STUDY OF RECENT BENTHIC FORAMINIFERAL ASSEMBLAGES IN THE MANGROVES OF LARUT MATANG, PERAK, MALAYSIA

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For my beloved;
Abah
Mak
Adik-adik
Muhammad Asrul Ramli

Abstract of thesis presented to the Senate of Universiti Malaysia Terengganu in fulfillment of the requirement for the degree of Master of Science

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Chairperson	:	**Professor Dr. Mohd Lokman Husain, Ph. D.**
Member	:	**Associate Professor Sulong Ibrahim, M.Sc.**
Institute	:	**Institute of Oceanography and Environment**

This thesis presents the results of a study of benthic foraminifera in the mangrove sediments sampled in a part of Larut Matang mangroves, Malaysia. Data on foraminifera assemblages in the tropical mangroves particularly are not well documented. Most studies on foraminifera were done in the temperate region, focusing more on salt marshes environment. Most taxonomic descriptions, therefore, are for foraminifera of the temperate rather than the tropical regions. In Malaysia, there are very few work done in establishing modern assemblages of foraminifera in mangroves. More modern foraminifera data are needed before reconstruction of paleoenvironment of the marginal marine habitats in Malaysia can be done accurately. Three transects were set up in the study site with each transect approximately 140m in length. Field sampling was conducted in June 2009 to collect samples for foraminifera, grain size and total organic carbon (TOC). *In situ* data collected during field sampling were elevation, porewater salinity and mangrove vegetation density.

Altogether, 23 species of benthic foraminifera were identified from the surface samples along Sangga River, Larut Matang mangroves, Malaysia. The foraminifera belongs to four orders (Foraminiferida, Rotaliida, Trochamminida and Lituolida), seven families (Lituolidae, Acupeinidae, Amphisteginidae, Trochamminidae, Elphidiidae, Haplophragmoididae and Rzehakinidae), two subfamilies (Caronidae and Elphidiinae) and 14 genera (*Acupeina, Ammobaculites, Ammoastuta, Ammotium, Amphistegina, Arenoparella, Jadammina, Paratrochammina, Siphotrochammina, Trochammina, Caronia, Elphidium, Haplophragmoides* and *Miliammina*). The benthic foraminifera assemblages at the study site consisted of 21 agglutinated and two calcareous species. The agglutinated species were *Acupeina triperforata, Ammobaculites balkwili, Ammobaculites exiguus, Ammoastuta salsa, Ammotium salsum, Ammotium fragile, Arenoparella mexicana, Caronia exilis, Haplophragmoides wilberti, Jadammina* sp. A, *Jadammina* sp. B, *Miliammina fusca, Miliammina obliqua, Miliammina petila, Paratrochammina* sp. A, *Paratrochammina* sp. B, *Siphotrochammina* sp. A, *Siphotrochammina* sp. B, *Trochammina globigeriniformis, Trochammina inflata* and *Trochammina macrescens*. The calcareous species were *Amphistegina* sp. and *Elphidium* sp.

Based on non-metric Multi Dimensional Scaling (MDS) and Cluster analyses, there are three groups of benthic foraminifera species associations. Group 1 includes *Trochammina macrescens, Ammobaculites exiguus* and *Elphidium* sp. Group 2 includes *Paratrochammina* sp. B, *Jadammina* sp. B and *Trochammina globigeriniformis*. Group 3 divides into two subgroups i.e. 3-A and 3-B. Subgroup 3-A with the highest number of species, includes *Ammotium fragile, Ammoastuta salsa, Caronia exilis, Miliammina*

petila, Paratrochammina sp. A, *Miliammina obliqua, Trochammina inflata, Arenoparella mexicana, Haplophragmoides wilberti, Jadammina* sp. A, *Siphotrochammina* sp. A, *Ammobaculites balkwili, Acupeina triperforata, Amphistegina* sp. and *Miliammina fusca.* Subgroup 3-B includes *Ammotium salsum* and *Siphotrochammina* sp. B. Statistical analysis revealed that porewater salinity has strong correlation with grain size. Land elevation, on the other hand has a strong correlation with number of *Rhizophora apiculata* trees per hectare. However, TOC percentage does not have any linear relationship with any other parameters. Based on the Canonical Correspondence Analysis (CCA) results, environmental parameters measured in this study portrayed significant correlation with foraminifera distribution in the mangrove sediments, especially grain size. The CCA results were able to provide a niche area (particular area) to each benthic foraminifera species based on the correlations with environmental parameters. Benthic foraminifera distribution was determined by a combination of environmental parameters and not by any single parameter.

