THE FERN DIVERSITY OF SOUTH EAST SULAWESI

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THE GRADUATE SCHOOL
BOGOR AGRICULTURAL UNIVERSITY

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LETTER OF STATEMENT

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THE FERN DIVERSITY OF SOUTH EAST SULAWESI

true represent result of my research and have never been publicized. All information and data used have been expressed clearly and can be checked its truth.

Bogor, July 2011

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NRP. G353080051
Abstract

Floristic study has played an important role in expressing the diversity of plant species in a region. However such fern explorations are very rare, thus the data and information about ferns in Sulawesi Island particularly in South East Sulawesi is very limited. The objectives of this study is to know the diversity of fern species in South East Sulawesi region. The methods used in this study were exploration and description based on morphological characters. The study had been carried out in three locations, namely Mekongga Mountains, Uluiwoi and Wawonii Island. Materials used for this study comprised of herbarium specimens in the Herbarium Bogoriense and new specimens collected from exploration during this research in South East Sulawesi. This study documented 189 species belonging to 70 genera and 29 families. There are 173 species new collections of Pteridophyte from South East Sulawesi, 28 species of it are new from Sulawesi for Herbarium Bogoriense. Two species presumed as new species and 4 species are new records from Sulawesi. Fern in South East Sulawesi varied in their habit, rhizome, hair/scale, fronds and soral characters. Based on the habitat, there are nine types of ferns. Among three locations the greatest species diversity found in Mekongga Mountains (126 species), followed by Wawonii Island (87 species) and Uluiwoi (76 species). The degree of similarity of fern species at three different locations is low. Fern species are also used by local people for foods, medicine, ornamental plants, handycraft and construction. The identification key to the families, genera and species are provided.

Keywords: pteridophyte, South East Sulawesi, identification key, new species, new record.
ARIEF HIDAYAT. Keragaman Tumbuhan Paku di Sulawesi Tenggara. Dibimbing oleh TATIK CHIKMAWATI dan DEDY DARNAEDI.


Kata kunci: Tumbuhan paku, Sulawesi Tenggara, kunci identifikasi, jenis baru, rekaman baru.
SUMMARY

Floristic study has played an important role in expressing the diversity of plant species in a region. In worldwide, the number of ferns species has been estimated to about 12,000 species. 65% of it are believed to be confined to the wet tropics (Chin 2005). In Southeast Asia including Indonesia, there are 4,400 known species (Winter & Amoroso 2003), of estimated more than 1,300 species occur in Indonesia (Sastrapradja et al. 1979). It means about 10% of the world known fern found in Indonesia.

There are some publications of flowering plant in Sulawesi reported by bitmore and Tantra (1989), Yuzammi and Hidayat (2002) and Keßler et al. (2002). However, fern diversity in Sulawesi particularly in South East Sulawesi very limited. Several taxonomist have explored for ferns in Sulawesi such as (Swakani (1912), Ohba (1974), Prapotoswiryo and Wardani (2008) and Froideville (Lam 1945), but they did not collected from South East Sulawesi. Steenis (1950) reported Kjellberg and Froideville have been visited to South East Sulawesi, but according to the database of Herbarium Bogoriense there are recorded only 16 species originated from South East Sulawesi, most of them were collected by Kjellberg in 1929. It is indicated that the data and information about ferns in South East Sulawesi is very limited. Therefore, this research on diversity ferns in South East Sulawesi is important and will contribute data to the overall collection of ferns in Sulawesi.

The objectives of this study is to know the diversity of fern species in South East Sulawesi region, to compose their description and the identification key of ferns in South East Sulawesi so it can be developed for general users.

This study was conducted at three locations in South East Sulawesi in Wawonii Island (2004, 2005 and 2006), Uluiwoi (June 2008) and Mekongga Mountains (July to August 2009. The Morphological observation and specimens identification were carried out at Herbarium Bogoriense, Research Center for Biology-LIPI, Cibinong.

Morphological character observation was based on Andrews (1990), Vogel (1987) and Rifai (2008). Specimens were observed on their specific morphological characters such as shape, structure and size of frond, type of rhizome, type of scales/hairs and number, structure, position, distribution and shape of sori. The identified specimens were also compared to the specimens stored in Herbarium Bogoriense and to the literatures such as Copeland (1947), Holtum (1966), Steenis & Holtum (1982), Piggot & Piggot (1988), Andrews (1990) and Hovenkamp et al. (1998). Following these steps, the identification key the families, genera and species were developed.

Data on economic uses of fern species were also collected through interview during the exploration. Index similarity analysis of the composition of species and in diferent locations were conducted using Index Similarity Jaccard (Cox 72).

This study documented 189 species belonging to 70 genera and 29 families. There are 173 species as new collections from South East Sulawesi and 28 species new from Sulawesi for Herbarium Bogoriense. Two species presumed as new species, namely *Polystichum macroscalam* sp. nov and *Bolbitis pinnatifidis* sp. nov. Four species are new records from Sulawesi, that are *Ctenopteris subminuta*
formerly known distributed only in Sumatra, Malay peninsula, Borneo and Java (Parris 2010), *Coniopteris fraxinea* previously known in West China, Himalayas, Pakistan, India, Malaysia, Taiwan, Philippines and Java (Huang 1994), *Tectaria barberi* formerly distributed in Malay Peninsula and Borneo as well as *Lygodium borneense* that previously distributed in Sumatra, Malay Peninsula and Borneo (Holttum 1966).

Polypodiaceae is the biggest family with 25 species and 19 species of it occur in Mekongga Mountain. The highest number of species is *Lindseya* (13 species) and *Asplenium* (11 species).

Based on collected and observed specimens fern in South East Sulawesi are varied in their habit, rhizome and fronds. The fern also varied in the number, structure, position, distribution and shape of sori. There are 13 soral variations such as sori in cones at the tips of branches called strobili, three sporangium fused the axil of leaves called Synangia, sori borne on sporocarp at the base of stipe, sori borne on the erect spike form, sporangium folded together (sorophores) at the apices of the branches, sori in longitudinal grooves on the marginal of fronds varying with reflexed margins, sori completely covering lower surface or part of lamina (acropliochoid), sori covering most of the lower surface of lamina or particular pinnae, sori with a cup or tubular form indusia on the apex of lobe margin, sori round or elongate spreading along the veins close to the costa (pericostal), sori along the veins between costa and margins, sori round or elongate spreading on the veins or areole with or without indusia and sori round elongate, terminal on the free veins near margins.

Based on the habitat of collected and observed specimens, there are nine types of ferns which are terrestrial sun-ferns (27 species), terrestrial shade-ferns (2 species), climbing ferns of sheltered places (8 species), Climbing ferns of exposed places (8 species), epiphytes of sheltered places (47 species), epiphytes of exposed places (8 species), river bank ferns (16 species), aquatic ferns (3 species) and rock-ferns (3 species).

Fern diversity is greatest in Mekongga Mountains of about 126 species, followed by Wawonii Island with 87 species and Uluwai with 76 species, there are 31 common species found at all three different sites, 62 species only occur in Mekongga Mountain, 38 species only occur in Wawonii Island as well as 20 species found only in Uluwai.

The degree of similarity of ferns species at three different locations is low. The similarity between Uluwai and Mekongga Mountains (mainland) is higher (34) than between Wawonii Island (small island) and Uluwai or Mekongga Mountain (0.28 & 0.26). It shows that fern species in mainland is different to the small island.

Fern species used by local people for foods, medicine, ornamental plants, handicraft and construction. The identification key of 189 species, 70 genera and families were developed.
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THE FERN DIVERSITY OF SOUTH EAST SULAWESI

ARIEF HIDAYAT

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Bogor, July 2011

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He received scholarship in 2008 from New England Tropical Conservatory (ETC) through the IBETP programme to continue his study at the Bogor Agricultural University (IPB) for his master degree majoring on plant taxonomy.
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1 INTRODUCTION

1.1 Background

Sulawesi, formerly known as Celebes, is one of the large islands of Indonesia. Sulawesi is situated in the Wallace region between Borneo and the Moluccas Islands. The presence of Wallace line distinguished Indonesia’s biodiversity to mainland Asia and Australia. Sulawesi Island is considered as the transition area that is influenced from both of mainland Asia and Australian continent, so that the composition of flora of Sulawesi is unique and specific (Darlington 1966).

Floristic study has played an important role in expressing the diversity of plant species in a region. In worldwide, the number of ferns species has been estimated to about 12,000 species. 65% of it are believed to be confined to the wet tropics (Chin 2005). In Southeast Asia including Indonesia, there are 4,400 known species (Winter & Amoroso 2003), of estimated more than 1,300 species occur in Indonesia (Sastrapradja et al. 1979). It means about 10% of the world known ferns are found in Indonesia.

There are some publications of flowering plant in Sulawesi reported by Whitmore and Tantra (1989), Yuzammi and Hidayat (2002) and Keßler et al. (2002). However, fern diversity in Sulawesi particularly in South East Sulawesi is very limited. Several taxonomist have done exploration of ferns in Sulawesi such as Kawakani (1912), Ohba (1974), Praptosuwiryo and Wardani (2008) and Froideville (Lam 1945), but they did not collected from South East Sulawesi.

According to database of Herbarium Bogoriense, there has 1,147 sheets of fern species have been collected from all over Sulawesi. Ferns specimens originated from South East Sulawesi are only 24 sheets belonging to 16 species stored in Herbarium Bogoriense. Steenis (1950) reported Kjellberg and Froideville have been visited to South East Sulawesi but according to the database Herbarium Bogoriense most of the species were collected by Kjellberg in 1929.

It is indicated that the data and information about ferns in South East Sulawesi is very limited. Therefore, this research on diversity of ferns in South
East Sulawesi is important and will contribute data to the overall collection of ferns in Sulawesi.

1.2 Objectives

The objectives of this research were to study the diversity of fern species in South East Sulawesi region and to compose their description and identification key of Pteridophyte in South East Sulawesi so it can be developed for general users.

1.3 Benefits

The benefits of this study were the identification key of Pteridophyte of South East Sulawesi as well as data and information that can be used as the basic data for potential future study on ferns and to determine their conservation strategy for the regions.
2 LITERATURE REVIEW

2.1 Pteridophyte

Pteridophyte or ferns belong to Cryptogamae. Different to other cryptogams, ferns habit is clearly a cormus, comprised three main parts: roots, stems and leaves. Ferns reproduce by spores, so often referred as “Cormophyta with spore”. Ferns are very diverse, there are many kinds of ferns, small ferns with small leaf with simple structure and large ferns with large leaf that reaches length up to two meters or more. Ferns can reach 30 m height with a large diameter as trees called tree fern. The habitat of ferns varied which are terrestrial (living on the ground), attached to other plants (epiphytes), climbing and floating or live in the water (Holttum 1966).

Fern roots vary in shape and size. There is fine roots (rhizoid) to real roots. Some fern species have slim and soft stem (rhizome), climbing on tree trunk or branch (climbing), some others spreading on the the ground (creeping), erect and have a large trunk (Johns 1997).

Some ferns are easily distinguished from the other plants based on their young curled leaves (crozier) that will open in mature. The leaf type of ferns called frond. There are simple, pinnate, bipinnate to tripinnate fronds. Some ferns have dimorphic frond, fertile fronds for producing spore and steril fronds for yielding food (photosynthesis) (Holttum 1966).

The sporangia on the lower surface of leaves sometimes grow regularly in rows or spread, protected with or without indusium (plural: indusia). The indusium shape is usually formed by the grouping formation of sporangium. Thus rounded sorus may have rounded indusium and elongated sorus may be formed by elongated indusium (Chin 2005).

