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PHYTOSOCIOLOGICAL STUDIES ON TROPICAL PEAT SWAMPS
5. FOREST VEGETATION AT NAMAN, SARAWAK, EAST MALAYSIA

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PHYTOSOCIOLOGICAL STUDIES ON TROPICAL PEAT SWAMPS 5. FOREST VEGETATION AT NAMAN, SARAWAK, EAST MALAYSIA

Kunio SUZUKI, *Yokohama National University, Yokohama, Japan*
Nobuo KANEKO, *Shimane University, Matsue, Japan*
Ernest Chan Oi KHUN, *Forestry Department, Sibü, Malaysia*
and
Frankie TIEH, *Forestry Department, Sibü, Malaysia*

Synopsis: In the wide zones of coastal lowlands in Sarawak, there are typical well-developed peat swamp forests. This paper presents a phytosociological description of peat swamp forests with a community table. The study site, Naman, is about 10 km south of Sibü, Sarawak, East Malaysia. The forests were summarized as a *Ilex hydroglauca-Cephalomappa paudicola* community in accordance with the concepts and methods of the Zürich-Montpellier School.

Key words: Peat Swamp, Phytosociology, Sarawak, Tropical Vegetation

INTRODUCTION

Most of the known reserves of tropical peat are in Southeast Asia, the Caribbean, Africa and Central and Southern America. There are about 30 million hectares of tropical peat land, about two thirds of which occurs in Southeast Asia. In Southeast Asia, peat lands cover extensive tracts of land in Indonesia, Malaysia, the Philippines and Thailand, mainly between coastal mangrove swamp and terrestrial rainforest (SUZUKI & NIYOMDHAM, 1992).

The age of tropical peat varies from around 2,000 years near the coast to over 8,000 years in some inland deposits, while some tropical peat lands are young and still accumulating, others are much older and eroding. It is estimated that there are about 12 million hectares of tropical peat land at Sarawak. The peat swamp forest of Sarawak is structurally divided into physic communities referred to as mixed swamp forest, alan swamp forest, padang alan forest and padang paya forest. The first three types have important commercial value and have been the mainstay of the sawmilling industry in the state since the mid-fifties.

OUTLINE OF THE SURVEY AREA

The survey area Sibü is located on a flat coastal plain of Sarawak (Fig. 1). The study site, Naman, is about 10 kilometers south of Sibü, Sarawak. Naman

is located at the center of the Sarawak lowland (2° 12' North and 110°49' East). The climate of the area is "Af - climate of tropical rainforest without distinct dry season-" according to Köppen's classification.

METHODS

The present work was carried out on the forest vegetation found growing in the peat swamp of the Naman site. The forest vegetation was investigated by the present field survey in accordance with the concepts and methods of the Zürich-Montpellier School.

It was determined that each and every stand selected for the survey had to have an area (10m by 10m) in habitat which showed homogeneous physiognomy, and therefore, could be judged evenly. All the species within the stand were checked to make a complete taxon list by layer. Each relevé was divided into emergent tree layer, tree layer-1 (overstory trees), tree layer-2 (understory trees), shrub layer, and herb layer according to the height of the stand. The cover degree-abundance scale is the following one, originally proposed by BRAUN-BLANQUET in 1964.

- 5 : any number of individuals but cover more than 3/4 of the area
- 4 : any number of individuals but cover 1/2 to 3/4 of the area

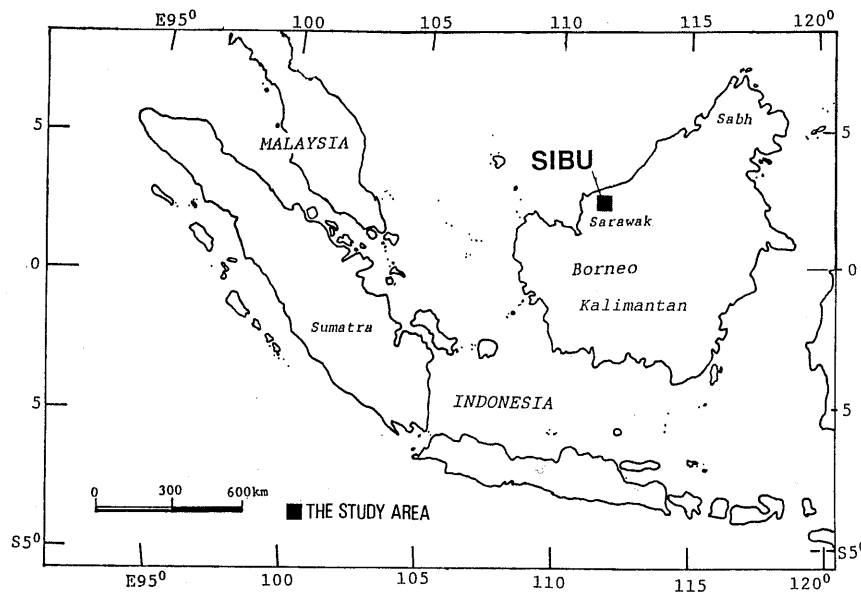


Fig. 1. Map showing the location of the survey area.

