UNIVERSITI PUTRA MALAYSIA

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By

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Chairman : Associate Professor Japar Sidik Bujang, PhD

Faculty : Science

Freshwater macrophytes were surveyed for their distribution, habitat characteristics and local uses around Bintulu division and Miri district, Sarawak, East Malaysia from year 2004 until 2006. Thirty nine (39) areas were covered where two lakes and five streams of natural and man made water bodies (one marsh, two temporary marshes, four ponds, one disused mining lake and eight ditches) from Bintulu division while from Miri district, one area of stream (natural) and four man made water bodies (two marshes, three ponds, seven ditches and three areas of water reservoirs). A total of 113 species and 42 families of freshwater macrophytes were recorded in various habitats and areas of Bintulu division and Miri district. Fifty five (55) species in 12 families are angiospermae monocotyledon e.g. *Limnocharis flava*, *Eriocaulon longifolium*, *Cyperus halpan* and *Blyxa aubertii*, 49 species in 24 families are angiospermae dicotyledon e.g. *Nelumbo nucifera*, *Nymphaea nouchali*, *Ceratophyllum demersum* and including seven species in three families of carnivorous plants, *Drosera spathulata*, *Utricularia aurea*, *U. bifida*, *U. caerulea*, *U. gibba*, *U. minutissima* and *Nepenthes gracilis*. Eight species in six families are categorized as ferns e.g. *Salvinia molesta*, *Nephrolepis bisserata*, *Lygodium*

microphyllum and macroalgae, *Chara zeylanica*. Based on life form categories, three species were emergent (*N. nucifera*, *N. nouchali* and *N. pubescens*), five species as submerse (e.g. *C. zeylanica*, *B. aubertii*, *Hydrilla verticillata* and *U. bifida*), eight species as floating (e.g. *Pistia stratiotes*, *Ipomoea aquatica*, *Lemna perpusilla*, *U. aurea*, *U. gibba* and *Eichhornia crassipes*) and 99 species as marginal or half-submerse (e.g. *L. flava*, *Ipomoea stolonifera*, *C. halpan*, *Eleocharis dulcis*, *N. bisserata*, *D. spathulata*, *U. caerulea* and *Typha angustifolia*).

The distribution of freshwater macrophytes e.g. *H. verticillata*, *U. gibba* in various natural (e.g. Kemena lake, Jalan Nyabau stream) and man made water bodies (e.g. Taman Mawar pond, UPM Bintulu campus ditch) were not affected by physical environmental factors where the water and substrate were slightly acidic to alkaline, pH ranged 6.79 to 7.82 with water temperature of 25°C to 34.6°C. Freshwater macrophytes grew in slightly acidic to alkaline of water and substrates of clay and sandy clay loam. Freshwater macrophytes also grew in water temperature of 24°C to 38°C and tolerated up to 40°C. Species such as *C. zeylanica* and *T. angustifolia* grew in water of 5 ppt and *N. nouchali* were abundantly growing in black colour water with a pH of 5.5 or less. The variations on morphology of vegetative and reproductive structures contribute to their adaptation and survival in a variety of environmental conditions. The arrangement of leaves e.g. rosette in *N. nouchali* to avoid shading and overlapping of leaves and helps the plant gets more sunlight. The vacuoles in the petioles and rhizomes e.g. *N. nucifera* function for gas transportation while swollen petioles in certain species e.g. *E. crassipes* enables the plant to float on water surface. Certain species have "head" inflorescences such as *Mimosa pudica* that function to avoid overlapping of flowers for easy pollination. The modification

of seed structure e.g. “winged” seeds in *U. gibba* allows buoyancy of seeds for dispersal. Forty three species of freshwater macrophytes are used by the local population. The marginal plants such as *Cyperus brevifolius*, *E. dulcis*, *Alternanthera sessilis* and *Homalomena propingua* are the sources of most food and medicines. Other than as food and medicine, freshwater macrophytes are also used as an ingredient in making cosmetics (e.g. *Melastoma malabathricum*), household items e.g. aromatherapy foam bath (e.g. *N. nouchali*), making mats, baskets and as binding material (*Cyperus malaccensis* known as “Tali bondong” among local peoples), aquarium and decorative plants (e.g. *Cabomba furcata*, *Monochoria hastata*, *M. vaginalis*, *D. spathulata*, *U. bifida* and *U. minutissima*). *Salvinia molesta* and *L. microphyllum* are cultivated by local peoples and used as biofilters and biodegradable plants in water reservoirs.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

