hairs. Stipe to 50 cm long, glabrous, brown. Lamina papery, glaucous abaxially, dark green, glabrous; the ultimate pinnae oblong-lanceolate, 15–25 x 5–7 cm, apex attenuate; veins 4 or 5 in each group; rachis dichotomously branched 1–2 times, glabrous. Sori more than one row at each side of costules.

Distribution and habitat India (Khasia), upper Myanmar, South and Southwest China, and Indochina. Terrestrial in open areas to forest edge of DINP (IUCN: LC).

Author: Hj. Shahrin Hj. Md. Jaafar



sori



upper surface with forking branch



rhizome and developing frond



habit

Hymenophyllum polyanthos

Sw.

Synonym *Mecodium polyanthos* (Sw.) Copel.

Description Rhizome creeping, slender 0.1–0.5 mm, with brown hairs. Frond tripinnatifid, variable in size and form, lanceolate, oblong-lanceolate. Stipe dark green, winged at the upper part, wingless at the base. Lamina light green, herbaceous, margin entire, wavy or flat; ultimate segment lanceolate; rachis winged, the wing narrow especially near the base part. Sori scattered on the upper part of fronds, involucre subdeltoid or kidney shape, bivalvate.

Distribution and habitat Tropics or subtropics throughout the world, north to central Japan. Epiphytic on tree trunks or lithophytic on mossy rocks in shaded montane forest of DINP (IUCN: LC).

Author: Dian Indah Pratiwi



sori



upper surface of frond



rhizome and stipe



habit

Odontosoria chinensis (L.) J.Sm.

Synonym *Sphenomeris chinensis* (L.) Maxon

Description Rhizome short, creeping, scaly with narrow glossy dark brown scales. Frond 10–100 by 8–20 cm, tripinnate–quadripinnate; basal pinnae largest, the rest get progressively smaller as they approach the tip of the blade giving the frond a long triangular shape; the tiny pinnules wedge-shaped, with the wide end at their terminus. Stipe reddish-brown, with grooved on abaxial surfaces. Sori terminal on veinlet, close to apex-lobes; indusia attached at base and basal part of both sides, nearly as long as lobes, toothed.

Distribution and habitat Tropical to sub-tropical Old World, Madagascar to Polynesia, north to Japan and Korea. Terrestrial on light shaded areas from lowland to montane forest of DINP (IUCN: LC).

Author: Farhad Yozarius



sori



upper surface of frond



rhizome and stipe



habit

Huperzia hamiltonii (Spreng.) Trevis.**Synonym** *Lycopodium hamiltonii* Spreng.**Description** Stems usually pendulous, 15–50 cm long, dichotomously branching a few times, 1–1.5 mm in diameter near base. Leaves ascending or subadnate, lanceolate but variable in form and size, narrowing toward sessile or very shortly stalked base, entire at margin, the middle or lower part is the largest; vein more or less distinct. Sporophyll usually smaller than the trophophylls.**Distribution and habitat** Himalayas, Indochina to China. Epiphytic of moss covered tree trunks in montane forest of DINP (IUCN: LC).**Author:** Farhad Yozarius

under surface showing the dehiscent sporangia



upper surface of the plant



habit



basal part of the plant with young shoot

Lycopodium clavatum L.

Description Main stems creeping, producing aerial stem and root, branched irregularly or dichotomously, 0.5–1 cm in diameter. Leaves curved in upper part, linear to linear-lanceolate, apex acuminate, long caducous membranous setae at the end, 4–6 mm long, 0.5–1 mm wide, yellowish green. Cones erect on the stalk; stalk 7–10 cm long, a few cone at the apex; cone cylindrical, erect, 3–8 cm long, 4–5 mm in diameter; sporophylls oblong-ovate, acuminate at apex, with setaceous membrane, 2.5 mm long, 1.5 mm broad.

Distribution and habitat Widespread. Terrestrial in open areas of DINP (IUCN: LC).

Author: Myint Myint San



habit



strobili



creeping branch



creeping branch with upright branch

Lygodium flexuosum (L.) Sw.

Synonyms *Ophioglossum flexuosum* L., *Lygodium dichotomum* Sw.

Description Rhizome short, densely covered with dark brown hairs. Frond climbing, usually several meters tall. Stipe 50 cm or more, monostichous, twining of indefinite growth; secondary rachis-branches regularly pinnate, with 3–5 pairs of leaflets, leaflet-stalks not thickened at base, thinly hairy, ultimate lobes up to 15 cm long, 2.5 cm broad. Sporangia-bearing lobes protruding at margin of tertiary leaflets, up to 1 cm long, 1.5 mm broad, indusia glabrous.

Distribution and habitat Sri Lanka, North India, Southwest and South China, Hong Kong, Ryukyus and Taiwan, southwards to Queensland through Malesia and Melanesia. Terrestrial, climbing on shrubs or on branches of tall trees in lowland to mid-montane open areas of QSBG (IUCN: LC).

Author: Pichai Yadee



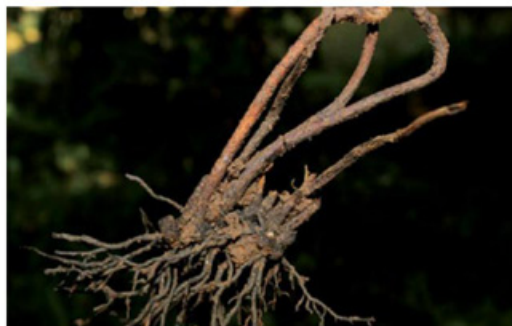
sori



portion of fertile lamina



portion of sterile lamina



rhizome and stipe

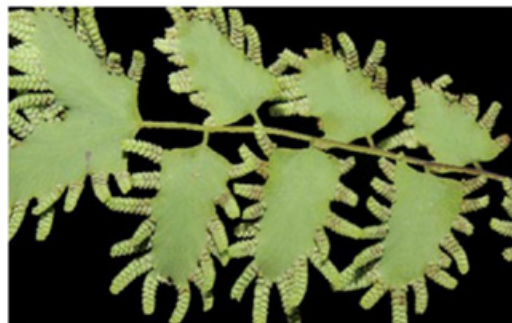
Lygodium microphyllum (Cav.) R.Br.