- 3 : any number of individuals but cover 1/4 to 1/2 of the area
 2 : very numerous in abundance of individuals or covering at least 1/20 of the area
 1 : plentiful but of small cover value
 + : sparsely or very sparsely present, cover very small or insignificant

For tree layers, especially larger trees, diameter at breast height (DBH) were also measured and recorded. In community table 1, total number of tree species on tree layers (emergent tree layer, tree layer-1 and tree layer-2) is shown instead of the cover degree-abundance scale and the sociability.

Each individual taxon must be estimated for its appropriate cover degree. All the individuals of the same plant taxon are considered jointly to represent to cumulative cover degree, and the appropriate symbol must be chosen from the above cover degree-abundance scale. Another quantitative estimate per taxon is its sociability rating. Included in sociability is the grouping or touching of individuals of the same taxon, and the clumping or clustering of that one species within the confines of the sampled area. The sociability scale is described in the following section, proposed BRAUN-BLANQUET (1964) and MIYAWAKI & SUZUKI (1980).

- 5 : growing in very extensive patches or covering the sample area in one large population
 4 : growing in large groups or colonies, forming

patchy carpets, fairly extensive

- 3 : growing in small patches or troops or cushions
 2 : growing in small groups or tufts or clumps
 1 : growing in small singly or the plant individuals are not touching each other by foliage

Plant names were identified by Mr. TIEH, Frankie, Mr. MORDIDI and staff of the Forestry Department at Sibu.

RESULTS

Ecological Character of Swamp Forest

In the wide zones of coastal lowlands in Borneo, Peninsula Malaysia and neighboring, there are four main types of swampy forest (WHITTEN, DAMANIK, ANWAR & HISYAM, 1987 *et al.*)

- Mangrove forest, situated on a fringe of muddy coast and flooded regularly with saline water
- Brackish-water forest, flooded occasionally; typical is limiting of river banks with the palm *Nyssa*, which needs brackish water for at least part of the year
- Peat swamp forest, which, sometimes, is situated on peat domes 2 to 10 meters deep
- Freshwater swamp forest, which lies in strips along the major river traversing the swamps;

