# IMPACT ON PTERIDOPHYTE DIVERSITY DUE TO FOREST CLEARANCE IN SG.MAHUA, CROCKER RANGE PARK, SABAH

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# ABSTRAK


## KESAN PENEBANGAN HUTAN KE ATAS KEPELBAGAIAN PAKU-PAKIS DI SG.MAHUA CROCKER RANGE PARK, SABAH

Kajian ini membandingkan kepelbagaian paku-pakis di antara hutan primer di substesen Sg. Mahua dan kawasan hutan yang telah ditebang di Sg.Mahua. Jumlah spesis paku-pakis di kawasan hutan yang telah ditebang adalah lima, manakala 12 spesis telah dijumpai di hutan primer. Nilai Indek Shannon-Weiner untuk kawasan hutan yang telah ditebang (0.54165) dan hutan primer (1.08674) menunjukkan bahawa kepelbagaian paku-pakis adalah lebih tinggi di hutan primer. Ujian T yang dijalankan telah memberikan nilai p yang kurang daripada 0.05, iaitu p = 0.07. Ini membuktikan bahawa terdapat perbezaan yang signifikan di antara min Indek Shannon-Weiner bagi kawasan hutan yang telah ditebang dan hutan primer. Perbandingan bagi nilai Indek Kesamarataan menunjukkan bahawa kesamarataan spesis di hutan primer (0.43734) adalah lebih tinggi daripada kawasan hutan yang telah ditebang (0.33655). Empat parameter persekitaran telah diukur untuk melihat hubungan antara parameter tersebut dengan kepelbagaian paku-pakis di antara kawasan pertumbuhan semula dan hutan primer. Parameter tersebut ialah keamatan cahaya, kelembapan, suhu dan pH tanah. Daripada hubungan yang diperoleh, telah didapati bahawa kepelbagaian paku-pakis adalah lebih tinggi di hutan primer berbanding kawasan hutang yang telah ditebang kerana kawasan tersebut mempunyai keadaan yang sesuai untuk pertumbuhan paku-pakis seperti cahaya yang sudah ditapis, tahap kelembapan yang tinggi, halangan daripada angin yang kuat dan tanah yang sedikit berasid.

## ABSTRACT


### IMPACT ON PTERIDOPHYTE DIVERSITY DUE TO FOREST CLEARANCE IN SG.MAHUA CROCKER RANGE PARK, SABAH

This study is to compare the pteridophyte diversity between permanent plot in Sg. Mahua substation and the plot in a regrowth area where the forest has been previously cleared. Total number of five pteridophyte species was found in regrowth area and 12 species were found in primary forest. The value of Shannon-Weiner Index for regrowth area (0.54165) and primary forest (1.08674) shows that the pteridophyte diversity in primary forest is higher. Paired t-test significance value which is less than 0.05 ($p = 0.007$) proved that there is a significant difference between the means of Shannon - Weiner Index for primary forest and regrowth area. On the other hand, comparison of Evenness Index between regrowth area (0.33655) and primary forest (0.43734) indicates that species equitability in primary forest is higher than regrowth area. There are four environmental parameters that were measured as supporting evidence to the differences in the pteridophyte between the two plots. They are light intensity, moisture, temperature and soil pH. It is shown that diversity of pteridophyte is higher in primary forest because the area has more ideal conditions for pteridophyte growth such as filtered light, adequate moisture, protection from excessive wind and a bit acidic soil. More studies about pteridophyte should be carried out especially on comparison of pteridophyte diversity between disturbed and undisturbed area. This is to see different level of disturbance on pteridophyte diversity.

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# CHAPTER 1

# INTRODUCTION

## 1.1 Forested Area

### 1.1.1 Primary Forest

Some primary tropical forests are the most luxuriant of all plant community (Burrows, 1990). Yet, over the past few decades of researches on tropical rain forest the complexity is still poorly remain unknown (Mittelbach *et al.,* 1995). The Malaysian forest is a biotic community, which stirs the human imagination and is one of the most dramatic and awesome biological systems on earth. The outstanding feature of the biotic community in the Malaysian forest is its richness and diversity, which is brought about by biogeographic, ecological and evolutionary factors (Mok, 1997). Mok (1997) stated that in almost every major plant and animal group, there are more species in tropical rain forests than in temperate forests.

