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Jalan Raden Saleh No. 43, Cikini Jakarta Pusat 10330, Indonesia
Telp. 021 - 3143080, Fax. 021 - 31927958
Email: indonesian.coral@yahoo.co.id
Web : www.coastal-unhas.com/incres

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Editorial Address : **Indonesian Coral Reef Society (INCRES)**
Gedung LIPI
Jl. Raden Saleh No.43, Cikini, Jakarta Pusat 10330, Indonesia
Tlp. +62-21-3143080; Fax. +62-21-31927958
&/or
Research & Development Center for Marine, Coastal, & Small Island (MaCSI)
Gedung PKP, Lt. 5, Kampus Universitas Hasanuddin, Tamalanrea, Makassar
Tlp./Fax: +62-411-586997
Email: jicor_incres@yahoo.com, Web: www.coastal-unhas.com/incres
Secretariat : Dwi Sekar Asih, S.Sos., Ratnawati, S.Pi., M.Si., Nur Abu, S.Si.
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Distribution and Abundance of Black Band Disease on Corals *Montipora* sp in Seribu Islands, Jakarta

Ofri Johan [1*], Dietriech G. Bengen [2], Neviaty P. Zamani [2] and Suharsono [3]

[1] Center of Research and Development of Fishery Cultures, Jakarta
[2] Faculty of Fisheries and Marine Sciences, Bogor Agriculture Institute, Bogor
[3] Center of Research and Development of Oceanology – LIPI, Jakarta

Abstrak

Penelitian tentang kelimpahan dan penyebaran penyakit karang telah dilaksanakan sejak Juni dan Juli 2011 untuk mengetahui kelimpahan awal penyakit karang jenis Black Band Disease (BBD – Penyakit Garis Tebal Hitam) pada beberapa pulau di Kepulauan Seribu, Jakarta. Metode pengamatan menggunakan transek sabuk dengan lebar 1 m ke kiri dan ke kanan, panjang bentangan meteran 20 m dengan ulangan sebanyak 3 kali. Transek ditempatkan pada dataran terumbu dengan kedalaman 0–3 m dengan mencatat jumlah koloni yang terinfeksi penyakit karang jenis BBD. Hasil penelitian menunjukkan bahwa penyakit karang jenis BBD banyak ditemukan pada tutupan karang yang tinggi dan karang jenis Montipora sp dominan di lokasi tersebut. Berdasarkan lokasi secara umum kelimpahan tertinggi terjadi di Pulau Pramuka bagian utara (0.15 kol/m), Pulau Pari bagian timur (0.092 kol/m), Pulau Penjaliran (0.092 kol/m), dan Pulau Tikus (0.085 kol/m). Hasil uji statistik dengan menggunakan ANOVA diperoleh kelimpahan penyakit karang BBD berbeda nyata antara kelompok lokasi penelitian, yaitu antara lokasi jarak terdekat dengan jarak sedang, dan lokasi jarak terdekat dengan jarak terjauh dengan nilai perbedaan (signifikan) berturut-turut 0.030 dan 0.025 (tingkat kepercayaan 5%). Sedangkan pada kelompok lokasi jarak sedang dan terjauh tidak terdapat perbedaan nyata. Berdasarkan data klimatologi, peningkatan suhu pada bulan Maret hingga Juli dapat memicu terjadi penyakit karang di kawasan Kepulauan Seribu.

Kata Kunci: *kelimpahan penyakit karang, black band disease, Montipora sp, Kepulauan Seribu*

Abstract

Research on the abundance and distribution of coral disease has been implemented since June and July 2011 to determine the preliminary abundance of coral disease on several islands in the Thousand Islands, Jakarta. Observation method used was a 20m-belt transect with 1 m width to the left and right, and 3 replicates. Transects placed on the reef flat with a depth of 0–3 m, and a record number of infected colonies of BBD. The results show that type coral diseases of BBD found in many high coral covers and where Montipora sp dominant at that location. Generally, highest abundances found were at northern of Pramuka Island (0.15 col/m), eastern of Pari Island (0.092 col/m), Penjaliran Island (0.092 col/m), and Tikus Island (0.085 col/m). Statistical test by ANOVA obtained that abundance of BBD was significantly different between groups of study sites, i.e. the distance between the nearest and middle sites, and between the nearest and farthest distance from the mainland of Java Island (significantly difference with value respectively 0.030 and 0.025; confidence level 5%). Meanwhile, the sites between middle and farthest show no real difference. Based on climatological data, the increase in temperature in March and July could lead to coral diseases that occured in the Thousand Islands region.