Synonyms *Ugenia microphylla* Cav., *Lygodium scandens* Sw.

Description Rhizome widely creeping, irregularly branching 2–3 mm covered with blackish brown hairs. Frond climbing, sometimes to several meters. Stipe about 10 cm long; monostichous, twining of indefinite growth, secondary rachis-branches pinnate with a few leaflets, or dichotomous primary rachis-branches distinct, usually more than 4 mm long, secondary rachis-branches simply pinnate, leaflets articulated at base. Sporangia-bearing lobes narrow, protruding at margin of segments, 3–7 mm long, about 1 mm broad; indusia serrate at margin, glabrous.

Distribution and habitat Tropics of the Old World, from Africa to Melanesia and Australia, north to the Ryukyus and south to New South Wales. Terrestrial, climbing on shrubs or on branches of tall trees in lowland to mid-montane open areas of QSBG (IUCN: LC).

Author: Pichai Yadee



sori



upper surface of frond



rhizome and stipe



habit

Angiopteris evecta (G.Forst.) Hoffm.

Synonyms *Polypodium evectum* G.Forst., *Angiopteris crassipes* Wall. ex C.Presl, *Angiopteris helferiana* C.Presl

Description Rhizome massive, globose, erect, radially arranged 20 cm diam. Frond oblong, bipinnate, 150–300 cm long, 100–150 cm broad; pinnae 5–9 pairs, alternate; pinnules about 25 pairs, oblong-elliptic 15–25 cm long, 2.5–3.5 cm broad, base rounded, apex acuminate, margin serrulate. Stipe 50–100 cm long, the swollen base 4–9 cm broad; stipule 15–20 cm broad, densely long-scaly above, triangular-keeled, the edges irregularly erose. Sori elliptic to oblong 1–1.2 mm long, 0.5–0.7 mm broad, connecting near the edge, the edge entire length of the pinnules.

Distribution and habitat From India and China through Southeast Asia and Malesia to the islands of the Pacific. Terrestrial, growing in shaded areas near streams in lowland to montane forest of DINP and QSBG (IUCN: LC).

Author: Kittiphong Kertsawang



sori



upper surface of frond



rhizome and stipe



habit

Osmunda angustifolia Ching

Description Rhizome short and erect. Stipe stramineous, short up to 25 cm long. Lamina pinnate with a distinct apical pinna, a few pairs of basal pinnae slightly shortened, lateral pinnae linear, gradually narrowing both toward acute apex and shortly stalked base, less than 15 cm long, 1.2 cm broad, the margin slightly wave, the sinus usually less than 1 mm in depth, texture papyraceous to softly coriaceous, fresh green in color, a few middle pinnate fertile, turns brown after shedding spores.

Distribution and habitat Hainan, Hong Kong, China (Guangdong), and Taiwan. Rheophyte fern and growing on wet rock, one of the ferns showcased in QSBG (IUCN: LC).

Author: Heng Sovanna



sori



upper surface of frond



apical part of lamina



rhizome and stipe

Crypsinus rhynchophyllus (Hook.) Copel.

Synonym *Selliguea rhynchophylla* (Hook.) H.Ohashi & K.Ohashi

Description Rhizome long, creeping, densely scaly throughout, membranous, brown. Frond simple, entire, dimorphic; sterile frond smaller, simple, ovate to lanceolate, with short stipe, 5 mm by 10 mm, ovate-oblong; fertile frond larger, lanceolate, with longer stipes, 4 cm by 2 cm, scaly at the base, glabrescent upwards, jointed to rhizome. Sori round, in a single row at each side of near costa, indusia absent.

Distribution and habitat North India, Myanmar, Southwest China, and Indochina. Epiphytic to lithophytic on moss covered rocks and tree trunks montane forest of DINP (IUCN: LC).

Author: Myint Myint San



sori



upper surface of sterile frond



rhizome and stipe



habit

Drynaria bonii Christ

Description Rhizome creeping, tightly fixed on substrate, flat, about 1.5–3 cm wide, densely scaly; scales ovate, peltate, round at base, up to 2 mm long, tip with tail of about 2–3 mm in length, bicolored with black-brown small central spot, margin paler. Kinds of leaves: nest-leaves or scaly leaves and foliage-leaves; nest-leaves sterile, imbricate, covering almost entirely the rhizomes, oval, margin subentire, up to 10 cm long, 5–7 cm broad; foliage-leaves fertile. Stipe stramineous, ± 10–25 cm long, narrowly winged almost to the base. Lamina pinnatifid, oblanceolate, moderately acute to caudate-acuminate, subentire, more or less narrowed towards base. Sori round, in 2–4 irregular rows between main vein.

Distribution and habitat China (Guizhou) and Indochina. Lithophytic or epiphytic from lowland to mid-montane forest, found in QSBG's fern garden (IUCN: LC).

Author: Dian Indah Pratiwi



habit showing nest frond



sori



under surface of rhizome with scales



apical tip of rhizome

Drynaria quercifolia (L.) J.Sm.

Synonym *Polypodium quercifolium* L.

Description Rhizome creeping about 15 cm densely scaly, dark brown. Stipe about 25 cm long, stramineous, very narrow wing throughout. Lamina oblong to narrower, up 80 by about 50 cm. Sori round or oblong, two rows between adjacent main veins.

Distribution and habitat Sri Lanka, India to South China and Indochina, throughout Malesia to Fiji and tropical Australia. Lithophytic or epiphytic from lowland to mid-montane forest, specimens collected in DINP (IUCN: LC).

Author: Heng Sovanna



sori



cross-section of rhizome



rhizome and nest frond



sterile lamina

Leptochilus decurrens Blume

Synonyms *Acrostichum variable* Hook., *Gymnopteris variabilis* (Hook.) Bedd.