Abstrak tesis yang dikemukakan kepada Senat Universiti Malaysia Terengganu sebagai
memenuhi keperluan untuk ijazah Sarjana

KAJIAN MENGENAI KUMPULAN FORAMINIFERA MODEN DI HUTAN PAYA BAKAU LARUT MATANG, PERAK, MALAYSIA

WAN NURZALIA BINTI WAN SAELAN

Mac 2011

Pengerusi	:	**Professor Dr. Mohd Lokman Husain, Ph.D.**
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Tesis ini mengemukakan hasil kajian kumpulan foraminifera moden yang terdapat di
tanah bakau yang disampel di sebahagian kawasan hutan paya bakau Larut Matang.
Foraminifera ini dikaji bagi memahami kedapatan dan pemilihan habitat di dalam hutan
paya bakau. Data mengenai foraminifera di kawasan tropika terutamanya hutan paya
bakau tidak didokumentasi dengan baik. Ini adalah kerana, kebanyakan kajian dilakukan
di kawasan beriklim sederhana yang tertumpu di kawasan paya air masin. Kajian
seumpama ini juga amat terhad di Malaysia. Oleh sebab itu, lebih banyak kajian yang
tertumpu pada foraminifera hutan paya bakau perlu dilakukan dengan lebih banyak lagi.
Tiga transek sepanjang 140m untuk setiap transek dibina. Persampelan dilakukan dalam
bulan Jun 2009 untuk mengumpul sampel tanah bagi analisis foraminifera, saiz sedimen
dan kandungan karbon organik, serta data *in situ* seperti altitud, saliniti air liang dan
kepadatan vegetasi bakau.

Hasil kajian ini telah mengenalpasti 23 spesies foraminifera di sepanjang Sungai Sangga, hutan paya bakau Larut Matang, Malaysia. Kesemua spesies ini tergolong dalam empat order (Foraminiferida, Rotaliida, Trochamminida dan Lituolida), tujuh keluarga (Lituolidae, Acupeinidae, Amphisteginidae, Trochamminidae, Elphidiidae, Haplophragmoididae dan Rzehakinidae), dua subfamili (Caronidae dan Elphidiinae) dan 14 genera (*Acupeina, Ammobaculites, Ammoastuta, Ammotium, Amphistegina, Arenoparella, Jadammina, Paratrochammina, Siphotrochammina, Trochammina, Caronia, Elphidium, Haplophragmoides* dan *Miliammina*). Foraminifera ini terbahagi kepada dua kumpulan utama iaitu '*agglutinated*' sebanyak 21 spesies dan '*calcareous*' sebanyak dua spesies. Spesies foraminifera dalam kumpulan *agglutinated* adalah *Ammobaculites balkwili, Ammobaculites exiguus, Ammoastuta salsa, Acupeina triperforata, Ammotium salsum, Ammotium fragile, Arenoparella mexicana, Caronia exilis, Haplophragmoides wilberti, Jadammina* sp. A, *Jadammina* sp. B, *Miliammina fusca, Miliammina obliqua, Miliammina petila, Paratrochammina* sp. A, *Paratrochammina* sp. B, *Siphotrochammina* sp. A, *Siphotrochammina* sp. B, *Trochammina globigeriniformis, Trochammina inflata* dan *Trochammina macrescens*. Manakala spesies foraminifera dalam kumpulan *calcareous* pula adalah *Amphistegina* sp. dan *Elphidium* sp.

Berdasarkan hasil analisis non-metric Multi Dimensional Scaling (MDS) dan Cluster, terdapat tiga kumpulan foraminifera yang telah dikenalpasti iaitu, **Kumpulan 1** terdiri daripada *Trochammina macrescens, Ammobaculites exiguus* dan *Elphidium* sp. **Kumpulan 2** terdiri daripada *Paratrochammina* sp. B, *Jadammina* sp. B dan *Trochammina globigeriniformis*. Kumpulan 3 terbahagi kepada dua sub-kumpulan iaitu

3-A dan 3-B. Sub-kumpulan 3-A terdiri daripada *Ammotium fragile, Ammoastuta salsa,*

Caronia exilis, Miliammina petila, Paratrochammina sp. A, *Miliammina obliqua,*

Trochammina inflata, Arenoparella mexicana, Haplophragmoides wilberti, Jadammina

sp. A, *Siphotrochammina* sp. A, *Ammobaculites balkwili, Acupeina triperforata,*

Amphistegina sp. dan *Miliammina fusca.* Sub-kumpulan 3-B terdiri daripada *Ammotium*

salsum dan *Siphotrochammina* sp. B. Berdasarkan hasil analisis statistik, didapati

hubungkait antara faktor persekitaran adalah *linear* di antara satu sama lain. Saliniti air

dalam tanah berkorelasi dengan saiz sedimen, manakala ketinggian tanah berkorelasi

dengan kepadatan pokok-pokok bakau, tetapi kandungan karbon organik tidak

berkorelasi dengan mana-mana faktor persekitaran yang lain. Berdasarkan hasil ujian

Canonical Correspondence Analysis (CCA) pula, didapati kesemua faktor persekitaran

memainkan peranan dalam menentukan taburan foraminifera di kawasan kajian.