Keywords: *abundance, coral disease, Black Band Disease, Montipora sp., Seribu Islands*

*Corresponding Author: *ofrijohan@yahoo.com*

INTRODUCTION

Thousand Islands consists of 105 islands extending vertically from Jakarta Bay to the north with the Sebira Island as the outer island with a distance of approximately 150 km from the coast of North Jakarta. Among the island, there are 11 inhabited islands: Panggang, Pramuka, Kelapa, Kelapa Dua, Harapan, Sebira, Tidung Besar, Payung, Pari, Lancang Besar, and Untung Java. Geographically, Seribu Islands is located from 106º20'00" E to 106º57'00" E and 5º10'00" L to 5º57'00" L. The administrative area of Thousand Islands is 897.71 Ha of land and 6997.50 km^2 of surrounding waters.

The reef area of Thousand Islands is close to the big city and capital of Indonesia, Jakarta. It has a very dense population (~9.59 million people), including residents in the Thousand Islands (~22.158 thousand inhabitants) (www.kependudukancapil.go.id). Growing city and intensive population activities lead to anthropogenic pollution from the land and impact to the Thousand Islands waters, concentrately in Jakarta Bay. This condition is evident in east season where a lot of garbage brought to the islands and the waters' color is somewhat murky. Other indications perceived is the sea grass which can not grow well in Pari Island, caused by bad condition from declining water quality in the area.

Another factor need to be examined is the effect of climate change with fluctuations in temperature and sea level, and can affect the survival of marine biota, including biota associated with coral reef ecosystem. Global warming could increase the sea water temperature, hence coral reefs will experience stress and if this disorder goes on can lead to coral bleaching and mass death. Death in reefs as habitat for various associated biota, will begin disrupted and eventually impact on fish production derived from coral reef ecosystem, where most coastal communities dependent on as a source of livelihood.

One result of unfavorable environmental conditions is fluctuations in temperature, this state will have a negative impact for the life of coral reef disease. Besides, coral disease also can be caused by anthropogenic pollution from land as well as high intensity of sunlight exposure into the waters where coral lives.

The result of coral reefs condition in the Thousand Islands conducted by the Indonesian Coral Reefs Foundation in the period of 2005–2009 at 19 locations showed a total of 63 genera of live coral (Setyawan et al., 2011), where the live hard coral cover was fluctuated between 28.9 to 34.3%, meaning that the condition was moderate (Gomez and Yap, 1984).

This research done was observing coral disease abundance of Black Band Disease (BBD) on *Montipora* sp and examined some factors related to the causes of coral disease. The purpose of this study was to assess the distribution and abundance of coral diseases, identify species of coral disease and other reef health parameters.

METHODS

Site Locations

The study began in June to July 2011 on several islands of the Thousand Islands, Jakarta, i.e. Peteloran, Penjaliran, Jukung, Putri, Belanda, Pramuka, Karang Bongkok, Kelapa, Semak Daun, Pari, and Tikus reefs (Table 1). All sites spread from south to north and from closest to the farthest from the mainland (Java island), as well as the core zone of the Thousand Islands Marine National Park, some of the islands are inhabited (Fig. 1). Islands in the core zone is assumed uninhabitant since it is away from anthropogenic pollution sources, either from the inhabited island or carried over from the mainland.

Data Collection

Reefs Condition

Reef data was retrieved by using the Line Intercept Transect method (LIT) at a depth of 1–3 m (reef flat) and 3–7 m (reef slope) by three replicates within 20 m transect length. Life form and substrate character were analyzed using the common percentage coral cover according to English et al. (1997) as follows:

Table 1. Research locations.

Research Sites	Lat.	Long.	Depth
Uninhabited sites (the farthest sites from the mainland)			
- Peteloran Island	05º27'07.6"	106º33'44.9"	1.5 m
- Penjaliran Island	05º27'34.0"	106º33'49.3"	1.5 m
- Jukung Island (northern)	05º34'00.1"	106º31'36.3"	7 m
- Putri Island (northern)	05º35'25.5"	106º34'03.6"	6 m
- Belanda Island (western)	05º36'16.4"	106º31'08.4"	7 m
Inhabited sites 1 (middle far sites from the mainland)			
- Pramuka Island (southern)	05º45'01.9"	106º36'41.5"	1.5 m
- Pramuka Island (norhtern)	5º44'24.9"	106º37'14.5	1.5 m
- Karang Bongkok patch reefs	5º40'44.2"	106º34'53.8	3 m
- Kelapa Island (southern)			6 m
- Semak Daun Island	05º43'37.0"	106º33'59.2"	6 m
Inhabited sites 2 (nearest site from the mainland)			
- Pari Island (southern-1)	05º52'14.0"	106º36'38.8"	1.5 m
- Pari Island (southern-2)	05º51.651'	106º37.250'	1.5 m
- Tikus Island (northern)	05º51'07.8"	106º34'53.8"	6 m