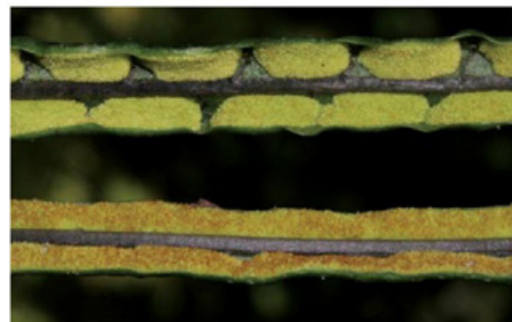
Description Rhizome long, creeping, bearing fronds more than 1 cm apart; scale brown. Frond strongly dimorphic; sterile frond simple, stipe \pm 10–20 cm long, more or less winged, scaly at the base, stramineous, lamina ovate-oblong lanceolate, apex caudately acuminate, dark green, midrib raised on both surfaces; fertile frond simple, stipe up to 40 cm, wingless, lamina linear up to 30 cm by 0.1–0.4 cm, whole covered by sporangia except on the midrib.

Distribution and habitat Sri Lanka, South India, North India, South China and Taiwan, Viet Nam, throughout Malaysia. Terrestrial or lithophytic on moist rocks in montane forest, one of the ferns showcased in QSBG (IUCN: LC).

Author: Dian Indah Pratiwi



habit



sori



upper surface of sterile lamina



rhizome and stipe

Lepisorus nudus (Hook.) Ching

Synonyms *Pleopeltis nuda* Hook., *Drynaria nuda* (Hook.) Fée, *Phymatodes nuda* (Hook.) J.Sm.

Description Rhizome long, creeping, c. 2 mm thick, bearing fronds 0.5–1.5 mm apart; scales 1–2 mm long, ovate, light brown, apex acuminate. Stipe 4–5.5 cm long, 1 mm thick, the base densely scaly, upper part glabrous. Lamina simple, 20–30 x 15–20 mm, linear-lanceolate, both base and apex attenuate, margin entire or often rolled inwards on the lower surface, with scattered minute, dark brown scales on the lower surface, thinly coriaceous; midrib raised on both sides. Sori elliptic to round, at the middle between midrib and margin, without indusia, 3–5 mm long, hollowing on upper surface of lamina.

Distribution and habitat Sri Lanka, South India, Himalayas, upper Myanmar to Southwest China (Yunnan). Epiphytic to lithophytic in montane forest of DINP (IUCN: LC).

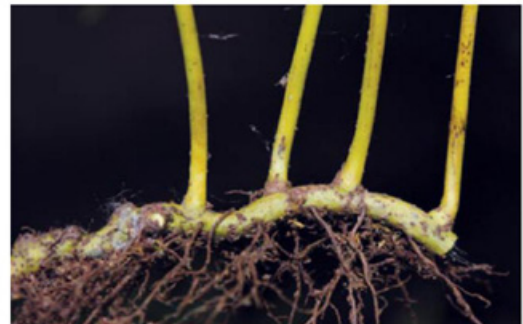
Author: Nor Ezzawanis Abdullah Thani



sori



upper surface of frond



rhizome and stipe



habit

Lepisorus sublinearis (Baker ex Takeda) Ching

Synonyms *Pleopeltis sublinearis* (Baker ex Takeda) Tagawa & K.Iwats., *Polypodium sublineare* Baker ex Takeda

Description Rhizome short creeping, c. 5 mm diameter, bearing fronds closely together, densely scaly; scale oblong-subtriangular, uniformly dark brown. Stipe very short, scaly at base. Lamina linear-lanceolate, 28 by 2.2 cm, broadest at basal 1/3, gradually narrowing toward the apex and base, coriaceous textures, veins rarely visible. Sori round, arranged in one row close to midrib, 3 mm in diameter; indusia absent.

Distribution and habitat Myanmar, Southwest China (Yunnan), and Indochina. Epiphyte in dense montane forest of DINP (IUCN: LC).

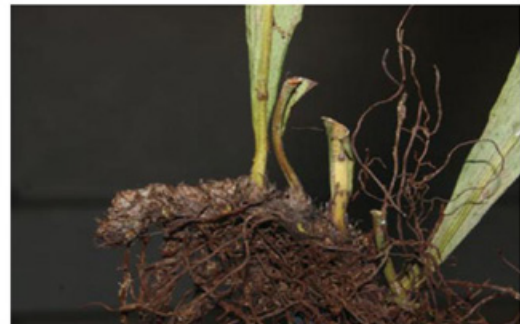
Author: Zaharin Hj. Abdul Kahan



sori



upper surface of frond



rhizome and stipe



habit

Leptochilus ellipticus (Thunb.) Noot.

Synonyms *Polypodium ellipticum* Thunb., *Gymnogramma pentaphylla* Baker, *Colysis pentaphylla* (Baker) Ching

Description Rhizome long, creeping, with \pm 4.5 cm apart from one frond to another, densely scaly; scale brown with long acuminate apex, up to 10 mm long and 1–2 mm width. Frond with 5–6 pairs impari-pinnate, pinnae lanceolate, 1–2 upper pairs slightly reduced, apex acuminate. Stipe stramineous, brown, up to 45 cm long, scaly at the base. Sori linear between to areoles, exindusiate.

Distribution and habitat Northeast India, Nepal, South China (Yunnan), Korea (Quelpart Island), South Japan, Myanmar, Thailand, Lao PDR, Viet Nam, and the Philippines. Terrestrial along forest trails and small streams from lowland to montane forest of DINP (IUCN: LC).

Author: Dian Indah Pratiwi



sori



upper surface of frond



rhizome and stipe



habit

Microsorium musifolium

Copel.

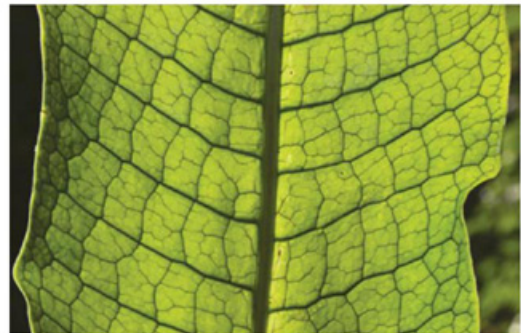
Description Rhizome dark brown, creeping, short internode, fronds arising from multiple nodes. Frond light green, strap-shaped, similar form for fertile and sterile fronds, 55–65 cm long and 8–14 cm wide, fairly thick and waxy with undulating margins, abaxially-protruding midrib and prominently-netted dark green. Sori round to oblong, numerous and densely scattered all across underside of frond in between veins, maturing from cream to brownish; indusia thin, all one side, crenate at margin.

