*J. Appl. Environ. Biol. Sci.*, 5(5)90-95, 2015

ISSN: 2090-4274
Journal of Applied Environmental and Biological Sciences
www.textroad.com

# Benthic Macrofauna in Mangrove Zonation at Poteran Island, Madura, Indonesia

**Aunurohim[1*], Bagus Karim Sujatmiko[2], Aminatul Badriyah Ikrom[2], Nengah Dwianita Kuswytasari[1], Maya Shovitri[1], Enny Zulaika[1], Nur Hidayatul Alami[1], Triono Bagus Saputro[1], Wirdhatul Muslihatin[1], Dini Ermavitalini[1], Taslim Ersan[3]**

[1]Department of Biology, Faculty of Mathematics and Natural Science, ITS
[2]Student of Department of Biology, Faculty of Mathematics and Natural Science, ITS
[3]Departmen of Chemistry, Faculty of Mathematics and Natural Science, ITS
Surabaya, Indonesia

*Received: January 25, 2015*
*Accepted: March 17, 2015*

## ABSTRACT

Some coastal areas of the Poteran Island had covered by mangrove that associated to benthic macrofauna and had given an ecologically value. This study was aim to determine the trend of living of benthic macrofauna on mangrove tree species at certain parts such as roots, stems, leaves, or substrate. Benthic macrofauna sampling had done using the random method with hand collecting at one meter squares of each area of mangrove zonation. Illustration of benthic macrofauna living tendency on mangrove zonation showed using multivariate Canoco. Dispersal pattern of benthic macrofauna in mangrove zonation calculated manually using Poisson Index. The population of benthic macrofauna that associated with mangrove zone of *Avicennia marina*, *Sonneratia alba* and *Rhizophora apiculata* respectively were 3, 10 and 10 species, while the pattern of dispersal of macrofauna associations had a tendency to cluster (clumped) in the zone of *Avicennia marina*, *Sonneratia alba* and *Rhizopora apiculata*, except for some specific types such as *Cerithidea cingulata*, *Metopograpsus latifrons* and *Gaffrarium pectinatum* that showed random pattern.
***KEYWORDS*** - Benthic macrofauna, dispersal pattern, mangrove zonation

## INTRODUCTION

Mangrove forest was one of the unique natural ecosystems that had a high ecological and economic value. Ecological functions of mangrove ecosystems include: coastal protection from attack wind, currents and waves of the sea, habitat (residence), foraging (feeding ground), care and rearing (nursery grounds), and breeding (spawning ground) for aquatic biota. Economic function of mangrove ecosystems produced household purposes, producer of industrial purposes, and producer of seeds [5].

According to [6] benthic communities were organisms that live in the bottom of waters. Further stated that the epifauna was live on a base, while infauna lived among the sediment particles. Based on the size of benthic fauna divided into macrofauna (> 0.5 mm), meiofauna (10-500 µm) and microorganisms (< 10 µm).

Benthic macrofauna communities included Gastropods could use also as an indicator of the recovery of function of mangrove vegetation, i.e by studying the community structure of Gastropods that found in various levels of mangrove vegetation [11]. Habitat conditions that included mangrove vegetation species composition and density would determine the characteristics of the physical, chemical and biological water which in turn would determine the structure of a community of organisms associated with mangrove communities include Gastropod [1].

Poteran Island had two types of beach with different substrates, which were rocky and sandy, in the north, east, and south of the island.Some Poteran Island coastal region with these substrates covered by mangrove ecosystems that had the potential to be developed. Mangrove ecosystem was also important for benthic macrofauna associated with economic value. It was therefore necessary to first establish a correlation between the benthic macrofauna and mangrove ecosystems in the area.

Some studies indicated that the composition of benthic macrofauna in mangrove zonation influenced by the composition of mangrove species in there. As in the study by [6], explained that the sampling sites had some common types of mangrove vegetation and common environmental conditions, gave rise to the common species of benthic macrofauna. This indicated a relationship between zone mangroves with benthic macrofauna diversity at the study site.

The purpose of this study was to determine the distribution of community linkages benthic macrofauna at mangrove zonation in Poteran Island, Madura, East Java.There was no research related to the study of the distribution of benthic macrofauna in mangrove zonation Poteran Island. This study complemented previous research related geology of the region, offshore, and Foraminifera in the Poteran Island conducted by the Department of Mines and Energy, Directorate General of Geology and Mineral Resources Development Centre of Marine Geology in 1994.