Table 1. *Ilex hydroglauca*-*Cephalomappa paudicda* community

| Releve no.: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|--|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Field no.: | S1 | S2 | S3 | S4 | S5 | T1 | T2 | T3 | T4 | T5 |
| Area of releve (qm): | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Height of emergent tree layer(m): | 33 | 28 | 30 | - | 29 | 27 | 27 | 27 | 27 | 28 |
| Cover of emergent tree layer(%): | 40 | 10 | 20 | - | 15 | 20 | 25 | 20 | 15 | 30 |
| Height of tree layer-1(m): | - | 27 | 27 | 27 | 27 | 24 | 24 | 24 | 24 | 24 |
| Cover of tree layer-1(%): | - | 40 | 60 | 30 | 60 | 40 | 20 | 10 | 50 | 40 |
| Height of tree layer-2(m): | 20 | 20 | 20 | 20 | 20 | 16 | 16 | 16 | 16 | 16 |
| Cover of tree layer-2(%): | 60 | 50 | 50 | 60 | 40 | 30 | 30 | 25 | 40 | 30 |
| Height of shrub layer(m): | 6 | 5 | 5 | 6 | 6 | 6 | 6 | 5 | 6 | 5 |
| Cover of shrub layer(%): | 35 | 15 | 30 | 20 | 40 | 35 | 60 | 50 | 25 | 20 |
| Height of herb layer(m): | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 1 | 1 | 1 | 0.8 | 1 |
| Cover of herb layer(%): | 20 | 25 | 30 | 20 | 10 | 15 | 15 | 10 | 30 | 10 |
| Total no. of species: | 50 | 52 | 54 | 45 | 44 | 43 | 38 | 44 | 54 | 44 |
| <i>Ganua motleyana</i> (de Vriesse) Pierre ex Dubard (Sapotaceae) | T2 | . | . | 2 | . | . | . | . | . | . |
| | S | + | + | + | + | . | . | . | . | . |
| | H | . | . | . | + | . | . | . | . | . |
| <i>Blumeodendron tokbrai</i> (Bl.) J.J.Sm. (Euphorbiaceae) | T2 | . | . | 1 | . | . | . | . | . | . |
| | S | + | + | . | 1.1 | . | . | . | . | . |
| ↓ (Euphorbiaceae) | H | . | . | + | . | . | . | . | . | . |
| <i>Neoscortechinia kingii</i> (Hk.f.) Pax et K.Hoffm. | S | + | + | + | + | . | . | . | . | + |
| <i>Aglaonema</i> sp. (Araceae) | H | 1.2 | +2 | + | 1.2 | +2 | . | . | . | . |
| <i>Polyalthia sclerophylla</i> Hk.f. et Th. (Annonaceae) | S | . | . | + | + | + | . | . | . | . |
| | H | + | . | . | . | . | . | . | . | . |
| <i>Antidesma montanum</i> Bl. (Euphorbiaceae) | S | + | + | + | + | . | . | . | . | . |
| <i>Mangifera havilandii</i> Ridley (Anacardiaceae) | S | 1 | . | + | + | . | . | . | . | . |
| | H | . | . | . | + | . | . | . | . | . |
| <i>Ixora havilandii</i> Ridley (Rubiaceae) | S | + | . | + | + | . | . | . | . | . |
| | H | . | . | + | . | . | . | . | . | . |
| <i>Eugenia subsessilifolia</i> Merr. (Myrtaceae) | E | . | . | . | . | 1 | . | . | . | . |
| | S | . | + | . | . | 2.3 | + | . | . | + |
| | H | . | . | . | . | +2 | + | + | + | + |
| <i>Canthium umbelligerum</i> Miq. (Rubiaceae) | S | . | . | . | . | + | + | + | + | . |
| <i>Lithocarpus dasystachyus</i> (Miq.) Rehd. (Fagaceae) | T1 | . | . | . | . | . | 1 | 1 | 3 | . |
| | S | . | . | . | . | . | . | . | 2.2 | 2.3 |
| | H | . | . | . | . | . | + | + | 1.2 | +2 |
| <i>Kibessia coriacea</i> Cogn. (Melastomataceae) | S | . | . | . | . | . | + | + | + | + |
| <i>Cephalomappa paludicola</i> Airy Shaw (Euphorbiaceae) | T1 | . | . | 1 | 1 | 1 | 2 | 1 | . | . |
| | T2 | 7 | 10 | 7 | 5 | 5 | 5 | 4 | 1 | 4 |
| | S | 2.3 | 2.3 | 2.3 | 2.3 | 3.3 | 2.2 | 4.4 | 3.3 | 2.2 |
| | H | 1.2 | + | + | + | + | 2.3 | . | 1.2 | 1.2 |
| | S | . | . | . | . | + | + | + | +2 | + |
| | H | + | + | +2 | . | + | +2 | . | . | . |
| Cyperaceae sp. | S | + | 1.2 | +2 | 3.3 | 1.2 | . | 1.2 | 1.2 | 2.3 |
| | H | + | . | 1.2 | +2 | 1.2 | 1.2 | . | 1.2 | . |
| <i>Diospyros siamang</i> Bakh. (Ebenaceae) (or <i>Diospyros havilandii</i> Bakh.) | T2 | . | . | . | . | . | . | . | . | 1 |
| | S | + | . | 2.2 | + | + | + | + | + | + |
| | H | . | . | + | . | . | . | + | + | . |
| <i>Ilex hypoglauca</i> (Miq.) Loes. (Aquifoliaceae) | T1 | . | . | . | . | 2 | 1 | . | . | . |
| | T2 | 6 | 6 | . | 3 | 2 | 4 | 1 | . | . |
| | S | . | + | + | . | . | + | . | . | + |
| <i>Garcinia bancana</i> Miq. (Guttiferae) | T2 | . | . | . | . | 1 | 3 | . | . | . |
| | S | . | + | . | + | . | + | + | . | + |
| <i>Diospyros avena</i> Bakh. (Ebenaceae) | T1 | . | 1 | . | . | . | . | . | . | . |
| | T2 | . | . | 2 | . | 1 | . | . | . | 3 |
| | S | . | . | . | . | . | . | . | . | + |
| <i>Santiria rubiginosa</i> Bl. v. nov. (Burseraceae) | S | . | + | + | . | . | . | . | + | + |
| <i>Eugenia leucoxylon</i> (Korth.) Miq. var. <i>phaeophyllum</i> (Myrtaceae) | T2 | . | 1 | . | . | . | . | . | . | . |
| | S | . | + | . | + | . | . | + | + | . |
| | H | . | . | . | . | . | . | + | . | . |
| <i>Pandanus</i> species (Palmae) | S | . | +2 | + | . | . | 2.2 | . | . | . |

