Faculty of Resource Science and Technology

COMPOSITION OF BENTHIC DIATOM IN MANGROVE AREA, SUNGAI MELABAN, KOTA SAMARAHAN, SARAWAK.

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Bachelor of Science with Honours
Aquatic Resource Science and Management
2015

UNIVERSITI MALAYSIA SARAWAK

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Final Year Project Report ☑

Masters ☐

PhD ☐

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COMPOSITION OF BENTHIC DIATOM IN MANGROVE AREA, SUNGAI MELABAN, KOTA SAMARAHAN, SARAWAK.

CHING KAI SIANG

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This project is submitted in partial fulfillment of the requirement for the degree of Bachelor of Science with Honours

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Department of Aquatic Science
Faculty of Resource Science and Technology
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DECLARATION

I hereby declare that no portion of the work referred to in this dissertation has been submitted of an application for another degree of qualification or any other university or institution of higher learning.

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List of Abbreviation

µm – micrometer

^{o}C – degree Celsius

% – Percentage

DO- dissolved oxygen

HCl – hydrochloric acid

$KmnO_4$ – Potassium Permanganate

mg/l – milligram per liter

NTU – nephelometric turbidity units

ml – milliliter

NH_4 –ammonium

NO_2 - nitrite

NO_3 -nitrate

PO^{3-}_4 - orthophosphate

ppt – part per thousand

rpm – revolutions per minute

SEM- Scanning Electron Microscopes

SiO_2 – silicate

TEM- Transmission Electron Microscopes

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Composition of benthic diatoms in mangrove area, Sungai Melaban, Kota Samarahan, Sarawak.

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ABSTRACT

The collection of benthic diatoms on a mudflat of Melaban River, Kota Samarahan, Sarawak was carrried out in March 2015 from five sampling stations. The diatom cells from each station were cleaned and later observed and identified under a compound microscopes and transmission electron microscope(TEM). A total 15 genera of benthic diatoms were identified, including *Amphiprora, Amphora, Bacillaria, Cyclindrotheca, Cyclindrothera, Cymbella, Encyonema, Frustulia, Gyrosigma, Licmophora, Navicular, Nitzschia, Pluerosigma, Stauroneis,* and *Tryblionella*. The dominant genera were *Navicula*, *Nitzschia*, *Amphiprora*, and *Cylindrotheca.* The physico-chemical parameters of the water were measured during high tide, which showed dissolved oxygen in the range of 2.3mg/l- 2.6mg/l, pH 6.4-6.8, Temperature 29.2^{o}C- 29.7^{o}C, salinity 5ppt- 6ppt, and turbidity 3.65NTU-6.285NTU.

Keywords: Benthic diatoms, mudflat, physico-chemical parameters, mangrove.

ABSTRAK

Pengumpulan diatoms bentik pada berlumpur daripada Melaban Sungai, Kota Samarahan, Sarawak telah carrried pada bulan Mac 2015 daripada lima stesen persampelan. Sel-sel diatom dari setiap stesen telah dibersihkan dan kemudian diperhatikan dan dikenalpasti di bawah mikroskop kompound dan Transmisi elektron mikroskop (TEM). Seramai 15 genera diatoms bentik telah dikenal pasti, termasuk Amphiprora, Amphora, Bacillaria, Cyclindrotheca, Cyclindrothera, Cymbella, Encyonema, Frustulia, Gyrosigma, Licmophora, Navicular, Nitzschia, Pluerosigma, Stauroneis *dan* Tryblionella. *Genus dominan adalah* Navicula, Nitzschia, Amphiprora *dan* Cylindrotheca. *Parameter fiziko-kimia air diukur air pasang, yang menunjukkan oksigen terlalut dalam lingkungan 2.3mg/l- 2.6mg/l, pH 6,4-6,8, Suhu 29.2^{o}C- 29.7^{o}C, kemasinan 5ppt- 6ppt, dan kekeruhan 3.65NTU-6.285NTU.*

Keywords: diatom bentik, lumpur, parameter fiziko-kimia, bakau.

1.0 Introduction

Mangrove forest is the forest that located at the estuary. Mangroves forest has different species of trees and shrubs that can grow in large influx of salinity and muddy area. According to Pernetta (1993), mangrove forest is dominant by the soft bottom plant communities of the estuary in subtropical and tropical region. The alternation of physical factors found in such environments, the biological communities exhibit outstanding adaptations which enable them to growth under these extreme environmental conditions. The plant survive in the mangrove are able to adapt in the conditions of high salinity, low nutrient and oxygen availability in the soil, wind and wave action, and substrate less stability. The families of plant that can adapt to mangrove area are Acanthaceae, Arecaceae, Combretaceae, Lythraceae and Rhizophoraceae. These plants have special characteristic such as the root can expose to air for breathing and can support plant in muddy area, which help them to survive.