Location of the sporangium in ferns varies. The sporangium on lower fronds called as foliar sporangium, while the sporangium located between the bones of leaves and stems is called axillary sporangium. Sporangia in Marsilea, Salvinia and Azolla form a structure called sporocarp. Sporangia in Lycopodium and Selaginella located at the end of their branches form strobilus. Sporangium in Psilotum borne in the axil of bracts form 3-lobed is called synangia.
2.2 Fern Distribution and Habitat

Winter and Amorosa (2003) estimated 65% of the Pteridophyte species are found in wet tropics in areas without a marked dry period. Some 30% of the fern species have relatively small range areas and some of them even are limited to a single mountain. Less than 10% of the species have very wide to cosmopolitan ranges. *Gleicheniaceae* is broadly distributed and easily found in open areas, in contrast some ferns are narrowly distributed for example *Cyatheaceae* that occur in mountain areas only (Sastrapradja *et al.* 1979).

Ferns are found in almost every country in the world and in a wide variety of habitats, from lowland to mountains, from coastal mangrove swamps to ponds and rivers. Most ferns prefer to live in the area with shade and high humidity to open and dry place.

Based on their adaption to the conditions under which they grow, Holttum (1966) divided into seven groups of ferns, terrestrial sun-ferns, terrestrial shade-ferns, climbing ferns, epiphytes of sheltered places, epiphytes of exposed places, rock-ferns or river bank ferns and aquatic ferns.

2.3 General Condition of South East Sulawesi

Southeast Sulawesi is situated in the south of equator line, that extends from north to south, in north bordering by South Sulawesi Province and Central Sulawesi Province, in south by Flores Sea, in east by Banda Sea and in west by Gulf of Bone.

Bappeda Sulawesi Tenggara (2008) reported the total area of Southeast Sulawesi is 38,140 km² area that consists of mainland and 60 small islands. Wawonii Island is one of the small islands that has ± 650 km² wide located in the eastern of Southeast Sulawesi with elevation about 0-880 m above sea level. Southeast Sulawesi region generally comprise of mountainous surface that is hilly and is mostly located at altitude of 100-500 meters above sea level.
Based on geological data, South East Sulawesi consists of sedimentary and metamorphic rock. The largest rock is sedimentary (about 75%). Meanwhile, the soil in Southeast Sulawesi consists of podzolic (62.79%), mediteranian soil (22%), latosol (8.66%), organosol (2.93%), alluvial (3.09%), and grumosol (0.5%)

South East Sulawesi has two seasons; i.e. the rainy season occur between November and March, dry season occurs in May to October. Rainfall is uneven distributed. The wet areas have rainfall of more than 2,000 mm per year, while in dry areas, the rainfall is less than 2,000 mm per year (Bappeda Sulawesi Tenggara 2008).

Two large clusters of mountains in mainland of South East Sulawesi are Tangkeleboke Mountain and Mekongga Mountain. The later mountain is the highest mountain in South East Sulawesi (2,620 m asl). This mountain is formed from the up havel of atol of about hundreds of million years ago. This phenomenon causes natural barrier for flora and fauna, and in the longer process they become endemic biota.
3 METHODS

3.1 Location of Study site

This study was conducted at three locations in South East Sulawesi in Wawonii Island (2004, 2005 and 2006), Uluiwoi (June 2008) and Mekongga Mountains (July to August 2009) (Figure 1). The Morphological observation and specimens identification were carried out at Herbarium Bogoriense, Research Center for Biology-LIPI, Cibinong.

Figure 1 Locations of fern inventory: a. Mekongga Mountains, b. Uluiwoi and c. Wawonii Island.

3.2 Materials and Equipment

Material and equipment were used for collecting specimens comprised of plastic bag, alcohol 70%, clipper or scissor, newspaper, string, cellophane tape, rice bag, notebook, soft black pencils, marker, tags/labels, GPS (Global Positioning System), handlens, camera and ruler.

Plant materials used for this study were herbarium specimens deposited in the herbarium Bogoriense and the specimens collected from field explorations.
3.3 Methods

3.3.1 Exploration and Processing Herbarium Specimens

The exploration was conducted for collecting fern samples at several locations in South East Sulawesi such as Wawonii Island that represented small island (0-880 m asl) and Uluiwoi (0-1,000 m asl) and Mekongga Mountains (20-2,620 m asl) that represented mainland of South East Sulawesi. Every encountered fern was collected, labeled and located using GPS. Data on habitat characteristics were recorded. Each collection number consisted of three or four duplicates to send to other Herbaria as gift. Specimen collection and herbarium procedure followed of Rugayah et al. (2004). Data on economic uses of fern species were collected through interviewing local people during the explorations.

3.3.2 Morphological Analysis

Morphological character observation was based on Rifai (2008), Vogel (1987) and Andrews (1990). Specimens were observed on their specific morphological characters such as shape, structure and size of frond, type of rhizome, type of scale/hair and number, structure, position, distribution and shape of sori.

The identified specimens were also compared to the specimens stored at Herbarium Bogoriense and to the literatures such as Copeland (1947), Holttum (1966), Steenis & Holttum (1982), Piggot & Piggot (1988), Andrews (1990), and Hovenkamp et al. (1998). Following these steps, the identification key to the families, genera and species were developed.

3.3.3 Index Similarity Analysis

Index similarity analysis were conducted to compare the composition of species found in three different locations. The analysis used Index Similarity Jaccard (Cox 1972), with formula as follow:

\[
S_j = \frac{C}{A+B+C}
\]

Note:
- A = number of species that found only on location A
- B = number of species that found only on location B
- C = number of species present in two locations (A and B)
4 RESULT AND DISCUSSION

4.1 Morphological Variation

The ferns body is clearly a cormus comprised of three main parts: roots, stems and leaves. The general parts of fern morphology are rhizome, fronds and sori (Figure 2). The stem on ferns is called rhizome, it may be creeping, climbing, short and compact called root-stock or caudex, erect and long with tuft of leaves called trunk. The rhizomes in some species are protected by hairs or scales.

Some fern genera have small leaves called microphyll, but most of fern have big leaves called megaphyll or frond. Frond stalk or petioles are called stipes, the blade of frond called lamina. The lamina is usually divided into some parts called leaflets when the axes of leaflets are borne called rachis. Fronds may be simple or they may consist of two to many leaflets which are borne by the rachis or its branches called pinnate, bipinnate, tripinnate to quadripinnate and their leaflets called pinnae, pinnules. When pinnately lobed is called pinnatifid or palmately lobed is called palmatifid.

![General morphology of ferns.](image-url)
4.1.1 Variation of Habit

Based on collected specimens there are variation of habit ferns, divided into three groups: tree ferns, herbaceous ferns and filmy ferns (Figure 3).

Tree ferns is characterized by rhizome erect, massive and long called trunk. Variations of the trunk of *Cyathea* found from short trunk in *Cyathea moluccana* with 30-40 cm tall to 150-300 cm tall as in *Cyathea angiensis*, *C. contaminans* and *C. gigantea*. Diameter of the trunk is 20-40 cm. Fronds are large that arranged in terminal crown with pinnate to tripinnatifid.

Herbaceous ferns include terrestrial and epiphyte ferns. Terrestrial ferns have erect or creeping stems. Erect stems are generally unbranched and may be stout and fleshy with terminal rosette fronds such as in Thelypteridaceae or stout and fleshy plants in *Marattia* and *Angiopteris*. Creeping stems have regular distance between their leaves with branched or unbranched stems. They grow on the ground surface or subterranean. Such plants can be thicket-forming (*Gleicheniaceae*) or some plants produce microphyll with particularly long stems (*Lycopodium*), stipes and rachises ascending into the crowns of small trees (*Lygodium*).
Climbing ferns have slender rhizome with roots in the ground, such as *Lomariopsis, Teratophyllum, Stenochlaena* and *Lomagramma*.

Epiphytes have compact or short to long-creeping rhizomes that attached to or rooted on the trunks or branches of trees. The stems may start on the tree or on the ground, but in any cases are attached to the tree and are not depended on the soil for the moisture and nutrients, such as *Antrophyum, Aglaomorpha, Drynaria, Vittaria* and *Pyrrosia*.

Filmy ferns have stout, long-creeping rhizome covered with bristle-like hairs. The lamina is dissected into deeply lobed with entire to toothed margins. Stipes are winged or unwinged. Sori borne on short laminal segments with a cup or tubular indusium. Two genera observed such as *Hymenophyllum* and *Trichomanes*.

4.1.2 Variation of Rhizome

The stem of a fern is known as rhizome. Based on observed specimens there are many variation of rhizome found (Figure 4). The rhizome develops horizontally beneath the surface of the soil, such as creeping or climbing rhizome.

![Figure 4](image)

On the creeping rhizome, fronds are borne on upper surface of the rhizome and the roots are entirely or mainly on the lower surface, such as *Gleichenia*, *Pteridium*, *Dicranopteris*, *Nephrolepis*, *Oleandra* and *Lindsaea*. The climbing rhizomes were found on some genera such as *Lygodium*, *Teratophyllum*, *Lomariopsis*, *Stenochlaena* and *Lomagramma*.

Some ferns have short and compact caudex or stock rhizome, bearing crowded leaves and usually radial in construction, likes on *Blechnum*, *Diplazium*, *Marattia*, *Angiopteris* and Thelypteridaceae. Erect rhizome with tuft of leaves at its apex is called trunk, likes on *Cyathea*.

4.1.3 Variation of Hair/Scale

The rhizome, bases of the stipes and young parts of the lamina is often covered by scales or hairs. Hairs or scales protected the rhizome by forming vulnerable parts from physical damage, herbivory, or dessication. The rhizome is normal without increasing in diameter, but in some cases the structure is reinforced by hairs, fibres, or mats of adventitious roots (Winter and Amoroso 2003). The shape, colour, types of apex and base and marginal of scales or hairs are important characters (Orchard AE et al. 1998; Holttum 1966). The hairs consist of single cell or of a single row of cells with different length and thicken, such as in *Dipteris conjugata* and *Histiopteris incisa* (Figure 5).

![Figure 5 Variation of hairs: a. unicellular, b. Single row cell.](image)

Scales are flat plates of cells consisted of one or more cells, thick. The majority of collected ferns have scales such as in *Asplenaceae*, *Dryopteridaceae*, *Lindsaeaceae*, *Lomariopsidaceae*, *Oleandraceae* and *Tectariaceae*. Based on attachment pattern of the scales there are Basifix, pseudopeltate and peltate. Basifix is when the scale attached along the basal margin, pseudopeltate when the
scales attached at the margins but with overlapping auricles such as in Aglaomorpha, Leptochilus and peltate when the scales attached on rhizome at the surface such as in Pyrosoia, Selliguea and Stenolaena.

The structure of the scales are divided into clathrate or not clathrate. The clathrate scales is the cells of the scale that form a clear lattice, translucent with thin walls that easily see through such as in Aspleniaceae, Lomagramma and Antrophyum. The margins of the observed scales are entire, toothed or ciliate. Most of the colour of scales are brown to dark colour (Figure 6).

![Figure 6](image)

Figure 6 Variation of scales: a. Basifix, b. Pseudopeltate, c. Peltate, d. Not clathrate, e. Clathrate.

4.1.4 Variation of Leaves

Based on collected specimens some fern genera have small leaves (microphyll) such as in Lycopodium and Selaginella (Figure 7). Most of fern have big leaves called megaphyll or frond. Frond of ferns vary in shape and size. There are monomorphic, dimorphic and polymorphic fronds (Figure 8).

![Figure 7](image)

Figure 7 Small leaves (microphyll): a. Lycopodium, b. Selaginella

Monomorphic fronds are similar in shape and size between fertile and sterile fronds. Most of the collected species are monomorphic. The frond shape are linear, elliptic to lanceolate, and also with variously lobed in its margin. There are simple, pinnate and bi-tripinnate fronds. The simple fronds come in many different shapes, while the other lamina of frond is divided once or more into many lobes.
When the lobes are distinct and many lobes make up a single frond so called compound leaves. When the frond is divided once and the division are arranged along of the stipes, the frond is commonly termed pinnate, and the division are known as pinnae. When the frond is divided into subdivision called pinnules, the frond called bipinnate. Such division can go on three or four times. Other fronds may be divided into many lobes which are arranged like fan-shaped, these fronds are palmate like in *Dipteris conjugata* (Figure 9).
Dimorphic fronds have different in shape and size of fertile and sterile fronds. In such cases the size of the lamina of the fertile frond is often narrowed. In contrast, fertile fronds has longer stipes than that of sterile ones. Ferns have dimorphic frond such as *Bolbitis, Ceratopteris, Drynaria* and *Leptochilus*.