## MATERIALS AND METHODS

### *A. Time and Place of Research*

This study conducted for 3 months (April - June 2014), it included determining the location of sampling and data analysis in the laboratory.

***Corespondence author:** Aunurohim, Department of Biology, Faculty of Mathematics and Natural Science, ITS
aunurohim@gmail.com

Sampling sites located in mangrove zonation of Poteran Island, Madura, East Java. Sampling conducted in the northern part of the Poteran Island, because the best mangrove zonation only found in this area of the Island. Samples of benthic macrofauna would be taken at each zonation and then identified at laboratory.


**Figure 1**. Sampling location at Poteran Island with three station of mangrove zonation

*Rhizophora mucronata* and *Avicennia marina* found at station 2 with coordinates S 07° 04 '18.8 "E 114 ° 01' 54.7". Then, *Sonneratia alba* founded at station 2 and 1with coordinates S 07 ° 04 '25.1 "E 114 ° 02'18 .0" and also station 3 with coordinates S 07 ° 04' 26.1 "E 114 ° 01 '37.6".

These mangroves then used as our main target to collect benthic macrofauna at a few parts of these plants, such as leaves, stem, root or substrates.

*B. Methods*

The method that used named random sampling, where the researcher makes squares placed randomly in the sampling in mangrove vegetation. Macrofauna on the surface of the substrate or attach at the parts of mangrove trees was taken by a hand collecting, Substrates then excavated using a trowel as deep as 10 cm for take benthic macrofauna that live in the sediment.

These macrofauna then took in a plastic clip include distinguished between those found in sediment, roots, stems, and leaves of mangrove. Samples then got fixation use 10% of formalin and transported to the laboratory to be identified and analyzed.

*C. Analysis of Dispersal Pattern*

The dispersal pattern of benthic macrofauna analyzed using Poisson distribution. Tabulated data obtained through Microsoft Excel, and then the data further analyzed in the index calculation using the Poisson formula as in the table below:

$$S^2 = \frac{\sum(x - \bar{x})^2}{n - 1}$$

Note:

$S^2$ : Variance

n : The number of benthic macrofauna that observed

$\bar{x}$ : The average number of benthic macrofauna were found

x : The number of species in each observation station

Values obtained from this index used to determine the dispersal pattern of benthic macrofauna in mangrove zonation

If,

S=$\bar{X}$ : dispersal pattern of random

S>$\bar{X}$ : dispersal pattern of clumped

S<$\bar{X}$ : dispersal pattern of uniform

*D. Ordination Analysis*

Data analysis performed using ordinate assistance program for Windows 4.5.Canoco program used to see a trend of benthic macrofauna at the sampling site and where it attached in certain mangrove organs or parts. There would be two types of diagrams, multivariate diagram where was the first to see the trend of discovery of benthic macrofauna in mangrove zonation in different species. And the second was a tendency to see the discovery of benthic macrofauna in a part of mangrove plants as roots, stems, leaves, and substrate.

## RESULTS

Benthic macrofauna in the mangrove ecosystem of Poteran Island consisted of 7 families and 12 species. Each species and families had different numbers on each particular mangrove species zonation.

***Dispersal pattern of benthic macrofauna in mangrove zonation at Poteran Island***

The dispersal pattern was one of ecological theme to be known more bio-ecology of the species. With knowing their dispersion, we could act with certain data to protect them more safely. In this research, we were focus to know more accurate about dispersal pattern of benthic macrofauna at mangrove zonation. Mangrove ecosystems were big habitats that protected many of animals, and the one was benthic macrofauna.

*Cerithidea cingulata's* pattern was random on zone of *Rhizophora apiculata* and *Avicennia alba.* This might because that *Cerithidea cingulata* were the original inhabitants of the mangrove ecosystem and dominated the community. So, they able to live at all mangrove zonation as long as it could utilize all of the nutrients that served in the mangrove substrate. In contrast, *Cerithidea alata* clumped dispersal on zone of *Rhizophora apiculata* [8].

