DIVERSITY AND ABUNDANCE OF BENTHIC ORGANISMS IN UNIVERSITI MALAYSIA SABAH BEACH SEPANGGAR BAY

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PERPUSTAKAAN
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MARCH 2006

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Sincerely,

Nor Atila Othman

20 March 2006

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ABSTRACT

Benthic organisms in Universiti Malaysia Sabah (UMS) beach in Sepanggar Bay were collected along eight transects in the intertidal zone during the sampling period. A total of 36 species of benthic organisms from 28 families were collected. The distribution and the heterogeneity of the community were low due to high collection pressure from surrounding communities on edible and marketable species such as sea cucumber and bivalves. *Umbonium vestiarium* dominated the Study Area One, while in Study Area Two, the *Clibanarius* and un-identified gastropod has found to dominate the area. *Umbonium vestiarium* possible to the environmental indicators for organic matter pollution. The differences in the organic matter resistance can be found according to the distribution of both classes. Shannon-Weiner index show the low heterogeneity (0.5515) in the UMS beach community indicating the presence of dominant species. Evenness index Pielou's, J' values range between 0-1. Lower index value (0.3544) in UMS beach also indicates the dominance of certain species in sampling.

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ABSTRAK

Organisma bentik telah dikutip di pantai Universiti Malaysia Sabah (UMS), Teluk Sepanggar semasa sesi persampelan dilakukan di lapan stesen yang diletakkan di antara tikas air rendah dan tikas air tinggi. Sebanyak 36 spesis bentik daripada 28 famili telah ditemui setelah kajian dijalankan. Taburan dan perbezaan spesis adalah rendah disebabkan oleh pemungutan oleh penduduk tempatan untuk spesis yang boleh dimakan dan mempunyai nilai di pasaran seperti timun laut (gamat) dan kerangan. *Umbonium vestiarium* adalah spesis yang paling dominan di Kawasan Persampelan Pertama dan Kawasan Persampelan Kedua, *Clibanarius* dan spesis umang-umang yang tidak dapat dikenalpasti adalah spesis yang paling dominan. *Umbonium vestiarium* adalah kemungkinan spesis penentu kehadiran bahan organik yang tinggi di persekitaran. Tahap ketahanan setiap species terhadap ketinggian nilai bahan organik dalam sekitaran dapat ditentukan dengan melihat taburan organisma pada kawasan kajian. Indek Shannon-Weiner menunjukkan tahap kepelbagaian yang rendah (0.5515) di dalam komuniti organisma di pantai UMS. Indek kesamarataan Pielou's, J' mempunyai skala antara 0-1. Nilai kesamarataan yang rendah (0.3544) di pantai UMS juga menunjukkan kehadiran spesis yang dominan dalam sampel.

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LIST OF SYMBOLS

cm	centimetre
˚C	degree Celcius
g	gram
ind/m^2	individu per metresquare
km	kilometre
ln	Natural logarithm
m	metre
mm	milimetre
n	numbers of samples
ODEC	Outdoor Development Centre
TOM	Total Organic Matter
UMS	University Malaysia of Sabah
-	negative
%	percentage
$\sum$	total

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Growing awareness of biodiversity issues has brought the need for comparable and meaningful measures of diversity into sharp focus. In particular, factors controlling the biodiversity of an area, and thus ecosystem function, are central to biodiversity research (Davidson *et al.*, 2004). Ecological systems are characterised by spatial and temporal variations in the density of organisms and resources, and in the intensity of processes which may affect them. This heterogeneity represents both a difficulty for field study design and statistical testing, and a challenge to describe the spatial structuring of populations, communities and ecosystems (Thrush *et al.*, 1997; Legendre *et al.*, 1997).

The community structure of benthic organisms that are exposed sandy beaches has been usually correlated with morphodynamic beach types. That relationship resulted in a paradigmatic model, which states that species richness, abundance and biomass increase from reflective to dissipative conditions. It has thus been argued that

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swash features associated with beach types significantly affect macrofauna community structure (Lastra *et al.*, 2004).