Polymorphic fronds is when a plant has different shape of sterile frond of the juvenile to mature plant. The fronds which are near the ground have distinctive shape called *bathyphylls* and the climbing parts called *acrophylls*. On the other hand the fertile frond is narrowed than the sterile frond. This characteristic was found in *Lomariopsis, Teratophyllum* and *Lomagramma*.

### 4.1.5 Variation of Soral Characteristics

The position and arrangement of sporangia on the frond are very important for the identification of the fern genera. Based on collected and observed specimens, there are 13 soral variations (Figure 10):

1. Sori borne on the axil of leaves, arranged in cones at the tips of branches called strobili, such as in *Selaginella* and *Lycopodium*.
2. Three sporangium fused located in the axil of leaves called synangia in *Psilotum*.
3. Sori borne on sporocarp at the base of stipe found in *Marsilea*.
4. Sori borne on the erect spike occur in *Helmintostachys*.
5. Sporangium folded together at the apices of the branches observed in *Schizaea*.
6. Sori in longitudinal grooves on the marginal of fronds covered with reflexed margins in *Vittaria, Histiopteris, Pteris* and *Pteridium*.
7. Sori completely covering lower surface or part of lamina called acrostichoid such as in *Acrostichum, Bolbitis, Elaphoglossum, Lomagramma, Lomariopsis, Teratophyllum* and *Plagiogyria*.
8. Sori covering most of the lower surface of lamina or particular pinnae in genus *Belvisia, Ceratopteris, Pityrogramma* and *Stenochlaena*.
9. Sori with a cup or tubular indusia on the apex of lobe margin such as in *Hymenophyllum* and *Trichomanes*. 
Figure 10  Variation of sori:  a. Strobili,  b. Synangia,  c. Sporocarp,  d. Spike,  e. Sorophores,  f. Covered with reflexed margins,  g. Acrostichoid,  h. Sori on particular pinnae,  i. Cup or tubular form,  j. Pericostal,  k. Along the veins between costa and margins,  l. Spreading on the veins,  m. Terminal on the free veins near margins.
10. Sori round or elongate spreading along the veins close to the costa (pericostal) in Blechnum and Oleandra.

11. Sori along the veins between costa and margin such as in genus Antrophyum, Asplenium, Coniogramme, Diplazium, Loxogramma, Pyrosia, Scleroglossum, Syngramma and Taenitis.

12. Sori round or elongate spreading on the veins or areole with or without indusia such as in genus Aglaomorpha, Amphineuron, Arcypteris, Christella, Christensenia, Ctenopteris, Cyathea, Dicranopteris, Dipteris, Drynaria, Dryopteris, Gleichenia, Goniothallus, Grammitis, Heterogonium, Lepisorus, Leptochilus, Macrothelypteris, Mesophlebion, Microsorum, Pneumatopteris, Polystichum, Pronerium, Selliguea, Sphaerostephanos and Tectaria.

13. Sori round or elongate, terminal on the free veins near margins such as Angiopteris, Davallia, Didymochlaena, Lindsaea, Lygodium, Marattia, Microlepi, Nephrolepis, Sphenomeris and Tapaenidium.

4.2 Diversity and Distribution

This study documented 189 species belonging to 70 genera and 29 families (Table 1). There are 173 species as new collections from South East Sulawesi and 28 species of it as new collections from Sulawesi for Herbarium Bogoriense. Two species probably as new species, namely Bolbitis pinnatifidis sp. nov and Polystichum macroscalium sp. nov. (Appendix 1 & 2).

The characters of Bolbitis pinnatifidis sp. nov. was very similar to B. quoyana on some characters such as fronds dimorphic, pinnate, pinnae alternate, fertile fronds without terminal segment, veins forming a regular network, sori acrostichoid, but it differs by the light brown scales, clathrate, rachis winged, sterile frond serrate margins with conspicuous spine in the sinuses.

While the characters of Polystichum macroscalium sp. nov. closed to P. prolificans on some characters such as frond bipinnate, pinnae shortly stalked, sori covered with peltate indusium, but it differs by its scales that cover all of the
fronds, with ciliate margins, pinnae orbicular, sorus one to each pinnae. Further investigation is needed to propose these species as new species.

Four species are new records from Sulawesi, *Ctenopteris subminuta* formerly known distributed only in Sumatra, Malay peninsula, Borneo and Java (Parris 2010), *Coniogramme fraxinea* previously known in West China, Himalayas, Pakistan, India, Malaysia, Taiwan, Philippines and Java (Huang 1994), *Tectaria barberi* formerly distributed in Malay Peninsula and Borneo as well as *Lygodium borneense* previously distributed in Sumatra, Malay Peninsula and Borneo (Holttum 1966).

**Polypodiaceae** is the biggest family with 25 species, 19 species of it occur in Mekongga Mountain. The highest number of species are *Lindsaea* (13 species) and *Asplenium* (11 species).

### 4.3 Habitats and Ecology

The important environment factors for living a fern are soil, light, humidity and temperature. Ferns vary in their demand for light. Based on their demand for light, there are shade ferns and sun ferns. Shade ferns grow under the canopy of trees, while sun ferns grow and proliferate in the open, under the full of the tropical sun.

Based on the environment of collected and observed specimens, there are nine types of ferns which are terrestrial sun-ferns (27 species), terrestrial shade-ferns (72 species), climbing ferns of sheltered places (8 species), Climbing ferns of exposed places (5 species), epiphytes of sheltered places (47 species), epiphytes of exposed places (8 species), river bank ferns (16 species), aquatic ferns (3 species) and rock-ferns (3 species) (Table 1).

Terrestrial ferns which are rooted in the ground but do not climb trees, may be divided into sun and shade ferns. There are 99 species of terrestrial ferns recorded.

Epiphytic ferns live on trees. They are not parasite but only live on the surface of the bark of a tree and take water and food from the living tissue inside. There are 48 species recorded as epiphytes of sheltered places such as *Asplenium,*
Davallia, Elaphoglossum and Loxogramma, and seven epiphytic species of exposed places such as Aglaomorpha, Drynaria and Pyrrosia.

Sixteen species were found on the river bank ferns as rheophytic, they are growing beside and periodically flooded by streams with compact or creeping rhizome such as Bolbitis, Hymenophyllum, Tectaria and Trichomanes.

Aquatic ferns grow on the surface of water or strike roots in the soil below the water. There are three species of aquatic ferns observed on the study site. Marsilia crenata is truly aquatic that can be free-floating on the surface of the water and rooted emergent. Ceratopteris was found in mud-places on freshwater and Acrostichum grow on the mangrove forest.

The rock-ferns grow on the thin layers of decaying organic matter accumulated on the surface of the rock where the nutrients are provided. There are three species of rock-ferns, Antrophyum latifolium, Asplenium tenerum and Bolbitis appendiculata. Most of collected ferns grow on sheltered places under the forest canopy where have high humidity, low light level, and a little or no air movement. The Sheltered places are usually with good drainage although it is on the forest floor.

Fern diversity is greatest in Mekongga Mountains of about 126 species, followed by Wawonii Island with 87 species and Uluiwoi with 76 species, there are 31 common species found at all three different sites, 62 species only occur in Mekongga Mountain, 38 species only occur in Wawonii Island as well as 20 species found only in Uluiwoi.

The epiphytes ferns such as Ctenopteris, Grammitis and Sclerroglossum were found in Mekongga Mountain. The occurrence of these species can be used as indicator that the location is in mountain area with mossy forest. In Malay Peninsula Parris (2010) described these species found in montane forest and usually growing with bryophytes.

A list of climber species such as Lomogramma and Lomariopsis were only found in Uluiwoi. In this location it was found many big trees with dense canopy so it become good habitat for growing the climbing ferns.
*Schizaea dichotoma* was found only in Wawonii Island, Winter and Amoroso (2003) also found this species on drier sandy soil in lowland area. It is indicated that some part of Wawonii Island also has sandy soil area.

Table 1  Diversity, habitat and distribution of ferns in Wawonii Island, Uluiwoi and Mekongga Mountain (South East Sulawesi)

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<th>Habitat</th>
<th>Distribution</th>
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<td>Distribution</td>
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In order to know the similarity of the composition species found in three different locations, the Index Similarity Jaccard (ISJ) was employed. The calculation based on a list of species only without involving the quantity of individual species (Table 2).

Table 2  Index similarity of fern species at three different locations

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<th>Location</th>
<th>Wawonii Island</th>
<th>Uluiwoi</th>
<th>Mekongga</th>
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<tr>
<td>Wawonii Island</td>
<td>-</td>
<td>0.28</td>
<td>0.26</td>
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<td>Uluiwoi</td>
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Table 2 showed that the degree of similarity of fern species at three different locations was very low. According to Cox index (1972) this data shows that the composition of species present in three locations were not similar possibly caused by different environment gradient that influence different types of species. The various distribution pattern of fern species were depended on the ecosystem type where they grow. There were some physical conditions that limited the distribution of ferns, such as soil, light and humidity.

The degree of similarity between the mainland Uluiwoi and Mekongga Mountains was higher (0.34) than that between Wawonii Island (small island) and Uluiwoi and Mekongga Mountain (0.26 & 0.28). It shows that the composition of fern species in mainland is different to the small island. Geographical isolation of a small island may lead to the level difference of the diversity of fern species in both areas.
4.4 Economic Uses

The diversity of ferns also extends to their many practical uses. Ferns are used for medicinal, decorative and environmental purposes in many countries. Several parts of the fern are edible, however it is the young, newly developing crozier, which is regarded as a delicacy (Chin 2005).

The young fronds or crozier of many ferns are eaten by local people around the study sites, such as Acrostichum aureum, Stenochlaena palustris and Diplazium esculentum. Roots of Helmintostachys zeylanica used as medicine for hepatitis (Rahayu et al. 2004).

Some ferns are also used for decorative and ornamental purposes because of attractive fronds such as Nephrolepis spp., Asplenium nidus and Cyathea spp. Dicranopteris linearis and Lygodium spp. are used as handycraft to make a small bag or simple bracelet. Trunk of Cyathea have been used as house pots usually for orchid media and for bridge construction.