Benthic macrofauna from Family Littorinidae, like *Littoraria melanostoma* and *Littoraria carinifera* had clumped dispersal in zone of *Rhizophora apiculata*. *Littoraria melanostoma* and *L.carinifera* prefers to stay at mangrove tree with a short stem that branches and roots that protrude so they can move from one stem to another mangrove stems due to various reasons, such as to obtain food [2].

The same pattern had shown by *Coenobita* sp. and *Euraphia* sp. which was prefer to live at *Rhizophora apiculata*, and the pattern dispersal clumped on *Rhizopora* zone, which the structure of the complex roots and branches provided shade and extra protection for their associations in mangrove trees [2].

*Uca sp.*1 had a clumped dispersal pattern on *Rhizophora apiculata* mangrove zonation. The nature of *Uca sp.*1 who like to live on mangrove zonation was slightly open which was likely to cause this distribution pattern had formed [7]. At the edges of the *Rhizophora apiculata* mangrove zone, there was also a substrate that not covered by mangrove tree, so that made an appropriate bio-ecology location for *Uca* sp1.

*Metopograpsus latifrons* on *Rhizophora apiculata* mangrove zonation showed random pattern. According to [7] *Metopograpsus latifrons* had a high ability to mobilize so they could move it the location easily. This was the one reason that expected to cause the pattern of dispersal of *Metopograpsus latifrons* was random.

*Gafrarium pectinatrum* had also found in *Rhizophora apiculata* area with random dispersal pattern. Bivalve like *Gafrarium pectinatrum* utilized many types of organic particles on the substrate so it tolerated and lived spread as long as mangrove forest even if tidal wave swept [13].

Benthic macrofauna found as clumped dispersal in mangrove zonation of *Sonneratia alba* were *Littoraria pallescens*, *Littoraria melanostoma*, *Littoraria carinifera*, *Uca* sp2., *Coenobita* sp., *Metopograpsus latifrons*, *Euraphia* sp. Benthic macrofauna in mangrove zonation of *Sonneratia alba* expected to form due to the different content of organic matter at each sampling location on this zone. Some sampling sites were near the residential area where the waste dumped directly into mangrove zonation of *Sonneratia alba* in Poteran island. Benthic macrofauna tend to clumped in locations that contain lots of organic nutrients that support them [3]. These organic materials obtained from the mangrove trees themselves or from human activity [4].

According to [10] *Littoraria articulata* were capable to utilize the mangrove bark as their food and stick on mangrove leaves to avoid predators, so they were often found living at mangrove trees in any spread. This expected to lead that this animal had random dispersal at mangrove zonation of *Rhizopora apiculata* and *Sonneratia alba.*

*Uca* sp1, its dispersal patterns on *Sonneratiaalba*zone is random. The nature of the high mobilization by *Uca* sp1 and *Sonneratia alba* roots that were not as complex as the root structure of another genera of *Rhizophora* was likely cause of the random dispersal pattern formation on this Ocipodidae [7].

Clumped dispersal pattern also indicated by benthic macrofauna in *Avicennia marina* zone with low density. These benthic macrofauna were *Cerithidea cingulata*, *Littoraria pallescens*, and *Coenobita* sp .The only group on *Avicennia marina* zone that bordering with *Sonneratia alba* zone indicated more density, because the mangroves with high density and litter were able to provide more lot nutrient for benthic macrofauna [10].

***Trends living benthic macrofauna at Mangrove specific zone***

Depiction ordinate tendency benthic macrofauna living in mangrove zonation at Poteran Island using Canoco Program that obtained by Principal Components Analysis or PCA. PCA used because according to [9] when using Canoco obtained

value ordination length of the gradient was less than 3, then the data consist too homogeneous and the corresponding modeling was Principal Components Analysis or PCA. PCA graphs tendency benthic macrofauna living on the zonation of mangrove species presented as follow:

