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Infestation of biofoulings (*Balanus* sp. and *Littoraria* sp.) on mangrove *Rhizophora* sp. and *Avicennia sp*. at Gadingrejo, Pasuruan, Indonesia

Oktiyas Muzaky Luthfi[1], Evi Safitri[1] and Agoes Soegianto[2]*

[1]Department of Marine Sciences, Faculty of Fisheries and Marine Sciences, University of Brawijaya, Jalan Veteran, Malang 65145, Indonesia
[2]Department of Biology, Faculty of Science and Technology, Universitas Airlangga, Surabaya 60115, Indonesia

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ABSTRACT

Biofouling or epibionts are common organisms colonize and growth in surface of any subjects in the marine environment, including on mangrove trees. *Balanus* sp. and *Littoraria* sp. are broad known as epibionts that grow from lowest low water until highest high water in Rhizopora root. The aim of this research was to know the abundance and effect of biofouling (Balanus and Littoria) on two major mangroves in Pasuruan, Indonesia, *Rhizophora* sp. and *Avicennia* sp. Three stations were chosen to observe abundance of biofouling and the result showed abundance of *Balanus* sp in station 1, 2 and 3 were 0.7 individual/m^2, 0.45 individual/$m^{2,}$ and 0.47 individual/m^2, while abundance of Littoria sp showed lower were 0.2 individual/m^2, 0.33 individual/m^2 and 0.26 individual/m^2 (station 1, 2, and 3). Based on physical view in mangrove trees *Balanus* sp made damages in root because chemical liquid that produced to attach in root, there were phenol and phenoloxydase. In other hands *Littoria* sp did not make damage to mangrove.

Key words: *Avicennia sp., Balanus sp., Gadingrejo, Littoraria sp., Rhizophora sp.*

Introduction

Mangrove forest is a complex ecosystem located in the intertidal area where region between land and sea or inter-tidal area. Ecosystem mangrove play on important role as live supporting of biota that inhabit inside them (Masiyah and Sunarni, 2015). Mangrove is the biggest nutrient source that are delivered in another ecosystem such as seagrass and coral reef. Mangrove also has function as pollutant filter from terrestrial and decreases the number of toxic substances before down to seawater (Pramudji, 2000). Mangrove creates complex habitat for macro-fauna such as crustacea and gastropods, their leaf are becoming main food for crustacea and gastropods. A more 73% mangrove leaf litter is eaten and decomposed by crab and crustacea (Steinke, 1993; Wahyuni *et al.,* 2017).

Biofouling is an organism colonize underwater surface for temporary or permanent purposes (Callow and Callow, 2002). Macro fouling is invertebrate that has hard or soft body and overgrowth micro fouling. These compromise barnacles, mussels and tubeworms. In mangrove tree these biota adhere to substrate, root, branch, and leaf. Common biota that common are *Balanus* sp. and *Littoraria* sp. Huge and massive distribution of biofouling suggested because larva of it has long lifespan and easy to adapt in new environment (Pettengill *et al.*, 2007). Barnacle, for example, has two live cycles, first is larva stadium (planktonic) and sessile stadium during adult. Barnacles have ability to glue of mangrove trees and make damage it, and sometimes because main cause death of mangrove trees. Other common biofouling is sea snail (gastropoda), *Littoraria scabra*, which has ability to migrate vertically on mangrove root and trunks. In juvenile phase littorinids live in low intertidal area while adult they move into above the higher water (Alfaro, 2007).

Pasuruan is known change into industrial areas that most of factories were built nearby coastal areas. Mangrove ecosystem in this area mainly are resulted from rehabilitation program, thus the only found mono stand of mangrove species such as Rhizophora. A little amount of mangrove trees in Pasuruan should be looked after from threats both natural or from human activities. Biofouling can be serious threat to mangrove tree health. To address this problem this study has aim to know the distribution and influence of infestation biota in mangrove trees such as *Rhizophora* sp. and *Avicennia* sp.

Materials and Methods

Study area

This study conducted in three stations in mangrove forests where located facing the Java Sea (Fig. 1). Station 1 located next to mooring boat of fishermen and residential area, station 2 next to fishpond and station 3 next to river and residential area. The field surveyed run two months in March – April 2019 at Pantai Gadingrejo, Pasuruan, East Java.

