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A Botanical Survey in Kalimantan during 1978-79

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カリマンタン植物調査報告***

The flora of Kalimantan (Indonesian Borneo) is far from complete even at the moment when the vast areas of primitive forests are endangered to destruction. It is estimated by van Steenis in 1950 that the total number of the specimens collected from East and Northeast Borneo counts only 11,800 showing only 6 in his density index. This density index is far less than the figures, 21 for NW Borneo (Sarawak and Brunei) and 35 for the British N Borneo (Sabah). Since that time some additional collections have been made mostly by the staff members of the Herbarium Bogoriense, though most of the materials are still waiting critical taxonomic study.

The Kyoto University Kalimantan Expedition was carried out in collaboration with the Herbarium Bogoriense during December 1978 and February 1979. In exploring the flora of Kalimantan, transportation was one of the principal problems. Some ten years before, the transportation was available only along the rivers by boats, and it was necessary to walk all the way in case one would botanize the sites far from the river-side. In lowland Kalimantan, however, the timber companies open up logging roads on which we could make more collections in various parts of the tropical rain forests. Because of this logging operation, however, the lowland forests are destroyed rather quickly, and it is highly necessary to make fundamental floristic researches in this area before the primitive forests will be taken away by the human activities. Our main purpose of this expedition was, therefore, to make the floristic survey mostly in the lowlands, especially where the timber companies are actually operating. This survey was carried out mostly in Kalimantan Timur (East Kalimantan) and a part of Kalimantan Selatan (South Kalimantan). The localities botanized during the expedition are mapped on Figure 1 with somewhat detailed descriptions provided in the text.

More than 15,000 sheets of the vascular plants were collected in this expedition, though many common species in the lowlands and open areas were included. Some additional collections of the bryophytes and lichens were also brought back for further

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study. The first three sets of all the specimens will be placed in BO, KYO and L, and the duplicates will be distributed to various herbaria including K, MO, TI and others. A check-list of all the collections of the pteridophytes will be published separately, and the results of the taxonomic studies on the flowering plants will be reported elsewhere. This paper is intended to draw a general aspect of the flora and vegetation in Kalimantan mostly based upon our own field survey there. The ‘Vegetation and environment of East Kalimantan’ was prepared by Kuswata Kartawinata.

Vegetation and environment of East Kalimantan

Geography

The Province of East Kalimantan is located between 4°22’N and 2°22’S, and between 113°38’ and 119°E. The total land area is 21,144,000 ha, and about 17.3 million ha are covered by natural forest, with the potential commercial timber volume of production forest of about 800 million cu.m. The land area consists of 70.7% of land with altitudes of 500–1000 m, 15.4% with altitudes of 1000–1500 m, and 0.6% with altitudes of more
than 1500 m (DARJADI et al. 1976). The mountainous region covers most part of the western and southwestern parts at the borders with Central Kalimantan, Sarawak and Sabah (Malaysian Borneo), where the Iban Range and the Muller Range extend. The high mountains on these ranges include Gunung (Mount) Liangpian (2240 m), G Kalung (1724 m) and Bukit Harun (2160 m). The Sambaliung Range extends from Sangkulirang area to the west, and peaks at G Suwaran (1230 m), G Menyapa (1380 m) and G Kemul (2053 m), and on the Southeast lies the Meratus Range with peaks at G Beratus (1200 m) and G Lumut (1238 m).

Three large lakes, Kenohan (Lake) Melintang, K Semayang, and K Jempang are located north of the Meratus Range, around the middle of the Mahakam River. The main large rivers running eastwards from the Iban Range are the Mahakam River, Kayan River and Sesayap River.

**Geology and Soils**

The following account on the geology and soils has been extracted from **BEMMELEN** (1971), **DUDAL & SOEPRAPTOHARDJO** (1957) and **SOEPRAPTOHARDJO** (1972). The Iban Range belongs to the Permo-Carboniferous, Triassic and Cretaceous formation which is a complex intensely folded formation. The youngest formation of this zone is capped with volcanic rocks formed during the Plio-Pleistocene.

To the east parallel to the above zone is a gentle folds and fault structure of the Paleogene. This zone is in a great part covered by the sea and the alluvial deposits.

The Meratus Range on the southeast is the northeastwards extension of the above zone and is a Pre-Tertiary basement complex, that partially subsided below sea level during the Lower Tertiary and then thrust up to a volcanic geanticline Paleogene and Lower Neogene. This subsiding area was filled up with Tertiary deposits. The Samarinda anticlinorium is the folding that was formed during the Upper Tertiary and Quaternary and extends towards the Meratus Range. The non-volcanic uplifting led to the formation of the Quaternary terraces, such as the Balikpapan peak (1200 m) and other terraces between Balikpapan and Samarinda. Concurrent with the formation of the Meratus-Samarinda zone the Quaternary inland basin (Mahakam Lakes) was formed.

The basins in the southeast and northeast, separated by the Mangkaliat Peninsula, are of Tertiary origin and are filled with clayey and sandy sediments. The Mangkaliat Peninsula itself is a limestone formation. To the north of the Mangkaliat Peninsula are two basins which submerged during the Upper Tertiary. This formation is intruded by the acid volcanic rocks which form an important part of Pliocene deposits.