4.5 Taxonomy

Key to the families of fern in South East Sulawesi

1. a. Leaves microphyll ................................................................. 2
   b. Leaves megaphyll (frond) .................................................. 4

2. a. Sporangia on ridges of the branches (synangia) .......... Psilotaceae (23)
   b. Sporangia on the axil of leaves (strobili) ........................... 3

3. a. Leaves arranged in four ranks, two lateral and two median leaves ................................................................. Selaginellaceae (26)
   b. Leaves arranged spirally ..................................................... Lycopodiaceae (15)

4. a. Terrestrial or filmy fern ..................................................... 5
   b. Epiphytes fern ........................................................................ 27

5. a. Filmy fern ........................................................................... Hymenophyllaceae (12)
   b. Terrestrial fern ........................................................................ 6

6. a. Leaf ferns .......................................................................... Cyatheaceae (5)
   b. Subterranean fern ............................................................... 7

7. a. Sporangia in spike or sporocarp .......................................... 8
   b. Sporangia on the lower surface of fronds .............................. 9
8a. Fronds 4-lobed, sporocarp at the base of stipes .................. *Marsileaceae* (17)
   b. Fronds tripartite, sporangium spike at the apical of branch ........................................
   .................................................................................. *Ophioglossaceae* (20)
9a. Sori covered with indusia .............................................. 10
   b. Sori exindusiate ................................................................. 19
10a. Sori linear ........................................................................ 11
   b. Sori round or elongate ....................................................... 13
11a. Sori near the costa (pericostal) ..................................... *Blechnaceae* (4)
   b. Sori between costa and margin ........................................ 12
12a. Sori two side along the veins ....................................... *Athyriaceae* (3)
   b. Sori one side along the veins ........................................... *Aspleniaceae* (2)
13a. Fronds with lobed of pinnae .......................................... 14
   b. Fronds entire, serrate or crenate ...................................... 16
14a. Rhizome covered with hairs ........................................ *Dennstaedtiaceae* (7)
   b. Rhizome covered with scales ........................................... 15
15a. Sori at the base of lobes near costa .............................. *Thelypteridaceae* (28)
   b. Sori terminal on the free veins .................................. *Dryopteridaceae* (9)
16a. Rhizome erect ............................................................ *Nephrolepidaceae* (18)
   b. Rhizome creeping ................................................................. 17
17a. Sori on each side near the costa ................................. *Oleandraceae* (19)
   b. Sori submarginal, marginal or terminal on the lamina .......... 18
18a. Stipes slender and twining ........................................... *Schizaeaceae* (25)
   b. Stipes not slender ......................................................... *Lindsaeaceae* (13)
19a. Sori acrostichoid ................................................................. 20
   b. Sori not acrostichoid ............................................................. 22
20a. Sori at apical of fronds ............................................... *Pteridaceae* (24)
   b. Sori on all over the fertile frond .................................... 21
21a. Rhizome erect ............................................................ *Plagiogyriaceae* (21)
   b. Rhizome creeping or climbing ..................................... *Lomariopsidaceae* (14)
22a. Sori linear ........................................................................ 23
   b. Sori round or elongate ....................................................... 24
23a. Sori along the veins or spreading on the lower surface .... *Adiantaceae* (1)
29. Sori marginal, protected with reflexed margins ......................... *Pteridaceae* (24)
24a. Sori elongate ............................................................................... *Marattiaceae* (16)
2b. Sori round .................................................................................. 25
25a. Fronds dichotomously branched .................................................. *Gleicheniaceae* (10)
25b. Fronds pinnate to bipinnatifid or palmate ........................................ 26
26a. Fronds pinnate to bipinnatifid ....................................................... *Tectariaceae* (27)
2b. Fronds palmate, fan-shaped ........................................................... *Dipteridaceae* (8)
27a. Sori covered with indusium............................................................ *Davalliaceae* (6)
2b. Sori covered with reflexed margins or exindusiate ............................. 28
28a. Sori linear ........................................................................................ *Vittariaceae* (29)
2b. Sori round to elongate ..................................................................... 29
29a. Sori terminal to the ends of veins or submarginal ............ *Grammitidaceae* (11)
2b. Sori spreading on lower surface of fronds ......................... *Polypodiaceae* (22)

1. ADIANTACEAE

*Adiantaceae* Presl, Tent. (1836) 133.

Terrestrial. Rhizome short, erect or short creeping. Fronds simple, pinnate to bipinnatifid, margins entire to deeply lobed. Sori along the veins, or spreading throughout the lower surface, exindusiate.

Key to the genera

1a. Terrestrial on the mud-places (aquatic fern)............................... *Ceratopteris*
1b. Terrestrial on the ground ............................................................... 2
2a. Rhizome erect ............................................................................. 3
2b. Rhizome creeping ....................................................................... 4
3a. Fronds pinnate ........................................................................... *Coniogramme*
3b. Fronds bipinnate ....................................................................... *Pityrogramma*
4a. Fronds simple ........................................................................... *Syngramma*
4b. Fronds pinnate .......................................................................... *Taenitis*

*Ceratopteris* Brongniart

Terrestrial, aquatic fern. Frond dimorphic, sterile lamina narrowly oblong and shorter than fertile ones, bipinnatifid, frond 15-20 cm long, pinnae alternate, the
lobes of pinnae lobed again, the ultimate lobes 3 cm long and 2-3 mm wide, the
venation reticulate. Fertile fronds more deeply dissected, with narrow lobes.
Sporangia borne in a single line along marginal vein with reflexed frond margins,
stipe 10 cm long ............................................................................ C. thalictroides.

**Coniogramme** Fee

Terrestrial. Rhizome erect covered with brown entire scales. Stipes 40 cm
long, green. Fronds simply pinnate with terminal leaflet like the lateral pinnae.
Pinnae narrowlly elliptical, entire, cuneate at base apex acuminate. Sori continuous
from the base of veins to the apices, without indusium ...... C. fraxinea.

**Pityrogramma** Link

Terrestrial. Rhizome short, erect with brown and narrow scales. Stipes 40-50
cm long. Scaly toward the base, covered with white powder. Fronds bipinnate, 50
cm long and 25 cm wide, lower pinnae from half of frond equal in size, gradually
shortened toward the apex in the upper half. Pinnae wide at the base, bipinnatifid
at base, deeply lobed to the acuminate apex. Pinnules narrowly deltoid, deeply
lobed, apex acute, the lobes elliptic, toothed, lower surface covered with a white
waxy powder. Fertile fronds with pinnules concave beneath, margins not reflexed.
Sori along the veins throughout the lower surface, when mature sori like
acrostichoid .................................................................................... P. calomelanos.

**Syngramma** J. Smith

Terrestrial. Rhizome short creeping, bearing fronds close together. Stipes
black, 8-20 cm long. Fronds simple, entire, 20 cm long and 8 cm wide, widest
part from the base, narrowed gradually upwards, apex acuminate, base cuneate.
Sori along the veins, from the costa to margin, without indusia ....... S. alismifolia.

**Taenitis** Willdenow

Terrestrial. Rhizome creeping. Stipes 15-28 cm long. Fronds pinnate with
simple typical pinnae, pinnae alternate, decreasing in size towards to the apex of
frond. Sterile one much wider than the fertile, upper pinnae sessile, pinnae 15-17
cm long and 3-5 cm wide, at base cuneate, apex acuminate. Sori half-way between costa and margins ................................................................. T. blechnoides.

2. ASPLENIACEAE

Aspleniaceae S.F. Gray, Ar. Brit. Pl. II (1821)11; Presl, Tent. (1836)91.

Terrestrial or epiphyte ferns. Rhizome short, erect to creeping, scales clathrate dark brown to black. Fronds simple, pinnate to bipinnate, stipes not atriculate to rhizome, veins free or forking. Sori linear, one side of veins, indusium narrow.

Key to the genera
a. Sori linear on one side along the veins ........................................ Asplenium
b. Sori elongate at free veins near margins ........................................ Sphenomeris

Asplenium Linnaeus

Rhizome erect or short creeping, terrestrial or epiphyte, Scales clathrate dark brown. Fronds simple, pinnate to tripinnate with free veins; margins entire, toothed to deeply lobed. Sori linear, one side along the veins protected by narrow indusium opening toward to the costa of the leaflet.

Key to the species
1a. Fronds simple ................................................................. A. nidus
   b. Fronds Pinnate to tripinnate .................................................. 2
2a. Frond pinnate ................................................................. 3
   b. Fronds bipinnate to tripinnate .............................................. 10
3a. Costa of pinnae grooved above ........................................... 4
   b. Costa of pinnae not grooved above ..................................... 7
4a. Lower pinnae smaller than middle pinnae ......................... A. pellucidum
   b. Lower pinnae larger than middle pinnae .............................. 5
5a. Pinnae 30-32 pairs .......................................................... A. caudatum
   b. Pinnae to 15 pairs ............................................................ 6
6a. Pinnae 4-5 cm wide, toothed .............................................. A. macrophyllum
   b. Pinnae 2-3 cm wide, deeply lobed toward base .................. A. adiantoides
7a. Rhizome erect ............................................................... 8
   b. Rhizome creeping or climbing .......................................... 9
8a. Pinnae toothed ................................................................. *A. tenerum*
b. Pinnae lobed to the costa ......................................................... *A. belangeri*

9a. Fronds 10 cm long, pinnae 10 pairs ........................................ *A. subnormale*
b. Fronds 18 cm long, pinnae 25 pairs ........................................... *A. unilaterale*

10a. Fronds 30 cm long 12 cm wide, largest pinnule 2 cm long..... *A. spathulinum*
b. Fronds 45 cm long 30 cm wide, largest pinnule 8 cm long ........ *A. robustum*

**Sphenomeris** Maxon

Rhizome short creeping with reddish-brown scales. Fronds bipinnate-bipinnatifid, lanceolate, oblong, elongate-ovate; rachis glabrous, upward gradually flattened; pinnae 6-8 a side of fronds, spreading, basal ones subopposite, apically gradually alternate, lower ones reduced. Sori elongate terminal at free veins near margins......................................................... *S. chinensis.*

3. **ATHYRIACEAE**

*Athyriaceae* Alston, Taxon 5 (1956) 25

**Diplazium** Swartz

Terrestrial. Rhizome or stock short erect with dark brown scales, serrate or toothed. Stipes stout. Frond simple to bipinnate; veins free in some species anastomosing, margins entire, serrate, undulate to lobed. Sori linear, along the veins both side of vein with narrow indusia.

Key to the species

1a. Fronds bipinnate ................................................................. *D. esculentum*
b. Frond simple to pinnate ................................................................. 2

2a. Fronds simple ................................................................. 3
b. Fronds pinnate ................................................................. 4

3a. Fronds 3 cm wide, narrow at base ........................................... *D. subserratum*
b. Fronds 8-10 cm wide, broadly cordate at the base ..................... *D. cordifolium*

4a. Rhizome with entire scales .......................................................... 5
b. Rhizome with toothed scales .......................................................... 6

5a. Costa hairy beneath ................................................................. *D. tomentosum*
b. Costa glabrous beneath ................................................................. *D. sorzogenense*
6a. Veins anastomosing .......................................................... *D. accedens*

b. Veins free ......................................................................................... 7

7a. Pinnae entire and toothed toward apex ........................................ *D. bantamense*

b. Pinnae lobed toward the costa ...................................................... *D. crenatoserratum*

4. **BLECHNACEAE**

*Blechnaceae* Presl, Tent. (1836)97; Epim. (1849)103

*Blechnum* Linnaeus

Terrestrial. Rhizome short, erect, brown scales. Stipes covered brown scales at the base. Fronds pinnate, entire, lower ones truncate to broadly cuneate at the base, gradually narrowed to the apex, veins simple or fork. Fertile pinnae narrower than sterile one. Sori linear parallel and close to the costa covered by indusium attached on the side away from the costa.

**Key to the species**

1a. Fronds 40 cm long 10 cm wide, pinnae toothed and articulate .......... *B. indicum*

b. Fronds 110 cm long 40 cm wide, pinnae not toothed nor articulate... *B. orientale*

5. **CYATHEACEAE**

*Cyatheaceae* Smith, Mem. Ac. Turin 5 (1793) 416; Swartz, Syn. Fil. (1806)139

*Cyathea* Smith

Tree ferns, with short or long massive trunk. Stipes closely arranged around the apex of the trunk, hairy or thorny (spiny) at the base or to upper parts of stipes. Fronds large, pinnate, bipinnate to tripinnatifid with deeply lobed. Sori round on the free veins forming regular or irregular rows, exindusiate.

**Key to the species**

1a. Fronds pinnate, pinnae simple .................................................. *C. moluccana*

b. Fronds bipinnate to tripinnatifid, pinnae with lobed ............................ 2

2a. Fronds bipinnate, margins toothed ................................. *C. gigantea*

b. Fronds tripinnatifid, margins lobed near to the costa ................. 3

3a. Rachises thorny, upper parts less strongly thorny ....................... *C. contaminans*

b. Rachises glabrous ............................................................................ *C. angiensis*
6. **DAVALLIACEAE**

*Davallia* Smith

Epiphyte. Rhizome creeping, without scales. Stipes with red-brown scales at base. Frond simple pectinate, bipinnate to quadripinnate; pinnae deltoid, linear to ovate. Sori separate, borne one or several on the segment at the forking point of veins. Indusium attached to broad base or along the side of segment.