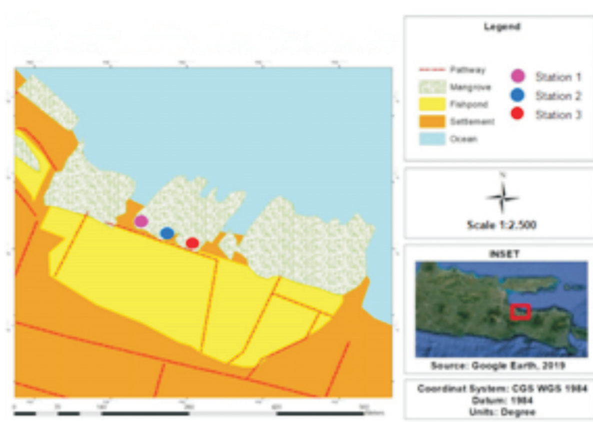

Fig. 1. Map of study site indicated with color dot

Biofouling

All root of mangrove trees in each station was surveyed and cataloged specific biofouling (*Balanus* sp. and *Littoraria* sp). In station 1 the number of surveyed mangroves (*Avicennia* sp stand for A and *Rhizophora* sp stand for R) were 78 (A 11 and R 67), station 2 (A: 19 and R: 52) and station 3 (A: 15 and R: 53). Barnacles and gastropod were from lower portions or near substrate (LLW) around 5-10 cm above substrate up to the highest portion from root were counted and photographed. Chemical and physical oceanography has been determined using Horiba Water Control and position. Each station was marked by GPS (Garmin Montana).

Data Analysis

Recorded data then transform in a spreadsheet program to calculate abundance, dominance indices, biodiversity indices, and uniformity indices. Abundance of organism calculate as number of individuals in certain area (Maulud *et al.*, 2017). The calculation using this simple equation:

$$xi = \frac{ni}{A} \quad \text{.....................................(1)}$$

where :

xi : abundance of species i
ni : number of species i
A : area of transect (m^2)

Dominance Indicescalculated using this formula:

$$D = \sum_{i}^{i} -\left(\frac{Ni}{N}\right)^2 \quad \text{.....................................(2)}$$

where :

D : dominance indice
Ni : number of individual-i
N : total number of individu or species

Biodiversity and uniformity indice using this formula:

$$H' = -\sum_{i=1}^{s}\left(\frac{n_i}{N} Log_2 \frac{n_i}{N}\right) \quad \text{..........................(3)}$$

$$E = \frac{H'}{H'max} = \frac{H'}{Log_2\ s} \quad \text{.......................(4)}$$

The relationship of biofouling abundance with mangrove tress was analyzed using simple regression. Mangrove trees as dependent variables and biofouling biota as the independent variable.

Results and Discussion

Environmental condition

Temperature, salinity, pH and DO of seawater in all stations have similar trend around 30 ^{o}C, 30 ppt, 7.8 and 6 mg/L. Water clarity was slightly different each station which the highest of turbidity at station 3 (Table 1).

Temperature and salinity are two factors directly limited to Balanus's larvae growth. During crypid stage Balanus can grow normally in temperature 27-30 ^{o}C and salinity around 30 ppt. Lower and higher of that condition the rate of mortality will increase. Research in laboratory-scale showed increasing mortality of Balanus larvae caused by low water temperature and salinity up to 58%; furthermore, cold water is other possible to make settlement failure of Balanus larvae in a substrate (Anil *et al.*, 1995). Water clarity linked to surface preference of Balanus to attach in some surface either types of substrates surface (Aldred *et al.*, 2010).

Abundance of Biofouling

The highest infestation of *Balanus* sp was found in station 1, it was 4,662 individuals in all mangrove trees, while *Littoraria* sp seemed to concentrate on station 2 (2,173 individual) (Table 2). In stations 2 and 3, the previous almost equal around 3,000 individuals and latter was around 1,000 individuals respectively. Figure 2 showed vertical distribution both of biofouling in *Rhizophora* sp and *Avicennia* sp. Overall, Littoraria has higher vertical cross in *Rhizopora* and *Avicennia*. *Balanus* sp prefers to live in *Rhizopora* sp than *Avicennia*.