The Red Yellow Podsolic Soils cover a large area in the inland, on plains to the uplifted mountains, extending from south to north at the altitudes of 50 to 503 m above sea level. These soils are highly leached, acid (pH 4.2-4.8), low in organic and nutrient contents and have a light grey to yellowish surface layer, over a red or yellow horizon of relatively heavy texture, low permeability and low degree of stable aggregation. They are formed on siliceous sedimentary materials on shales, sandstones and ‘claystones’.

The alluvial soils extend along most parts of the coastal area and around the middle Mahakam River and its tributaries north and northwest of Samarinda. The soils underlie the swamp vegetation. Adjacent to the alluvial soils lie the organic soils both in the
coastal and inland areas, especially around the lower parts of large rivers (Sesayap R., Sebuku R. and Kayan R.). These are acid soils which have a relatively thick peat layers overlying a gleyed mineral horizon and are permanently inundated.

The Podsolms mostly occupy the highland of the Apokayan area, south and southwest of Long Nawang on the Iban Range, but they may be found also as pockets in the Red-Yellow Podsollic Soil region in the lowland area, such as at Sebulu, Semboja, and in the vicinity of Melak. These soils have a high raw organic matter layer over a light grey strongly leached sandy horizon overlying a dark brown to reddish illuvial layer (accumulation of iron oxides and/or organic materials). They developed from siliceous sediments, such as sands, sandy loams, sandstones and acid volcanic tuffs.

To the north of the Podsol area in the Iban Range lies a relatively extensive area of Andosols. These soils have a thick black or dark brown surface layer which is rich in organic matter overlying a porous brown to yellowish brown subsurface layer with low nutrient content and low to medium acidity (pH 4.5–6.0).

The Latosols which differ from the Red-Yellow Podsollic Soils primarily in the higher degree of aggregate stability and the accumulation of sesquioxides, occur as scattered spots in the mountainous regions. These soils developed from volcanic parent materials.

A complex of soils cover an extensive area extending from south to north in undulating to mountainous region, about one third of the total area of East Kalimantan.

Climate

The climate in East Kalimantan is everwet with the mean annual rainfall ranging from 1625 mm at Sangkulirang to 4178 mm at Tabang. The driest area where the mean annual rainfall is from 1600 to 2000 mm, extends from Samarinda, Tenggarong, Muara-muntai to Sangkulirang. The wettest area, with the mean annual rainfall of more than 4000 mm, occurs in the mountainous region along the Iban Range. Being located around the equator, the province of East Kalimantan is continuously wet, in which the mean monthly rainfall exceeds 200 mm. However, Sangkulirang experiences very mild dry period during the months of August and September when the rainfall drops to 93 and 68 mm, respectively (Fig. 2). In general the drier period occurs from May to September and January to February, and the wet months in March to April, and October to December.

In the mountainous region the heavy precipitation is attributed to the combined effects of monsoonal and orographic lifting. The orographic rains take place during the wet as well as the dry seasons, but are more striking during the change of the monsoons, when the monsoonal circulation is minimal (OLDEMAN, 1978). Heavy precipitation on the mountain slopes is expected to occur in the afternoon. During the northwest monsoon (October–April), the mountain slopes on the west side receive very much heavier rainfall than the slopes on the leewards side. During the southeast monsoon (May–September), on the other hand, the orographic lift-up of the humid air brings heavy rainfall on the east-facing slopes.

The mean monthly temperature in the coastal areas fluctuates slightly around 25.8°C,
Fig. 2. The geography and climate of East Kalimantan. The climate diagram were constructed following the method of WALTER and LIETH (1960).

as exemplified by temperature at Balikpapan. The mean monthly minimum is 21.5°C and the mean monthly maximum is 31.1°C, and the fluctuation is less than 1°C throughout the year. The temperature data for the inland areas are not available, but it is expected that the mean annual minimum temperature in the coastal areas is about 1°C lower and the mean annual maximum temperature is 1°C higher than the inland areas (OLDEMAN, 1978). Due to the elevational effect, the temperature in the mountainous areas is ex-
expected to be lower than in the lowland. The annual variations and diurnal fluctuations at higher elevations are not so pronounced, but above 2000 m the diurnal fluctuations are greater, due to the strong irradiation (Oldeman, 1978). In East Kalimantan the latter case is expected to occur only around the summits of mountains along the Iban Range.

**Vegetation**

The following is a brief account of the major vegetation types:

1. **Lowland dipterocarp forest**

The lowland dipterocarp forest covers most of the dry-land and occurs on Red Yellow Podsolic soils, Latosols and the complex of soils at elevations of up to about 800 m. It is the most luxuriant, tall, dense evergreen forest with height of 40 m or more, which is conveniently stratified into three layers. Usually there is no monospecific dominant, but the family Dipterocarpaceae is usually dominant in the upper canopy. Frequently several genera of dipterocarps (*Antisopera, Dipterocarpus, Dryobalanops, Hopea, Parashorea*, and *Shorea*) and a large number of species grow side by side. East Kalimantan has 9 genera and about 128 species (about 30% of the total number of species in Malesia) of Dipterocarpaceae and probably there are more, awaiting further exploration. The largest genus is *Shorea* containing about 60 species.