ASPEK BIOLOGI DAN EKOLOGI MAKROFIT AIR TAWAR DI KAWASAN PESISIRAN BINTULU DAN MIRI, SARAWAK, MALAYSIA

Oleh

SUZALINA AKMA BINTI AWING

Pengerusi : Profesor Madya Japar Sidik Bujang, PhD

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Tinjauan terhadap taburan, ciri-ciri habitat dan kegunaan tempatan makrofit air tawar telah dilakukan sekitar bahagian Bintulu dan daerah Miri, Sarawak, Malaysia Timur dari tahun 2004 hingga 2006. Tiga puluh sembilan (39) kawasan telah diterokai di mana dua tasik dan lima sungai adalah badan air semulajadi dan buatan manusia (satu paya, dua paya sementara, empat kolam, satu tasik bekas lombong dan lapan parit) daripada bahagian Bintulu manakala daripada daerah Miri, satu kawasan adalah sungai (semulajadi) dan empat badan air buatan manusia (dua paya, tiga kolam, tujuh parit dan tiga kawasan air takungan). Sejumlah 113 spesies dan 42 famili makrofit air tawar direkodkan di pelbagai habitat dan kawasan bahagian Bintulu dan daerah Miri. Lima puluh lima (55) spesies dalam 12 famili adalah monokotiledon angiosperma cth. *Limnocharis flava*, *Eriocaulon longifolium*, *Cyperus halpan* dan *Blyxa aubertii*, 49 spesies dalam 24 famili adalah dikotiledon angiosperma cth. *Nelumbo nucifera*, *Nymphaea nouchali*, *Ceratophyllum demersum* dan termasuk tujuh spesies dalam 3 famili tumbuhan karnivor, *Drosera spathulata*, *Utricularia aurea*, *U. bifida*, *U. caerulea*, *U. gibba*, *U. minutissima* dan *Nepenthes gracilis*. Lapan spesies dalam enam famili dikategori sebagai paku pakis cth. *Salvinia*

molesta, *Nephrolepis bisserata*, *Lygodium microphyllum* dan makroalga, *Chara zeylanica*. Berdasarkan ke atas kategori ciri hidup, tiga spesies termuncul (*N. nucifera*, *N. nouchali* dan *N. pubescens*), lima spesies sebagai tenggelam (cth. *C. zeylanica*, *B. aubertii*, *Hydrilla verticillata* and *U. bifida*), lapan spesies sebagai terapung (cth. *Pistia stratiotes*, *Ipomoea aquatica*, *Lemna perpusilla*, *U. aurea*, *U. gibba* dan *Eichhornia crassipes*) dan 99 spesies sebagai marginal atau separuh tenggelam (cth. *L. flava*, *Ipomoea stolonifera*, *C. halpan*, *Eleocharis dulcis*, *N. bisserata*, *D. spathulata*, *U. caerulea* dan *Typha angustifolia*).

Taburan makrofit air tawar cth. *Hydrilla verticillata*, *Utricularia gibba* di pelbagai badan air semulajadi (cth. tasik Kemena, sungai Jalan Nyabau) dan buatan manusia (cth. kolam Taman Mawar, parit UPM kampus Bintulu) tidak dipengaruhi oleh faktor persekitaran fizikal di mana air dan tanah agak berasid ke beralkali, purata pH 6.79 hingga 7.82 dengan suhu air 25°C hingga 36.4°C. Makrofit air tawar tumbuh di dalam air yang agak berasid ke beralkali dan tanah adalah tanah liat dan tanah liat berpasir. Makrofit air tawar juga tumbuh di dalam suhu air 24°C hingga 38°C dan boleh tahan hingga suhu 40°C. Spesies seperti *C. zeylanica* dan *T. angustifolia* tumbuh di dalam air 5 ppt dan *N. nouchali* tumbuh dengan banyak di dalam air berwarna hitam dengan pH 5.5 atau kurang. Variasi ke atas struktur morfologi vegetatif dan reproduktif membantu tumbuhan beradaptasi dan boleh hidup di pelbagai keadaan persekitaran. Susunan daun cth. "rosette" pada *N. nouchali* mengelak peneduhan dan penindihan daun dan membantu tumbuhan mendapat lebih cahaya matahari. Vakuol di dalam petiol dan rizom cth. *N. nucifera* berfungsi sebagai pengangkutan gas manakala petiol menggelembung pada sesetengah spesies cth. *E. crassipes* membolehkan tumbuhan tersebut terapung di atas permukaan air.

Sesetengah spesies mempunyai “kepala” jambak bunga seperti *Mimosa pudica* berfungsi mengelak penindihan bunga untuk membolehkan pendebungaan. Modifikasi pada struktur biji cth. biji “bersayap” pada *U. gibba* membolehkan biji terapung untuk penyebaran. Empat puluh tiga spesies makrofit air tawar telah digunakan oleh penduduk tempatan. Tumbuhan marginal seperti *Cyperus brevifolius*, *E. dulcis*, *Alternanthera sessilis* dan *Homalomena propingua* adalah sumber kebanyakan makanan dan perubatan. Selain digunakan sebagai makanan dan perubatan, makrofit air tawar juga berguna sebagai bahan dalam pembuatan kosmetik (cth. *Melastoma malabathricum*), barangan isi rumah cth. sabun mandi aromaterapi (cth. *N. nouchali*), membuat tikar, bakul dan sebagai pengikat barang (*Cyperus malaccensis* yang dikenali di kalangan penduduk tempatan sebagai “Tali bondong”), tumbuhan akuarium dan hiasan (cth. *Cabomba furcata*, *Monochoria hastata*, *M. vaginalis*, *D. spathulata*, *U. bifida* and *U. minutissima*). *Salvinia molesta* dan *L. microphyllum* digunakan dan ditanam oleh penduduk tempatan sebagai tumbuhan penapis biologi dan biodegradasi dalam air takungan.

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This thesis submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master of Science. The members of the Supervisory Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

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SUZALINA AKMA AWING

Date: 10 January 2008

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%	percent
&	and
CO_2	Carbon dioxide
O_2	Oxygen
cm^2	centimeter square
cm	centimeter
DPX	DePeX mounting medium
e.g.	for example
FAA	Formalin acetic alcohol
E	Earth
m	meter
mm	milimeter
N	North
TBA	Tert-butyl alcohol