During high tide, seawater will introduce into the river below freshwater of the river, due to high density of sea water. Sometime two different density of water will mixed together by diffusion and make salinity of water same as sea water. During low tide, the salinity of the water reduces back to brackish water (Saint & Scheider, 2010).

Diatoms are one of the main groups of algae which in bisymmetrical shape, and most common types of phytoplankton. Diatoms are unicellular that can live in colonies forming various type of shape, such as zigzag, or filaments. Diatoms can be divided into 2 order depend on their cell shape pattern which are centric (order Biddulphiales) and pennate (order

Bacillariales). The cell wall morphology and shape also play important roles in identifying diatoms up to genus level (Hasle et al., 1996).

Furthermore, diatoms can categorize according to their habitats, which are planktonic diatoms and benthic diatom. Planktonic diatoms are the diatoms that able to stay afloat on the water surface or water column to obtain sufficient sunlight for photosynthesis (Shuter, 1979). For the benthic diatom, it is found in the bottom of water column which attach to sediment or hard substrate. Unlike planktonic diatoms, benthic diatoms are anchored on the surface of hard substrate that helps to fix in constant position at high water circulation of environment. Besides that, benthic diatoms have special photosynthetic pigment, which can help it to adapt in a low light intensity of environment (Mercado et al., 2003).

Diatoms have larger surface area and small volume that can easily uptake the nutrient from the water. The available of nutrient can affect growth rate of benthic diatoms (Darrow, 2008). According to Ling et al. (2012), the nutrient level in river of the Sarawak is particularly high, this enable benthic diatom to grow into large population. However, their growth rate was limited by the light intensity caused by high turbidity of water.

In Sungai Melaban, the populations of benthic diatom are very important, this is because many juvenile of the aquatic organisms are depend on it for food source, such as juvenile of puffer fish and crab. However, there are less information or research on this area. Therefore, the objective of this study is the assembly of benthic diatoms on mudflat in Sungai Melaban.

2.0 Literature Review

2.1 The structure of diatom

Diatom have been classify into two major groups that are centric and pennate diatom (Figure 1). The symmetry of centric diatom is radial symmetry and pennate diatoms are bilaterally symmetrical.

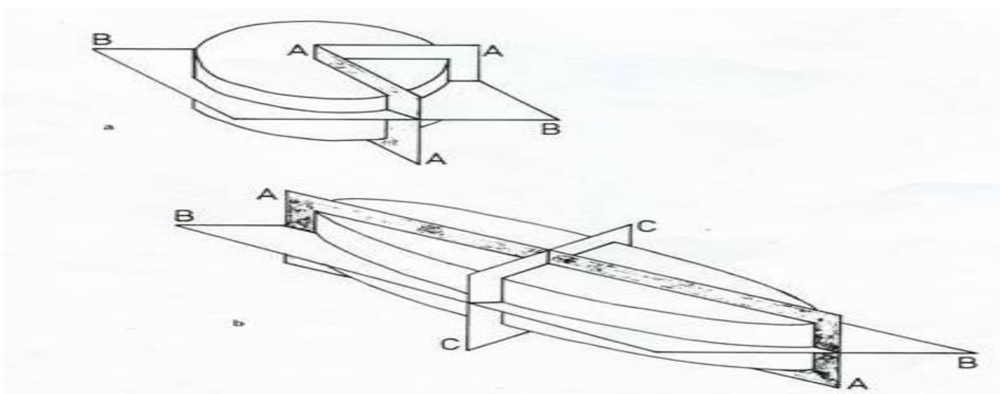

Figure 1: Show the symmetrical of the diatom for two major groups. For centric diatom, AA is radial, BB is vulvar. For pennate diatom, AA is apical, BB is valvar, C-C is transapical.

2.2 Reproduction of diatom

Cell division of diatom is asexual reproduction. During their life cycle, diploid diatoms will divide by cytokinesis and mitosis. The division of diatom is shown in Figure 2.

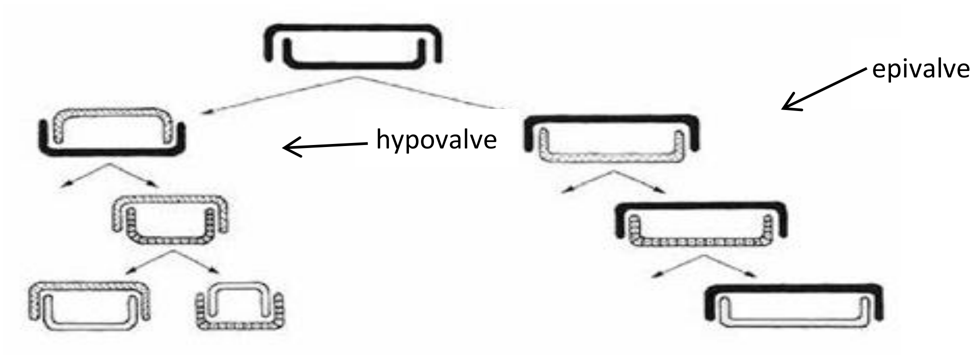

Figure 2: Show that the cell division of the diatom. The cell divides the valve into 2 separated valves; each of the valve is reproduce another valve to form a diatom (MacDonald, 1869).