Distribution and habitat Southern Myanmar, Peninsular Malaysia, Sumatra, Indonesia, Borneo, Philippines, and New Guinea. Lithophytic to epiphytic in lowland forest, one of the ferns showcased in QSBG's fern garden (IUCN: LC).

Author: Myint Myint San



sori



under surface of sterile lamina and venation



habit



rhizome

Neocheiropteris normalis (D.Don) Tagawa

Synonyms *Polypodium normale* D.Don, *Tricholepidium normale* (D.Don) Ching

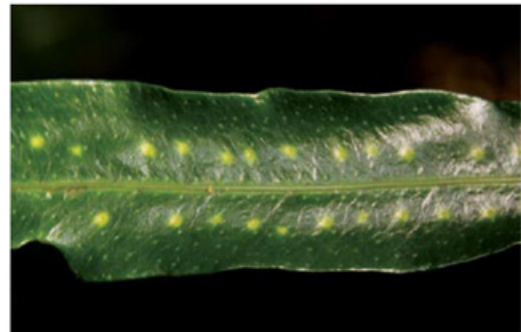
Description Rhizome long, creeping 2–3 diam., bearing fronds with irregular intervals 0.5–3 cm apart. Stipe with wing at upper part, scaly at lower portion, stramineous simple leaf. Lamina narrowly lanceolate attenuately long acuminate at apex slightly waved at margin up to 45 by 3 cm. Sori rather irregular in one row between midrib and the margin of frond, costular, round, up to 2.5 mm diam.

Distribution and habitat Himalayas, upper Myanmar, South China, Viet Nam, and Western Malesia (Peninsular Malaysia and Sumatra). Scandent on tree trunks in montane forest of DINP (IUCN: LC).

Author: Heng Sovanna



sori



upper surface of frond



rhizome and stipe



habit

Phymatosorus scolopendria (Burm.f.) Pic.Serm.

Synonyms *Polypodium scolopendria* Burm.f.,
Chrysopteris phymatodes (L.) Link, *Microsorium scolopendria* (Burm.f.) Copel.

Description Rhizome long, creeping with dark color, bearing frond 1.2 cm apart, scaly. Stipe to 70 cm long, dark to light color. Lamina ovate, 80 by 40 cm, pinnatifid, lateral pinnae 2 pairs, the basal the longest in fertile frond, gradually narrowing toward the apex; costa raised on both surfaces; vein rarely visible. Sori round, 3 mm in diameter, irregularly arranged in rows on both side of midrib.

Distribution and habitat Old World tropical regions. Epiphytic or lithophytic in lowland forest, common in QSBG's fern garden (IUCN: LC).

Author: Zaharin Hj. Abdul Kahan



habit



sori



upper surface of frond



rhizome

Pyrrrosia lanceolata (L.) Farw.

Synonyms *Acrostichum dubium* Poir., *Acrostichum lanceolatum* L.

Description Rhizome long, creeping, 1.5 mm in diameter, bearing fronds c. 3 cm apart, densely covered with large scales; scales brown in the center, pale toward margin. Stipes short, about 3 mm long, densely hairy. Lamina linear-lanceolate, gradually narrowing toward both ends, 11 cm by 10 mm, midrib and vein invisible, thick, rough in texture, stellate hair present on both surfaces. Sori round, covering the lower surface of apical parts of fronds.

Distribution and habitat Himalayas to Myanmar, South China (Yunnan), Taiwan, and the Ryukyus, Indochina, South India and Sri Lanka, throughout Malesia to Polynesia. Epiphytic and lithophytic from lowland to mid-montane forest of QSBG and DINP (IUCN: LC).

Author: Zaharin Hj. Abdul Kahan



sori



upper surface of frond



rhizome and stipe



habit

Psilotum nudum (L.) P.Beauv.

Synonyms *Lycopodium nudum* L., *Psilotum triquetrum* Sw.

Description Rhizome creeping. Foliage is reduced to small, scale-like leaves, about 1–2 mm long and with no venation. Stipe is green to yellowish-green, smooth and distinctly angular, dichotomously forked irregularly. Sporangia are 3-lobed, changing from green to yellow when mature, and born on the axils of the leaves.

Distribution and habitat Tropical and subtropical areas. Usually epiphytic on moss-covered tree trunks from lowland to mid-montane forest, one of the ferns showcased in QSBG's fern garden (IUCN: LC).

Author: Ng Zi Qiang Arthur



habit



sori (synangium)



dichotomous branching plant



rhizome

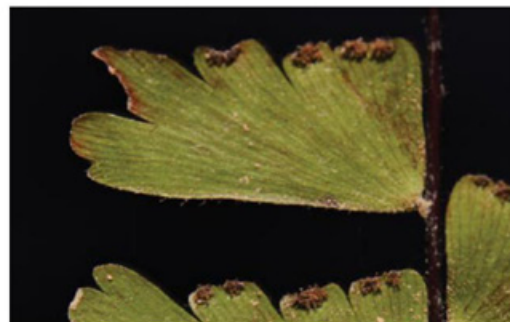
Adiantum caudatum L.

Synonyms *Adiantum caudatum* L. var. *angustilobatum* Bonap., *Adiantum caudatum* L. var. *edgeworthii* (Hook.) Bedd.

Description Rhizome short, erect, covered with scales; scale linear, bicolored. Stipe up to 10 cm long, castaneous to black purple, polished, densely hairy, scaly at base. Lamina linear-lanceolate, 1 - pinnate, bears a bud at the end of a whip-like tip, hairy on both surfaces, lower surface with short and long hairs, upper surface with stiff hairs. Sori on apices of lobes, covered by marginal false indusium, the reflexed flaps narrow, hairy.