| | | | | | | | | | | | | |
|--|----|-----|---|----|---|---|---|---|---|---|---|---|
| | H | 2·3 | . | . | . | . | . | . | . | . | . | . |
| Blumeodendron kurzii (Hook.f.) J.J.Sm. (Euphorbiaceae) | S | + | . | + | . | . | . | . | . | . | . | + |
| Elaeocarpus beccarii A.DC. (Tiliaceae) | S | + | . | . | + | . | . | . | . | . | . | + |
| Elaeocarpus marginatus Stapf (Tiliaceae) | T2 | . | . | . | . | . | . | . | . | . | . | 1 |
| | S | . | . | . | . | . | . | . | . | + | . | + |
| | H | + | . | . | . | . | . | . | . | . | . | . |
| Aromadendron nutans Dandy (Magnoliaceae) | T2 | . | . | . | 1 | . | . | . | . | . | . | . |
| | S | . | + | + | . | . | . | . | . | . | . | + |
| Shorea inaequilateralis Sym. (Dipterocarpaceae) | T1 | . | . | 1 | . | . | . | . | . | . | . | . |
| | T2 | . | 1 | 2 | . | . | . | . | . | . | . | 1 |
| | S | . | . | + | . | . | . | . | . | . | . | + |
| | H | . | + | . | . | . | . | . | . | . | . | . |
| Dillenia pulchella (Jack) Gilg. (Dilleniaceae) | S | . | . | . | + | . | . | . | . | . | . | + |
| | H | . | + | . | . | . | . | . | . | . | . | . |
| Lophopetalum multinervium Ridley (Celastraceae) | T2 | . | . | . | 1 | . | . | . | . | . | . | . |
| | S | . | . | + | . | + | . | . | . | . | . | + |
| Eugenia havilandii Merr. (Myrtaceae) | T2 | . | . | . | 1 | . | . | . | . | . | 2 | . |
| | S | . | . | + | . | . | . | . | . | + | . | . |
| Goniothalamus andersonii J.Sinclair (Annonaceae) | T2 | . | . | . | . | . | 1 | . | . | . | . | . |
| | S | . | . | + | . | + | . | . | . | . | . | + |
| | H | . | . | . | . | . | . | . | . | . | . | . |
| Camposperma coriaceum (Jack) Hall.f. ex van Steen. (Anacardiaceae) | E | . | . | 1 | . | 1 | . | . | . | . | . | . |
| | S | . | . | . | . | . | . | . | . | . | . | + |
| Rhamnaceae species N-1 | S | + | + | . | + | . | . | . | . | . | . | . |
| | H | . | + | . | . | . | . | . | . | . | . | . |
| Litsea crassifolia (Bl.) Boerl. (Lauraceae) | S | . | . | . | + | + | . | . | . | . | . | + |
| Tetramerista glabra Miq. (Tetrameristaceae) | T2 | . | . | . | 4 | . | . | . | . | . | . | . |
| | S | + | + | . | . | . | . | . | . | . | . | . |
| | H | + | . | . | . | . | . | . | . | . | . | . |
| Rhamnaceae species N-2 | S | . | . | . | + | + | . | . | . | . | . | + |
| Gymnacranthera eugeniifolia (A.DC.) Sinclair var. griffithii(Warb.)Sinclair (Myristicaceae) | T2 | . | 1 | . | . | . | . | . | . | . | . | . |
| | S | + | . | . | . | . | . | . | . | . | . | + |
| Santiria rubiginosa Bl. (Burseraceae) | S | . | + | . | . | . | . | . | . | . | . | + |
| | H | + | + | . | . | . | . | . | . | . | . | . |
| Barringtonia reticulata (Bl.) Miq. (Lecythidaceae) | T2 | . | . | . | 1 | . | . | . | . | . | . | . |
| | S | + | . | . | + | + | . | . | . | . | . | . |
| Xylopia coriifolia Ridley (Annonaceae) | T2 | . | . | . | . | 1 | . | . | . | . | . | . |
| | S | + | . | . | . | . | . | . | . | . | . | . |
| Baccaurea bracteata M.A. (Euphorbiaceae) | S | + | . | . | . | . | + | . | . | . | . | . |
| Ctenolophon parvifolius Oliv. (Linaceae) | E | . | . | . | . | . | . | . | . | . | 1 | . |
| | S | + | . | . | . | . | . | . | . | . | . | + |
| Horsfieldia crassifolia (Hk.f.et Th.) Warb. (Myristicaceae) | E | 1 | . | . | . | . | . | . | . | . | . | . |
| | T1 | . | . | . | . | . | 1 | . | . | . | . | . |
| | T2 | . | . | . | . | . | . | . | . | 1 | . | . |
| Stenochlaena palustris Bedd. (Polypodiaceae) | H | . | . | + | + | . | . | . | . | . | . | . |
| Polyalthia hypoleuca Hk.f. et Th. (Annonaceae) | S | . | . | + | . | . | . | . | . | . | . | + |
| Amoora rubiginosa Hiern (Meliaceae) | T2 | . | . | . | 1 | . | . | . | . | . | . | . |
| | S | . | . | . | . | . | . | . | . | . | . | + |
| Uncaria sp. (Rubiaceae) | S | . | . | . | . | . | . | + | . | . | . | + |
| Calophyllum hosei Ridley (Guttiferae) | S | . | . | . | . | . | . | . | + | . | . | + |
| | H | . | . | . | . | . | . | . | . | . | . | . |
| Combretocarpus rotundatus (Miq.) Dans. (Rhizophoraceae) | E | . | . | . | . | . | 1 | . | . | . | . | . |
| | T1 | . | . | . | . | . | . | . | . | . | . | 8 |
| | T2 | . | . | . | . | . | . | . | . | . | . | 1 |
| | S | . | . | . | . | . | . | . | . | . | . | + |
| Kibatalia borneensis (Stapf) Merr. (Apocynaceae) | S | . | . | . | . | . | . | . | . | . | . | + |
| | H | . | . | . | . | . | . | . | . | . | . | + |
| Shorea teysmanniana Dyer ex Brandis (Dipterocarpaceae) | E | . | . | . | . | . | . | . | . | . | . | 1 |
| | T1 | . | . | . | . | . | . | . | . | . | . | 1 |
| | T2 | . | . | . | . | . | . | . | . | . | . | 1 |
| Susum anthelminticum Bl. (Fagllariaceae) | H | 1·2 | + | ·2 | . | . | . | . | . | . | . | . |
| Cyathocalyx biovulatus Boerl. (Annonaceae) | E | 1 | . | . | . | . | . | . | . | . | . | . |
| | T1 | . | . | 1 | . | . | . | . | . | . | . | . |