The records show that most of the dipterocarps occur below 800 m elevation. Some of the most widespread species include *Shorea parvifolia, S. johorensis, S. leprosula, S. exeliptica, Dipterocarpus kunstleri, D. gracilis, D. crinitus, Dryobalanops lanceolata, Hopea dryobalanoides, H. beccariana* and *Anisoptera marginata*. Some species, such as *Shorea laevis, S. ferruginea*, and *S. obscura* occur mostly on skeletal soils, while others, such as *S. nitida, S. kunstleri, Dipterocarpus geniculatus* are found generally on ultrabasic soils. Such species as *Shorea superba, S. polyandra, S. gibbosa, S. hopeifolia, Dipterocarpus caudiferus, D. hasseltii, Dryobalanops lanceolata, Hopea nervosa, H. sangal* and *Vatica oblongifolia* grow more abundantly on fertile clay soils.

A non-dipterocarp species, *Eusideroxylon zwageri* or Borneo ironwood, is quite widespread and common in East Kalimantan lowland dipterocarp forest. It is usually found in the second stratum and grows on sandy and alluvial soils on undulating to hilly terrain. The main families other than Dipterocarpaceae commonly found in this forest include Euphorbiaceae, Annonaceae, Lauraceae, Rubiaceae, Meliaceae, Myristicaceae, and Burseraceae. The forest varies from place to place, but usually there are no sharp boundaries to distinguish the variations. These are related to landform, rock types, topography and to the depth and physical properties of soils (Whitmore, 1975). A rather distinctive variation is the riparian forest along rivers, developed under the influence of water courses. Tree species characteristic to this forest include *Heritiera littoralis, Lagerstroemia speciosa, Dracontomelon fuberulum, Dillenia excelsa, Sapindum indicum, Shorea lepida*, and *Cerbera manghas*, and poorly drained alluvial soils *Dipterocarpus oblongifolius, Shorea macrophylla* and *S. seminis* may be locally common. At present there are no quantitative data for East Kalimantan to show the relationship between habitat conditions and forest variations.
2. Kerangas forest

The "kerangas" or heath forest over podsols occurs generally within the region of the lowland dipterocarp forest at the altitude of up to about 800 m (Kartawinata, 1978). It is found most extensively on the highland plateau in the Apo Kayan area where the giant podsols derived from inherently acid, coarsely textured and freely draining siliceous parent materials, occur. Elsewhere it may be found as islands within the matrix of the dipterocarp forest, such as at Long Iram, Sebulu, and the area between Balikpapan and Samarinda, and in the inland area of Bulungan and Sangkulirang. The streams draining the heath forest area are tea-coloured to black owing to the presence of colloidal humus.

Structurally this forest is more stunted than the lowland dipterocarp forest, and it varies from a relatively tall and closed forest to an open scrubby, savanna-like vegetation. Trees are smaller in diameter and lower in height, and have smaller buttresses, stilt roots and sclerophyllous leaves. The ground has commonly bryophyte cover. Epiphytes are frequent and myrmecophytes (e.g. Hydophyllum, Myrmecodia and Myrmecophila) are abundant. Among the ground herbs, the most distinctive plants are the insectivorous species, Drosera, Nepenthes and Utricularia.

The species composition varies from place to place, but certain species are rather typical. In many cases it is similar to that of the peat swamp forest, but is usually different from the lowland dipterocarp forest where the boundary between them is often very sharp. Trees common and abundant in this forest include Tristania obovata, Cratoxylum glaucum, Dacytolycaeus stenostachys, Combretocarpus rotundatus, Dacrydium elatum, Ilex hypoglaucu, and Calophyllum spp. Among the dipterocarps, Cotylelobium malayum, C. burckii, Diptero-carpus borneensis, Anisoptera marginata, Shorea balangeran, and Dryobalanops rappa are common to occur.

3. Montane forest

The montane forest of East Kalimantan has been little explored botanically. Existing records (e.g. Endert, 1927) show that at the altitude of 800-1800 m, the forest is different from that lower down, and the tree height and size are increasingly lower and smaller with increasing elevation. Agathis borneensis and Shorea platyclados are often the most common big trees. Other frequently found tree species include Podocarpus imbricatus, Schima wallichii, Turpinia pomifera, Eugenia banksii, Engelhardtia sp., Lithocarpus spp., Quercus spp., Palaquium spp., Ericaceae (e.g. Rhododendron spp., Vaccinium spp. and Diplycosia spp.) as well as tree ferns (Cyathea spp.), as in many montane forests elsewhere, are common. Trees are usually abundantly loaded with lianas (e.g. species of Freycinetia and Fagraea) and epiphytes. At higher elevations epiphytes often grow on the ground.

On ridges and steep slopes, trees are usually lower and often shrubby, and these are well represented by Tristania whiteana, Phyllocladus hypophyllus, and the species of Rapaena, Helicia, Illicium, Calophyllum, Agathis and Ericaceae. On quartzite ridges, trees (Dacrydium elatum, Phyllocladus hypophyllus, Ericaceae) trunks are frequently heavily loaded with mosses. The moss flora is often quite rich, and it is not uncommon that these mosses (e.g. Sphagnum
and *Myriodendron*) cover the ground also.