Distribution and habitat Old World tropical areas, from Africa to Polynesia. Terrestrial in shaded forest, terrestrial or lithophytic lowland, common fern found in QSBG (IUCN: LC).

Author: Wenni Setyo Lestari



sori



upper surface of lowest pinna



habit



rhizome and stipe

Adiantum hispidulum Sw.

Synonyms *Adiantum hispidulum* Sw. forma *strictum* Gilbert, *Adiantum pedatum* G.Forst., *Adiantum pubescens* Schkuhr

Description Rhizome short, erect, covered with scales; scale brown, entire. Frond erect, tufted, young fronds are often red or pink. Stipe castaneous, polished, up to 17 cm long, clothed towards the base with brown scales, covered with short stiff multicellular hairs. Lamina ovate to deltate, 2- to 3-pinnate. Sori at 2-3 vein tips, covered by marginal false indusium, 4-13 for each leaflets; the reflexed flaps oblong, bearing brown hairs.

Distribution and habitat Africa, Australia, Polynesia, Malaysia, New Zealand, and other Pacific Islands. Terrestrial in shaded forest, one of the ferns showcased in QSBG's fern garden (IUCN: LC).

Author: Wenni Setyo Lestari



sori



upper surface of frond



rhizome and stipe



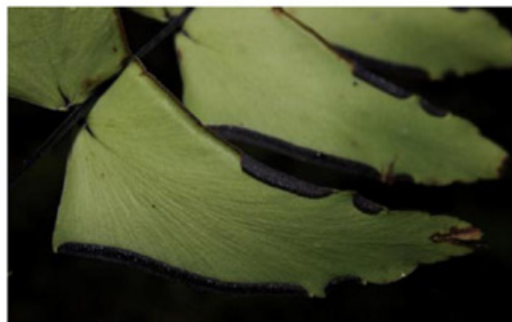
habit

Adiantum macrophyllum Sw.

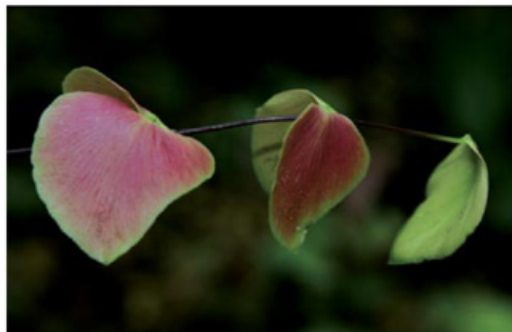
Description Rhizome short creeping to semi-erect, covered with scales, scale brown. Frond erect, young fronds are often red or pink. Stipe black, polished, up to 15 cm long with brown scales at the base. Lamina falcate, 1-pinnate blades and wide, sessile (or nearly so) pinnae that are glaucous beneath. Sori at lower margins of the pinnae, covered by marginal false indusium; the reflexed flaps narrow, shiny.

Distribution and habitat Neotropical species. Terrestrial in shaded forest, one of the ferns showcased in QSBG's fern garden (IUCN: LC).

Author: Wenni Setyo Lestari



sori



young frond



rhizome and stipe



habit

Adiantum tenerum Sw.

Synonyms *Adiantum extensum* Fée, *Adiantum tenerum* Sw. var. *obtusissimum* Christ, *Adiantum trapezoides* Fée

Description Rhizome short-creeping, covered with scales; scales bicolorous. Frond tripinnate, ultimate segments conspicuously articulate to the stalks, up to 50 cm long. Ultimate segments fan-shaped or rhombic, base cuneate, apex rounded or acute. Sori covered by marginal false indusium; the reflexed flaps narrow.

Distribution and habitat Neotropical species. Terrestrial in shaded forest, one of the ferns showcased in QSBG's fern garden (IUCN: LC).

Author: Wenni Setyo Lestari



sori



upper surface of frond



rhizome and stipe



habit

Cheilanthes pseudofarinosa
(Ching & S.K.Wu) K.Iwats.

Synonym *Aleuritopteris pseudofarinosa* Ching & S.K.Wu

Description Rhizome short, with linear-lanceolate, stiff, dark in the center and light brown at the entire margin. Stipe castaneous to dark brown, scaly at the base, 2–8 cm long. Lamina oblong-subtriangular, bipinnatifid, 2–10 cm long, 1.5–4.5 cm wide, lowermost pinnae with enlarged basiscopic lobe, densely covered with farina, no scales on costae or costule. Sori along the margin with broad indusia, interrupted, fimbriate.

Distribution and habitat Nepal, India, China, Indochina (Chiang Mai, Thailand), and the Philippines. Terrestrial to lithophytic in the shaded forest trail in DINP. (IUCN: LC).

Author: John Rey C. Callado



lower surface of frond with sori



upper surface of frond



rhizome and stipe



habit

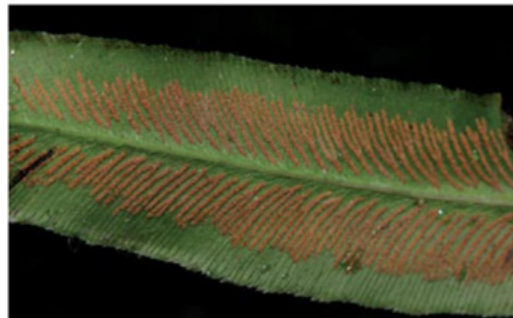
Coniogramme fraxinea (D. Don)
Diels var. ***serrulata*** (Blume) Hieron

Synonym *Gymnogramma serrulatum* Blume

Description Rhizome short, creeping; scales c. 5 mm long, ovate, reddish brown, apex long pointed. Stipe c. 50 cm long, the base sparsely to densely scaly, upper part sparsely scaly with minute scales. Lamina bipinnate, subdeltoid; rachis grooved on upper surface; pinnules 12–16 cm long, subopposite, shortly stalked, oblong-lanceolate, apex caudate, margin dentate, glabrous. Sori elongate along veins, often near costae, often dichotomous, without indusia.