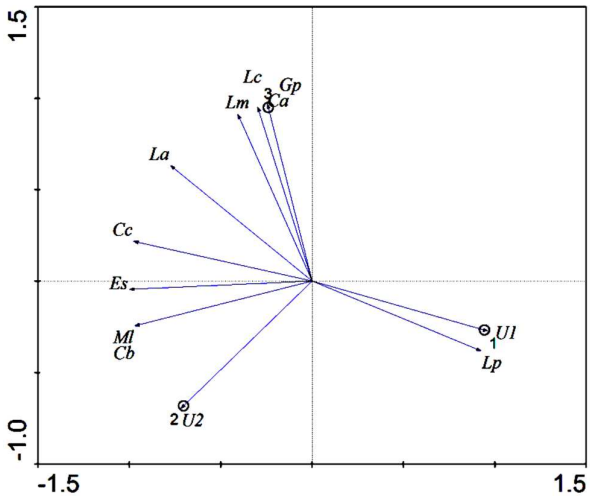
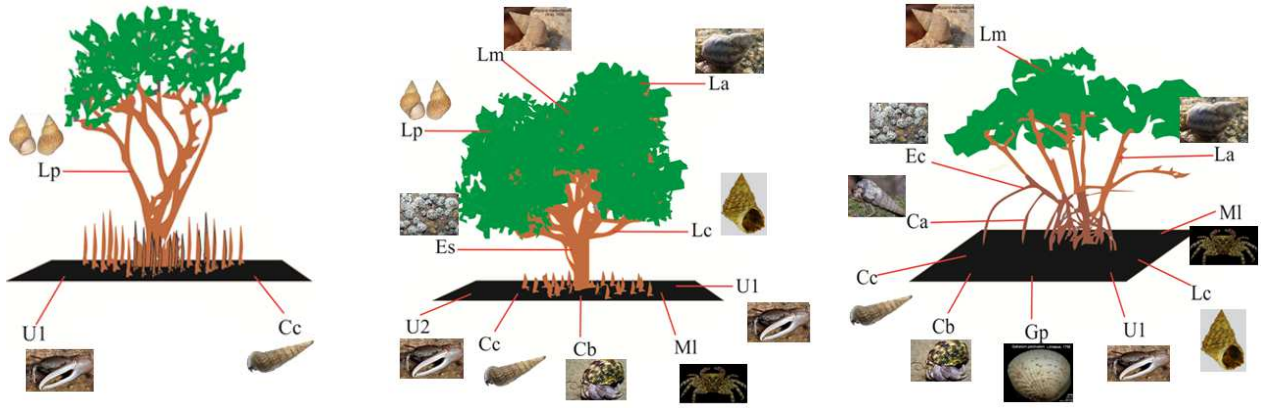



**Figure2**.Graphic of Principal Component Analysis (PCA) of benthic macrofauna living on mangrove species zonation.

Benthic macrofauna at mangrove zonation as follows

Cc :*Cerithideacingulata*
Lp :*Littorariapallescens*
U1 :*Uca* sp1.
Lm :*Littorariamelanostoma*
Cb :*Coenobita*sp.
Ml :*Metopograpsuslatifrons*
U2 :*Uca* sp2.
La :*Littorariaarticulata*
Es :*Euraphia*sp.
Lc :*Littorariacarinifera*
Gp :*Gafrariumpectinatrum*
Ca : *Cerithideaalata*

And the mangrove zonation was:
1 :*Avicennia marina*
2 :*Sonneratia alba*
3 :*Rhizophoraapiculata*




(a) (b) (c)

**Figure 3**. Illustration of preference habitat from each benthic macrofauna at specific mangrove zonation (a) *Avicennia marina* ; (b) *Sonneratia alba*, and (c) *Rhizophoraapiculata*

From the graph PCA above (figure 2), it can be seen that the benthic macrofauna most likely to be found living on mangrove zonation of *Rhizophora apiculata* and *Sonneratia alba*. They showed 5 species tend to live on *Rhizophora*

*apiculata* and *Sonneratia alba* zonation. Species who tend to live on *Rhizophora apiculata* zonation were *Littoraria articulata* (La), *Littoraria melanostoma* (Lm), *Littoraria carinifera* (Lc), *Cerithidea alata* (Ca) and *Gafrarium pectinatrum* (Gp), while who tend to live on *Sonneratia alba* zonation are *Cerithidea cingulata* (Cc), *Euraphia* sp. (Ice), *Metopograpsus latifrons* (Ml), *Coenobita* sp. (Cb), and *Uca* sp2. (U2). And, on *Avicennia marina* mangrove zonation are *Uca* sp1. (U1) and *Littoraria pallescens* (Lp).