When a cell is growing to mature, the cell undergoes binary diffusion to produce two daughter cells, which are almost same morphology to the parent cell.

In the sexual reproduction, the centric and pennate diatoms have different type of reproduction, although both have same asexual reproduction. In centric diatom, oogamous is present, while isogamous is present for pennate diatom during sexual reproduction. When the environments of diatoms are turning to unfavorable, the cell may undergo to the process of resting spores (Edlund & Stoermer, 1997).

2.3 The environment factor that influence the motility of diatoms

2.3.1 Nutrients

Nutrient is an inorganic substances present inside the water bodies and come from decomposition and discharge from the terrestrial. Mangrove was a type of wetland, which support biodiversity and ecosystems. Besides that, it is allow the sediment suspended in wetland floor. The nutrient from agriculture, sewage and urban runoff are often filtered by mangrove forest before into marine. In mangrove area, the major of the nutrient, which can be found in mangrove area are ammonium (NH_4), nitrite (NO_2), nitrate (NO_3), orthophosphate (PO_4^{3-}), and silicate (SiO_2) (Desikachary & Dweltz, 1961). Mostly, the nutrients are needed for plants that help it to grow, but silicate is important for diatoms, because their cell walls are make-up of silica.

2.3.2 Temperature

Temperature in the mangrove area are always in vary, mainly affect by the solar radiation and the mixing of the water. Solar radiation is the main factor affect the water temperature, because heat energy was transfer from the sun into water to increase water temperature. Therefore, the longer the periods of solar radiation, the higher the water temperature will increase (Saravankumar et al., 2008). The second factors that affect water temperature are the mixing of the cold freshwater and hot seawater. The temperature high or low was depending on the mixing ratio, the large the seawater ratio, the high the temperature will measure at the mangrove area. In the nature, temperature is one of the parameter that controls the rates of metabolic processes and thus potential range over all living organisms. For the diatoms, the range of temperature suitable for growth is 18^{o}C to 30^{o}C (Drebes, 1977).

2.3.3 Salinity

Salinity in the mangrove area is changing due to the tide influence. During high tide, the seawater was carry by tide into mangrove area. High salinity of water mixing with freshwater will increase the salinity of water in mangrove area (Arumungam & Kumar, 2014). So, salinity is the one of the limiting factor that affects the growth of diatoms in mangrove, because some diatoms are stenohaline organisms. In estuary, the range of salinity is between 8ppt to 32ppt, this is due to daily mixture of seawater and freshwater. Hence, the growth of diatom are large depend on the salinity (Horton et al., 2006).

2.4 The application of diatom

According to a report by Martin and Fernandez (2012), it stated that diatoms are the good indicators of environment conditions in streams. The physico-chemical parameters of the water quality are measure which correlated to the species diversity of diatoms. The result shown that, the better the water quality, the more complex of diversity of diatom will establish in the water. On the other hand, some of the genus of diatoms can survive in polluted water, such as *Hantzschia*, *Navicula*, *Nitzschia*, and *Surirella*. The existence of those genera of diatoms will indicate pollution of water is significant.

Diatoms are the eukaryotic, photosynthetic, unicellular algae that can be found the environment of moist. Diatoms have major ecological important on the earth and display pattern diversity and structure at the nanometer to millimeter scale. Diatom nanotechnology is a new interdisciplinary area, biotechnology, chemistry, engineering, material science and physics. Since 2005, diatom nanotechnologies are emphasizing recent advances in diatom biophotonics, biomineralization, computer design and so on. Besides that, diatoms are able to become the first organisms for which able to close the gap in our knowledge of close relationship between phenotype and genotype (Gordon et al., 2008).

In Malaysia, the related studies on the diatoms are very limited. However, still have some published works that related to aquatic pollution assessment relative to diatoms communities in Pinang River Basin, Malaysia (Maznah & Mansor, 2002).