$$L_i = \frac{n_i}{L} \times 100\%$$

where: L_i = percentage cover of coral to-i; n_i = total length a group of corals to-I; L = total length of line intercept transect.

Coral Disease Abundance

Retrieval of data was using a belt transect with a width of 1 m to the left and right side each on the 20m transect line and 3 replications, the total coverage area 120 m². The data taken in the field was coral diseases abundance, specifically the Black Band Disease (BBD) and White Syndrome (WS), beside other types of disease included in the Coral Health list (Raymundo et al., 2008).

Water Quality Data

Environmental parameters measured were physical (depth, water temperature, visibility, light intensity and substrate), and chemical limnology (DO, pH, nitrate, and orthophosphoric). Data in situ was measured by YSI 556 MPS (temperature, conductivity, TDS, salinity, DO, pH), others were analyzed at Environmental Testing Productivity and Water Laboratory (Proling), Department of Water Resources Management, Bogor Agricultural University.

Temperature data from the Coral Reef Watch satellite of Sea Surface Temperature (SST) anomalies, issued by the National Oceanographic and Atmospheric Adminis-

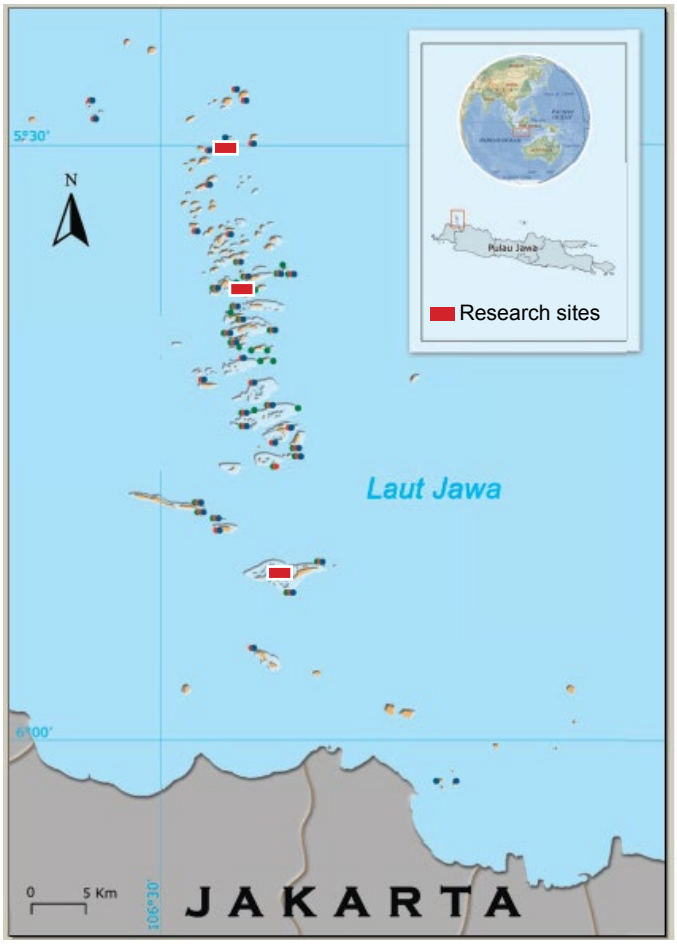

Fig 1. Research sites located to the nearest, middle and farthest distance from the mainland (Estradivari et al., 2009).

ration (NOAA) in 2009, 2010, and 2011 (http://coralreefwatch.noaa.gov), was set as a comparison to see the impact of global warming.

Data Analysis

Statistical analysis of ANOVA was used to compare the abundance of coral disease between sites (120 m^2). The relationship between live coral cover and *Montipora* sp cover where BBD found was conducted by a regression test. Water quality data were analyzed by Discriminant Analysis using SPSS program, to get the difference between sites characterized by dominant water quality parameters.