Benthic macrofauna possibility that tend to live on *Rhizophora apiculata* and *Sonneratia alba* zonation because they would gain more shade and nutrients in these zonation. According to [12] the diversity of mollusks determined by the availability of protection and feeding ground by mangrove roots, so at least mangrove roots will trigger the organism to migrate from each root to another if any danger from their predators. Root system of *Rhizophora* not only protected benthic macrofauna from the tropical heat of the sun, but also as feeding ground of other organisms, including these benthic macrofauna [8].

This was according to the conditions in the field, where root system of *Rhizophora apiculata* and *Sonneratia alba* at Poteran Island is more complex than *Avicennia marina*, so the benthic macrofauna that tend to be found at zone of *Avicennia marina* is less than *Rhizophora* or *Sonneratia*.

In the open space of zonation of *Avicennia marina* found live crabs from the family Ocypodidae. According to [7] the crabs of Ocypodidae prefer substrate that was not too densely overgrown with mangrove trees. *Uca* spp. searched nutrient to eat when a new ebb and substrate was still wet, whereas when dry *Uca* spp. would do social interaction [7].

**Life tendency of benthic macrofauna at *Avicennia marina's* trees**

The existence *Cerithidea cingulata* and *Uca* sp1 only found in *Avicennia marina's* substrate. Unlike the *Littoraria pallescens* were more likely to be found in the stem of *Avicennia marina*. This was in accordance opinion [7] that *Cerithidea cingulata* most kind lived at the mud and crawling on the surface as epifauna.

Crabs from Ocipodidae were often found on substrate of mangrove zonation at Poteran Island. *Uca* spp lived burrowing in mangrove substrate. Its width body was almost equal to the length and near-circular at the center of the body, it made *Uca* spp easy to burrows into substrate [7].

**Life tendency of benthic macrofauna at *Sonneratia alba's* tress**

Each species had a tendency found at different part of *Sonneratia alba*. *Uca* sp1, *Uca* sp2., *Cerithidea cingulata*, *Coenobita* sp., and *Metopograpsus latifrons* tend to be found in substrate of *Sonneratia alba*. *Coenobita* sp. also found living in roots of *Sonneratia alba*, but the tendency to live in the substrate much higher than root. Hermit crab *Coenobita rugosus* and *Coenobita* sp. were active 24 hours a day, but they were most active among the mangrove roots. *Coenobita* sp. applied this because among the mangrove roots wind speed and potential desiccation (drying) are lower [2].

*Metopograpsus latifrons* was crab tree climber, but they would not always be found in the stem or roots of trees. This crab climber presented at mangrove substrates to eat the leaves drop long enough and start to rot. Crab prefers rotting leaves because it was easier to digest [7]. Benthic macrofauna that found at stem of *Sonneratia alba* were *Littoraria carinifera* and *Euraphia* sp.

*Littoraria articulata* almost had the same characteristic as *Littoraria melanostoma*, tend to be found living in leaves of *Sonneratia alba*. Besides found at the leaves, this benthic macrofauna also found at root, but much less than to leaves.The same case for *Littoraria pallescens*, that was find at the roots and leaf of *Sonneratia alba*, but much greater at the leaves. *Littoraria pallescens* had a flat aperture and also has a shell that was very thin and weak. A shell-breaking crab predators presented anywhere such as in the trunk or in the mangrove roots, but was not able to be in the leaves. *Littoraria pallescens* living in mangrove leaves need more protection against physical damage caused by shell-breaking crab's predators, so it was not a problem to have a thin shell [7].

**Life tendency of benthic macrofauna at *Rhizophora apiculata's* tress**

Species that found at *Rhizophora apiculata* had 4 different tendencies, on the substrate, roots, stems, and leaves. Species such as *Cerithidea cingulata*, *Uca* sp1., *Coenobita* sp., *Metopograpsus latifrons*, *Gafrarium pectinatrum*, and *Littoraria carinifera* tend to be found living at substrate of *Rhizophora apiculata*.

Bivalve like *Gafrarium pectinatrum* was benthic macrofauna with a slow movement. Bivalve had an association with nitrogen bacteria fixative to eat substrate [13]. Bivalve not eating mangrove litter directly, but rely on organic particles that had processed by other organisms [7].

