

**COMPARISON OF PTERIDOPHYTE DIVERSITY
BETWEEN SUNGAI MAHUA AND KENINGAU
PERMANENT PLOTS, CROCKER RANGE PARK, SABAH**

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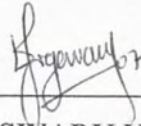
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ABSTRACT

COMPARISON OF PTERIDOPHYTE DIVERSITY BETWEEN SUNGAI MAHUA AND KENINGAU PERMANENT PLOTS, CROCKER RANGE PARK, SABAH

This study is to assess the diversity of pteridophytes in Sungai Mahua permanent plot and compare it with the diversity of pteridophytes in Keningau permanent plot. The research on pteridophyte diversity of Keningau permanent plot had been done by Teh Pooi Keat from School of International Tropical Forestry in year 2006, and his data was used in doing the comparison of both the plots. Pteridophyte diversity in Sungai Mahua permanent plot is assessed by setting up sub-plots there and counting the individuals of pteridophyte species that is present there. The data collected is then used to count diversity indices. A total of 18 species from 11 different families are present in Sungai Mahua permanent plot. Meanwhile 24 species of pteridophyte is present in Keningau permanent plot. The dominant species in Sungai Mahua permanent plot is *Heterogonium pinnatum* and in Keningau Permanent plot is *Selaginella brooksii*. The diversity indices show that both the plots are more or less similar to each other in terms of species evenness, richness and diversity. These two plots only differ in the species composition because both the plots are set in two different type of forest. Sungai Mahua substation is a primary forest and Keningau substation is a disturbed forest.



ABSTRAK

PERBANDINGAN KEPELBAGAIAN PAKU-PAKIS DI ANTARA KAWASAN PLOT KEKAL SUNGAI MAHUA DAN KENINGAU, CROCKER RANGE PARK, SABAH

Tesis ini dijalankan untuk menganggarkan kepelbagaian paku-pakis di plot kekal Sungai Mahua dan membandingkannya dengan kepelbagaian paku-pakis di plot kekal Keningau. Kajian mengenai kepelbagaian paku-pakis di plot kekal Keningau telah dilakukan oleh Teh Pooi Keat daripada Sekolah Perhutanan Antarabangsa pada tahun 2006 dan data yang diperolehinya diggunakan semasa perbandingan dibuat antara dua plot kekal ini. Kepelbagaian paku-pakis di plot kekal Sungai Mahua diketahui dengan menyediakan sub-plot dan mengira individual species yang hadir di situ. Data yang diperolehi kemudiannya diggunakan untuk mengira indeks kepelbagaian. Sebanyak 18 spesis daripada 11 famili yang berlainan hadir di plot kekal Sungai Mahua. Sementara itu, sebanyak 24 spesis paku-pakis hadir di plot kekal Keningau. Spesis dominan di plot kekal Sungai Mahua ialah *Heterogonium pinnatum* manakala di plot kekal Keningau adalah *Selaginella brooksii*. Indeks kepelbagaian menunjukkan bahawa kedua-dua plot kekal ini adalah hampir serupa antara satu sama lain dari segi kepelbagaian dan kekayaan spesis. Walaubagaimanapun, kedua-dua plot ini berbeza dari segi jenis spesis yang hadir. Ini adalah kerana kedua-dua plot ini dibina di jenis hutan yang berbeza. Plot kekal Sungai Mahua terletak di hutan primer manakala plot kekal Keningau terletak di hutan yang telah diterokai.



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CHAPTER 1

INTRODUCTION

1.1 Biodiversity

Biodiversity or biological diversity refers to “total variability among living organisms.” It is considered at three levels which are genetic diversity, species diversity and ecosystem diversity. Genetic diversity is variation within and between populations of species, species diversity is variation of species and sub-species among living organisms and ecosystem diversity is variation of habitat, biotic community, and ecological resource.

Biodiversity has three important values, economic, ecological functions and intrinsic. Economic is the direct use of biological resources, timber, fish and many more. Ecological functions means hydrological cycle, recycling of essential nutrients in the soil and intrinsic means cultural diversity which varies within and between different cultures.