| | | | | | | | | | | | | |
|---|----|---|-----|---|---|-----|---|---|---|---|---|----|
| Tetractomia parviflora Ridley (Rutaceae) | S | + | . | + | . | . | . | . | . | . | . | . |
| | H | . | . | + | . | . | . | . | . | . | . | . |
| Alangium havilandii Bloemb. (Alangiaceae) | T2 | . | . | . | 1 | . | . | . | . | . | . | . |
| | H | + | . | . | . | . | . | . | . | . | . | . |
| Prastemon urophyllum (A. DC.) A. DC. (Rosaceae) | T1 | . | . | . | . | 2 | . | . | . | . | . | . |
| | S | + | . | . | . | . | . | . | . | . | . | . |
| Drynaria sp. (Polypodiaceae) | S | + | . | . | . | . | . | . | + | . | . | . |
| Araceae sp. | H | + | . | . | . | . | . | . | + | . | . | . |
| Nauclea parva (Havil.) Merr. (Rubiaceae) | S | . | . | . | . | . | . | . | . | . | + | . |
| | H | + | . | . | . | . | . | . | . | . | . | . |
| Copaifera palustris (Sym.) De Wit (Leguminosae) | S | . | + | + | . | . | . | . | . | . | . | . |
| Shorea scabrida Sym. (Dipterocarpaceae) | T2 | . | . | . | . | . | 1 | . | . | . | . | . |
| | S | . | + | . | . | . | . | . | . | . | . | . |
| Memecylon sp. (Melastomaceae) | S | . | + | . | . | . | . | . | + | . | . | . |
| Carallia brachiata (Lour.) Merr. (Rhizophoraceae) | S | . | . | + | . | + | . | . | . | . | . | . |
| Croton korthatsii ? Muell. (Euphorbiaceae) | T2 | . | . | . | 2 | . | . | . | . | . | . | . |
| | S | . | . | + | . | + | . | . | . | . | . | . |
| Cratoxylum glaucum Korth. (Guttiferae) | E | . | . | 1 | . | . | . | . | . | . | . | . |
| | T1 | . | . | . | . | . | . | . | . | . | 1 | . |
| Knema intermedia (Bl.) Warb. (Myristicaceae) | S | . | . | . | + | + | . | . | . | . | . | . |
| Shorea macrantha (Brandis) Sym. (Dipterocarpaceae) | S | . | . | . | + | + | . | . | . | . | . | . |
| | H | . | . | . | . | + | . | . | . | . | . | . |
| Asplenium nidus Linn. (Aspleniaceae) ↓ Jarett (Moraceae) | S | . | . | . | + | . | . | . | . | . | . | +2 |
| Parartocarpus venenosus (Zoll. & Mor.) ssp. forbesii (King) | S | . | . | . | . | . | + | + | . | . | . | . |
| Ardisia polyactis Mez. (Myrsinaceae) | S | . | . | . | . | . | . | . | + | . | . | . |
| | H | . | . | . | . | . | + | . | . | . | . | . |
| Alseodaphne coriacea Kosterm. (Lauraceae) | T2 | . | . | . | . | . | 1 | . | . | . | . | . |
| | S | . | . | . | . | . | . | . | . | . | + | . |
| Pithecellobium borneense Benth. (Leguminosae) | S | . | . | . | . | . | . | . | + | . | + | . |
| Tarenna fragrans (Bl.) Koord. et Val. (Rubiaceae) | S | . | . | . | . | . | . | . | + | . | + | . |
| Palaquium pseudocuneatum H.J. Lam (Sapotaceae) | T2 | . | . | . | . | . | . | . | . | . | 2 | . |
| | S | . | . | . | . | . | . | . | . | . | . | + |
| Calamus sp. (Palmae) | H | . | . | . | . | . | . | . | . | . | + | + |
| Antidesma coriaceum Tul. (Euphorbiaceae) | S | . | . | . | . | . | . | . | . | . | + | + |
| Lindsaea ensifolia Sw. (Lindsaeaceae) | S | + | . | . | . | . | . | . | . | . | . | . |
| Litsea gracilipes Hook. f. (Lauraceae) | S | + | . | . | . | . | . | . | . | . | . | . |
| Dacryodes macrocarpa (King) H.J. Lam (Burseraceae) | S | . | + | . | . | . | . | . | . | . | . | . |
| Zingiberaaceae sp. | H | . | 1.2 | . | . | . | . | . | . | . | . | . |
| Gardenia pterocalyx Val. (Rubiaceae) | S | . | + | . | . | . | . | . | . | . | . | . |
| Goniothalamus malayanus Hk. f. et Th. (Annonaceae) | S | . | + | . | . | . | . | . | . | . | . | . |
| Stemonurus scorpioides Becc. (Icacinaceae) | S | . | + | . | . | . | . | . | . | . | . | . |
| Polyalthia sp. (Annonaceae) | T2 | . | 1 | . | . | . | . | . | . | . | . | . |
| Eugenia zeylanica (L.) Wight (Myrtaceae) | T2 | . | 2 | . | . | . | . | . | . | . | . | . |
| Ficus sp. | H | . | . | + | . | . | . | . | . | . | . | . |
| Dacryodes incurvata (Engl.) H.J. Lam (Burseraceae) | S | . | . | + | . | . | . | . | . | . | . | . |
| Seedling -Garcinia sp. (Guttiferae) | H | . | . | + | . | . | . | . | . | . | . | . |
| Prunus turfosa Kalkm. (Rosaceae) | S | . | . | . | + | . | . | . | . | . | . | . |
| Hoya sp. | S | . | . | . | + | . | . | . | . | . | . | . |
| Garcinia vidua Ridley (Guttiferae) | T2 | . | . | . | . | 1 | . | . | . | . | . | . |
| Calamus sendens ? (Palmae) | S | . | . | . | . | 1.2 | . | . | . | . | . | . |
| Timonius flavescens (Jack) Baker (Rubiaceae) | S | . | . | . | . | . | . | + | . | . | . | . |
| Randia kuchingensis W.W. Sm. (Rubiaceae) | S | . | . | . | . | . | . | + | . | . | . | . |
| Seedling -Callophyllum sp. | S | . | . | . | . | . | . | + | . | . | . | . |
| Eugenia lineata (Bl.) Duthie (Myrtaceae) | H | . | . | . | . | . | . | + | . | . | . | . |
| Seedling -Eugenia sp. | S | . | . | . | . | . | . | + | . | . | . | . |
| Stemonurus secundiflorus Bl. (Icacinaceae) | T2 | . | . | . | . | . | . | . | 1 | . | . | . |
| Hopea pentanervia Sym. (Dipterocarpaceae) | S | . | . | . | . | . | . | . | + | . | . | . |
| Santiria laevigata Bl. f. laevigata (Burseraceae) | S | . | . | . | . | . | . | . | . | + | . | . |
| Diospyros confertiflora (Hiern) Bakh. (Ebenaceae) | S | . | . | . | . | . | . | . | . | + | . | . |
| Nephrolepis tuberosa (Bory) Presl (Nephrolepidaceae) | S | . | . | . | . | . | . | . | . | . | + | . |
| Adenanthera pavonina L. (Leguminosae) | S | . | . | . | . | . | . | . | . | . | + | . |
| Vatica sp. (Dipterocarpaceae) | T2 | . | . | . | . | . | . | . | . | . | . | 1 |

