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Distribution of Massive Porites at Reef Flat in Kondang Merak, Malang, Indonesia

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ABSTRACT

Kondang Merak was lied on south of Java sea that has monitored coral reef inside. Environment condition such as load of terrestrial's nutrient into the sea, increase of surface water temperature and tourism activities were affected on coral reef health. The massive Porites that common coral found in this location need be monitored gradually to see coral condition over time. The research was conducted in reef flat area of Kondang Merak. The aims of the research were to know distribution of massive Porites and oceanography condition in Kondang Merak. The highest sea surface temperature was 26,46^{o} C in transect number 2 at station 1 (eastern part). Salinity of sea water was in normal range between 34, 42$^{o}/_{oo}$ to 35,75$^{o}/_{oo}$, dissolved oxygen was on range 6 mg/l sampai 9,1 mg/l and pH was 7, 23 sampai 8,68 respectively. Two species on massive Porites they were Porites lobata dan P. lutea. In station 1 the average diameter of P. lobata was 228.57 cm and P. lutea 63.89 cm, in while P. lobata in station 2 was 260. 57 cm and P. lutea 153.56 cm.

Keyword: Porites lutea, Porites lobata, South of Java Sea, Coral diameter, Coral reef.

INTRODUCTION

Coral reefs are tropical marine ecosystems play an important role in supporting fisheries however their exsitance were vulnerable. Changes in water quality either directly or indirectly will affect on condition of coral reefs. Terrestrial pollution that came out from upper land also can damage on coral reef. Deforestation, land-use change has been releasing sediment and pollutants from industrial waste, household, and other fertilising substances through the major rivers has polluted the coral reefs in the waters around the mouth of the river. Environmental pressures have been resulted on reducing of coral reef biodiversity areas by 30-60% (Burke *et. al.*, 2002). In addition, increase in sea surface temperature more than 1^{o} C for more 8 weeks resulting in catastrophic mass coral bleaching (Glynn, 1991).

Porites coral has a wide distribution and spread throughout Indonesia. This is due to the coral Porites is able to survive on a variety of environmental conditions from sea water with low to high sedimentation. The other of advantages of this coral that they can live in low and high salinity (Morton, 1990). Porites coral can live in various habitats such as rocky shore, sand shore or in habitat with an abundance of rubble.

Kondang Merak is one of the beaches in south of Malang that has enormous appeal for tourists and has a good diversity of coral reefs. Recent condition the coral reef in this site was under threat that was found many rubbles in near by of utilization zone that may caused by tourism activity. Actually the coral reef condition in Kondang Merak decrease rapidly due to many fisheries

activities in that area, increase of sea water temperature, load of fresh water from upper land.

The coral growth means the increase of coral length, weight, volume or extent of coral carbonate skeleton within a certain time. In general, the formation of coral skeletons interpreted as an increase in the weight of coral skeletons are composed by calcium carbonate in the form of crystalline aragonite and calcite (Goreau *et. al*, 1982).

The purpose of this study was to determine the size distribution of the coral Porites in Kondang Merak that provide basic information of Porites structure for manage coral reef in that area. Porites as natural barrier for coastal area from abrasion and will keep suistanibility of fisheris in this area.

METHODS

Time and Study Site.

This research has been conducted in the Kondang Merak (112°30'19.80"E- 8°24'14. 14"S), Malang district in May 2015. Two stations were assigned, station 1 was on the eastern part and station 2 in western part. In each station we developed 3 time of belt transect was lied down in paralelly.

Porites Size Distribution Preparation of pond.

Data coral size distribution was quantified using belt trasect method. Belt transect is used to describe the distribution, abundance and population density of a particular coral who holds diverse relative size or have a certain maximum size. Data obtained from this method is the distribution of coral reefs and the diameter size in a particular area of research sites (Suharsono, 1998). 100 x 1 m of belt transect was lied down parallel with coastal line with interval 5 m each belt transects. We used 3-time replication in each research station. And then counted all Porites inside of belt transect and photographed (using under water camera Canon G-16). We also noted color, the longest diameter and the shortest diameter of coral Porites, and type of coral (normal coral or micro-atoll coral). The average of diameter Porites coral was calculated using this equation Todd *et. al* (2001):

$$\bar{x} = \frac{\sum x\,(A+B)}{n}$$ ..... equation (1)

where:

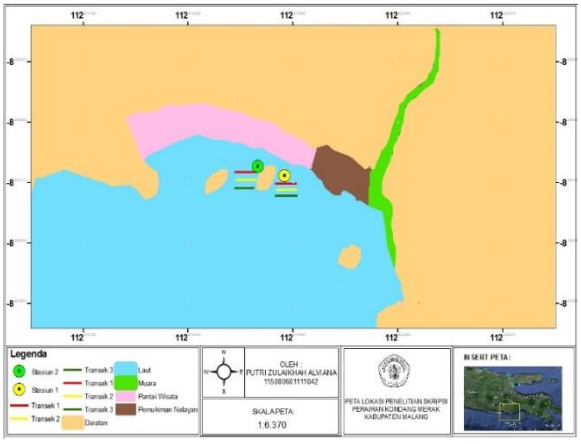
$\bar{x}$ = The average of coral diameter
$\sum x$ = Number of individu
n = Number all counted coral
A = The shortest diameter
B = The longest diameter

And then the Porites area was quantified using this equation (Naumann *et al*., 2009):

L = $\pi\ X\ A\ X\ B$.....equation (2)

where:

L = Area of coral colony
π = Phi ($\frac{22}{7}$ equal with 3,14)
A = The shortest diameter
B = The longest diameter.



Picture 1. Study area marked by green and yellow dot.

RESULT & DISCUSSION

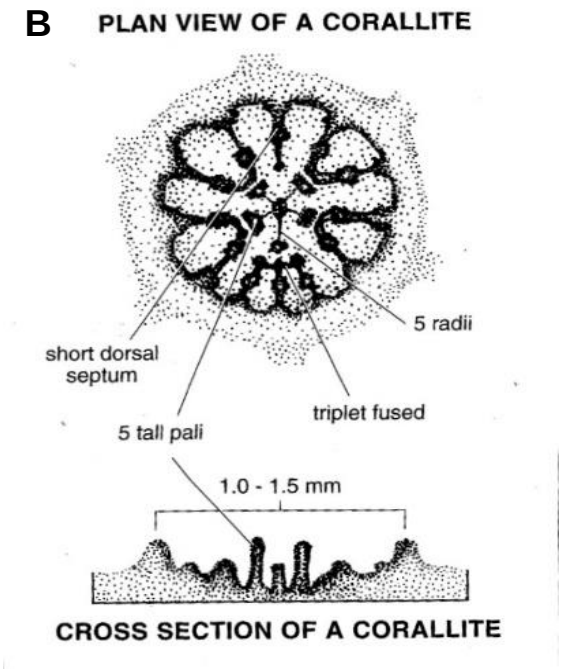
Result.

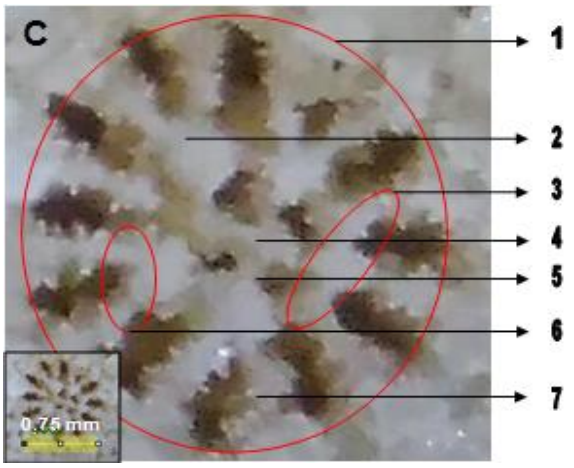
Coral Identification.

Appendix 1 (A) is a colony of *Porites lutea* that was found in Kondang Merak. *P. lutea*

colonies usually have a light brown or cream. The structure of coral koralit *P. lutea* (B), characterized by the amount of 5 pali, that has radi forming a circle and inter-related, and have columella in the middle (Veron, 2000). Annex 1 (C) is a coral koralit who had been observed using a microscope, (C.1) is koralit wall of coral, (C.2) is pali, amounting to 5, (C.3) is 3 pali interconnected (triplet), (C.4) is columella, (C.5) is radi interconnected, (C.6) represents 2 related pali (duplet) and (C.7) is dentikel of coral *P. lutea*.