4. **Swamp vegetation**

The swamp vegetation covers an extensive area in the northeastern coastal plain, extending from Tanjung Selor (Kayan River estuarine region) to the lower Sebuku River, and in the basin around the lakes in the middle Mahakam River, extending from Muara Pahu in the west to Muara Kaman and then to Muara Ancalong in the north. This vegetation consists of the swamp forest and the grass-dominated swamp vegetation, both overlying organic soils. In the northeastern coastal plain, the swamp forest appears to be well developed and lies behind the mangrove forest, but no information on its floristic composition is available.

The swamp forest and grass-dominated swamp vegetation on the basin around the middle Mahakam River have been briefly reported by ENDERT (1927). The swamp forest, locally known as “hutan rapak”, occurs over permanently inundated dark grey sandy or clay soils. The height of the forest is not more than 10 m, and during high flood the tree crowns are about 4–6 m above the water level. The prevalent species of trees include *Coccoceras sumatrana*, *Ficus retusa*, *Barringtonia spicata* and *Ixora* sp. Each of them frequently forms very dense and almost pure stands. Other species that often mix with them, but are usually scattered, are *Crudia reticulata*, *Mangifera gedebe*, *Dillenia excelsa*, *Scolopia rianthera* (=*spinosa*), etc., while the most common undergrowth are *Mapania* sp. and the climbing bamboo (*Dinocloa* sp.). The dipterocarp species that have been recorded to occur in the non-peaty swamp forest are *Dipterocarpus tempehes*, *D. elongatus*, *Hopea nutans*, *H. rudiformis*, and *Shorea scabrida*, and those growing on periodically inundated or swampy habitats are *Shorea macrophylla*, *S. palebanica*, *S. seminis* and *S. sumatrana*.

The peat swamp forest can be found also in East Kalimantan, but how extensive it is is not known. The specific composition of this forest is to a greater extent similar to that of the kerangas forest. Dipterocarp species that have been recorded in the peat swamp forest in East Kalimantan are *Cotylelobium malayanum*, *Hopea nutans*, *Shorea longiflora*, *S. platycarpa*, *S. scabrida*, and *S. balangeran*. The latter species is reported to be the common and largest tree in the peat swamp forest around the middle Mahakam River.

Behind the swamp forest is the forest that developed on higher ground but always wet, which is inundated only during high flood. The floristic composition is similar to the riparian forest mentioned earlier.

The grass-dominated swamp vegetation occupies a very extensive area around the lakes in the middle Mahakam River, and it is locally known as “padang kumpai”. *Panicum stagninum* or “kumpai” is the dominant species, and mix with this are *Ischaemum digitatum*, *Hymenachne amplexicaula*, *Oryza sativa* var. *spontanea*, *Leersia hexandra*, *Paspalum scrobiculatum*, *Polygonum celebicum*, and *Rynchospora corymbosa*. Here and there stands of tall grass communities consisting of *Phragmites karka*, *Saccharum arundinaceum* and *Lepironia mucronata* may be present. Scattered in this grass field are trees of *Coccoceras sumatrana*, *Phyllanthus reticulatus*, *Dillenia excelsa* and *Lagerstroemia speciosa*. 
It is believed that this grass community developed after repeated burning of forest, thus similar to the *Imperata* grassland on dryland. During the dry season the water level goes down so low and both the forest and grass fields become dry and are susceptible to fire.

5. Mangrove forest

The most extensive mangrove forest can be found along the coast, extending from Tanah Grogot to Balikpapan in the south, in the estuary of Mahakam River, and in the estuarine region stretching from Tanjung Selor to the border with Sabah in the north. It developed on deltas and riverbanks extending for tens of kilometers inland. The forest zonation is apparent, and the dominants and species composition in each zone is dependent on habitat conditions (soil texture and structure, salinity and tides, in particular). *Rhizophora mucronata*, *R. apiculata*, *Bruguiera gymnorrhiza*, *B. parviflora*, *Sonneratia alba*, *S. casuarinoides*, *Avicennia alba*, *A. officinalis*, and *Nypa fruticans* are commonly the prominent species.

6. Secondary forest

The secondary forest on dryland, known also as "belukar", is estimated to be more than one million hectares, scattered throughout the province. It represents secondary growth of different ages, and has developed as the result of shifting cultivation practices and recently mechanized logging activities. Structurally it ranges from a simple young unistral, mixed herbaceous and woody plant community to a more complex three-layered old secondary forest. The floristic composition varies from place to place, depending on the age, degree of destruction of the original vegetation, habitat conditions, and surrounding vegetation.

In general the prevalent woody species in young secondary growth on red-yellow podsolic soils and latosols are *Trema orientalis*, *Callicarpa longifolia*, *Melastoma malabathricum*, *Macaranga bancana*, *M. gigantea*, *M. triloba*, *Mallotus affinis*, *Anthoecephalus chinensis*, *Endospermum diadenum*, *Dillenia excelsa*, and often also species of primary forest that grow through resprouting. In many places, *Schima wallicheii*, a primary forest species occurring from sea level to about 2000 m above sea level, is frequently found in secondary forests of different ages. Herbs in the early secondary growth are primarily dominated by *Paspalum conjugatum*, which usually soon disappears after the ground is completely shaded.