Benthic macrofauna found to be living on the roots of *Rhizophora apiculata* are *Cerithidea alata* and *Euraphia* sp. Species like *Euraphia* sp. was barnacle that easily and commonly found in the root of *Rhizophora*. The barnacles can be even found on the stems and leaves of mangrove if floated by a high tide when the larval phase. Barnacle was a filter-feeder that depends on mangrove roots or stems just as the stick that was strong and stable [7].

At *Rhizophora apiculata* leaves, *Littoraria melanostoma* there were likely to be found there, while *Littoraria articulata* was alive in the stem. *Littoraria* spp. was the most abundant Gastropods that found in mangrove zonation. According [3] *Littoraria* spp. eat the outer skin of the roots and stems of the mangrove. [10] added that *Littoraria* spp. eat mangrove leaves, thus reducing litter fall.

## IV.CONCLUSION

The conclusions of this research divided into two main focuses:

1. The dispersal pattern of benthic macrofauna at mangrove zonation at Poteran Island was clumped and random, depends each species that are investigated.
2. The population of benthic macrofauna that associated with mangrove zone of *Avicennia marina*, *Sonneratia alba* and *Rhizophora apiculata* were 3, 10 and 10 species.

**ACKNOWLEDGEMENT**

This project funded by BOPTN of LPPM ITS with contract no. 016457.5/IT2.7/PN.01.00/2014. Thanks to our beloved students, Karim and Amina, that gave our research to make beautiful. Thanks to our member of research that supports their laboratorium for making anything easier. And special thanks to Prof. Christian Stoolberg, that gave his opportunity to make a joint in this research, hope it would realize in the next year.

## REFERENCES

[1] Arifin. 2002. Struktur Komunitas Pasca Larva Udang Hubungannya dengan Karakteristik Habitat pada Ekosistem Mangrove dan Estuaria Teluk Cempi NTB. *(Thesis)*. Pascasarjana Institut Pertanian Bogor. Bogor.

[2] Barnes, D.K.A. 1997. Ecology of Tropical Hermit Crabs at Quirimba Island, Mozambique: Distribution, Abundance and Activity. *Marine Ecology Progress Series 154: 133-142.*

[3] Camilleri, J.C. 1989. Leaf choice by crustaceans in a mangrove forest in Queensland. *Marine Biology 102: 453–459.*

[4] Connel, D. W., dan Miller, G. J. 1995. *Kimia dan Ekotoksikologi*. Penerjemah Koestoer, Y dan Sehati. UI Press. Jakarta.

[5] Dahuri, Rohmin. 2001. *Pengelolaan Sumber Daya Wilayah Pesisir dan Lautan Secara Terpadu*. Pradnya Paramita Publisher. Bogor.

[6] Dobson, M., dan Frid, C.1998. *Ecology of Aquatic Systems*. Addison Wesley Longman. Singapore.

[7] Hogarth, P. J. 2007. *The Biology of Mangroves and Seagrasses.* Oxford University Press Inc. New York.

[8] Kamardin, N. N., C. Ulare and M. Sangare. 2006. Peculiarities of adaptive behavior of mangrove mollusks at the Guinea Coast. *Journal of evolutionary biochemistry and physiology. 42(1): 38-42*.

[9] Leps, J. 1953. *Multivariate Analysis of Ecological Data Using CANOCO*. Cambridge University Press.

[10] Marguillier, S., van der Velde, G., Dehairs, F., Hemminga, M.A., and Rajagopal, S. 1997. Trophic relationships in an interlinked mangrove-seagrass ecosystem as traced by δ 13C and δ 15N. *Marine Ecology Progress Series 151: 115–121.*

[11] Perry, D.M. 1988. Effects of associated fauna on growth and productivity in the red mangrove. *Ecology 6: 1064–1075.*

[12] Vilardy, S. and J. Polania. 2002. Mollusks fauna of the mangrove root-fouling community at the Colombian Archipelago of San Andres and Old Providence. *Wetlands ecology and management. 10: 273-282.*

[13] Waterbury, J.B., Calloway, C.B., Turner, R.D., 1983. A cellulolytic nitrogen fixing bacterium cultured from the gland of Deshayes in shipworms (Bivalve, Teredinidae). *Science 221, 1401–1403*.