Location & date : Naman Forest Reserves, Sibul, Sarawak at 9-11 October 1990.

soil is clay or shallow peat over clay

ANDERSON (1961) divided the peat swamp forests in Sarawak and Brunei into six types which were distinct in structure, physiognomy, and flora:

- Type 1, mixed swamp forest: the *Gonystylus-Dactylocladus-Neoscortechinia* association
- Type 2, alan forest: the *Shorea albida-Gonystylus-Stemonurus* association
- Type 3, alan bunga forest: the *Shorea albida* consociation
- Type 4, padang alan forest: the *Shorea albida-Litsea-Parastemon* association
- Type 5, the *Tristania-Parastemon-Palaquim* association
- Type 6, padang keruntum: the *Combretocarpus-Dactylocladus* association

Types 1 to 4 are tall tree forests, having a height of 30-50 meters. Type 5 is a very dense pole-like forest with a low canopy. Type 6 is an open savanna woodland.

Phytosociological Analysis

In this research, the phytosociological data of the mixed swamp forest were collected from 10 relevés (5 relevés at the Naman-1 plot and 5 at the Naman-2 plot). The plot Naman-1 was about 500 meters from the bank of the river Assan and the plot Naman-2 was 1,000 meters from the river bank. These sites were already exploited by selective cutting between 1951 and 1963. The forest at Naman was a typical mixed swamp forest on the thick peat layer.

The forests of the Naman-1 plot were composed of a) an emergent tree layer having a height of 27-33 meters and a cover of 10-40 per cent, b) a tree layer-1 having a height of 27 meters and a cover of 30-60 per cent, c) a tree-2 layer having a height of 20 meters and 25-60 per cent, d) a shrub layer having a height of 5-6 meters and a cover of 15-40 per cent, e) a herb layer having a height of 1 meter and a cover of 10-30 per cent. The forests of Naman-2 plot were composed of a) an emergent tree layer having a height of 27-28 meters and a cover of 15-30 per cent, b) a tree layer-1 having a height of 24 meters and a cover of 10-50 per cent, c) a tree layer-2 having a height of 16 meters and a cover of 25-40 per cent, d) a shrub layer having a

height of 5-6 meters and an cover of 20-60 per cent, and e) a herb layer having a height of 0.8-1 meter and a cover of 10-30 per cent. The number of component species of relevés is 44-54 (Naman-1) and 38-54 (Naman-2). Total number of present taxa is 121. 83 per cent of the taxa grows on more than two relevés and 17 per cent of the taxa grows on a relevé.

From a phytosociological perspective, the mixed peat swamp forests at Naman were summarized as a *Ilex hydroglauca-Cephalomappa paudicola* community. *Argostemma solaniflora* (Rubiaceae), *Cephalomappa paludicola* (Euphorbiaceae), *Diospyros siamang* (Ebenaceae), *D. evena*, *Garcinia bancana* (Guttiferae), *Ilex hypoglauca* (Aquifoliaceae) and *Santiria rubiginosa* (Burseraceae) are very common in the forest. The main species of emergent tree layer were *Eugenia subsessilifolia* (Myrtaceae), *Campnosperma coriaceum* (Anacardiaceae), *Combretocarpus rotundatus* (Rhizophoraceae), *Cratoxylum glaucum* (Guttiferae), *Ctenolophon parvifolius* (Linaceae), *Cyathocalyx biovulatus* (Annonaceae), *Horsfieldia crassifolia* (Myristicaceae) and *Shorea teysmanniana* (Dipterocarpaceae).