Bell *et al.* (1997) noted that in shallow water coastal systems, environmental factors such as bottom topography, sediments characteristics and hydrodynamic processes play a definite role in structuring benthic communities and producing patchiness through a variety of mechanisms. He also described physical environmental factors which may affect benthic community structure at meso- and macro–scales on the sandflat, namely: (1) "static" factors such as sediment characteristics, bed topography and tidal inundation; (2) tidal and residual currents on the sandflat (Hewitt *et al.*, 1997), which is the mechanism by which sediment, food and juvenile macrofauna are transported and (3) hydrodynamic factors which affect bed disturbances such as mobilising bed material (including juvenile macrofauna), through coupled interactions between waves, currents and tidally-varying water depth.

Benthic organisms are important because (1) they are an important trophic step between living and detrital particulate organic matter and higher trophic levels such s fish, birds, and people; (2) they contribute to the flux of dissolved and particulate materials (including contaminants) between the sediment and the overlying water; (3) the types and abundance of benthic animals and their variation are commonly used as indicators of water quality; (4) the benthos of coastal aquatic systems is particularly susceptible to invasions of exotic species releases from ballast water. Because most benthic organisms do not move far after settlement, the benthic community provides a continuing record, through changes in species composition or abundance, of the effects of both short and long-term changes in the environment.

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Chain transects and quadrats are used to assess the limited mobility of benthic community in the study area. Some organisms (e.g. coral or sponges) have individuals that vary enormously in size whereas in the others (e.g. algae or zoanthids) the extent of single individual is not obvious. For these organisms, it is often more appropriate to express abundance as percent cover (proportion of available area occupied by biomass), rather than as density (number of individuals per unit area). Few studies can practically measure factors such as substratum complexity, habitat heterogeneity, rugosity and the fractal nature surfaces. Some of these factors influence both biodiversity measurements on rocky shores and the nature of communities on intertidal boulders (Davidson *et al.*, 2004).

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1.2 OBJECTIVES

There are four objectives in this study, which are:

i. To list out the species composition of benthic organisms in UMS beach.

ii. To show the distribution of benthic organisms in UMS beach.

iii. To get the diversity of benthic species in the UMS beach.

iv. To quantify species diversity and abundance in the study.

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CHAPTER 2

LITERATURE REVIEW

2.1 BENTHIC ORGANISMS

Benthic organisms can be divided into 2 groups, microbenthos and macrobenthos. Macrobenthos are benthic organisms (macroflora or/and macrofauna) whose dimensions are greater than or equal to 0.5 mm. These benthic organisms are categories by their habitat which is living on or within the sediment. Some benthic organisms are sessile, or attached to one place; others move around (Peter, 2003). Robertson (1992) has found that most burrowing organisms occurred in the upper 20 cm, although some polychaetes and decapods were found deeper than 1 metres deep in the sediment.

Noticeably, polychaetes and bivalves are two major groups of marine fauna that produce sediment biodeposition as a result of their filter-feeding, and are widely distributed in both soft and hard bottom environment (Murray *et al.*, 2002). Sessile macrofauna provide an additional, biogenic structure on rocky intertidal shores. Mobile species, such as limpets, snails and chitons graze on rock surface (Kostylev *et al.*, 2005).

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Whitlatch *et al.* (1997) have shown that suspension feeders can have strong interactions of benthic-pelagic coupling in shallow water and may affect infaunal community structure by removing small planktonic larvae before they reach the sediment surface. He also found that suspension feeding bivalves also may interact with deposit feeding population by removing phytoplankton and/or by deposition of feaces or pseudofeaces (Murray *et al.*, 2002), while large infaunal bivalves that live near the sediment surface can also affect other species by providing refugia from predation.

Benthic communities are widely used in the monitoring of effects of marine impacts as the organisms are mostly sessile and integrate effects of pollutant over time. Currie and Isaac (2005) found that most infaunal communities comprise a large number of species and because of varying sensitivities of species it should be possible to identify subtle effects of contaminant reflected in changes in community structure.

Physical disturbance is an important factor in soft bottom community structure of intertidal organism; it can provide an unpredictable source of mortality for benthic organism. Severity and duration of disturbance can determine whether entire populations are destroyed or reduced in abundance. Substratum type and sediment grain size plays a role in the response of a community to disturbance (Dreyer, Brock and McCarthy, 2005).