Distribution and habitat Sri Lanka, India, South China to Taiwan, Indochina, and Malesia to the Philippines. Terrestrial in montane forest, one of the ferns showcased in QSBG's fern garden (IUCN: LC).

Author: Nor Ezzawanis Abdullah Thani



sori



fiddlehead of the frond



rhizome and stipe



habit

Pteris bella Tagawa

Description Rhizome erect, scaly, scales brown up to 4 mm by below 1 mm. Stipe brown, shining, scaly at base, up to 25–55 cm long. Lamina oblong with acute apex, deeply bipinnate, rachis shining brown, glabrescent, lateral pinnae 4–6 pairs, opposite, lanceolate, caudately acuminate at apex, costa stramineous, glabrescent, pinnules oblique, apex rounded, margin entire, adnate at base and decurrent to the costa, with wings less than 0.5 mm broad, green, vein forked, free, raised beneath. Sori marginal, usually less than 7 mm long, indusia pale brown, thin.

Distribution and habitat Thailand, China, and Taiwan. Terrestrial in montane forest of DINP (IUCN: LC).

Author: Dian Indah Pratiwi



sori



upper surface of pinna with spine



rhizome and stipe



habit

Pteris biaurita Retz.

Synonyms *Pteris quadriaurita* Retz. var. *grevilleana* Christ, *Campteria biaurita* (L.) Hook. *Pteris repandula* Link

Description Rhizome short and erect, apex of the rhizomes scaly. Stipe up to 50 cm long dark brown and scaly at the base. Lamina deeply bipinnatifid; pinnae opposite or nearly, linear-lanceolate, glabrous; basal veinlet uniting with those opposite groups forming arches close to costa (vein anastomosing). Sori marginal; indusia thin and pale.

Distribution and habitat Pantropical. Terrestrial from lowland to lower montane forest, specimens observed in DINP and QSBG (IUCN: LC).

Author: Dian Indah Pratiwi



habit



sori



under side of pinna showing veins



rhizome and stipe

Pteris nepalensis H.Ito

Description Rhizome short, erect, scaly at apex; scales narrow, bicolorous, dark brown at the middle and light-pale brown at the edge, about 3–4 mm by 1 mm. Lamina papyraceous, dull green, veins distinct on both surfaces. Stipe up to 35 cm long, pale, scaly at the base. Frond bipinnate, lateral pinnae 4–5 pairs, lowest pinnae the longest, bearing one large pinnatifid basal pinnules. Sori continuous along 1/3–1/5 part of the margin.

Distribution and habitat East Himalayas to Indochina. Terrestrial on humus-rich montane forest of DINP (IUCN: LC).

Author: Dian Indah Pratiwi



sori



upper surface of pinna with spine



rhizome and stipe



habit

Selaginella helferi Warb.

Description Rhizome restricted to lower part of stem or branched from lower to middle. Frond tripinnate, glabrous, leaves borne sparsely on the main branches but densely on lateral branches; dorsal leaves smaller than ventral leaves, appressed, falcate, acuminate at apex; ventral leaves patent oblong, falcate, acuminate at apex, round to subtruncate. Sporophylls ovate-lanceolate, acuminate at apex, about 3–5 mm long, 1.5–2 mm broad.

Distribution and habitat India, Indochina to China. Terrestrial in forest floor clearings in lowland to mid-montane forest, specimen observed in QSBG (IUCN: LC).

Author: Farhad Yozarius



habit



strobili



under surface branch



upper surface branch

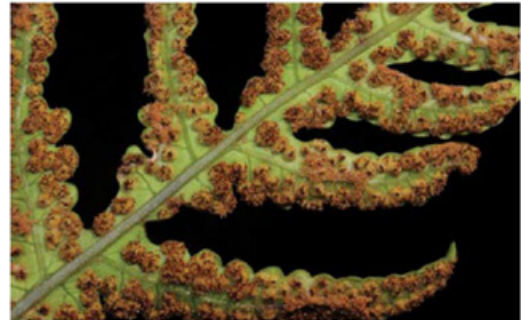
Heterogonium alderwereltii Holttum

Synonym *Pleocnemia stenosemioides* Alderw.

Description Rhizome short, sub-erect, scale lanceolate, up to 8 by 1 mm. Frond strongly dimorphic, sterile frond. Stipe 10–30 cm long, densely scaly at the base. Lamina oblong-subdeltoid, bipinnatifid, 15–25 cm long and wide, caudate-acuminate at the apex, subtruncate to broadly cuneate at base, papyraceous, deep green, glabrous on both surfaces; fertile frond; stipe 20–45 cm long, lamina bipinnatifid, oblong, much contracted, pinnae caudate-acuminate at apex and subtruncate to broadly cuneate at the base, lobed to half way towards costa, veins anastomosing. Sori round or extending along veins, with fairly large glabrous indusia.

Distribution and habitat Peninsular Thailand, Sumatra, and West Malesia. Terrestrial along dense lowland forest, one of the ferns showcased in QSBG's fern garden (IUCN: LC).

Author: Hj. Shahrin Hj. Md. Jaafar



sori



fertile basal pinna



rhizome and stipe



habit

Tectaria remotipinna

Ching & Chu H.Wang

Description Rhizome very short, creeping to erect, scales bicolored dark brown in center. Stipe polished, brown, sometimes green above, 35–56 cm long. Lamina deltoid-ovate, 48–114 x 36–144 cm, dull pale green above, hardly paler beneath, texture soft, minutely and densely hairy above except on veins, basal pinnae largest, 22–6 x 14–24 cm. Costae not grooved. Sori terminal on included veinlets, slightly, sunken, sporangia not setiferous.

Distribution and habitat China and Thailand. Terrestrial along streams in mid-montane forest of DINP (IUCN: LC).

Author: Heng Sovanna



sori



scales of the apical part of the rhizome



rhizome and stipe



habit

Macrothelypteris torresiana (Gaudich.) Ching

Synonym *Thelypteris torresiana* (Gaudich.) Alston

Description Rhizome short, scaly, scale brown with hairy on dorsal surface and margin. Stipe 30–45 cm long, lower part with scale. Lamina tripinnate, oblong-ovate 40–50 cm long, 30–40 cm broad. Pinnae oblong up to 20 cm long, 6–10 cm broad, pinnule oblong-subdeltoid 5–6 cm long, 0.5–2 cm broad, ultimate segments oblong, rounded to moderately acute at apex, lobes oblong, veins all free, veins and surfaces hairy. Sori round close to midrib, indusia round-reniform, hairy.