In the old secondary forest, except for *Callicarpa longifolia* and *Melastoma malabathricum*, the above tree species remain the important components of the forest. The main families containing large number of species are generally Euphorbiaceae, Annonaceae, Lauraceae, Rubiaceae, Myrtaceae and Moraceae in that order.

On podsol soils, the secondary forest which derives from kerangas forest differs in composition and structure; it is often scrubby. In general the flora contains a large number of species of the original vegetation, as the regeneration takes place frequently through resprouting of cut or burnt stems and roots. However, a pioneer species typical to the kerangas forest is *Ploiarium alternifolium*, which often dominates the secondary growth.

7. Grassland

The grassland in East Kalimantan is largely dominated by *Imperata cylindrica*. Cur-
rently it is estimated to cover more than 300,000 ha, and most prevalent in the southern part of the province. It derives largely from the shifting cultivation areas that have experienced repeated burning. Only a few species, such as *Melastoma malabathricum*, are associated with *Imperata cylindrica*.

The grassland on white sand podsol soils, derived from the kerangas forest, has different species composition. *Imperata cylindrica* is in general less common, but other species, such as *Themeda gigantea, Saccharum spontaneum* and *Pteridium aquilinum* are more prominent.

8. **Limestone forest**

Limestone forest appears to cover a substantial area in East Kalimantan, especially in the Berau and Bulungan areas. At present, however, little is known about the structure and composition of this type of forest.

**Vegetational and floristic observation on the localities botanized**

**Tarakan and Sekatak**

Tarakan is a town situated on Pulau Tarakan which has been developed along with the oil production. The island itself has no primitive forest at the moment and is open in most part. All the plants growing in the open places are those common in sunny lowlands in SE Asia. In the northern part of this island there is a small experimental garden belonging to the P.T. Inhutani where the tall *Agathis* trees are preserved in natural condition, though the vegetation around them seems to have been changed greatly.

From Tarakan we visited a camp along the Sekatak river. The United Investment & Finance (H.K.) Ltd. kindly offered us the facilities to stay at their guest house at Sekatak and the transportation to send us some 35 km interior of the camp in Sekatak. The camp is situated at about 3°20'N and 117°10'E and is about one hour and a half sail by a speedboat from Tarakan. Leaving from Muara Sekatak, we proceeded up to Sungai Sekatak by that boat. Along the river we could observe a finely developed mangrove forest, changing gradually to beautiful Nippa forest, and then we saw the tropical rain forests developed along the river-side just before we arrived at the camp.

We botanized in Sekatak for three days. In the first day, we worked in a forest some 10 km to the interior of the camp where the commercial trees were cut down several years before. The forest is mostly dry inside even along small streamlets. Along newly constructed road, there were wild bananas growing very well on open places in a recent clearing. In the second and third days, we visited various places where the operation of the timber company had just set on. We could observe the forest in which the trees were either cut down recently or to be cut down in near future. There were a variety of soils in this area: *Agathis* was conspicuous on sandy soils, mostly consisting of weathered granites, and Dipterocarpaceous trees were dominant in moist clayey places. The slope appeared to be rather dry even in the rainy season when we visited the area, though the branches of the trees were covered with mosses especially along the streams. In such an area, the surface of the branches seemed to be too wet to bear more epiphytic plants.
Most of the epiphytes growing in the mossy forests seemed to prefer moist air, but they appeared to avoid very wet condition where no temporary draught has never occurred.

The Sekatak river seems to be frequently flooded after heavy rains, and there is a sign of rheophytic vegetation along the river. We saw from our boat a colony of *Dipteris lobbiana* occurred on such habitat, though we lost any chance to observe and collect the rheophytic plants around Sekatak.

**Samarinda**

We set our base in this lovely city while we worked in Kalimantan Timur for about ten weeks. We could, therefore, have botanical observations in and around the city while we stayed there. This area is well populated for a long time, and the forests were mostly destroyed by various human activities. We tried to collect the plants carefully to include all the species from this area, although it was rather pity that several epiphytic species, including *Platycerium coronarium*, were observed only on the tall trees and we could not get any specimens of them. Most of the species in Samarinda and vicinity are those common in the open areas with wide distribution throughout Malesia, though some others were found in a deep shade of rather dense tall trees.

**Sebulu**

P.T. Kutai Timber Indonesia established its camp at Sebulu about eight years before, and they operated there to cut down and bring out the big commercial trees. The primitive forests still remain in some areas with many logging roads cutting through them (Fig. 3).
3) Along the main logging road which now extends more than 50 km from the bank of Mahakam River northwards to Sedulang, we could compare the flora and vegetation of the areas where the big trees have been recently cut down with the primitive forest. In enumerating the fern species as an indicator, most of which are terrestrial there, we could not find any distinct difference between these two areas, although the primitive forests are better populated by the ferns both in number of species and of individuals.