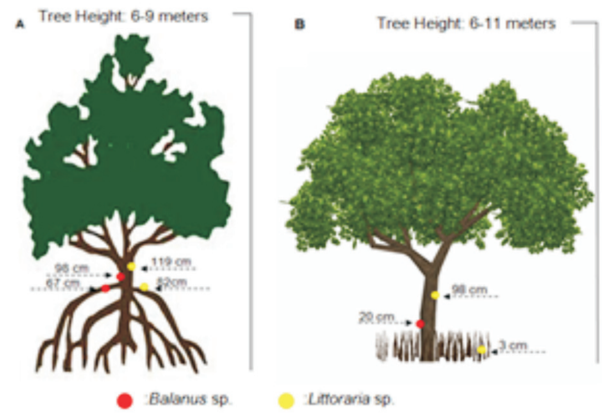

Fig. 2. Biofouling on *Rhizophora* sp. (A) and *Avicennia sp.* (B)

The high abundance of *Balanus* sp on *Rhizopora* sp because the stem bark of these trees rough as sharkskin that help barnacle larvae to adhere to it. Fluid like glue produced by barnacle through antennular secreted phenol and phenoloxydase during presettlement and using cement from calcium carbonate during post-settlement. This cement is very strongly affected strong bond between the barnacle and mangrove trees. Some of the chemical substances then entra into mangrove stem in branch and root affects on growth rate of mangrove trees.

Avicennia sp had the silky smooth texture of skin that allows *Littoraria* sp move around and it was the reason many of them be found in this tree. Littorinids has unique movement which always follows neighbors' mucous trail ahead. They migrate up and down of mangrove tree avoiding tidal immersion. *L. scabra* for instance can make fast upward migration around 1 cm/ minute in the first 120 minutes before high tide approaches. The slower downward movement (0.6 cm/ minute) for active feeding, they move into bottom of tree and spread laterally (Alfaro, 2007).

Table 1. Oceanography parameters

Station	Temp. (^{o}C)	Salinity (ppt)	pH	DO (mg/L)	Water clarity (NTU)
1	30.4 ± 0.9	30.2 ± 0.3	7.8 ± 0.1	5.8 ± 0.4	9.9 ± 0.6
2	30.6 ± 1.1	29.8 ± 1.0	7.9 ± 0.0	6.1 ± 1.0	8.3 ± 1.1
3	30.6 ± 0.5	30.1 ± 0.2	7.8 ± 0.1	6.6 ± 0.3	10.1± 0.3

Table 2. Abundance of biofouling

Biofouling	Station	ni	Ni/A
Balanus sp.	1	4,662	0.70
Balanus sp.	2	3,030	0.45
Balanus sp.	3	3,150	0.47
Littoraria sp.	1	1,304	0.20
Littoraria sp.	2	2,173	0.33
Littoraria sp.	3	1,743	0.26

Structure community

Biofouling diversity index in Pasuruan was low H' <1, while uniformity index was high E>0.6. The dominance index has high value as well (C>1). The dominance of 2 species biota in mangrove stem bark is why the diversity is very low. Low diversity can be caused by several factors, first is competition. The competition winner will occupy space dominantly and feedlot resources in certain areas (Rajaniemi, 2002). Second, are adaptability and security. Climate change sometimes eradicates species naturally, only certain organism that has good adaptation can survive in nature (Lo, 2011). Thirdly, human intervention, for instance, Balanus usually eradicate from boat surface with physical action, effect on reduce or distinct these biotas(Ulum *et al.*, 2012).

Table 3. Indices ofDiversity, Uniformity and Dominance of Biofouling

Indeks	Stations		
	1	2	3
Diversity (H')	0.52	0.67	0.65
Uniformity (E)	0.75	0.98	0.93
Dominance (C)	2	2	2

Structure community is important to generate basic data of ecosystems such as mangrove, seagrass and coral reef. Through this method authority can monitor changing process of biota composition regularly and can make quick decisions if needed. In some cases, structure community data used as zoning tool to develop marine protected areas. Each species has uniqueness and can be classified in certain zone.

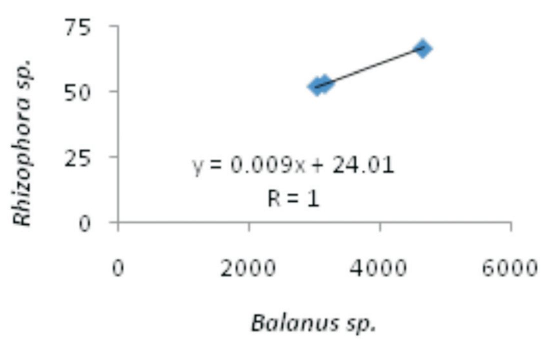

Fig. 3. Correlation of *Balanus* sp. with *Rhizophora sp.*

Conclusion

Barnacle (*Balanus* sp) and sea snail (*Littoraria* sp) infested on two common mangroves in *Pasuruan*. Barnacle which prefers live in *Rhizophora* effects_on mangrove growth while littorinids have commensalism with their host. The diversity index of both foulers does reflect diversity of ecosystem mangrove needs more data in broader scale to describe the diversity ecosystem mangrove in Pasuruan.