**Key to the species**

1a. Indusium attached along the side of segment ................................................... 2
b. Indusium attached to broad base ...................................................................... 4

2a. Single sori on a segment at the forking point of veins ......... *D. trichomanoides*
b. Several sori on a segment at the forking point of veins ................................... 3

3a. Pinnae linear-triangular or narrowly ovate .......................................... *D. solida*
b. Pinnae deltoid ...................................................... *D. denticulata*

4a. Fronds simple, pectinate ............................................................ *D. pectinata*
b. Fronds bipinnate – quadripinnate .................................................... *D. repens*

7. **DENNSTAEDTIACEAE**


*Microlepia* Presl

Terrestrial. Rhizome creeping, covered with light brown hairs. Stipes 60 cm long, hairy toward to the base with shorter hairs near the apex. Fronds bipinnate to tripinnate; rachis densely short hair, bearing alternate pinnae, basal pinnae reduced. Sori round on the veins at base of the sinuses between lobes of pinnules or on each the lobes, covered with indusium.

**Key to the species**

1a. Fronds bipinnate ............................................................................ *M. strigosa*
b. Fronds tripinnate .............................................................................. 2

2a. Pinnules margin entire ............................................................... *M. trapeziformis*
b. Pinnules margin lobed, toothed ..................................................... *M. speluncae*
8. DIPTERIDACEAE
Smith et al. (2006), Taxon 55 (3) 705-731.

Dipteris Reinwardt
Terrestrial. Rhizome creeping, covered with black shining hairs. Stipes 50 - 120 cm long with few hairs at base. Fronds divided to the base into spreading fan-shaped halves, each half divided more than half-way to its base into four unequal lobes, margin coarsely serrate with acute or acuminate apex. Veins dichotomous with 2 – 4 main veins entering each lobe, lateral veins anastomosing with free veins in areoles. Sori round on the veins, numerous and irregularly scattered without indusium .................................................. D. conjugata.

9. DRYOPTERIDACEAE
Smith et al. (2006), Taxon 55 (3) 705-731.

Terrestrial. Rhizome erect, covered with brown scales. Fronds bipinnate or more simply divided, leaflets usually unequal-sided at the base, veins free. Stipes not swollen at the base. Basal pinnae not reduced in shape and size. Sori round, terminal on the free veins with indusium.

Key to the genera
1a. Pinnules jointed to the rachis, sori elongate ......................... Didymochlaena
   b. Pinnules not jointed to rachis, sori nearly round ......................... 2
2a. Fronds densely scale .................................................. Polystichum
   b. Fronds without scale .......................................................... Dryopteris

Didymochlaena Desvaux
Terrestrial. Rhizome erect covered with red-brown scales. Stipes 30 cm long. Fronds bipinnate, 120 cm long with numerous alternate pinnae. The lowest pinnae shorter than upper pinnae, about 25 cm long, margins entire. Sori terminal on the veins, covered with elongate indusium ............................................. D. truncatula.

Dryopteris Adanson
Terrestrial. Rhizome with brown scales. Stipes 15-20 cm long, with brown scales at base. Fronds narrowly deltoid, the longest basal pinnae with much
elongated basiscopic basal pinnules, other pinnules unequal at the base, round at the apex, margin shallowly lobed, with one short sharp tooth to each lobe at the apex of acroscopic vein. One sorus to each lobe, indusia brown, persistent .............................................................. D. sparsa.

Polystichum Roth

Terrestrial. Rhizome erect. Stipes covered with brown scales from the base to apex. Fronds bipinnate to tripinnate, densely scaly. Sori circular, dorsal on the veinlets.

Key to the species

a. Fronds tripinnate, stipes and rachis covered with dark brown scales ......................
   ................................................................................................................... P. aristatum

b. Fronds bipinnate, stipes and rachis covered with light brown scales ......................
   ............................................................................................................ Polystichum macroscalium sp. nov.

10. GLEICHENIACEAE

Terrestrial. Rhizome long creeping. Fronds dichotomously branched, ultimate branch (leaflets) lobed almost to the costa. Sori round on the veins, 2-14 sporangia, exindusiate.

Key to the genera

a. Sori 10-14 sporangium ........................................................................ Dicranopteris

b. Sori 2-4 sporangium ........................................................................... Gleichenia

Dicranopteris Bernhardi

Terrestrial. Primary rachis-branches unequal-equal forked, stipular leaflets at the base, at each fork the smaller branch unbranched and leafy throughout, no accessory branch, ultimate branches thick and rigid when dry and usually with edges reflexed, form by two normal leafy; lower surface slightly glaucus, flat and rigid; apices retuse or short simple hair, not prominent on upper surface;
veins grooved on lower surface, pale but not raised or distinctly prominent on the upper surface. Sori one to each veins about 10-14 sporangia.

Key to the species

a. Stipular leaflets 3 cm long at base of primary branches .................... D. curranii
b. Stipular leaflets 1 cm long at base of primary branches ..................... D. linearis

**Gleichenia** Smith

Terrestrial. Rhizome creeping. Fronds bipinnatifid, main rachis of fronds not grow continuously. Primary branches 120 cm long and 30 cm in diam; leaflets 2-3 cm apart, 3 cm wide, 12-15 cm long, lobed to about 1 mm from the costa, the lobes separate by narrow sinuses; beneath of fronds glaucous, vein once or twice forked. Lowest leaflets short, very near the main rachis. Sori half-way between costa and margins of lobe, each with 2-4 large sporangia.............. G. longissima.

11. **GRAMMITIDACEAE**

**Grammitidaceae** Holttum, Rev. Fl. Malaya 2, 2nd ed. (1968) 212.

Epiphyte. Rhizome erect to short-creeping. Fronds simple or pinnatifid, veins free. Sori round or elongate sunk in longitudinal grooves, terminal to the ends of veins or submarginal, exindusiate.

Key to the genera

1a. Fronds pinnatifid ................................................................. Ctenopteris
b. Fronds simple ........................................................................ 2

2a. Sori near the bases of veins near the costa ......................... Grammitis
b. Sori submarginal, 1/3 apical of frond, toward to costa .......... Scleroglossum

**Ctenopteris** Blume

Epiphyte. Rhizome erect, short creeping with dark scales. Stipes hairy, 1-5 cm long. Fronds pinnatifid, narrowed gradually to both base and apex, 10 – 20 cm long and 2-5 cm wide. Sori small, round, terminal on the veins between costa and margins.

Key to the species
1a. Stipes same or more than 3 cm long, sori terminal on the veins ...................... 2
b. Stipes 1 cm long, sori 6 on each side of costa ................................. C. subminuta

2a. Stipes 3 cm long, sori terminal on the veins toward to the apex of pinnae .......
........................................................................................................... C. contigua
b. Stipes 5 cm long, Sori halfway between costa to margin ................ C. obliquata

Grammitis Swartz
Epiphyte. Rhizome short. Stipes 2 cm long with spreading reddish hairs about 1.2 mm long. Fronds simple, linear grass-like, 8-10 cm long and 4-6 cm wide, hairy throughout like the stipe but sparsely; base gradually narrower than apex, rounded; veins simple or forked. Sori round near the bases of veins near the costa
.................................................................................................................. G. hirtella.

Scleroglossum v. Alderwerelt v. Rosenburgh
Epiphyte. Rhizome short with narrow brown scales. Stipes crowded. Fronds simple, 8-10 cm long and 2 mm wide, narrowed to the rounded apex. Sori submarginal grooves in 1/3 apical of frond, toward to costa ............ S. pussilum.

12. HYMENOPHYLLACEAE
Filmy ferns, rhizome creeping; fronds finely dissected with many segments, segments entire or toothed. Sori terminal on the segments with lips or tubular shaped indusium.

Key to the genera
a. Sori covered with lips indusium .............................................. Hymenophyllum
b. Sori tubular to trumpet shaped indusium ............................ Trichomanes

Hymenophyllum Linnaeus
Rhizome creeping. Stipes 1-3 cm long with wing toward of fronds or only upper part of stipe; wings crisped or flat, with hairy or not. Fronds 6-10 cm long and 3-5 cm wide, dissected, with 1-veined ultimate segments; segments entire or toothed, pinnae close each other but not overlapping or not quite touching each
other. Sori terminal on the segments on upper part of pinnae covered with lips indusium; lips elliptic, ovate or triangular.

Key to the species
1a. Margin of lobes toothed ............................................................ *H. denticulatum*
b. Margins of lobes entire ................................................................. 2

2a. Wings of stipe and rachis crisped ................................................................................. *H. javanicum*
b. Wings of stipe and rachis flat ................................................................................. *H. productum*

**Trichomanes** Linnaeus
Rhizome erect or creeping. Fronds minute, simple to finely dissected. Sori terminal on the segments with tubular to trumpet shaped indusium.

Key to the species
1a. Rhizome tuft, creeping ................................................................. *T. bilabiatum*
b. Rhizome erect with tufted fronds .................................................. 2

2a. Fronds simply pinnate ............................................................................. *T. javanicum*
b. Fronds bipinnatifid to quadripinnatifid .................................................. 3

3a. Segments of each pinnule spreading ................................................ *T. meifolium*
b. Segments distinctly winged ........................................................................... 4

4a. Sori on basal acroscopic lobes, indusium tubular ............................... *T. maximum*
b. Sori on segment, indusium cup-shaped ........................................... *T. superbum*

13. **LINDSAEACEAE**
*Lindseaeeae* Presl, Tent. (1836) 130.

Lindseaeae Presl, Tent. (1836) 130.

Terrestrial. Rhizome creeping, unbranched. Fronds pinnately divided, veins free or anastomosing. Sori submarginal, terminal on the veins or continuous along the margins with narrow indusia or with half-cup indusium.

Key to the genera
a. Indusium elongate, narrow................................................................. *Lindsea*
b. Indusium half-cup shaped ................................................................. *Tapaenidium*
Lindsaea Dryander

Terrestrial. Rhizome creeping or climbing with narrow scales. Fronds pinnate or pinnately branched, margins entire or toothed. Sori submarginal, terminal on single veins or continuous along the margins with narrow indusia open towards to the margins.

Key to the species

1a. Fronds simple pinnate .................................................................................... 2
   b. Fronds bipinnate ............................................................................................. 9

2a. Rhizome creeping or climbing ....................................................................... 3
   b. Rhizome erect ................................................................................................. 6

3a. Rhizome climbing .......................................................................................... 4
   b. Rhizome creeping............................................................................................ 5

4a. Sori on the end of a single veins ................................................................. L. repens
   b. Sori on continuous on the leaflets .............................................................. L. scandens

5a. Margins entire ................................................................................................. 7
   b. Margins serrate ............................................................................................. 12

6a. Pinnae linear ................................................................................................. L. ensifolia
   b. Pinnae deltoid ............................................................................................... 7

7a. Sori on terminal segment ............................................................................... L. tenuifolia
   b. Sori along the upper marginal of pinnae ...................................................... 8

8a. Pinnae more widely spaced ........................................................................ L. ob lanceolata
   b. Pinnae close each other ............................................................................... L. lucida

9a. Margins of pinnae toothed ............................................................................ 10
   b. Margin of pinnae entire ............................................................................... 12

10a. Stipes long, more than 15 cm ...................................................................... 11
    b. Stipes 8-10 cm long ..................................................................................... L. lobata

11a. Fronds both simply pinnate and bipinnate ................................................ L. obtusa
    b. Fronds with 3-5 pairs of pinnae ................................................................. L. cultrata

12a. Veins distinct both on lower and upper surface ......................................... L. napaea
    b. Veins indistinct both on lower and upper surface .................................... L. heterophylla
**Tapaenidium** Presl

Terrestrial. Rhizome short creeping; scales brown. Stipes 15-20 cm long. Fronds simply pinnate, bipinnate to bipinnatifid; the pinnae very narrow, toothed or wider and deeply lobed to pinnate, the wider pinnae deltoid, veins free or forked. Sori terminal on the veins, each close to a marginal tooth, with half-cup indusium.