There are peculiar sandy places some 18 km north of Sebulu, where kerangas forests occur. There are a few Dipterocarpaceous trees (e.g. Shorea balangeran), but Tristania obovata (Fig. 4) in the periphery and Combretocarpus rotundatus and Dactylocladus stenostachys in the centre are dominant. The soils seem to be poor, and the pH was observed to be 3.8–4.0. All the trees are not very big, and forests are rather thin with more light inside, though no trees have been cut down there. This forest has been described by KARTAWINATA (1980).

It is rather pity to observe the shifting cultivation is expanding forwards the interior of the forest along the newly constructed roads. After burning the forests completely,
the soils are exposed to direct sunshine and quick recovery of the original forests can never be expected there. For more effective conservation of the forest in Kalimantan, it should be urgently recommended to have an appropriate regulation of the shifting cultivation practices, which destroy the forest completely.

**Tabang and Gunung Mendam**

Another camp was newly operated by P.T. Kutai Timber Indonesia in Tabang, situated at the centre of Kalimantan Timur, or about 0°35’N and 165°E. The logging has been operating for just one year, and the forests are mostly in primitive condition. As shown in the map G Mendam with the peak of 1015 m above sea level is located in the concession area. We botanized it, and found in our portable altimetre that this peak, as indicated by the geodetic tower built by the Dutch geologists during their topographic survey before the Second World War, is about 900 m. This mountain is like a dome, and the slope in every direction is very steep. There are no particular species characterizing this steep slope, which is very dry, and the Dipterocarpaceae are growing even

![Fig. 5. A dipterocarp on G Mendam.](image-url)
at the elevation of 600 meters there (Fig. 5). At about 750 m alt. we arrived at the ridge which is rather narrow and extended to the summit in a gentle slope.

Around the highest peak of G Mendam, there are several hills with altitudes of more than 500 m. We climbed up two of them, though the species observed are nearly the same as those found in the middle elevation of G Mendam. The forests at low altitudes of G Mendam have been recently logged by the timber company, and more sunlight is penetrating inside. We are not sure whether or not the vegetation and flora have changed, for there are still a variety of species there which are similar to those collected in the virgin forests in this area.

**Jelini to Gunung Batukenye**

We at first expected to explore Gunung Menyapa which according to the map is 2000 m above sea level. There is a variety of information on this mountain and the river by which we have to approach it. The conclusion we had at Tabang was that it would take nearly one month to explore this mountain, and we changed our mind to botanize Gunung Batukenye which was said to need a week to explore in details.

A long-boat sailed up the river for about three hours from the Tabang camp of P.T. Kutai Timber Indonesia, which is located at about a quarter of an hour up the river from Kampong Tabang, and arrived at Jelini where we had to leave the boat. On the upper course of the Belayan river near Jelini, the primitive forests developing on both sides of the river are loaded with a variety of climbers (Fig. 6). Sungai Belayan is the largest branch of the Mahakam, and the current in the upper course is rather rapid especially during the rainy season. When we visited G Batukenye in the first half of January 1979,
there were unusually heavy rains. The current of the river was very strong, and hence we could not go beyond Jelini by the long-boat we hired.

There is a distinct path along Sungai Belayan, and is said to lead to Gunung Bulu (or Gunung Belayan on the map), but according to the villagers it needs one month walk to arrive there. Small villages with several houses are said to be located on the way, and the people there, the Dayaks, still practice the shifting cultivation and hunting. They can get a good money by collecting the bird’s nests for Chinese food. A timber company owned by a Malaysian is operating somewhere there, and there is a small cottage of that company on the way several hours from Jelini. The forests are still undisturbed in this area, and we had a comfortable walk in the dense forest collecting a variety of plants on the way.

The most conspicuous floristic element we observed near Jelini along Sungai Belayan is a variety of species that form the so-called rheophytes. The water-level of S Belayan was high after several heavy rainy days when we were there, and the rheophytic plants along the river were mostly under or a little above the water-level. The narrow belt of about 2–3 metres wide on the river-side had been repeatedly washed by river floods, and hence normal vegetation can not be observed there.

We may better record here two of our experiences which are valuable to understand the habitat of the rheophytic plants. On the second day of our trip to G Batukenye, there was a heavy rain in the morning. When we arrived at the cottage of the Malaysian timber company, we saw a small branch of the river over there was nearly flooded and we were not able to cross it. Our guide confidently told us that we could expect to go across the river in the next morning. In the afternoon the river was some five metres across and about two metres deep. We were rather doubtful whether we could go across it easily in the next morning or not. We found, in the next morning, that the guide was correct and we could go across the river without difficulty and the water level was only knee-high. Another experience we met was on the day up to G Batukenye. Just after we left our camp in the morning, we went across easily another branch of the river. While we were on the top of that mountain, we were heavily rained out for about two hours. After having rich collections on that mountain, we went back rather triumphantly, but we suddenly found it impossible to cross the river. The water formed a rapid current, and the depth was about our height. Our camp was just over the river, but we could not wait there overnight completely wet. Our labourers cut a tall tree, and put it over the stream. Depending on that tree trunk, we went across immersed in the rapid stream of the river. In the next morning the river was quiet again, leaving that tree trunk remained more than one metre above the surface of water. We are noting these experiences just to show how the water level is frequently changing in this area.

In such a habitat live the so-called rheophytes characteristic in having narrower laminae (leaves, leaflets, pinnae, pinnules, or lobes) and sharper angle between different orders of the axes (rhachis-costa, costa-costule, costule-mainvein) (Fig. 7).