Biodiversity is the variety of ecosystems, species, and populations within species and genetic diversity within species. The biological diversity of the planet is being rapidly depleted as a direct and indirect consequence of human actions. Biodiversity hotspots are generally characterized by attributes such as high species richness, and high numbers of endemic, rare, or threatened species (Citroen, 2004). Biodiversity analysis has become an increasingly important field as 'hotspots' of biodiversity are now becoming a targeted priority for conservation planning and preservation of natural areas (Citroen, 2004).

1.2 Biodiversity in Sabah

Malaysia is identified as one of the world's twelve mega-diversity areas with extremely rich biological resources. There are over 15,000 known species of flowering plants, 286 species of land mammals, 736 species of resident birds, 268 species of reptiles and over 150,000 species of invertebrates in the whole Malaysia. East Malaysia in particular is a rich biodiversity area. 80% of the country's plants and 77% of the country's mammals are found in Sabah and Sarawak (Pigott, 1988).

1.3 Diversity

Pteridophyte include over 10,000 living species (365 genera) distributed worldwide, with 893 species (124 genera, 76 hybrids and 176 infraspecific taxa) in North America north of Mexico (Wee,1998). The divisions are also characterized, in part, by the nature of the sporangia. About 97% of living pteridophytes are ferns. During the Carboniferous period,



some 350 million years ago, the earth was dominated by the ancestors of the present-day ferns and fern allies. Treelike Horsetails and Clubmosses up to 40 meters high towered above other large ferns. Giant Horsetails formed impenetrable thickets along river banks. Towards the end of this era, when the world's climate changed, these plants were replaced by the more competitive seed plants. The huge masses of ferns rotted away or become the coal seams of today. Since then, many new fern species have evolved. Others have become extinct. Although there may have been many species that left no traces when they become extinct, the presence of a few is seen in fossils.

About half of the number of pteridophyte that is present today is believed to come from water tropics (Schooley, 1997). In Malaysia, there are more than 650 species of ferns and fern allies, about 5.4% of the world's population (Soepadmo, 1998). In Peninsular Malaysia alone, where the fern flora has been extensively studied, more than 500 native species have been recorded. This diversity can be appreciated if we compare it with the 54 species found in England, a country of similar land area. Or consider the African continent, which has a more than 200 times the land area but about the same number of species as Peninsular Malaysia. If the east Malaysian states of Sabah and Sarawak are taken into consideration, the fern flora of Malaysia can easily exceed 650 species. This is because the forests are much extensive in Sabah and Sarawak. In Sabah alone, there are 804 species of pteridophytes from 148 genera and 34 families (Said, 2005).



1.4 Sungai Mahua and Keningau Permanent Plots

This research was carried out in Sungai Mahua Permanent Plot to find out the pteridophyte diversity there. The diversity is then compared with the diversity of pteridophytes in Keningau Permanent Plot. The research in Keningau plot had been done by Teh Pooi Keat, a student from School of International Tropical Forestry in year 2006. His data will be used to do the comparison.

1.5 Objectives

The objectives of this research are as follows:

- a) To determine the pteridophyte diversity at Sungai Mahua Permanent Plot
- b) To compare the pteridophyte diversity in Sungai Mahua Permanent Plot with the pteridophyte diversity in Keningau Permanent Plot.



CHAPTER 2

LITERATURE REVIEW

2.1 Crocker Range

Crocker Range was made a forest reserve in 1969 through a gazette notification No. 596 of 1969, under section 12 of the forest enactment 1968. It became a reserve forest effective on 25 September 1969. Crocker Range was then renamed as Crocker Range Park in 1984 under the 1996 Amendment to the Parks Enactment 1984. Crocker Range Park was registered as category II protected area in United Nations list for protected areas compiled by the World Conservation Union (IUCN) (Teh, 2006).

Crocker Range Park was established in 1984. It covers the north-south Crocker Range, of 1200-1800 meter mountains in Sabah (www.wikipedia.com). It is located in the east Malaysia, on the island of Borneo, which separate the western coastal plain with the rest of the state. The park covers 139.9 square kilometers, making it the largest park in Sabah. The park consists of both hill and montane forest, with many species of flora and



fauna endemic to Borneo (www.bbec.sabah.gov.my).

Crocker Range Park consists of eight districts. The eight districts are Beaufort, Papar, Penampang, Tuaran, Ranau, Tambunan, Keningau and Tenom. This is shown in Figure 2.1. There are four main rivers that are located in the West Coast of Sabah which is in Papar, Kimanis, Bongawan and Membakut. Besides that, there are eight main rivers in the interior which is the Padas, Melalap, Pegalan, Pampang, Liawin, Apin-Apin, Tendulu and Tikolod (www.bbec.sabah.gov.my).