Appendix 1. Morphological identification of *P. lutea* used a light microscope.





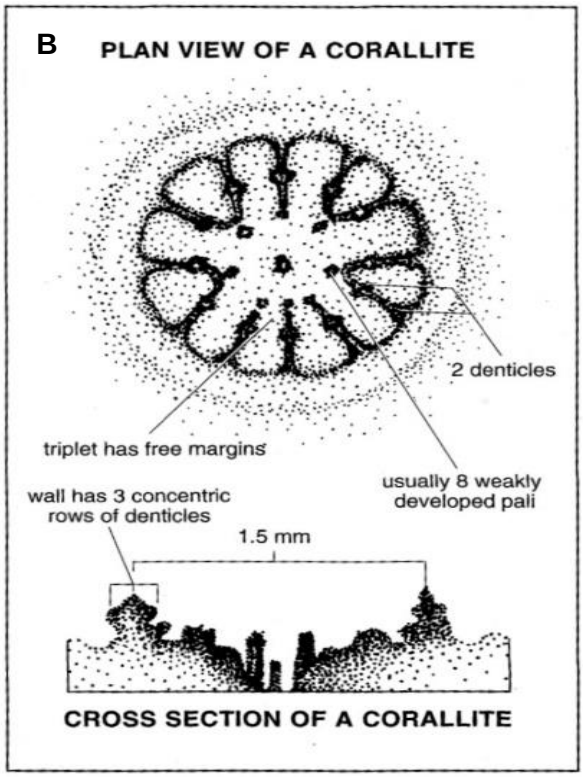
Physically *P. lutea* has a smooth surface and small bumps called hillocky. *P. lutea* and *P. lobata* coral are a cosmopolitan species of coral that be able to live in the reef flats, reef crest to the reef slope. These coral can be found the field sizes with variety of size from 10 cm to 3 m (Potss *et. al.*, 1985). The adaptability of coral genus Porites were very high on the condition of the reef much sediment they will cover its surface with mucus which prevents the sediments fall into the coral polyp and covered its mouth from sediment. The existence of *P. lutea* and *P. lobata*, sometimes forming a micro-atoll that can also be used as a bio-indicator of the increase or decrease substrate of the sea. The neat layer in a micro-atoll can be used to analyze of increase or decrease of sea level (Meltzner and Woodroffe, 2015).

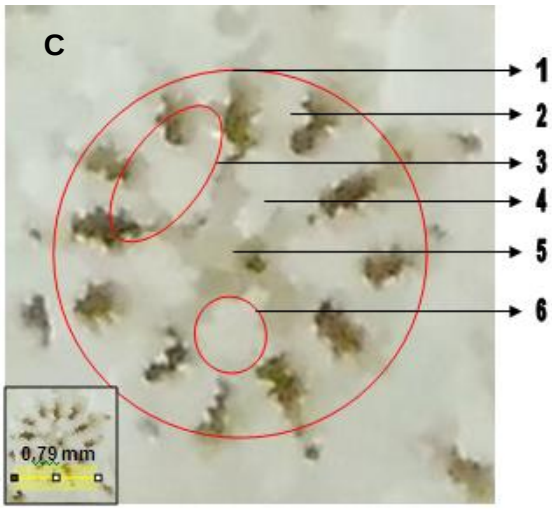
Porites has small corallite with a size less than 2 mm and also has small septa. Coral tentacle usually extends during night to capture nano plankton and some time to attack other coral to expand its space. The color of *P. lutea* usually gray or brown. *P. lutea* has a smaller size than the *P. lobata*, where some time that coral can reach 6m in diameter (Veron, 2000).

Appendix 2 (A) was a colony of *P. lobata* that found in Kondang Merak. *P. lobata* colonies usually have a relatively larger size with a diameter of ± 2 meters and has dark

brown color. Figure B is an overview of corallite *P. lobata* that has 8 pali, while columella was found in the middle of corallite (Veron, 2000). Figure (C), in appendix, is corallite that had been observed using a light microscope. Corallite wall of *P. lobata* (C.1), dentikel coral (C.2), 3 free pali (triplet) which are not interconnected (C.3), pali 8 pieces (C.4), columella in the middle of corallite (C.5), 2 pali related (duplet) (C.6).