Although total numbers of plants and land vertebrate species of Malaysia are not the greatest in four countries in East Asia, number of species per sq. km is still the highest.

The rich biodiversity of Malaysia is supported by diverse habitats, especially by tropical rainforest (www.bbec.sabah.gov.my/ParkManagement/bbeccrp.html). Whitmore (1975) stated that the flora in Malaysia contains more than 1196 seed plant species. Other biota such as animals, both vertebrate and invertebrate, in the tropics is one of the most important causes of maintenance of richness of the flora because they play a role in seed dispersal and herbivory (Burrows, 1990).

Janzen (1970, 1975) & Hubbell (1980) investigated that there are many species of tree in tropical lowland forest because insect predators do not allow anyone to become common. Although the tree flora of many moist tropical forests is diverse, relatively species poor forests also occur in many places as stated by Burrows (1990).

In tropical forest areas the most diverse forests are on rather infertile soils. Very fertile and very infertile soils both have reduced diversity (Burrows, 1990). Pomeroy (1970), De Angelis (1980), Janos (1983) and Huston (1980) concluded that maintenance of diversity in the tropical forests in general is intimately connected with the biological processes and various forms of feedback taking place, such as nutrient budget. According to (Jordan & Herrera, 1981) vegetation studies are usually done for the above ground component, even if it is known long since that the below ground components are of decisive importance to the anchoring of plants, the uptake of water and nutrients and the storage of photosynthesis.

### 1.1.2 Regrowth Area

Regrowth area is a part of the forest or the whole forest that is experiencing species replacement due to disturbance from natural or non natural disturbance. Burrows (1990) investigated that after a major disturbance episode in the eastern forest, provided that there is no further disturbance, there will be a continuous sequence of species replacement culminating, after several centuries, in a relatively stable or slowly changing community.

It had been claimed that tropical forests are not a renewable resource and therefore cannot be managed as such (Burrows, 1990). It is true that it is not possible to utilize a primary forest and keep the same mix of species and age or size classes over time as stated by Burrow (1990). This can be proofed from Viereck (1970) studies that showed that even after 40 years of recovery; secondary forest richness is less than half of a primary forest. Yet this contrast the studies done by Hubble & Foster (1986) on Barro Colorado Island indicated that the probability of self-replacement is no lower than the probability of replacement by other species provided the environmental condition such as light condition is favorable.

Few population analyses covering large areas have been done in tropical forests by Knight (1975). Knight's study indicated that the young and old forest canopies were qualitatively similar in composition, although the proportions of species differed. The patterns of vegetation change in moist tropical lowland forest are the same like those in the temperate forest as stated by Connell (1978).

## 1.2 Types of Forest Disturbance

According to Hawkins (1992) the definition of disturbance is to move from a settled or usual position or state. In ecology context, forest disturbance is factors that cause damage to plants and their substrate as defined by Burrows (1990). Forest disturbance can be categorized into natural and non natural causes as stated by Collins (1961). Natural causes are such as fire, global warming, disturbance by gales, catastrophic insect attack, storm and many more, whereas non natural causes are usually induced by human activities. Examples of human activities are such as, agricultural settlements, logging, forest clearing, construction of dams, mining activities, highway construction, aquaculture, shifting cultivation and human induced burning as stated by Maarel (2005).

On the other side, Mok (1997) stated that, eventhough there are several factors contributing towards forest disturbance, yet the most damaging factor in forest exploitation is the construction of a network of roads and tracks and the climatic conditions in those areas where timber production is increasingly being concentrated.

## 1.3 Impact of Forest Disturbance on Vegetation

Maarel (2005) stated that vegetation dynamics are increasingly affected by human activities and it becomes important to understand how human activities affect succession. Burrows (1990) investigated that fire, selective logging, clear cutting, agriculture and various kinds of disturbance followed by forest regrowth, have contributed to the very complex patterns of forest composition and structure.