This research is carried out in a permanent plot that has been set up near the Sungai Mahua which is located at the Crocker Range Park (CRP), Sabah. The park stretches from south of Kundasang in the north to Tenom in the south, approximately between latitudes 5° and 6°N and longitudes 115° and 119°E. To the east CRP is bordered by the flood plain of the Pegalan/Padas River and to the west by the coastal plain of the west coast of Sabah. Sunagi Mahua is situated 40 minutes from Tambunan and located near the base camp within the primary forest. Photo 2.1 shows the map of Crocker Range Park showing the study area.



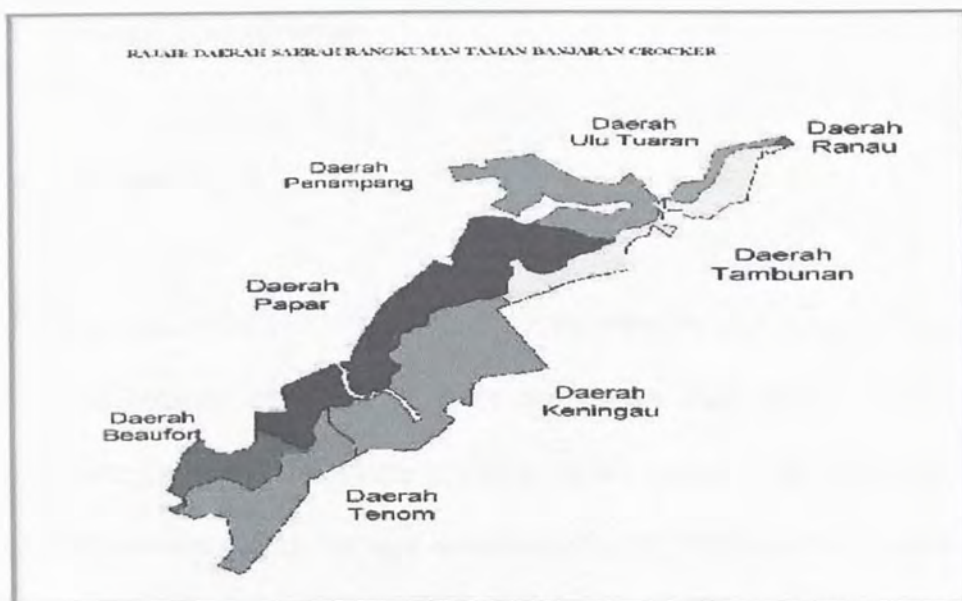


Figure 2.1 District Map of Crocker Range Park

(source : www.bbec.sabah.gov.my)