The main species of the tree layer-1 and -2 were *Cephalomappa paludicola* (Euphorbiaceae), *Combretocarpus rotundatus* (Rhizophoraceae), *Diospyros evena* (Ebenaceae), *Eugenia havilandii* (Myrtaceae), *E. zeylanica*, *Ganua motleyana* (Sapotaceae), *Horsfieldia crassifolia* (Myristicaceae), *Ilex hypoglauca* (Aquifoliaceae), *Lithocarpus dasystachyus* (Fagaceae), *Palaquium pseudocumeatum* (Sapotaceae), *Prastemon urophyllum* (Rosaceae), *Shorea teysmanniana* (Dipterocarpaceae), *S. inaequilateralis* and *Tetramerista glabra* (Tetrameristaceae).

The shrub layer is mainly composed of *Antidesma montanum* (Euphorbiaceae), *Argostemma solanifloram* (Rubiaceae), *Blumeodendron kurzii* (Euphorbiaceae), *Canthium umbelligerum* (Rubiaceae), *Cephalomappa paludicola* (Euphorbiaceae), Cyperaceae species, *Diospyros siamang* (Ebenaceae), *Elaeocarpus beccarii* (Tiliaceae), *Eugenia leucoxylon* var. *phaeophyllum* (Myrtaceae), *E. subsessilifolia*, *Ganua montleyana* (Sapotaceae), *Garcinia bancana* (Guttiferae), *Goniothalamus andersonii* (Annonaceae), *Ilex hypoglauca* (Aquifoliaceae), *Ixora havilandii*

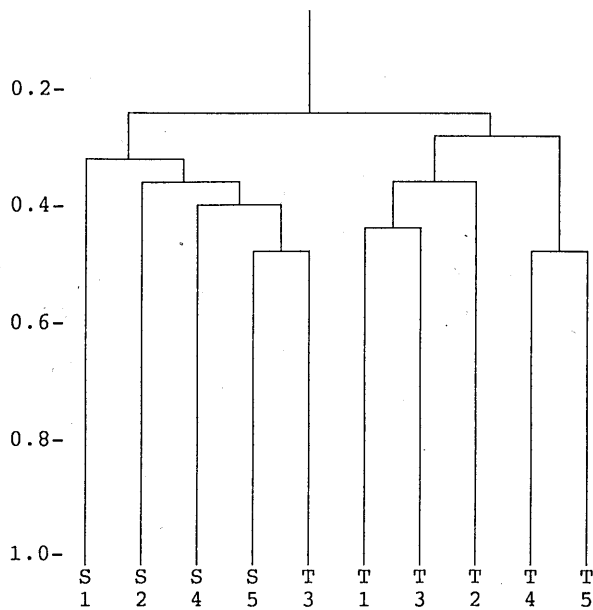


Fig. 2. Dendrogram of the study sites by the cluster analysis based on the component species.

(Rubiaceae), *Kibessia coriacea* (Melastomataceae), *Litsea crassifolia* (Lauraceae), *Mangifera haviilandii* (Anacardiaceae), *Neoscortechinia kingii* (Euphorbiaceae) and *Santiria rubiginosa* (Burseraceae). The shrub layer is dominated by *Cephalomappa paludicola*.

The herb layer is mainly composed of seedlings of the tree species, *Aglaonema* species-*A. pictum?* (Araceae), *Asplenium nidus* (Aspleniaceae) and *Stenochlaena palustris* (Polypodiaceae). Some climbers and epiphytic plants are not listed in the community table, because these plants are difficult to identify in the field and are located on the higher layer. In the forest (Naman-1 and-2), climbers and plants are not so common. The pH value of the site at Naman is 3.5-4.0 and the depth of the peat layer with a very high organic contents more than 5 meters.

The forest community is "Type 1 -mixed swamp forest-" according to ANDERSON'S classification (1961). The community is found on the periphery, more or less confined to the outer, steeper slopes of the dome surface of the estuary.

DISCUSSION

Previous plant ecological research on forest in

Sarawak, except ANDERSON (1964, 1972) *et al.*, were mostly limited to taxonomical or silvicultural aspects. This paper provides a phytosociological description of the peat swamp forest with a community table.

The peat swamp forests in Sarawak and Brunei are unique because of the presence of *Shorea albida*. The dipterocarp tree is the sole dominant or co-dominant on the top-of-canopy and plays a major role in the swamp forest. However, the phytosociological data of the peat swamp forests at Naman were collected from the mixed forests, which were very common.

The peat swamps, occasionally, have a biconvex shape. The lower surface owes its concavity to the decomposition of alluvium at the river margins. It is noticeable that the peat swamps furthest from the coast line, which are oldest, are thickest and most markedly lens-shaped (ANDERSON, 1964). But it is not clear that the peat swamps at Naman have a biconvex shape, because the forests are not natural forest and the area is not large enough to have a biconvex shape.

The plants *Combretocarpus rotundatus* and *Carallia brachiata* are component species of the peat swamp forests. These species belong to the Rhizophoraceae family as do the mangrove forest representative component species: the genus are *Rhizophora*, *Bruguiera* and *Ceriops*. The *Combretocarpus rotundatus* is a emergent or overstory tree. The *Carallia brachiata* is not a tall tree at all and it occurs infrequently.