Other type of forest disturbance such as fires of natural and Indian origin had a very long influence on eastern forests as stated by Burrows (1990). Burrows (1990) also indicated that different fire intensities have very different effects on the resultant forest composition, regardless the area. For example, in northern Wisconsin, where fire frequency is greater than it is further east, it was investigated that light surface fires favors sugar maple which regenerates rapidly from seedlings and seedlings sprouts whereas hotter fires kill the sugar maple seedlings and sprouts (Burrows, 1990).

According to Burrows (2005), rates of gap formation and gap sizes vary according to various unpredictable events and trees are more likely to fall if they are alongside a gap than if they are in an undisturbed area. He also included that gap formation initiates a continuous sequence of regrowth. Pomeroy (1970), De Angelis (1980), Janos (1983), Huston (1980) investigated that relatively uniform stands of trees often arise when large areas of lowland forest are disturbed.

According to study done by Richards (1964) only one or few species are dominant in fertile sites, which are subject to extensive disturbance whereas Maarel (2005) stated that, since disturbance is a major trigger of vegetations dynamics, some disturbance typology is useful. There are also advantages of some forest disturbance such as fire and grazing as indicated by Collins (1961). He revealed that a combination of burning and grazing resulted in the highest species diversity whereas the lowest species diversity was found on ungrazed, and unburned sites. On the other side, Bormann & Likens (1979) stated that the recently disturbed site is most diverse, sites with transitional forest are lowest in diversity and mature forest is probably intermediate.

Despite the challenges of tropical rain forest complexity, the factors that lead to its disturbances are much stronger than the factors towards its understanding and conservation as stated by Mittelbach *et al*. (1995).

## 1.4 Forest Clearance

Clearance of forest itself is a varied process, taking place in a wide range of topographic, edaphic, and hydrological conditions at different rates as defined by Maarel (2005). Oliver (1980) researched that clear cutting and other disturbances, especially if repeated at intervals, causes shifts in species composition towards greater abundance of transitional species. North Carolina forests clear cuts in 1939 and 1962 were followed by increases of tulip tree, red maple and chestnut oak whereas other species changed very little in density (Burrows, 1990). According to Mok (1997) investigation, since all the areas developed for agriculture are devoted to tree crops, once the new vegetation gives cover, conditions will be similar to the original state. However, this suggestion is contrary to Maarel (2005) investigation. He observed that in the Malaysian virgin forest, the presence of several tree storeys, as well as dense undergrowth, results in a larger interception of precipitation than in a cultivated rubber plantation. There are several impacts of forest clearance such as soil erosion, impact on ecological processes, effects on rainfall patterns, contribution to greenhouse gas emissions and many more as stated by Glanznig (1995).

### 1.4.1 Impact of Native Vegetation Clearance on Ecological Processes

A major impact of inappropriate native vegetation clearance on ecological processes is the alteration of water cycles and the rise in water tables and salinity problems as stated by Janos (1983). Eventhough the effects of altered ecological processes on biodiversity may not be seen now, recent research has highlighted the serious implications of current and future impacts as stated by Maarel (2005). In a recent examination of the consequences of a changing hydrologic environment for native vegetation in South Western Australia, George *et al.* (1977) calculated that as a result of native vegetation clearance and replacement by crop species which use less water, water tables are rising beneath cleared lands and remnant vegetation. They conclude that most of the remnants that have survived to date will become severely degraded within a generation and that nearly all the remaining remnants will be permanently modified. Not only is that, many significant wetlands, for example Lake Toolibin, also being affected as stated by Janzen (1970).

### 1.4.2 Effects of Native Vegetation Clearance on Rainfall Patterns

According to Glanznig (1995) native vegetation clearance can also affect regional rainfall patterns. Recent research indicates that regional rainfall and atmospheric energy patterns have been changing in certain areas which have been extensively cleared as stated by Janos (1983). In a major review of rainfall patterns and atmospheric conditions in south Western Australia between 1946 and 1988, Smith (1978) concluded that the meteorological records indicate that annual rainfalls were being reduced by 1.5 mm/yr and that the mean summer temperatures had increased by one to five degrees centigrade. The present 14 per cent reduction in mean annual rainfall is likely to have a significant impact on native flora and fauna, and will compound the problems faced by our decaying remnant ecosystems as studied by Huston (1980).