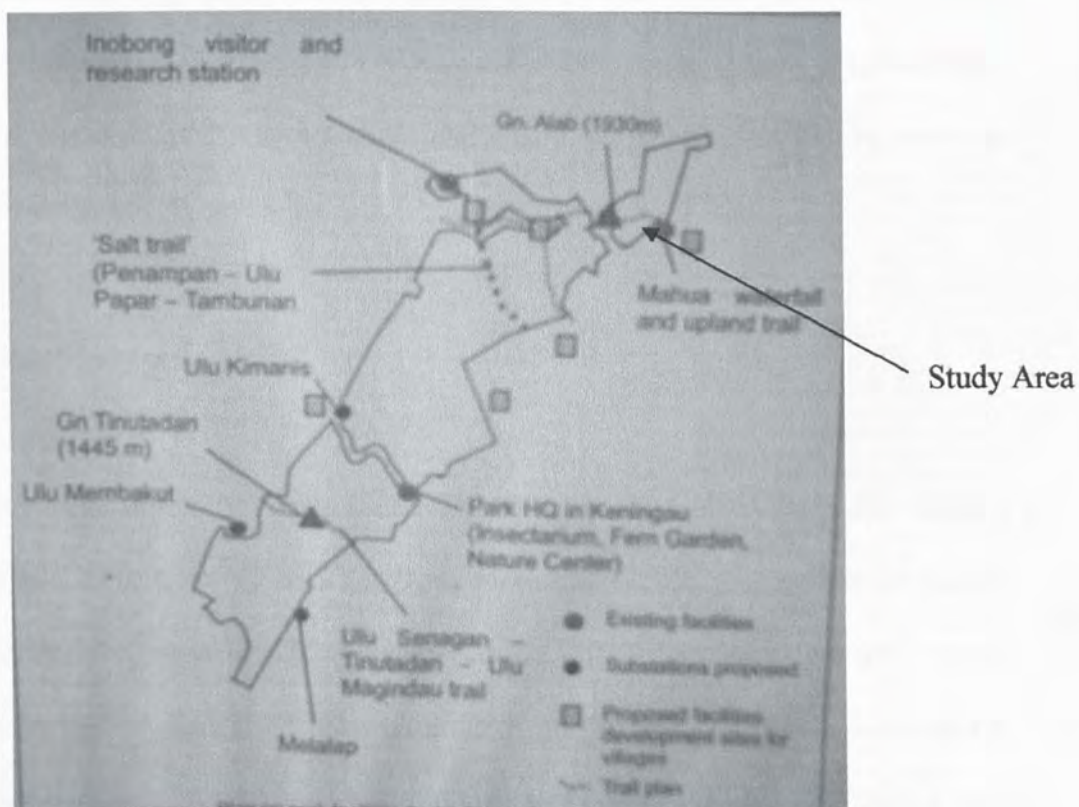


Figure 2.2 Map of Crocker Range Park showing the Study Area

2.2 Traditional Classification

2.2.1 Psilotophyta

Psilotophyta consist of the whisk ferns which are the simplest and most primitive vascular plants. This is because they lack of roots and leaves. This makes up the issue of classifying psilophyta as a separate division controversial. The psilotophytes have rhizomes with absorptive rhizoids as a substitute of roots. *Psilotum*, has enations instead of leaves. Enations are an outgrowth on the surface of an organ. Botanists hypothesize that the enations of *Psilotum* are green and photosynthetic. The name *whisk ferns* probably come from the highly branched stems of *Psilotum*, which give the plant the appearance of whisk broom. *Psilotum* is widespread in subtropical regions of the southern United States and Asia, and it is a popular and easily cultivated plant that is grown in greenhouses worldwide (Wee, 1998).

2.2.2 Lycopodiophyta

Lycopodiophyta is commonly known as the club mosses. Despite this, it is not made of true mosses and consists of 10 to 15 genera. More than 1,100 species live in various habitats worldwide (Uno *et al*, 2001). Lycopods are primarily tropical but also form a conspicuous part of the plant life in two genera, the club mosses (*Lycopodium*, about 400 species) and the spike mosses (*Selaginella*, about 700 species), both of which get their common names from their club-shaped or spike-shaped strobili (Wee,1998). Most species



are terrestrial, but many are epiphytic (growing on other plants). One species of *Selaginella* which is *Selaginella lepidophylla* is called the resurrection plant because of its ability to defy drought conditions. It occurs in the desert of southwestern United States and Mexico (Lehmann *et al*, 2002). During periods of drought, this plant forms a tight, dried-up ball and when the rain comes its branches absorb water, expand, and resume photosynthetic activity. The sporophytes of club mosses are differentiated into leaves that are known as called microphylls, stems, and roots. The roots branch from perennial rhizomes that sometimes grow outward from a central point to form “fairy rings”. One such fairy ring of a *Lycopodium*, when measured for its size and annual growth rate, was calculated to have started growing in 1839 (Lehmann *et al*, 2002). Lycopodiophyta also includes the quillworts (*Isoetes*). It is so named because of their narrow, quill-like leaves. Quillworts may be aquatic or they may grow in small lakes or pools that dry out during some seasons. These plants live in freshwater habitats on almost every continent. Most of the leaves of quillworts are fertile and do not aggregate into strobili; some leaves produce sporangia that abort before they mature. Quillworts are also distinctive in the divisions because they have CAM photosynthesis. Some lake-dwelling species in the Peruvian Andes have no stomata in their leaves and obtain carbon dioxide for photosynthesis from the muddy substrate where they grow (Wee, 1998).