There are conspicuous parallels in structure and physiognomy between the peat swamp forests at Naman and the evergreen broad-leaved forest (for example, in the Ryukyu Islands or Taiwan by MIYAWAKI, SUZUKI, HUANG & KUO in 1981). The number of composed species of relevés (100 square meters each) ranged from 44 to 54 (Naman-1), and from 38 to 54 (Naman-2). The total number of present species was 121. As to the species uniformity, 83 per cent of the species grew on more than two relevés and 17 per cent of the species grew on a single relevé. The percentage of common species per relevé is not lower than that of the evergreen forest in the Ryukyu Islands (SUZUKI, 1979), in the case of the Ryuku Island, the forests were classified into the community, that is, the *Ilex hydroglauca*-*Cephalomappa paudicola* community.

REFERENCES

- ANDERSON, J. A. R. 1961. The ecology and forest types of the peat swamp forests of Sarawak and Brunei in relation to their silviculture. Ph. D. thesis, Edinburgh University.
- ANDERSON, J. A. R. 1964. The structure and development of the peat swamps of Sarawak and Brunei. *J. Trop. Geogr.*, 18 : 7-16.
- ANDERSON, J. A. R. 1972. *Trees of peat swamp forests of Sarawak*. 200 pp. Forest Department, Sarawak.
- BRAUN-BLANQUET, J. 1964. *Pflanzensoziologie*. 3 Aufl. 865 pp. Springer. Wien.
- DRIESSEN, P. M. 1978. Plant soils. In : *Soils and Rice*, edited by IRRI, p.763-779. Los Banos : IRRI.
- MIYAWAKI, A. & K. SUZUKI. 1980. Process of phytosociological studies and vegetation mapping. *Bull. Inst. Env. Sci. Techn. Yokohama Nat'l Univ.*, 7 : 492-506.
- MIYAWAKI, A., K. SUZUKI, T. HUNG & C. KUO. 1981. Pflanzensoziologische Untersuchungen in Taiwan, Erster Bericht: Küsten-Vegetation und immergrüne Laubwälder auf dem Berg Nan-Fong-San. *Hikobia Supplement* 1, p.221-233.
- NAKAMURA, T. & K. SUZUKI. 1984. Studies on the plant communities of the Yap Islands. *J. Phytogeogr. & Taxon*, XXX (1) : 19-30.
- SUZUKI, K. 1979. Vegetation of the Ryukyu Islands. *Bull. Inst. Env. Sci. Techn. Yokohama Nat'l Univ.*, 5 : 87-160.
- SUZUKI, K. & C. NIYOMDHAM, C. 1992. Phytosociological studies on tropical peat swamps. 1. Classification of Vegetation at Narathiwat, Thailand. *Tropics*, 2 (1) : 49-65.
- WHITTEN, A. J., S. J. DAMANIK, J. ANWAR and H. HISYAM. 1987. *The Ecology of Sumatra*. 583 pp. Gadjah Mada University Press.

REFERENCES

- ANDERSON, J. A. R. 1961. The ecology and forest types of the peat swamp forests of Sarawak and Brunei in relation to their silviculture. Ph. D. thesis, Edinburgh University.
- ANDERSON, J. A. R. 1964. The structure and development of the peat swamps of Sarawak and Brunei. *J. Trop. Geogr.*, 18 : 7-16.
- ANDERSON, J. A. R. 1972. *Trees of peat swamp forests of Sarawak*. 200 pp. Forest Department, Sarawak.
- BRAUN-BLANQUET, J. 1964. *Pflanzensoziologie*. 3 Aufl. 865 pp. Springer. Wien.
- DRIESSEN, P. M. 1978. Plant soils. In : *Soils and Rice*, edited by IRRI, p.763-779. Los Banos : IRRI.
- MIYAWAKI, A. & K. SUZUKI. 1980. Process of phytosociological studies and vegetation mapping. *Bull. Inst. Env. Sci. Techn. Yokohama Nat'l Univ.*, 7 : 492-506.
- MIYAWAKI, A., K. SUZUKI, T. HUNG & C. KUO. 1981. Pflanzensoziologische Untersuchungen in Taiwan, Erster Bericht: Küsten-Vegetation und immergrüne Laubwälder auf dem Berg Nan-Fong-San. *Hikobia Supplement* 1, p.221-233.
- NAKAMURA, T. & K. SUZUKI. 1984. Studies on the plant communities of the Yap Islands. *J. Phytogeogr. & Taxon*, XXX (1) : 19-30.
- SUZUKI, K. 1979. Vegetation of the Ryukyu Islands. *Bull. Inst. Env. Sci. Techn. Yokohama Nat'l Univ.*, 5 : 87-160.
- SUZUKI, K. & C. NIYOMDHAM, C. 1992. Phytosociological studies on tropical peat swamps. 1. Classification of Vegetation at Narathiwat, Thailand. *Tropics*, 2 (1) : 49-65.
- WHITTEN, A. J., S. J. DAMANIK, J. ANWAR and H. HISYAM. 1987. *The Ecology of Sumatra*. 583 pp. Gadjah Mada University Press.