Other than nature, human exploitation of intertidal marine invertebrates is also known to alter benthic community structure. Exploitation could lead to changes in the

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abundance of the prey species, thereby altering the community structure (Boer and Prins, 2002).

Since most benthic organisms are patchily distributed over a range of spatial scale, it is important to study the major variables characterizing spatial arrangements: organism density and three components of scale (grain or patch) size, lag or distance between patches and extent or area occupied (Whitlatch, 1997).

2.2 INTERTIDAL HABITAT

Spatial heterogeneity is an intrinsic property of the natural worlds. Classical models explaining species diversity patterns have assumed that habitats are spatially homogenous. Habitat complexity on a wide range of scales plays an important role in community structure. Heterogeneity of the environment is essential for species co-existence, with structurally complex habitats offering a great variety of different microhabitats and niches, therefore allowing species to co-exist and contributing to within-habitat diversity (Kostylev *et al.*, 2005).

The benthic habitats that occur in coastal environments have been comparatively well studied, at least in some areas of the world. Considerable progress has been made in mapping the zoogeography of many species in areas except for the tropics, which are considerably less well known (Middleboe and Kaj, 2004).

Mudflats are different from rocky shores in permitting escape from predation by burying (Boer and Prins, 2002). Rocky shores support a variety of habitats of

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different types and degrees of heterogeneity. The importance of physical heterogeneity in marine ecology is reviewed to discuss the fundamental processes leading to heterogeneity in marine ecosystems and formation of community patterns. Habitat complexity and spatial heterogeneity are important factor in structuring rocky shore community and contributing to community diversity and species co-existence in marine benthic systems (Kostylev *et al.*, 2005).

As shown by Lastra *et al.* (2004), intermediate beaches are the most variable beaches with respect to along-shore topography. It follows that swash characteristics at those beaches will also be most variable. He has test the hypothesis that different morphodynamic characteristics occurring at a particular beach affect the population abundances, tidal migration, borrowing ability and metabolic activity of benthic organisms.

2.3 DIVERSITY, ABUNDANCES AND EVENNESS

An emergent theme in ecology is that the process influencing distribution of organisms may change with scale (Hewitt *et al.*, 1997). Ecology is often defined as the study of patterns of abundance and distribution of organisms. It follows that one of the basic sets of data gathered by any ecologist, terrestrial or marine, is the abundance of particular species in a specified area. For both practical and theoretical reasons, it is more appropriate to determine density rather than absolute abundance of each species. Patterns of species number have been observed in relation to habitat heterogeneity and environmental conditions (Middleboe and Kaj, 2004). Environmental heterogeneity provides a diversity of resources that can lead to co-existence of competitors, which

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would not be possible in homogenous environments and is, therefore, and important mechanisms in the maintenance of biological diversity (Kostylev *et al.*, 2005).

The influence of mobile organisms on marine ecosystem may be significant because small-scale patterns of movement are known to positively influence biodiversity. High richness paired with low abundance, however may result in underestimating the functional role of mobile intertidal species. Davidson *et al.* (2004) has study the differences between the mobile and sessile components of assemblages at each shore level were assessed using species density, species richness and abundance of individuals. Species density or the number of species per quadrat was used to quantitatively assess mobile and sessile species distributions, shore level and substratum variability and in SIMPER (similarity percentage) analysis.

Middleboe and Kaj (2004) confirmed that evenness is the simplest feature of the distribution of abundance among species. A community in which each species present is equally abundant has high evenness, while a community in which the species differ widely in abundance has low evenness. Some studies indicate that patterns in relative abundance could depend on the spatial scale of the study. Field experiments need to encompass an appropriate scale not only for the mechanics of the interaction, but also for the potential affect on abundances (Hewitt *et al.*, 1997).

Davidson *et al.* (2004) has study that the definition of diversity vary substantially but generally include two components – the number of species and the evenness of individuals within those species – terms used must be clearly specified. Species density is commonly mistaken for species richness, whereby comparisons of

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the number species from one area or sampling unit to neglect differences in abundance or density of organisms. It is important to distinguish species density and (or versus) species richness because they can yield confounding results. Kostylev (2005) had found that species co-existence and diversity is dependent on the number of microhabitats in virtually all ecosystems.