G Batukenye is noted on the map as having the elevation of 656 m above sea level, but our two altimetres showed only 580 m and 575 m respectively, thus making uncertain again its accurate altitude. Although this is not a very high peak, there are mossy forests with a variety of epiphytic plants developed at the top. The flora is rich on this mountain, which is wholly kept virgin and enveloped with moist air.

**Balikpapan**

Hiring a boat we botanized a day in a mangrove thicketed on the opposite side of the...
city at Teluk Balikpapan. Typical mangrove has developed there, and we could work also on the sandy beach collecting the plants commonly found on such a habitat (Fig. 8).

**Gunung Beratus**

This is situated at more than 50 km west of Balikpapan and has already been explored
by several botanists. The altitude is said to be 1223 m above sea level. P.T. Balikpapan Forest Industries is operating in this area, having the concession area of about 240,000 ha there, and we owed them the transportation between Balikpapan and the foot of that mountain. We rode a speed-boat for one hour from Balikpapan to Sotek, and proceeded to the foot of Gunung Beratus by a jeep for about 50 km on the road constructed by that company. The operation has been carried on since 1969, and we could observe along the road a serial change of the vegetation recovered from the damage by cutting down the big trees at various times. It is natural that we can see only limited members of common weeds in open places along the road. We were not very sure about the species growing there, for we saw them only from a moving jeep and actually collected only a few specimens along the road. As to the ferns, we saw several species which are never seen in the dense forests and are known only in the open places, such as *Pityrogramma calomelanos*, *Pteris vittata*, *P*. sp., *Macrothelypteris torresiana*, *Blechnum orientale*, varieties of *Dicranopteris linearis*, and so on. They are the common members of the ferns which are the first invaders in the cleared places. We set our camp for two nights at the southwestern foot of G Beratus, at about 350 m above sea level, and explored around there in the afternoon of the first day. That area was rather dry, though we met a heavy shower in the evening, and the people there told us that there were showers every day somewhere in the area of that mountain.

On the second day we botanized G Beratus. We were expected to arrive at the top by one-day trip from our camp, but unfortunately we could not find any good guide and we had to manage the trip wholly by ourselves with the result that we could go along the ridge only up to about 900 m above sea level. As we went up along the ridge cutting off the trail there, we could not see many terrestrial species, and most of the epiphytes were common species usually expected to be in the middle elevation of the mountains there. It was an unsuccessful trip, but still we collected various interesting materials. The ridge and the slopes just below it were generally dry, though the tree-trunks were mostly covered with the thin layers of the bryophytes and the filmy ferns, with some additional epiphytic ferns and orchids. This was not mossy at all, and the filmy ferns observed there were: *Mecodium polyanthos*, *Meringium pachydermicum*, *M. holochilum*, *M. meyenianum*, *M. lobbii*, *Pleuromanes pallidum*, *Microtrichomanes digitatum* and others, all of which are the species not forming a thick mat on the tree-trunks.

**Bandjarmasin**

We stayed in Kalimantan Selatan for about three weeks setting our base in Bandjarmasin. We made a week trip to Pegunungan Meratus and several one-day trips around Bandjarmasin. In the southernmost part of Borneo near Bandjarmasin, there is a wide area of acidic marshy plains, with dark soils and transparent water often tinted brown. There were several water plants observed, including such species as *Ceratopteris thalictroides*, *Ottelia asiatica*, *Nymphoides indica*, *Hydrocera triflora*, *Scirpus* spp., *Polygonum* spp., *Utricularia*, *Nymphaea* and others. The marshy vegetation has widely developed with
scattered bushes consisting of *Melaleuca leucadendra*, *Dillenia*, *Melastoma* and others.

**Gunung Besar** (Pegunungan Meratus)

Pegunungan Meratus is a mountain range projecting to the southernmost portion of Borneo and consists of several peaks higher than 1000 m above sea level. Gunung Besar is the highest on this mountain range, with a peak of 1892 m above sea level. We made a nine-day trip to G Besar on which we could collect in some details.

There were paddy fields and forests along path to the last village, Batu Kambar, at about 250 m above sea level. We went up to a pass of some 800 m and went down again to the river at about 350 m alt. From this river-side, the trail goes up to G Besar. There were several Dayak houses at about 500 m above sea level where we set our base camp. The Dayak people live mostly on shifting cultivation, and rubber plantation was seen near the village. The bamboo thickets developed especially along the streams. Except for these small modifications, the mountain slopes above 600 metres were generally covered with the primitive forests. The montane forests developed below 1200 m above sea level, and a rich flora was observed in this area. The outstanding members were: *Palmae*, *Zingiberaceae*, *Rubiakeae*, *Acanthaceae*, *Urticaceae*, *Moraceae*, *Dirrenicaceae*, *Annonaceae*, *Araliaceae*, *Myrtaceae*, and various ferns including the tree-ferns especially along the streams. There were a few species of Labiatae observed, including such Himalayan-Malesian montane members as *Gomphostemma* and *Scutellaria discolor*. The rheophytic habitat was observed along the river-side at about 1000 m alt., with *Asplenium dichotomum* on the rocks in the stream-beds (Fig. 9).