Key: The species

- a. Fronds simply pinnate ................................................................. *T. pinnatum*
- b. Fronds bipinnate to bipinnatifid .............................................. *T. bisseratum*

14. **LOMARIOPSIDACEAE**


Terrestrial or epiphyte ferns. Rhizome short or climbing. Fronds monomorphic to polymorphic, simple to pinnate, margins entire or with deeply lobed. Climbing species has polymorphic fronds, adult plants (acrophylls) bearing small fronds, juvenile plants or new branches of different shape of adults plants (bathyphylls). Sori acrostichoid, exindusiate.

Key to the genera

- 1a. Fronds monomorphic or dimorphic ........................................... 2
- b. Fronds polymorphic ................................................................. 3

2a. Fronds simple ................................................................. *Elaphoglossum*
- b. Fronds pinnate ................................................................. *Bolbitis*

3a. Veins anastomosing .......................................................... *Lomagramma*
- b. Veins free ................................................................. 4

4a. All pinnae jointed to the rachis ....................................... *Teratophyllum*
- b. Only at the base of pinnae jointed to the rachis ..................... *Lomariopsis*

**Bolbitis** Schott

Terrestrial, rhizome creeping to climbing, stipes with scale at base. Fronds dimorphic, pinnate, margin of pinnae crenate to deeply lobed. Stipes of fertile fronds longer than sterile fronds. Sori acrostichoid without indusia.
Key to the species

1a. Steril fronds with a long terminal pinnae ........................................ B. heteroclita
b. Steril fronds without a long terminal pinnae ............................................. 2
2a. Rachis winged ........................................................................ B. pinnatifidis sp. nov.
b. Rachis not winged .................................................................................... 3
3a. Steril fronds lobed ............................................................................ B. quoyana
b. Steril fronds without lobed ................................................................. 4
4a. Margins sinuate ................................................................................ B. sinuata
b. Margins crenate ........................................................................... B. appendiculata

*Elaphoglossum* J. Smith

Terrestrial, rhizome short-creeping or massive; scales dark brown. Fronds dimorphic, simple, entire, coriaceous, acuminate, base cuneate, apex rounded, sterile frond more shorter than fertile one, narrowed to both base and apex; costa prominent beneath or both surface, Sori acrostichoid.

Key to the species

1a. Costa prominent on both surface .............................................. E. commutatum
b. Costa prominence beneath ........................................................................ 2
2a. Rhizome short creeping, margin hairy........................................ E. blumeanum
b. Rhizome massive, margins glabrous.................................................. E. callifolium

*Lomagramma* J. Smith

Climbing ferns. Rhizome with thin scales, clathrate. Stipes gradually decurrent at their bases to ridges of rhizome. Fronds widely separated, of distinctive form (bathyphylls). Fronds simply pinnate, veins anastomosing, margins of sterll pinnae entire, covered beneath with sporangia.

Key to the species

a. Veins distinct and prominent on upper surface ......................... L. sinuata
b. Veins indistinct, not prominent on upper surface ......................... L. lomarioides
**Lomariopsis** Fee

Climbing ferns. Rhizome with brown thin scales. Stipes gradually decurrent at base. Fronds simply pinnate, base of pinnae jointed to the rachis; fertile fronds with pinnae narrower than sterile, veins free. Sori acrostichoid.

Key to the species

a. Fertile pinnae 4-6 cm wide, apex caudate .............................. *L. cochinchinensis*

b. Fertile pinnae 2-3 cm wide, apex acuminate .............................. *L. spectabilis*

**Teratophyllum** Mettenius

Climbing ferns. Stipes with swolen at base. Acrophyls (adult fronds) simply pinnate, all pinnae jointed to the rachis. Fronds pinnate to bipinnate, margin entire, veins free; fertile fronds with very narrow pinnae.

Key to the species

1a. Pinnae crenate ....................................................................................... *T. ludens*

b. Pinnae deeply incised ............................................................................. 2

2a. Segments of pinnae linear .............................................................. *T. aculeatum*

b. Segments of pinnae orbicular ............................................................. *T. rotundifoliatum*

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15. **LYCOPODIACEAE**


**Lycopodium** Linnaeus

Rhizome short or creeping with irregular dichotomous branching, covered with numerous small leaves (microphyll). Leaves arranged spirally, linear-lanceolate, scale-like, apex acuminate. Strobili borne from the end of branches.

Key to the species

1a. Strobili solitary at the end of short branch .............................. *L. cernuum*

b. Strobili branched ............................................................................. 2

2a. Strobili branched once, leaves scale-likes ........................................ 3

b. Strobili branched more than once ................................................. 4

3a. Strobili 30-35 cm long ................................................................. *L. proliferum*

b. Strobili 3-7 cm long ..................................................................... *L. squarossum*
4a. Sterile leaves ovate to lanceolate ........................................... *L. phlegmaria*

b. Sterile leaves scale-like ......................................................... *L. wightianum*

16. **MARATTIACEAE**

*Marattiaceae* Kaulfuss, Enum. (1824) 31.

Terrestrial. Rhizome short, erect or creeping, fleshy. Stipes fleshy and swollen at the base. Fronds bipinnate or palmate with free veins or anastomosing. Sporangia large, close together in elongate groups or joined laterally in small groups, exindusiate.

Key to the genera

1a. Fronds palmately divided with 5 leaflets, veins anastomosing .... *Christensenia*

b. Fronds bipinnate with veins free ........................................... 2

2a. Sori two linear rows along the veins near the apex ............. *Angiopteris*

b. Sori along the veins close to the margin, fused ...................... *Marattia*

**Angiopteris** Hoffmann

Terrestrial. Rhizome short. Fronds bipinnate, 180-220 cm long; rachises green, hairy and scaly. Stipes sparsely hairy and scaly, large prominent stipules at the base. Pinnae alternate, oblong at the base; pinnules attached to the pinnae by short swollen stalks, acuminate, margin serrated and more strongly toothed at the apex. Veins simple or forked, raised on both surfaces. Sori two linear rows along the veins near the apex, about 8-10 sporangia .................. *A. evecta.*

**Christensenia** Maxon

Terrestrial. Rhizome creeping, fleshy. Stipe 40-50 cm long. Frond consisting of 5 leaflets which joined by short stalks directly to the top of the stipe, the middle leaflet largest, under surface whitish, base of leaflets cuneate apex acuminate, margin entire. Sori spreading irregular row between the main veins, sporangia joined laterally ........................................... *C. aesculifolia.*
Marattia Swartz
Terrestrial. Rhizome short. Stipes fleshy, 40 cm long covered with brown scales at base. Fronds bipinnate about 80-120 cm long, the base of pinnae swolen, margins serrate, apex acuminate, veins simple. Sori along the veins close to the margin about 2 mm long, fused ........................................... M. sambucina.

17. MARSILEACEAE

Marsilea Linnaeus
Terrestrial, aquatic ferns. Rhizome submerged stage bearing leaves 4 cm apart. Stipes of floating leaves to about 15 cm long, of sunaerial leaves 3 cm long. Fronds 4-lobed; leaflets of floating leaves to 3 cm long and 2.5 cm wide, the outer margins broadly rounded and entire; leaflets of subaerial leaves 4-6 cm long, the outer margins lobed. Stalks of sporocarp about 4 mm long, attached at the base of stipe. Sporocarp 3-4 mm long, olong with rounded end as seen laterally. ................................................................. M. crenata.

18. NEPHROLEPIDACEAE
Smith et al. (2006), Taxon 55 (3) 705-731.

Nephrolepis Schott
Terrestrial. Rhizome erect, short. Fronds simply pinnate, narrow; lowest pinnae reduced, more widely spaced, apical of fronds short and small; pinnae sessile, articulate, broad and unequal at the base, margins serrate to crenate, veins free. Sori terminal on the veins near margins covered with round - reniform indusium.

Key to the species
1a. Sori on marginal lobes ................................................................. N. dicksonioides
   b. Sori near or far from the margins ............................................. 2
2a. Sori near margins of fronds ..................................................... N. bisserata
   b. Sori far from the margins .......................................................... 3
3a. Scrambling plant, apex of pinnae rounded ................................ N. radicans
   b. Not scrambling plant, apex of pinna truncate ........................ 4
4a. Indusium round ................................................................. *N. falcata*
b. Indusium reniform .......................................................... *N. Hirsutula*

19. **OLEANDRACEAE**


**Oleandra** Cavanilles

Terrestrial. Rhizome creeping covered with imbricating brown scales, branched, bearing 6-12 fronds close together, the groups of fronds separated by 5-10 cm. Stipes 6-8 m long. Fronds unbranched, simple, narrowed, widest above the middle, 28 cm long, 3-4 cm wide, apex acuminate, margin entire, hairy on lower surface. Sori round on each side near the costa covered with indusium ................................................................. *O. pistillaris.*

20. **OPHIOGLOSSACEAE**

*Ophioglossaceae* Presl, Tent. (1936) 10.

**Helmintostachys** Kaulf.

Terrestrial. Rhizome creeping, fleshy, 5 mm in diam, bearing very numerous fleshy roots. Stipes fleshy, 25-30 cm long, with 2 small stipules at base. Fronds equally tripartite, each part with 2-3 lanceolate lobes; terminal leaflet broadly decurrent, whole lamina 10-15 cm long; leaflets 8-14 cm long and 2-4 cm wide, base cuneate and apex acuminate, margins entire. Fronds and spike parts separating from the apex of the stipe.................................................. *H. zeylanica.*

21. **PLAGIOGYRIACEAE**

*Plagiogyriaceae* Bower, Ann. Bot. 40(1926)484

**Plagiogyria** Kunze

Terrestrial. Rhizome erect. Fronds dimorphic, pinnate. Stipes 15 cm long, stipes of fertile fronds longer than sterile ones. Sterile fronds 18 cm long and 12 cm wide; pinnae stalked, spreading at the rachis, the lower ones narrowed at base but joined to a rachis wing which narrow upwards; pinnae narrowly oblong, acute apex, margins finely toothed. Sori acrostichoid, exindusiate .......................................................... *P. glauca.*
**22. POLYPODIACEAE**

*Polypodiaceae* Berchtold & J. Presl, Prir. Rostlin. 1 (1820)272; Ching, Sunyatsenia 5 (1940)257.

Epiphyte ferns. Rhizome creeping. Fronds monomorphic or dimorphic, simple, pinnate to pinnatifid. Sori round or elongate on the apical or spreading on the lower surface of lamina, exindusiate.

Key to the genera

1a. Sori on the apical of lamina .............................................................................. 2
1b. Sori spreading on the lower surface of lamina ................................................. 5

2a. Sori covered with reflexed margins ....................................................... *Belvisia*
b. Sori not covered with reflexed margins, exindusiate ....................................... 3

3a. Sori linear ................................................................................................. *Loxogramme*
b. Sori round or elongate ...................................................................................... 4

4a. Scales basifixed ............................................................................................ *Lepisorus*
b. Scales peltated ............................................................................................ *Pyrrosia*

5a. Sori one or many rows on the veins ................................................................. 6
5b. Sori spreading along veinlets .......................................................................... 8

6a. Scales peltated ............................................................................................ *Selliguea*
b. Scales pseudopeltated .................................................................................... 7

7a. Sori in irregular rows to the connecting of veins ........................... *Aglaomorpha*
b. Sori in single row between each part of vein ........................................... *Leptochilus*

8a. Base fronds present .................................................................................... *Drynaria*
b. Base fronds absent ............................................................................................ 9

9a. Fronds simple to pinnatifid ............................................................................. *Microsorum*
b. Fronds pinnate ............................................................................................. *Goniophlebium*

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*Aglaomorpha* Schott

Epiphyte, rhizome short-long creeping covered with pseudopeltate scales, spreading. Fronds monomorphic or dimorphic, pinnate to pinnatifid, base fronds absent. Sori spreading irregular rows to the connecting of veins.