Distribution and habitat Mascarene Islands, throughout tropical Asia, Polynesia, Hawaii, north to Japan and south to Australia. Terrestrial in open to partially shaded areas from lowland to mid-montane, specimens found in QSBG (IUCN: LC).

Author: Kittiphong Kertsawang



habit



sori



fiddlehead of the frond



rhizome and stipe

Cyclosorus ciliatus (Wall. ex Benth.) Panigrahi

Synonyms *Aspidium ciliatum* Wall. ex Benth., *Lastrea calcarata* (Blume) Bedd. var. *ciliata* (Wall. ex Benth.) Bedd., *Thelypteris ciliata* (Wall. ex Benth.) Ching

Description Rhizome short, erect; scale up to 3 by 1.5 mm. Stipe stramineous to greyish hairy throughout about 30 cm long. Lowest pinnate shortened than the few deflexed pinnate of lowest 1/3 largest patent, subsessile linear – lanceolately, acuminate at apex, hairy at margin, green. Sori subcostular, often confluent at maturity, indusia firm, persistent hairy.

Distribution and habitat Nepal to West Malesia, north to Hong Kong. Terrestrial in muddy stream beds in lowland to mid-montane forest of DINP (IUCN: LC).

Author: Heng Sovanna



sori



upper surface of frond



rhizome and stipe



habit

Cyclosorus falcilobus (Hook.) Panigrahi

Synonyms *Lastrea falciloba* Hook., *Lastrea calcarata* (Blume) Bedd. var. *falciloba* (Hook.) C.B. Clarke, *Thelypteris falciloba* (Hook.) Ching

Description Rhizome short, erect; scale up to 4 by 2 mm, pale brown, thin and appressed hairy at margin. Stipe up to 25 cm long, with reduced pinnae nearly to base. Lamina oblong lanceolate acute at apex, up to 30 by 13 cm; cuneate at sessile base up to 30 by 13 cm deeply lobed toward costa and costule at apex. Sori round, medial indusia persistent glandular.

Distribution and habitat India (Assam), upper Myanmar, Southwest and South China, and Viet Nam. Terrestrial near streams in mid-montane forest of DINP (IUCN: LC).



habit



sori



upper surface of frond



rhizome and stipe

Thelypteris crinipes (Hook.) K.Iwats.

Synonyms *Nephrodium crinipes* (Hook.) Ching,
Christella crinipes (Hook.) Holttum

Description Rhizome short erect or ascending; scales linear-lanceolate with long-tailed apex. Stipe up to 60 cm long, with reduced pinnae on upper part, densely scaly. Lamina pinnate, oblong-lanceolate, 100 by 40 cm; pinnae many, linear, 25 by 1.5 cm, apex long-acuminate, lobed at margin to half way to costa. Sori medial or near margin, round; indusia hairy.

Distribution and habitat Himalayas and Southwest China. Terrestrial along small streams in lowland to mid-montane forest, along shaded small streams in QSBG (IUCN: LC).

Author: Kittiphong Kertsawang



sori



fiddlehead of the frond



rhizome and stipe



habit

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GLOSSARY

acroscopic – pointing towards the apex.
acuminate – forming a narrow angle (less than 30°) with sides slightly concave.
acute – forming an angle in the range 30°-90° with both sides straight or slightly convex.
anterior – on the side away from the axis.
aquatic – lives in wet or completely submerged habitats.
castaneous – having the colour of a chestnut.
concolorous – uniform in color.
creeping – extending horizontally in or on the soil.
cuneate – leaf base wedge-shaped, becoming gradually thinner at base towards petiole.
deltate – broadly triangular with obtuse apex.
dimorphic – the sori are located on a differently shaped fertile frond.
epiphyte – living on trees.
entire – smooth edge (leaf or scale).
erect – growing upright.
falcate – asymmetrically curved and narrowing towards apex.
false indusium – a rolled-over leaf margin under which sporangia form and mature.
glabrous – lack of surface ornamentation (hair, scale, etc.).
glaucous – a pale bluish waxy or powdery layer on a surface.
hair – one cell in width or depth constitutes the surface ornamentation that can be found on the rachis, rhizome, stipe, costa or blade.
indusium – epidermal membrane partly or fully protecting (young) sporangia.
lamina – blade of the fern (usually green and responsible for photosynthesis).
lanceolate – with long, tapering apex and short-tapering base, widest above base.
linear – long, narrow, more or less parallel-sided.

lithophyte – growing on rocks or stony soil .
lobe – portion of lamina, pinna, pinnule or segment with a shallow sinus on each side that extends less than half way from the apex of the lobe to the axis that bears the lobe.
monomorphic – the sterile and fertile fronds have the same shape.
oblong – longer than wide with the long sides parallel.
ovate – egg-shaped outline.
pinnae – first division of the front which can be further divided into pinnules.
pinnate – divided into pinnae that are contracted at the base.
pinnate-pinnatifid – divided into pinnae with the pinnae pinnatifid.
pinnatifid – incised nearly to the axis, not contracted at the base.
proliferous – the rachis produces a vegetative bud or gemmae.
rachis – the main axis of a pinnately compound leaf or of a fern frond.
rheophyte – lives in fast moving water currents in an environment where few other organisms can survive.
rhizome – the part of a fern from which the fronds (leaves) and roots grow.
scale – small membranous tissue resembling a loose fish scale that can be found on the rachis, rhizome, stipe, costa or blade.
segment – portion of a lamina, pinna or pinnule that is fully adnate and with a deep sinus on each side that extends more than half way from the segment apex to the axis that bears the segment.
sessile – the blade attaches directly to the stem.
simple – not divided.
sorus (pl. sori) – a cluster of sporangia.
sporangia – structures producing and containing spores.
spore – unicellular structure produced within the sporangium and used for reproduction.
stipe – part between the rhizome and the first leaflet (analogous to the petiole of a leaf).
syngonium – a sorus made up of sporangia variously united or cohered into a compound structure.
terrestrial – grows on or in or from land.