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References

Aldred, N., Scardino, A., Cavaco, A., de Nys, R. and Clare, A.S. 2010. Attachment strength is a key factor in the selection of surfaces by barnacle cyprids (*Balanus amphitrite*) during settlement. *Biofouling*. 26(3): 287-299.

Alfaro, A.C. 2007. Migration and trail affinity of snails, Littoraria scabra, on mangrove trees of Nananu-i-ra, Fiji Islands. *Marine and Freshwater Behaviour and Physiology*. 40(4) : 247-255.

Alfaro, A.C. 2007. Migration and trail affinity of snails, Littoraria scabra, on mangrove trees of Nananu-i-ra, Fiji Islands. *Marine and Freshwater Behaviour and Physiology*. 40(4) : 247-255.

Anil, A.C., Chiba, K., Okamoto, K. and Kurokura, H. 1995. Influence of temperature and salinity on larval development of Balanus amphitrite: implications in fouling ecology. *Marine Ecology Progress Series. Oldendorf*. 118(1) : 159-166.

Callow, M.E. and Callow, J.A. 2002. Marine biofouling: a sticky problem. *Biologist*. 49(1) : 1-5.

Chusna, R.R.R., Rudiyanti, S. and Suryanti, S. 2017. Hubungan Substrat Dominan Dengan Kelimpahan Gastropoda Pada Hutan Mangrove Kulonprogo, Yogyakarta. Saintek Perikanan. *Universitas Diponegoro.* 13 (1) : 19-23.

Lo, L.H. 2011. November. Diversity; Security; and Adaptability in Energy Systems: a Comparative Analysis of Four Countries in Asia. In *World Renewable Energy Congress-Sweden. 8-13 May; 2011; Linköping; Sweden* (No. 057, pp. 2401-2408). Linköping University Electronic Press.

Masiyah, S. and Sunarni, 2015. Komposisi Jenis dan Kerapatan Mangrove Di Pesisir Arafura Kabupaten Merauke Provinsi Papua. *Jurnal Ilmiah Agribisnis dan Perikanan.* UMMU-Ternate. Vol.8.

Maulud, A., Purnawan, S. and Nurfadillah, N. 2017. Kelimpahan Biota Penempel Yang Terdapat Pada Mangrove Di Muara Alue Naga Kecamatan Syiah Kuala Kota Banda Aceh. *Jurnal Ilmiah Mahasiswa Kelautan and Perikanan.* Unsyiah. 2 (4): Hal. 490-496.

Mudzni, Al. 2014. Sebaran Teritip Intertidal dan Hubungannya Dengan Kondisi Lingkungan Perairan Di Pelabuhan Kota Dumai. Tesis. Institut Pertania Bogor. Bogor.

Pettengill, J.B., Wendt, D.E., Schug, M.D. and Hadfield, M.G. 2007. Biofouling likely serves as a major mode of dispersal for the polychaete tubeworm Hydroides elegans as inferred from microsatellite loci. *Biofouling*. 23(3) : 161-169.

Pramudji. 2000. Hutan Mangrove Di Indonesia: Peranan Permasalahan Dan Pengelolaan. Osena. Volume XXV (1) 13-20. ISSN 0216-1877.

Rajaniemi, T.K. 2002. Why does fertilization reduce plant species diversity? Testing three competitionbased hypotheses. *Journal of Ecology*. 90(2) : 316-324.

Rani, S. Sophia., S Bragadeeswaran., K Prabhu., S Priyadharshini. 2010. Infestation of Barnacle (*Balanus amphitrite*) in the mangrove Environment of vellar estury,Tamilnadu. *Word Journal of Fish and Marine Sciences.* Annamalai University. India. 2 (4): 307-310.

Steinke, T.D., Rajh, A. and Holland, A.J. 1993. The feeding behaviour of the red mangrove crab Sesarma meinerti De Man, 1887 (Crustacea: Decapoda: Grapsidae) and its effect on the degradation of mangrove leaf litter. *South African Journal of Marine Science*. 13(1) : 151-160.

Ulum, Muchammad Miftshul., Widianingsih., Retno Hartati. 2012. Komposisi dan Kelimpahan Makrozoobenthos Krustasea di Kawasan Vegetasi Mangrove Kel. Tugurejo, Kec. Tugu, Kota Semarang. *Journal of Marine Research. Universitas Diponegoro.* 1 (2). Hal. 243-251.