2.5 Previous study of diatoms

The diatoms are widely study around the world, most of them try to relate the species composition of the diatoms with the environment and water quality of the aquatic ecosystems. In Indonesia, research by Hendrarto and Nitisuparjo (2011) relate the ecological function of secondary mangrove forests by determine the biodiversity of diatoms in three different areas of central Java, that are Rembang, Demak and Pemalang coasts. The results state that the population of diatoms is not always depending on the inundation levels and mangrove density. They find out that the maximum density of mangrove to have the highest benthic micro-flora primary productivity was between 8000 to 10000 trees/ha. In Brazil, a study about the effect of substrate selection on benthic diatom community structure along a city pollution rise. They found out that the benthic diatoms populations are more diverse and abundance in clean compare to polluted areas. The selective nature of the chemical and physical properties of non-natural substrates cause benthic diatom more likely to select the naturals substrates, especially vegetation compare to non-natural substrates (Bere, 2010). In Malaysia, Maznah and Mansor (2002), diatoms specimen was collected and fixed in glass slides at 12 sampling sites for study of diatom communities along Pinang River Basin. The water quality in Pinang River basin can relate to the diatom community structure and the specific sensitivity of certain diatom species. The richness of certain species of diatoms could be used as biological indicator to measure influence of river pollution.

In Sarawak Malaysia, a study was carried out in two estuaries of Kuching, Sarawak, Malaysia. During study period, seven genera of benthic diatoms were recognized that were commonly found Sarawak estuary. The common genera are *Amphiprora*, *Surirella*, *Delphineis*, *Navicula*, *Nitzschia*, *Cylindrotheca* and *Pleurosigma* (Fareha et al., 2011). *Navicula* sp and *Nitzschia* sp present in this study can be used as a water quality indicated (Bere, 2010; Maznah & Mansor, 2002). Besides that, the species found in study like *Nitzschia longissima* and *Cylindrotheca closterium* are been classified into a bloom forming algae (Ozman-Say & Balkis, 2012). That mean, if eutrophication, these two species are to blooming at the estuary and causing adverse effect estuary.

2.6 The chlorophyll *a* on the surface sediment

According to Farooq and Siddiqui (2011), chlorophyll *a* content (Chl *a*) is a tool to measure the diversity of the microphytobenthos (MPB) and predict of the benthic productivity in the sediment. In this study, both vertical and horizontal of Chl *a* concentration in the mangrove forest were taken. The result show that the highest Chl *a* is due to nutrient loading from small ephemeral river by observation. For the lower values of Chl *a* is due to the condition of dry, long exposure period, and high salinity. Another study case about the sediment properties and benthic microalgae were investigated for the intertidal flats which located in Kwangyang Bay, Korea. The samples were collect every 100 m in the intertidal flats from land-side toward sea site during winter 2004, and summer 2005. The sample types collected are temperature, water content, sediment bulk density, and nutrient concentration in the porewater and the Chl *a* concentration in the surface of sediment. The Chl *a* concentration was higher in winter compare to summer. The result shown that, the available of temperature and nutrient (ammonia and silicate) can affected the benthic algae community the diversity of the benthic microalgae was affected by sediment temperature and nutrient (ammonia and silicate). The chlorophyll was using as an indirect indicator to measure the grazing activity, and the result shown that was have correlation of the ratio and Chl *a* implied that microalgae diversity is affected by grazing of the zoobenthos (Sin et al., 2009).

3.0 Materials and Methods

3.1 Study site

This study was carried out in mangrove forest, at mudflat along Sungai Melaban, Kota Samarahan, Sarawak (Figure 3). Five stations were selected along the river of the mudflat as shown in Figure 3, and sampling was carried out on March 2015.

Figure 3: Map of sampling stations located in Sungai Melaban, Kota Samarahan, Sarawak; the coordinate was taken from the bridge at External lab (red circle) that was 1 °28' 5.0838''N, 110 °26' 44.9808'' E.

3.2 Sampling of benthic diatoms

During low tide, the diatoms were collected by using a lens tissue, and this method was modified from the method used by Williams (1963) to collect diatoms. First, the tissues were place on the surface of the mudflat at each station. After 2 hours approximately, the lens tissues from each station were collected using a forceps kept in a petri dish and labeled. Then, lens tissues from each station were brought back to the aquatic botany laboratory for futher processing.

Triplicate surface water and bottom water samples were also taken by suing a van Dorn water sampler during high tide. The water samples collected were poured into acid-washed bottles. The physico-chemical parameters (DO, pH, Turbidity, and Temperature) of the water samples were measured by using HANNA instruments..

3.3 Laboratory preparation and analysis

3.3.1 Extracting of diatoms

The lens tissues brought back from the sampling site were put into separate clear bottle containing about 300 ml distilled water according to their respective sampling stations. Each bottle was shaken vigorously about 2 minute to separate out the diatoms from the lens tissues. After shaking, the water in the bottle transfer into a beaker and the lens tissues were rinsed with distilled water and removed by using forceps. The water containing diatoms cells in the beaker was preserved with the Lugol's solution and the left to settle overnight. The