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ABOUT THE AUTHORS

John Rey C. Callado is a Museum Researcher at the Philippine National Herbarium, Botany Division, the National Museum of the Philippines and curates the Pteridophyte (Ferns and Lycophtyes) collections. He obtained his Bachelor's degree in Forestry from West Visayas State University – College of Agriculture and Forestry, Lambunao, Iloilo. He has been studying plant specimens from all over the Philippines and has published new species and new records for the country.

Bayu Adjie is the Head of Laboratory of Plant Conservation at the Bali Botanic Garden, LIPI. His field of expertise is plant taxonomy and molecular biology. Dr Adjie is currently conducting research on ferns from eastern Indonesia.

Piyakaset Suksathan finished his Bachelor's and Master's degree in Horticulture from Kasetsart University, Bangkok and PhD in Systematic Botany from Aarhus University, Denmark. He has been working as a botanist and horticulturist at Queen Sirikit Botanic Garden since 1998. His field of expertise includes pteridophytes, Marantaceae, Zingiberaceae, and Balsaminaceae.

Wenni Setyo Lestari finished her BSc degree in Biology from the University of Brawijaya, Malang, Indonesia, and her Master's degree from Udayana University, Bali. She joined the Bali Botanic Garden, LIPI in 2001 and has published a series of studies on ferns of the Lesser Sunda Islands.

Dedy Darnaedi is a research professor in plant taxonomy, with special interest in tropical pteridophytes, at the Herbarium Bogoriense (BO), Indonesian Institute of Sciences (LIPI). He currently holds the position of Executive Director of Plant Resources of South East Asia. Dr Darnaedi is also a Member of the Expert Panel for Interdisciplinary Platform for Biodiversity and Ecosystem Services.

CONTRIBUTING AUTHORS

Dian Indah Pratiwi
Kerinci Seblat National Park, Indonesia

Farhad Yozarius
Lorentz National Park, Indonesia

Hj. Shahrin Hj. Md. Jaafar
Department of Environment, Brunei Darussalam

Heng Sovanna
Department of International Conventions
and Biodiversity, Cambodia

Kittiphong Kertsawang
Queen Sirikit Botanic Garden, Thailand

Ling Shing Mang
Forest Department, Myanmar

Myint Myint San
Forest Department, Myanmar

Ng Zi Qiang Arthur
National Parks Board, Singapore

Nor Ezzawanis Abdullah Thani
Forest Research Institute Malaysia

Pichai Yadee
Queen Sirikit Botanic Garden, Thailand

Zaharin Hj. Abdul Kahan
Department of Environment, Parks and Recreation,
Brunei Darussalam

Pham Van Hoan
Biodiversity Conservation Agency, Viet Nam

EDITORS

Edwino S. Fernando

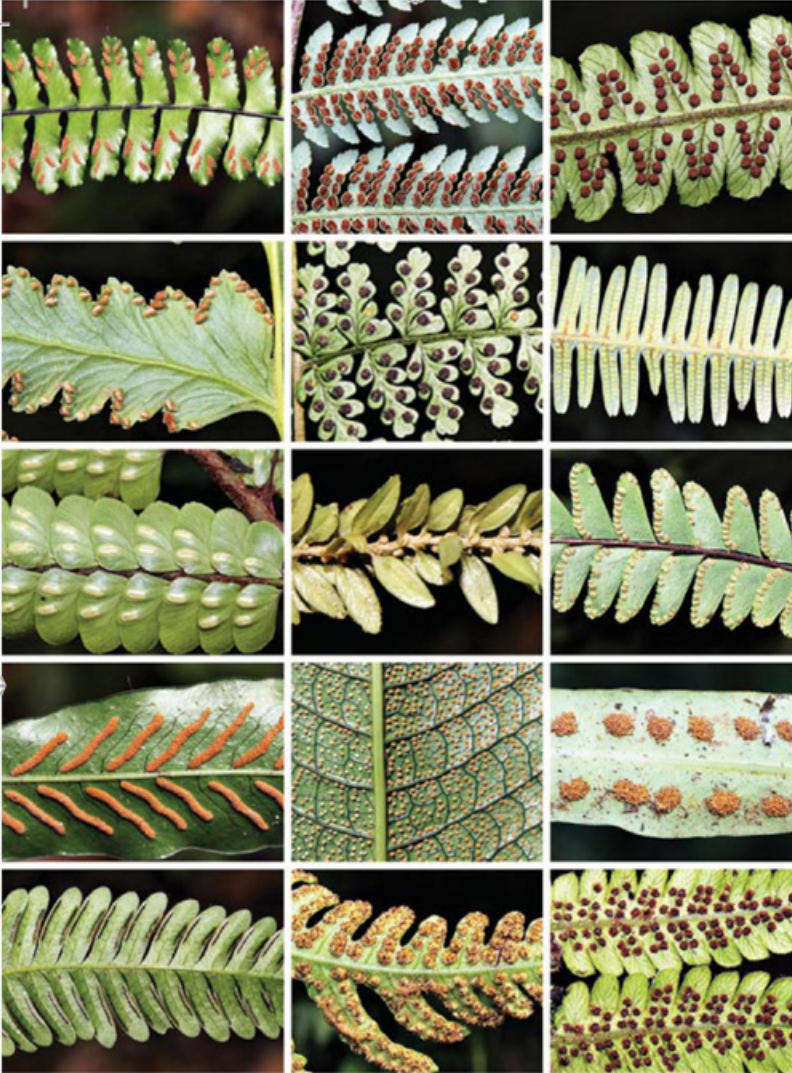
University of the Philippines Los Baños, Philippines
Scientific Advisory Committee, ASEAN Centre for
Biodiversity

Hidetsugu Miwa

Biodiversity Center of Japan
Ministry of Environment - Government of Japan

Filiberto A. Pollisco Jr.

ASEAN Centre for Biodiversity



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