2.2.3 Equisetophyta (Sphenophytes)

Sphenophytes are commonly known as horsetails because of their often brushy experience. The sphenophytes were once granted their own phylum but recent molecular



data suggest that they are closely related to ferns and should be classified with them. *Equisetum* is the only living genus of the *Equisetophyta*. Some of the 15 species of *Equisetum* have branched stems, and some have unbranched stems (Lehmann *et al*, 2002). *Equisetum* species are called horsetails or scouring rushes because their epidermal tissue contains abrasive particles of silica. Scouring rushes were used by Native Americans to polish bows and arrows and by early colonists and pioneers to scrub their pots and pans (Lehmann *et al*, 2002). *Equisetum* occurs worldwide in moist habitats along the edge of streams or forests. Its rhizomes are highly branched and perennial. Because its rhizomes can grow rapidly and its aerial stems are poisonous to livestock, *Equisetum* can be a serious problem for farmers and ranchers (Wee, 1998). Gardeners have often chopped up the rhizomes while trying to remove it from the soil, only to have new plants arise from each of the fragments left behind. Although *Equisetum* has true leaves, the stem is the dominant photosynthetic organ of the plant body. The most conspicuous feature of the stem is the series of “joints” formed by whorls of small leaves (Wee, 1998). The leaves are fused along most of their length, but their brown tips give the appearance of a collar around the stem just above each node. When the stems are pulled apart, they break easily at the nodes to yield pipelike internodal pieces. In addition, *Equisetum* stems are notable for a branching pattern that is unique among vascular plants. Instead of growing in the axils of leaves, the lateral branches of horsetails sprout from between the leaf bases. Gametophytes of *Equisetum* are photosynthetic, pincushion-shaped plants that can grow up to 1 centimeter in diameter. The sexuality of *Equisetum* gametophytes is not well understood because it is variable and appears to be related to environmental conditions (Wee, 1998).

2.2.4 Polypodiophyla

Ferns are primarily tropical plants, but some species inhabit temperate regions, and some even live in deserts. The abundance of ferns decreases with the decreasing moisture regardless it is the north or the south of tropics (Grillos, 1996). For example, in tropical Guam, about one eighth of the species of vascular plants are ferns but in mostly dryer California, ferns constitute only about one-fiftieth of the total species.

Some genera of ferns have leaves that are the largest and most complex in the plant kingdom. For example, one species of tree fern in the genus *Marattia* has leaves that are up to 9 meters long and 4.5 meters wide. At the other extreme, the aquatic ferns *Salvinia* and *Azolla* have relatively tiny leaves. For most people, however, a typical example of a fern is *Pteridium aquilinum*. The bracken fern, like most ferns, is classified in the order Pteridales, which includes about 10,000 species.

Often the most conspicuous parts of fern are its compound leaves, called fronds. A pinna is the leaflet of a frond. New leaves grow from a fleshy rhizome. Early leaves are curled because they grow faster on their lower surface than on their upper surface (Jones, 1987). This growth pattern which is called the circinate vernation, produces young leaves that are coiled into fiddleheads. New fiddleheads arise close to the growing tip of the rhizome at the beginning of each growing season. The leaves of most ferns die back each year, but the leaves of the walking fern can form new plants. Near the tip of each leaf, certain cells revert to meristems and grow into new roots, leaves, and a rhizome (Pigott,



1988). The fiddleheads of certain ferns are considered a delicacy by some and can be found in a health food stores and restaurants.

2.3 Modern Classification

Although the traditional classification of the pteridophytes consists of four divisions, this classification has been modified in the later days due to the extinction of many species. Some recent development has been done on the classification based on the molecular evidences (Pryer *et al.*, 2004). The pteridophytes have been separated into two groups which is the Lycophytes and Ferns. The families that are included in the Lycophytes are the Lycopodiaceae, Selaginellaceae and the Isoetaceae. A phylogenetic tree of the Lycophytes is shown in Figure 2.2. Meanwhile the Ferns are made of Equisetales, Marattiales, Polypodiales, Ophioglossales and Psilotales (Pryer *et al.*, 2004).

2.4 Reproduction

The life cycle of a fern consist of two phases. It is the sexual and the asexual phase. During the process of germination, the spore develops into a heart-shaped structure called a prothallus. The prothallus is usually not more than 5 mm across (Citroen, 2004). This is the sexual phase of the fern's life cycle, and is not normally obvious.

The prothallus central cushion is many cells thick and bears numerous, brown, threadlike rhizoids (Citroen, 2004). Rhizoids function like roots. It absorbs water and



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