Davidson (2004) had shown that an important and almost ubiquitous aspect of zonation: the decrease in abundance, species density and richness of organisms from lower to higher levels on the shore.

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CHAPTER 3

METHODOLOGY

3.1 STUDY AREA

Universiti Malaysia Sabah (UMS) is located next to Sepanggar Bay. Sepanggar Bay is about 15km from the Kota Kinabalu City. Located between two headlands, Tanjung Lita and Tanjung Tarak Tarak.

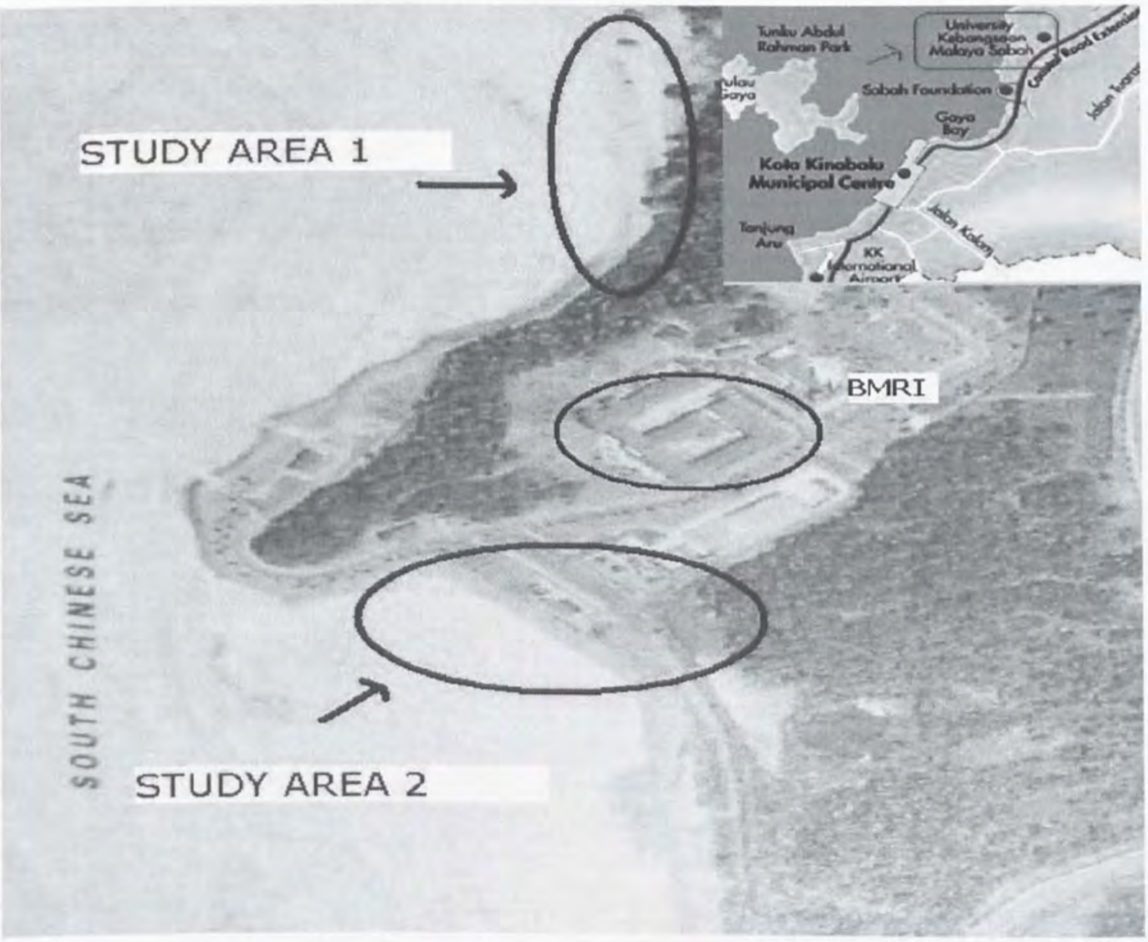

Figure 3.1: Location of study area.