The mossy forests typically developed beyond 1500 m alt., with a variety of bryophy-

![Fig. 9. A river-side view at about 1000 m alt. on G Besar with Bamboo thicket.](image-url)
Fig. 10. Mossy forest at about 1500 m alt. on G Besar.

Fig. 11. *Rhododendron* sp. near the summit of G Besar.

tes, orchids and the epiphytic ferns including Hymenophyllaceae, Grammitidaceae, and Polypodiaceae (Fig. 10). The ridge above a peak of 1600 metres consists of granite bases, covered with the ericoids, such as *Rhododendron* (Fig. 11), *Vaccinium*, *Gaultheria* and others, and the notable plants found near the summit area were *Dacridium*, *Clethra*, *Drimys*, *Dipteris* and others.
Discussion

Natural regeneration of the dipterocarp forest.

In all the tropical rain forest, the climax vegetation seems to be maintained by gradual fulfilments of the successors. In deeply shaded places on lowlands, we did not have any chance to observe the seedlings or the juveniles of the dipterocarps. In open places especially in recent clearing, however, numerous seedlings of some dipterocarps were often observed. It is rather interesting to see the juveniles and the young plants along the newly constructed roads, and the ages of these trees are usually corresponding to those of the roads concerned (Figs. 12, 13).

There are sometimes small empty spaces among the dense lowland forests, and these spaces seem to be formed by big fallen trees by various reasons. The age of the adult trees can not be guessed, and we have no information as to how long the dipterocarps can live on. In primitive forests, we rarely see the trees fall down, though there are empty places for instance after land-slides or floods. In these open places, the seedlings and/or the juveniles of the dipterocarps are usually observed, and they seem to occupy the empty places after all. The natural regeneration of the dipterocarps seems to occur through such a way, and the partly cleared areas, for instance by the natural fires, may be recovered partially by gradual growth of the dipterocarps, although we do not yet know how long does it take for these trees to grow up to the height of more than 50 m tall.

Fig. 12. Juvenile plants of Anthocephalus chinensis along newly constructed road in partly cleared area at foot of G Mendam.
March, 1980  


21

Fig. 13. Young plants in pioneer forest along road in recent clearing in Sebulu.

**Destruction of natural forests.**

It is one of the biggest problems at the moment that most of the tropical rain forests are being destroyed by the human activities. When we flew from Samarinda to Tabang, we saw the lowland forests in Kalimantan Timur from the air at about 1500-2000 m altitude. Most of the lowlands are covered by the green crowns by a first appearance, though by careful observation in almost every part we have seen the new roads could be traced. This means that most parts of the lowlands in Kalimantan Timur have already been logged by the timber companies.

In most parts of the lowland forests, only the big trees with commercial values were cut down, hence the roads to carry these woods out are important to be constructed through the forests. We have compared the flora of the concession areas of these timber companies, that is the flora in the primitive forests and that in the areas already selectively logged. In enumerating the species observed in various parts in the same concession areas, there is a difference between the primitive and cut down areas, especially in the number of individuals of some uncommon species. The distinct difference is seen in many invaders in the clearings: there are a variety of newly formed vegetations along the road or in recently cleared areas, and various successive stages are observed according to the age of the sites concerned (Figs. 12, 13).

The most conspicuous changes of landscape is introduced by a shifting cultivation (Fig. 14). In the areas without any new roads the Dayaks burn the forest only near the boat-harbour along the rivers. Only a few houses are seen in each village, and the
cultivated areas are usually narrow and quite primitive. The recovery of the forests seems to be natural in this type of fields. When the natives burn the logged-over forests, however, the area becomes wider. More complete and extensive burning occurs especially when a number of people take part in the work, and it is aggravated by a better transportation facilities through newly constructed roads. In such a case, especially if combined with repeated burnings over the same sites, the recovery of the natural vegetation seems hardly possible. High temperature of the ground and direct strong sun-shine will prevent the growth of primary forest species. In such a case only pioneer species will thrive well. The destruction of nature proceeds more devastatingly by this kind of an organized shifting cultivation.

*Nature conservation*

In view of the fact that the destruction of the natural vegetation proceeds very rapidly, we have to propose urgently the following actions. 1) More nature conservation areas should be established immediately with a proper management. It is necessary to preserve various types of forests and keep them in natural state. For this purpose, a considerable area for each type of the forest should be kept virgin. 2) Shifting cultivation should be controlled, especially in logged-over areas, or better replaced by a permanent agriculture. As noted in the preceding section, the damage of the forest by large-scaled shifting cultivation is very serious. A strict control of shifting cultivation is important to keep perpetual regeneration of the forest in tropical countries. 3) The fundamental research on the forests should be carried out in the concession areas before the primitive condition is modified by the operation of the timber companies.

The third action is a duty for the biologists, especially for the taxonomists, for the study on the flora and fauna can not be made fully after the natural vegetation has been destroyed, and they will not return to the original condition even if the vegetation become rich again after many years. It is necessary to have more actions on nature conservation. It is, however, rather pity to recognize that it goes along with the development of the civilization. Therefore, the fundamental botanical researches should be made before
the destruction of the forests will proceed further.

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