Appendix 2. Morphological identification of P. lobata used a light microscope.





The color on this coral tend to be brown or dark brown at a depth of 5 m, but at shallow water (reef flat) color can change to blue or green and diameter can reach ± 4 meters, coral can form micro-atoll in intertidal areas. The colors on the reef is very affected by pigment that owned by algal symbiont while live in coral tissue, basically coral it self did has a specific color (Dove et al., 2001).

Porites faster growth in shallow areas compared in deep water, because of the intensity of the sun in the shallower areas and accelerate the process photosyntesis algae symbiont inside of coral. Acceleration photosynthesis will generate a lot of deposits of calcium carbonate and will make the growth of coral colonies faster. Effect of aquatic environments such as ocean currents, waves and nutrient also influences the growth of Porites coral. In Great Barrier Reef Australia was reported that large size of massive Porites were easily being found in the lee ward are where has more calm water conditions and more nutrient (Potts *et. al.*, 1985).

The existence of massive Porites in south of Java was be characteristic of the rocky shore and high wave faced Indian Ocean. The dominance of coral *P. lobata* and *P. lutea* in an area can also associated with reproductive system in these coral. *P. lobata* and *P. lutea* have external fertilization reproduction mode

that means sperm and ovum vertilized in coloumn of water and during embryonic period the planulae has 36-48 hours to spread in waters to get a suitable substrate to grow and develop, it was Porites become cosmopolite coral in the world (Kojis and Quin, 1981).

CONCLUSION

Size Frequency of Massive Porites.

Table 1. Size distribution massive Porites was found in Kondang Merak.

Class interval (cm)	Frequency			
	P. lobata (colony)		*P. lutea* (colony)	
	Sta. 1	Sta. 2	Sta. 1	Sta. 2
10-65	4	2	8	3
65-120	3	-	1	4
120-175	2	1	-	2
175-230	4	4	-	-
230 -285	-	-	-	-
285-340	1	-	-	-
Total	14	7	9	9

Based on table 1 stated that both coral P. lobata and P. lutea distribute on station 1 and station 2 repectively. In station 1 (west part) the smallest massive Porites was 15 cm and the largest one was 308 cm. Massive Porites in Kondang Merak was dominant in class interval 10-65 cm that found about 17 corals. And *P. lobata* were dominant (21 coral) than *P. lutea* (18 coral) in all station, that differences were not reflected the dominance of *P. lobata* due to the diference did not significance.

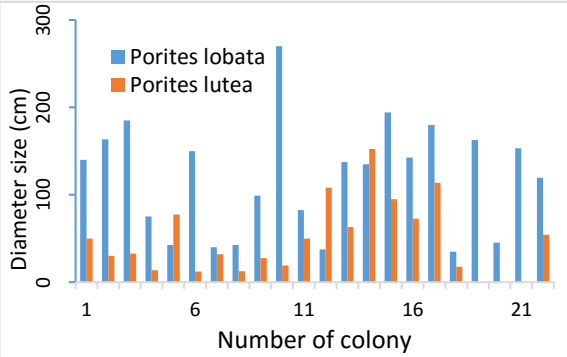


Figure 1. The diameter of coral in Kondang Merak.

Physical-chemical parameter.

Table 2. Water quality in Kondang Merak during research.

Transects	Parameters			
	Temp. (°C)	Salinity (‰)	DO (mg/l)	pH
1 T	27.61	34.5	6.3	7.45
2 T	27.52	34.42	6	7.23
3 T	27.34	35.08	6	7.42
1B	26.46	35.75	8.5	8.68
2B	26.49	35.5	9.1	8.65
3B	26.75	35.33	8.6	8.35

Table 2 showed that the water temperature on normal condition, on range of 26.46° C to 27.52° C. The higher temperature was on station 1 in east side and the lower one was found in station 2 (west side). The highest salinity was on station 2 (35.75 ‰) and the lowest one was on station 1, 34,42 ‰. The dissolved oxygen (DO) was on range 6 mg/l (stasiun 1) to 9,1 mg/l (station 1), while other physics variable that was pH in range 7,23 to 8,68.