Key to the species

a. Fronds dimorphic, pinnate ........................................................................... *A. acuminata*
b. Fronds monomorphic, pinnatifid. ................................................................... *A. heraclea*
**Belvisia** Mirbel

Epiphyte. Rhizome short creeping, scales brown margin entire or toothed. Stipes short up to 3 cm long. Frond simple, linear, narrowed to apex and base, entire. Sori over the whole lower surface of narrow apical portion of frond, broad to linear, protected by the reflexed margins.

Key to the species

a. Rhizome scales ovate with entire margins .................. *B. revoluta*

b. Rhizome scales acuminate with toothed margins .................. *B. callifolia*

**Drynaria** J. Smith

Epiphyte. Rhizome creeping, 1-3 cm thick with brown-blackish scales, internodes 10-12 cm long. Fronds dimorphic, pinnatifid, base of fronds present, rachises persistent or not, base frond contiguous separate sessile or imbricate, lobed, margin entire. Sori round, regular or irregular row parallel and close to the veins.

Key to the species

a. Rachises persistent, base frond sessile shallowly lobed .......... *D. quercifolia*

b. Rachises not persistent, base frond imbricate .................. *D. sparsisora*

**Goniophlebium** Presl

Epiphyte. Rhizome creeping, green turning brown when dry; scales appressed base, pseudopeltate. Fronds pinnate, glabrous, widest at the base, pinnae articulate, base angustate, margin entire to crenate, apex acuminate, venations areoles 2-4 serial. Sori uniserial, costal, sunken. Sori round on free veins near the costa ................................................................. *G. persicifolium.*

**Lepisorus** J. Smith

Epiphyte. Rhizome short creeping bearing fronds close together with brown scales basifixed. Stipe 4-6 cm long. Fronds monomorphic, simple 50-70 cm long and 2-4 cm wide, gradually narrowed at base, apex rounded, margin entire. Sori elongate spreading at apical of 2/3 of lamina, in a single row, submarginal .......................................................... *L. longifolius.*
**Leptochilus** Kaulfuss

Epiphyte. Rhizome short creeping, internodes 4 cm long; scales psudopeltate, sparsely, narrowly ovate. Fronds dimorphic, simple, stipes short 2 cm long; lamina narrowly, elliptic to obovate, 20-25 cm long and 6-10 cm wide, base truncate to narrowly angulate, apex acuminate, margins entire, veins dichotomously branched near the margin. Sori in a single row between each part of vein. ............................................................... *L. macrophyllus.*

**Loxogramme** Presl

Epiphyte. Rhizome creeping. Fronds simple, close together on the rhizome, glabrous, narrow, entire, widening upwards gradually from the narrow base, widest above the middle, apex acuminate, costa raised or not on lower or upper surface of fronds. Sori linear upper half of frond reaching from costa to margins.

Key to the species

a. Fronds 40-50 cm long and 4-6 cm wide ................................................ *L. avenia*
b. Fronds 15-18 cm long and 1 cm wide ........................................... *L. subecostata*

**Microsorum** Link

Epiphyte. Rhizome creeping with internodes, scales peltate, psedopeltate, with white waxy or not. Fronds simple to pinnatifid, base narrowly angulate to ovate-obovate, apex rounded, acute-acuminate, veins dichotomously branched, prominent, distinct. Sori round to elongate, separate, along veinlets.

Key to the species

1a. Fronds simple ................................................................................................... 2
   b. Fronds pinnatifid .............................................................................................. 3

2a. Rhizome with white waxy, fronds apex acute-acuminate ............ *M. pteropus*
b. Rhizome without white waxy, fronds apex rounded ................. *M. punctatum*

3a. Sori several rows between costa and margin ............................................ 4
   b. Sori one in each primary costal areole ...................................................... 5

4a. Rhizome dorsiventral with pseudopeltate scales ..................... *M. insigne*
b. Rhizome terete with peltate scales .................................................. *M. scolopendria*

5a. Rhizomes scales peltate with rounded apices ...................... *M. commutatum*
b. Rhizomes scales psepdeltate ........................................ M. membranifolium

**Pyrosoia** Mirbel

Epiphyte. Rhizome long creeping, scales peltate, spreading or appressed. Fronds Monomorphic or dimorphic, simple, coriaceous, margins entire. Sori round to elongate at apical of fronds.

Key to the species

1a. Fronds monomorphic .......................................................... P. longifolia

b. Fronds dimorphic ............................................................................................. 2

2a. Female frond with short stipes, less than 2 cm long ........................................ 3

b. Female frond with longer stipes, more than 5cm long ...................................... 4

3a. Sterile frond circular to broadly ovate .................................... P. nummularifolia

b. Sterile frond linear .............................................................. P. pilloseloides

4a. Apex acute to acuminate .................................................. P. angustata

b. Apex obtuse .......................................................... P. lanceolata

**Selliguea** Bory

Epiphyte. Rhizome creeping covered with peltate scales, spreading or appressed. Stipes 2-20 cm long. Fronds monomorphic or dimorphic, simple. Sori round-elagante in one or many rows between costa to margins, superficial to deeply sunken.

Key to the species

1a. Fronds monomorphic .......................................................... 2

b. Fronds dimorphic ............................................................................................. 3

2a. Fronds lanceolate, sori 5 rows between costa and margins, superficial .......... S. enervis

b. Fronds linear, sori one row between costa and margins, deeply sunken ........... S. stenophylla

3a. Scales acute, dentate but entire toward apex, spreading ........... S. heterocarpa

b. Scales obtuse-rounded, entire, appressed ................................................ S. triquetra
23. **PSILOTACEAE**


**Psilotum** Swartz

Rhizome-like non-aerial branched stem. Aerial stems green, repeatedly forked. Leaves small (microphyll) reduced like scale along the angles of the axes. Sporangia borne in axils of leaves, 3 lobed.

Key to the species

a. Branched of the frond flattened .................................................. *P. complanatum*
b. Branched of the frond triangular .................................................. *P. nudum*

24. **PTERIDACEAE**

*Pteridaceae* Gaudichaud, in Freycinet, Voyage (1826) 262.

Terrestrial. Rhizome erect, creeping to climbing. Fronds monomorphic or dimorphic with pinnate, pinnatifid to tripinnate. Sori linear, near the margins, exindusiate, protected by the reflexed margin, one species acrostichoid.

Key to the genera

1a. Rhizome creeping or climbing .................................................. 2
b. Rhizome erect .............................................................................. 4
2a. Rhizome climbing, ................................................................. *Stenochlaena*
b. Rhizome creeping, ................................................................. 3
3a. Sori submarginal, linear.......................................................... *Pteridium*
b. Sori continuous on the lobe margins........................................ *Histiopteris*
4a. Sori acrostichoid at the apical of fronds ............................... *Acrostichum*
b. Sori linear, submarginal near the margins ................................. *Pteris*

**Acrostichum** Linnaeus

Terrestrial. Rhizome stout, erect covered with dark brown scales, thickened toward the base, 2.5 cm long and 1.5 cm wide. Fronds and stipe 2.5 m tall, only the upper ones fertile, acrostichoid. Sterile pinnae cuneate to rounded margin entire, 30 cm long, 8 cm wide, the apical half slightly narrowed, rounded to truncate. Fertile pinnae same shape as the sterile but smaller. Sori acrostichoid ................................................................. *A. aureum*.
**Histiopteris** J. Smith

Terrestrial. Rhizome long creeping; stipes dark purplish hairy at the base. Fronds bipinnate to tripinnatifid; pinnae and pinnules opposite, pinnae 40-20 cm long, pinnules 5-6 cm wide, lowest pinnules much smaller than the next pair, stipules at base of pinnae, veins reticulate according to the width of the lobes, prominent below, distinctly marked but not raised on the upper surface. Sori continuous on the margins of lobes .......................................................... *H. incisa.*

**Pteridium** Scopoli

Terrestrial. Rhizome long creeping. Stipes long. Frond bipinnate to tripinnatifid. Pinnae 60 cm long and 30 cm wide. Rachises hairy in the groove above and sparsely beneath. Sori submarginal, linear, indusia two, one is reflexed thin of margins .................................................................................... *P. aquilinum.*

**Pteris** Linnaeus

Terrestrial. Rhizome erect-suberect. Stipes covered by scales or hair at base. Fronds simply pinnate to bipinnate and tripartite, basal pair of pinnae branched near the base, veins free, sterile frond veins ending to the margins. Sori linear, submarginal covered with indusium formed from the thin reflexed margins of lamina.

Key to the species

1a. Frond monomorphic ................................................................. 2
   b. Frond dimorphic ................................................................. 7

2a. Basal pinnae not branched .................................................. *P. vitata*
   b. Basal pinnae branched .......................................................... 3

3a. Pinnae without lobed ............................................................ *P. venulosa*
   b. Pinnae with lobed ................................................................. 4

4a. Branched pinnae as large as the other pinnae ....................... *P. tripartita*
   b. Branched pinnae shorter than the others pinnae ...................... 5

5a. Veins free ............................................................................. *P. semipinnata*
   b. Veins forked .......................................................................... 6

6a. Lobes margins undulate .......................................................... *P. longipinnula*
Stenochlaena J.Smith
Terrestrial. Rhizome climbing with round peltate brown scales. Stipes 12-18 cm long. Fronds simply pinnate, about 50-70 cm long with 10-15 pairs of pinnae and similar terminal pinnae; sterile fronds with elliptical pinnae, margin toothed; fertile frond with narrowly linear pinnae, 18 cm long and 2-3 cm wide, the lower surface covered with sporangia (acrostichoid) ........................................ S. palustris.

25. SCHIZAEACEAE

Schizaeaceae Martius, Icones Selectae Bras. (1834)112.

Terrestrial. Rhizome creeping. Fronds with slender twining rachis or very narrow tough leaflets. Sporangium confined to very narrow along marginal or apical part of fronds. Sori covered with indusium.

Key to the genera

a. Sori along marginal of fronds ............................................................... Lygodium
b. Sori in apical part of fronds ................................................................. Schizaea

Lygodium Swartz
Terrestrial. Rhizome branched, creeping with fronds close together or longer spaced between fronds. Stipes slender, twining, the whole frond often a few metres long. Fronds borne on two rows on upper surface of rhizome. Primary branches ending in a tuft of brown hairs, each primary branches bearing a pair of secondary branches. Sterile leaflets entire or toothed, veins free, fertile leaflets narrower than sterl ones. Each lobe bearing two sporangia rows, attached to a vein and covered with small indusium. Sori borne along marginal of fronds.

Key to the species

1a. Fronds distinctly spaced ................................................................. L. microphyllum
b. Fronds closed together ................................................................. 2
2. **Schizaea** Smith

Terrestrial. Rhizome creeping. Fronds linear, grass like 15-20 cm long, dichotomously branched, stipes 10 cm long, closely spaced along the rhizome. Sori borne in terminal tufts, when young protected by reflexed thin margins ................................................................. *S. dichotoma*.

### 26. SELAGINELLACEAE


**Selaginella** Beauv.

Terrestrial, stems erect or creeping. Leaves small (microphyll), simple with a single vein, arranged spirals or four regular axial rows, two median rows and two lateral rows, the medial leaves smaller and different shape to the lateral leaves. Fertile leaves arranged in terminal spikes. Sporangia borne in the axil of the fertile leaves.