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3.2 SAMPLING METHOD

3.2.1 Chain Transects and Random-point Quadrats

A total of eight transect stations were selected as the sampling site. Four transects were set in front of the Outdoor Development Centre (ODEC), while another four transects were set in front of the hatchery.

Transects was laid from the high tide mark perpendicular to the beach (Figure 2). Three random quadrats were laid along the transects at 0 metres, 25 metres and 50 metres. Percentage of rock, algae, seagrass or coral cover was recorded. All organisms found within the quadrat were collected. Burrowing organisms were collected by digging an area about 0.04 m^2, 20 cm deep into the substrate within the quadrat. All organisms within the sediment were collected.

Soil samples were collected from 0 meters, 25 meters and 50 meters points of each for organic matter analysis.

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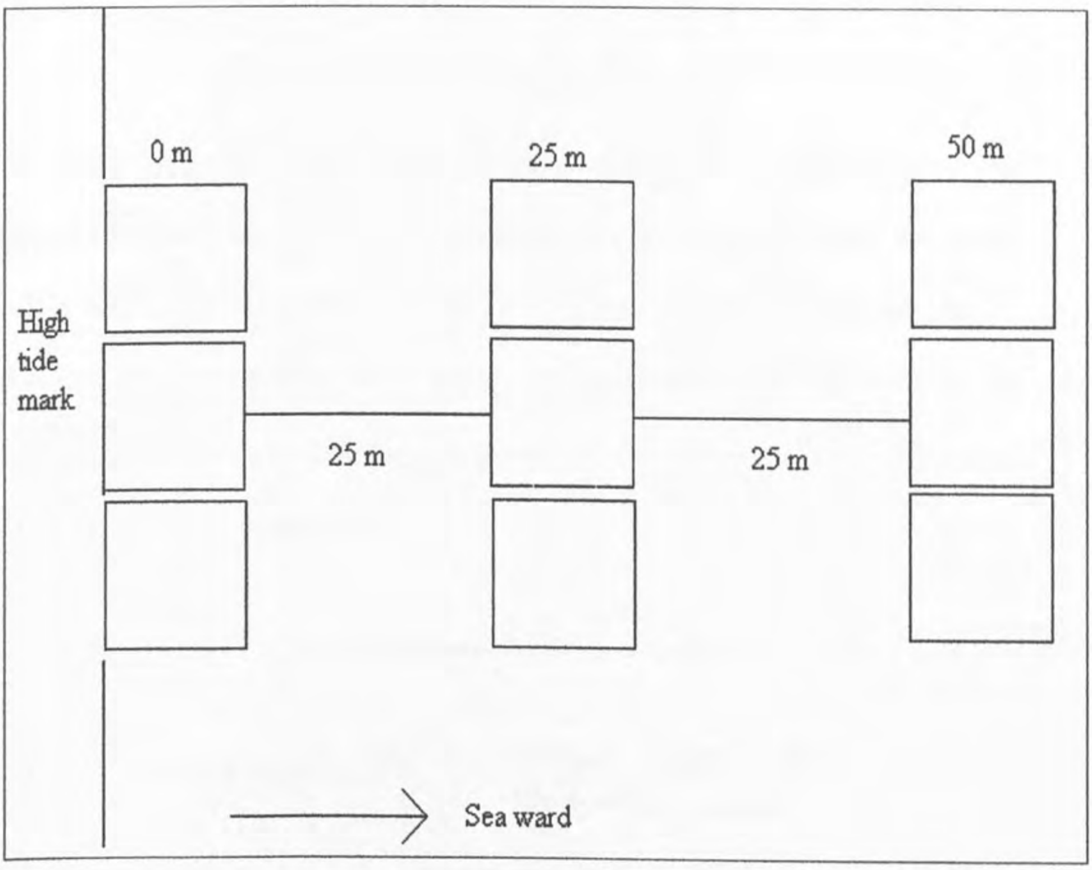

Figure 3.2: Quadrat Setting During Sampling.

3.3 LABORATORY WORK

3.3.1 Preservation

Specimens collected were fixed in 5% formalin solution for identification. Pictures were taken before preserving the organisms to help identification, as the original colors of the organisms might fade due to the preservation process.

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