While annual rainfall decreased from 1947 to 1988 over the agricultural area of South Western Australia, meteorological records indicate it increased by a similar amount over uncleared native vegetation further to the east as stated by Glanznig (1995). A later study observed that convective clouds may form earlier in the day over extensive areas of native vegetation than over similar land that has been cleared for agriculture as investigated by Huston (1980).

### 1.4.3 Contribution of Native Vegetation Clearance to Greenhouse Gas Emissions

Native vegetation clearance is a major contributor to greenhouse gas emissions. The net total of greenhouse gases emitted in 1990 was the equivalent of 572 million tones of carbon dioxide. Of this total, the National Greenhouse Gas Inventory provides estimates that during 1990 carbon dioxide emissions from forest clearing for agriculture totaled 156 million tones, which is some 27.3 % of Australia's net emissions in carbon dioxide equivalent. This estimate is subject to the caveat that there is much uncertainty associated with emissions from native vegetation clearance due to the lack both of statistics on land clearing and of data on the carbon content of the vegetation cleared and of the soils involved (Glanznig, 1995).

### 1.4.4 Soil Erosion

A direct and obvious outcome of the rapid clearance of forest areas is soil erosion. The rapid rate of forest clearance, however, has meant that some states are no longer able to provide sufficient logs for each mill and in several states the timber industry as a whole is already facing inefficient operation. Soil erosion will immediately cause a loss of soil fertility and the break down of soil structure, consequently resulting in the impoverishment of the remaining soil. All this will have an adverse effect on its capacity to support agricultural crops or the regeneration of the forest (Mok, 1997). According to Mok (1997), future agricultural and forest productivity will therefore be reduced. Not only that, in areas being developed for agriculture, there is often a protracted interval between clearing the forest and planting the crop during which time soil erosion can be excessive as stated by Huston (1980).

## 1.5 Justification

The focus of this research project is to compare the diversity of pteridophytes between primary forest and a regrowth area where the forest has been previously cleared.

Various types of studies had been carried out elsewhere on comparison of fern diversity due to forest disturbances but this type of study is rarely carried out in Sabah. Moreover, study on comparison of diversity of pteridophytes due to forest clearance was never done before in sub station Sg. Mahua, Crocker Range Park. The scope of this study is to compare the diversity of pteridophytes between permanent plot in Sg. Mahua substation (permanent plot that has been set up earlier by Borneon Biodiversity and Ecosystem Conservation (BBEC) and the plot in a regrowth area where the forest has been previously cleared. Besides that, this study is also carried out to compare differences in environmental parameters in both areas. The environmental parameters are such as acid level in soil, moisture level, temperature and light intensity.



### 1.6 Aim of the Study

For this study, there are three major objectives as the following:

1. To determine the diversity of pteridophytes at both plots.
2. To compare the diversity of pteridophytes between permanent plot in Sg. Mahua substation and the plot in a regrowth area where the forest has been previously cleared.
3. To compare differences in environmental parameters in both areas.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Background

Crocker Range Park (CRP) is the largest single totally protected area in Sabah and comprised of eight districts. They are Tambunan, Keningau, Beaufort, Papar, Penampang, Tenom, Tuaran and Ranau (Map 2.1). The boundaries are still being surveyed and no visitor facilities have yet been developed, the Park being administered from Kota Kinabalu. CRP is located in west coast of Sabah. The park is slender shaped approximately 75 km length and 15 km width, runs along northeast southwest axis. It is the largest state park comprising an area of 139 919 ha, about twice size of Singapore. The elevation ranges between 100 m to 2050 m at the peak of Mount Alab. Most of the park is covered by rainforest. Sabah Parks has been managing the area since 1984 in order to conserve the area. There are two major threats to CRP. They are illegal logging and forest fire. CRP is vast and very important to Sabah. It plays a role as water catchment area, terrestrial ecosystem for flora and fauna species, and untapped potentials for tourism and recreation (www.bbec.sabah.gov.my/Park Management/bbeccrp.html).

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