**Key to the species**

1a. Stems creeping with rooting at intervals ........................................... *S. durvillei*

b. Stems erect, rooting at base ................................................................. 2

2a. Stems branched dichotomously ..................................................... *S. intermedia*

b. Stems irregularly branched .................................................................. 3

3a. Main stems erect, apex of lateral leaf apiculate ............................... *S. delicatula*

b. Main stems suberect, apex of lateral leaf acuminate ........................... *S. plana*
27. **TECTARIACEAE**

Holttum (1991) Fl. Mal. 2 (2)1-132

Terrestrial. Rhizome erect to creeping. Fronds pinnate to bipinnatifid, costa raised on the upper surface, margins entire, crenate. Sori round without indusia, several rows between costa and margins or spreading irregularly on lower surface.

**Key to the genera**

1a. Sori several rows between costa and margins ........................................... *Tectaria*

b. Sori irregularly spreading on the veins, ............................................................ 2

2a. Margins of pinnae crenate ................................................................*Arcypteris*

b. Margins of pinnae entire .............................................................*Heterogonium*

**Arcypteris** Underwood

Terrestrial. Rhizome short, erect with dark brown scales at the base of stipe. Stipes 40-40 cm long. Frond 80 cm long, bipinnatifid and bipinnate toward the base; pinnae with crenate margins and acute apex; veins forming single narrow areoles along either side of costa between one costule and the next, and shorter areoles on either side of the costules. Sori round, small, scattered irregularly without indusia ............................................................................................ *A. irregularis.*

**Heterogonium** Presl

Terrestrial. Rhizome erect. Stipes 20-40 cm long covered with brown scales at base. Fronds dimorphic, bipinnatifid, lowest pinnae largest, much widened in the middle and narrowed to the base, margin entire, fertile fronds narrowed than sterile ones; veins free; the apical portion deltoid with lobed. Sori irregularly spreading on the veins without indusia.

**Key to the species**

a. The whole lower surface densely covered with sporangia ............... *H. pinnatum*

b. Sori in a single row on either side of each costule ............................ *H. saxicolum*

**Tectaria** Cavanilles

Terrestrial. Rhizome erect to short-creeping. Fronds pinnate to bipinnate, basal pinnae largest, basiscopic pinnules of lowest pinnae enlarged, lobed, veins
anastomosing. Sori round or elongate on the end of veins, several rows between costa and margins.

Key to the species
1a. Basal pinnae deeply lobed ................................................................. 2
b. Basal pinnae with single basiscopic lobe or not .................................. 5
2a. Stipes covered sparsely with scales from base to apex ........... T. pleocnemioides
b. Stipes with scales only at base .......................................................... 3
3a. Lobes of pinnae half-way to the costa ........................................ T. melanocaulon
b. Lobes of pinnae 1/3 to the costa ..................................................... 4
4a. Stipes 50-60 cm long ................................................................. T. barberi
b. Stipes 18-20 cm long ............................................................... T. polymorpha
5a. Stipes winged .................................................................................. 6
b. Stipes not winged ............................................................................ 7
6a. Rachis hairy on lower surface ..................................................... T. decurrens
b. Rachis not hairy on lower surface ................................................ T. vasta
7a. Base of pinnae cordate ................................................................. T. angulata
b. Base of pinnae cuneate to oblique ............................................. 8
8a. Sori on the ends of veins, 2 rows between costa and margin ........ T. siifolia
b. Sori irregular rows between costa and margin ........................ T. crenata

28. THELYPTERIDACEAE

Thelypteridaceae Ching, Sunyatsenia 5 (1940) 237-240.

Terrestrial. Rhizome erect, short–creeping or long-creeping, covered with narrow scales. Fronds pinnate, bipinnate to bipinnatifid with crenate or lobed pinnae, basal pinnae reduced or not at their base. Sori round-elongate on the veins at the base of lobes near costa with indusium.

Key to the genera
1a. Veins not reaching the margins ....................................................... Macrothelypteris
b. Veins reaching the margins .............................................................. 2
2a. Rhizome erect .................................................................................. 3
b. Rhizome creeping ............................................................................. 6
3a. Reduced pinnae absent at the base of frond ..................................... Mesophlebion
b. Reduced pinnae present at the base of frond ........................................... 4
4a. Fronds bipinnate ................................................................. *Pneumatopteris*
b. Fronds pinnate ..................................................................................... 5
5a. Sori close to the margins of lobes ................................................... *Amphineuron*
b. Sori elongate on medial veins near the costa ........................ *Sphaerostephanos*
6a. Pinnae with deeply lobed ............................................................. *Christella*
b. Pinnae with crenate to serrate margins ........................................ *Pronephrium*  

**Amphineuron** Holttum

Terrestrial. Rhizome erect, covered by narrow scales. Stipes minutely hairy, scaly at the base. Fronds pinnate, pinnae with lobed, basal pinnae much narrowed at their base. Stipe long 40-60 cm. Sori close to margin of lobes with indusium.

Key to the species

- a. Lobes 1/3 toward to costa, veins 7-9 pairs, indusia large ............... *A. terminans*
- b. Lobes ¾ toward to costa, veins 16-20 pairs, indusia thin ............ *A. immersum*

**Christella** Leveille

Terrestrial. Rhizome creeping covered with narrow scales with many superficial hairs. Fronds pinnate to bipinnate, pinnae with deeply lobed, a few pairs of lower pinnae gradually reduced. Veins reaching the margins. Sori medial apart from lowest ones which some times touch those on veins from neighbouring costules, indusia hairy.

Key to the species

- a. Frond 80 cm long, lobed ¼ toward to costa ................................. *C. arida*
- b. Frond 40 cm long, lobed ½ toward to costa ............................... *C. dentata*

**Macropthelypteris** Ching

Terrestrial. Rhizome erect (caudex). Stipe 40 cm long. Fronds tripinnate, 60 cm long, lower pinnae 30x12 cm, rest gradually smaller, largest pinnules 10x2 cm, with tertiary leaflets connected by a very narrow wing on costa, upper costa densely hairy, of costules sparsely, veins not reaching to the margins. Sori small on branch of veins with indusium .................................................... *M. setigera*
**Mesophlebion** Holttum

Terrestrial. Caudex short. Stipe 40 cm long, basal scale 3 mm long. Fronds bipinnate, 65 cm long, pinnae 15-20 pairs. Largest pinnae 15 x 2 cm, apex acuminate, margins lobed to 3 mm from costa; veins 10-12 pairs, basal pair of veins passing to either side of sinus membrane. Reduced pinnae absent. Lower surfaces of rachis, costa and costule bearing very short hairs and narrow scales. Veins reaching the margins. Sori not very closed to costules, indusia large. ................................................................. *M. chlamydophorum.*

**Pneumatopteris** Nakai

Terrestrial. Caudex erect. Stipes short to 30 cm long. Fronds bipinnate to tripinnate, 100-140 cm long, with reduced pinnae at base, pinnae broadly cuneate to truncate at base, apex acuminate, margins with lobed 1/3 toward costa, lobes entire, lower surface of rachis and costa hairy. Veins reaching the margins. Sori on base of veins near costule indusium

Key to the species
a. Reduced pinnae opposite, 2-3 pairs, .................................................. *P. callosa*
b. Reduced pinnae alternate, 8-10 pairs, .................................................. *P. truncata*

**Pronephrium** Presl.

Terrestrial. Caudex creeping. Stipes up to 60 cm long with scales at base. Fronds pinnate, pinnae 6-8 pairs, subopposite, margins crenate to serrate. Veins reaching the margins. Sori on the veins.

Key to the species
a. Lowest pinnae reduced, base of stipes with narrow thin scales ........ *P. asperum*
b. Lowest pinnae not reduced, base of stipes with dark rigid scales ....... *P. nitidum*

**Sphaerostephanos** J. Smith

Terrestrial. Caudex erect with narrow scales. Fronds pinnate with lobed, several pinnae reduced at base, hairy. Veins reaching the margins. Sori round-elongate on medial veins near the costa with indusium.

Key to the species
a. Reduced pinnae 20 pairs or more, lobed halfway to costa ............ *S. polycarpus*
b. Reduced pinnae 6-10 pairs, lobed ¾ way to costa ................. *S. heterocarpus*

29. **VITTARIACEAE**

*Vittariaceae* Presl, Tent. (1836) 164.

Epiphyte. Rhizome short-creeping. Fronds simple, entire, gradually narrowed to the base. Sori linear on the lower surface of fronds or marginal covered with reflexed thin margins.

**Key to the genera**

a. Sori along the veins forming a network ............................................ *Antrophyum*
b. Sori marginal and reflexed with thin margins ........................................ *Vittaria*

**Antrophyum** Kaulfuss

Epiphyte. Rhizome short, creeping, fleshy, covered by clathrate scales. Fronds simple, widening gradually from the base, entire, costa not prominent some species distinct only toward the base of frond. Sori along the veins forming a network.

**Key to the species**

1a. Costa distinct on the fronds............................................................................... 2
1b. Costa indistinct on the fronds ........................................................................... 3

2a. Costa distinct near the base only, scales 6 mm long .................... *A. reticulatum*
b. Costa distinct more than half of the fronds, scales 1 cm long . *A. semicostatum*

3a. Fronds 15 cm long and 8 cm wide, apex acuminate, scales 1 cm long .............. ........................................................................................................ *A. latifolium*
b. Fronds 8-10 cm long, 2 cm wide, apex obovate, scales 4 mm long .................... ........................................................................................................ *A. parvulum*

**Vittaria** Smith

Key to the species

1a. Fronds 1-3 mm wide

V. angustifolia

2b. Fronds more than 4 mm wide

2a. Costa distinct on lower surface

V. lineata

2b. Costa indistinct on lower surface

3a. Fronds about 5-7 mm wide

V. ensiformis

3b. Fronds about 10-15 mm wide

V. elongata
5 CONCLUSION

This study documented 189 species belonging to 70 genera and 29 families. There are 173 species as new collections from South East Sulawesi and 28 species of it is new from Sulawesi for Herbarium Bogoriense. Two species presumed as new species, namely *Polystichum macroscaulium* sp. nov and *Bolbitis pinnatifidis* sp. nov. Four species are new records from Sulawesi, that are *Coniogramme xinea*, *Ctenopteris subminuta*, *Lygodium borneense* and *Tectaria barberi*.

Ferns habit is varied, consisted of tree ferns, herbaceous ferns and filmy ferns. Rhizomes are varied as well, categorize into erect (caudex/rootstock), creeping, climbing and trunk. Based on attachment pattern of the scales there are basifix, pseudopeltate and peltate. The structure of the scales are divided into clathrate or not clathrate. The margins of the observed scales are entire, toothed or ciliate. Most of the colour of scales are brown to dark colour. The fronds are monomorphic, dimorphic and polymorphic. In addition to those findings, there are 13 types of soral variations such as sori arranged in strobili, Synangia, sporocarp, erect spike, sorophores, sori on the marginal of fronds covering with reflexed margins, sori acrostichoid, sori covered most of lower surface of lamina or particular pinnae, sori with a cup or tubular form indusia, pericostal, sori along the veins between costa and margins, sori round or elongate spreading on the veins and sori terminal on the free veins near margins.

Based on its habitat, there are nine types of ferns: terrestrial sun-ferns (27 species), terrestrial shade-ferns (72 species), climbing ferns of sheltered places (8 species), climbing ferns of exposed places (5 species), epiphytes of sheltered places (47 species), epiphytes of exposed places (8 species), river bank ferns (16 species), aquatic ferns (3 species) and rock-ferns (3 species).

The similarity of fern species at three different locations is low. Fern species are also used by local people for foods, medicine, ornamental plants, handicraft and construction. The identification key to the families, genera and species were developed.
REFERENCES


Appendix 1  New Species of ferns from South East Sulawesi, *Bolbitis pinnatifidis* sp. nov.

*Bolbitis pinnatifidis* sp. nov.: a. Scale at the base of stipe, b. Scale at the upper part of stipes, c. Venation and winged of rachis, e. Sporangium.
Appendix 2. New Species of ferns from South East Sulawesi, *Polystichum macroscadulum* sp. nov.