Discussion.

Coral Identification.

The massive Porites which has identified in this location were two species, *P. lobata* and *P. lutea*. *P. lobata* has 8 pali and columella in the middle of polyp and usually has dark brown color which has ± 2 m wide of diameter. In the shallow water (reef flat area) P. lobata can reach 4 m in diameter and has color variation such as blue or green (Veron, 2000). P. lobata was good adapted coral, in case dealing with environment such as depth this coral can make a micro atoll.

P. lutea has 5 pali that connected by the bridge (radi) to the columella in the middle of polyp, in the field this coral has bright brown or cream. Other characteristic that possed by this coral was the connection of triplet (Veron, 2000). Naturally both of these coral

can be easy to find in almost all sea water from the shallow to deep one (Endean, 1973).

Pali is almost found in all Porites coral that was one of the vertical pillar and located near the columnela. The development of pali in each Porites species has different size and growth development. Four pali which supports the pair lateral septum usually is the largest, while the fifth pali usually rested with the dorsal septum directive. Two or three pali can form duplet and triplet (Veron, 2000). Columella usually in the middle of polyp and has function as mouth, extended tentacle will catch nutrient or plankton and bring it into columella. Some time columella was missed because of borer invertebrate

Radi is located in corallite and serves to connect the pali with columella. Columella, pali and dentikel covered by the granule and the same view. Dentikel a vertical pillar-like pali and are located along the upper part of septa in fixed intervals. Pali and dentikel forming concentric circles (Veron, 2000).

Avarage of Porites Diameter.

The average diameter size of Porites was found at station 1 ranged from 63.89 cm to 28.57 cm, in the station 1 the average of coral diameter of *P. lobata* was 228.57 cm and *P. lutea* diameter was 63.89 cm. The average size of Porites was found at station 2 ranged from 153.56 cm to 260.57 cm, the average size of *P. lobata* species was 260.57 cm and 153.56 cm for *P. lutea*.

There were any different growth rate of *P. lobata* and *P. lutea* in station 1 and 2. This difference suggested many tourism and fishing activities in station 1 also high sedimentation and nutrient loaded from residential and river where near by in this location. High sedimentation in the sea water could impact on coral growth (Rogers, 1990). Environment is key of healthy and growth rate of coral reef, in normal condition the coral reef production near 10^5 (mg $CaCO_3/m^2$)/ year but in bad environment the values may go as low as 10^3 (mg $CaCO_3/m^2$)/ year (Chave *et. al.*, 1972). High load fresh water from river can reduce the salinity of sea water and will impact on Porites health, low salinity up to $20^o/_{oo}$ resulted mass mortality in coral of Kaneohe, Hawaii (Jokiel *et. al.*, 1993; Coles and Jokiel, 1978). Porites in Kondang Merak were found in shallow water that was vurnerable to fresh water damage due to low salinity less dense than sea water and usually formed persistant layer in surface area.

The area of coral Porites colonies.

The average area of coral in station 1 was 85.12 cm^2 and at station 2 was 101.03 cm^2. The environment factor was suggested influence for this wide. The area of coral was calculated using equation 2 that influenced by the coral diameter. Some how massive Porites can deal with the high of sea water, in shallow water area (less than 60 cm) they can growth horizontally than vertically. In shallow water (back reef) massive Porites has higher calcification than in fore reef, high energy resulted by current probably would reduce the number of zooxanthellae inside of coral impacted on it growth (Smith *et. al.*, 2007).

Environmental parameters are physical factors such as salinity, temperature, water depth, wave action, light, sediment and oceanic circulation patterns was influence in the development of hard coral (Chave *et. al*., 1972). In ecology term, completion is the key of survive, they used the wide area to get more food, breed and light. All coral or sessile organism always compete for space to be a winner (Veron, 1986).

Conclusions.

P. lobata have greater average in diameter and surface area than *P. lutea*. Physical-chemical parameter in Kondang Merak showed the sea surface avarege was

27.03° C, salinity was 35.10 °/$_{oo}$, dissolved oxygen was in 7.42 mg/l and the pH was 7.96.

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