RESULTS

Reefs Condition

Overall live coral cover was quite high even the sites were invaded by BBD (57.17–76.88%) (Fig. 2), and it is categorized as good to excellent reefs (Gomez and Yap, 1984). Coral cover was dominated by foliose form of *Montipora* sp (32.08–57.75%). Live coral cover at the farthest site, Peteloran Island, was higher (76.88%) compare to Pari Island (71.79%), while the lowest was in Pramuka Island (57.17%).

The ANOVA results showed no difference between live coral cover among groups of sites (nearest, middle, and farthest distance from the mainland), assumingly because

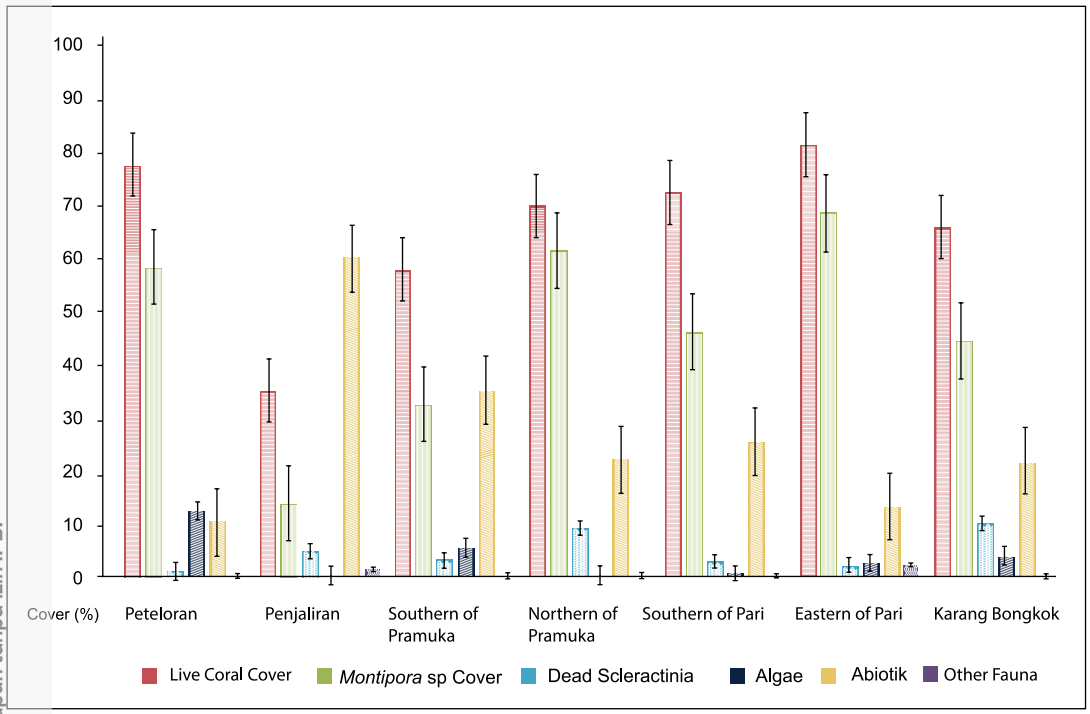

Fig 2. Presentage of life coral cover, *Montipora* sp cover and other biota cover according to line transect on several locations at Seribu Island, Jakarta.

of the large presence of *Montipora* sp. Statistical regression between cover of live coral and *Montipora* sp obtained that there was a strong relationship (R=0.91).

Coral Disease Abundance

Coral disease mostly infected the reefs at 1–2 m depth (reef flats), however no BBD disease was found at 3–7 m (reef crest) and 7–12 m (reef slope). Fig 3 showed highest abundance of BBD at northern of Pramuka Island (0.15 col/m), eastern of Pari Island (0.092 col/m), Penjaliran Island (0.092 col/m), and Tikus Island (0.085 col/m). Coral species infected only occurs on *Montipora* sp which resembles the growth of foliose and encrusting, except in branching forms, there was no BBD infection in early study. The BBD did not infect any other species, in compare with other disease, the white syndrome (WS) that were found on foliose *Montipora* sp as well as on encrusting *Acropora* sp. The abundance of WS was highest in southern of Pramuka Island (0.11 col/m), Kelapa Island (0.07 col/m) and Karang Bongkok patch reefs (0.05 col/m).

The condition of compromised health was found at Karang Bongkok patch reefs, where there was a competition with sponge and the predator *Achantaster plancii* (0.17 col/m; Fig. 3). Other sites such as in Kelapa Island was also dominated by *Achantaster plancii* by leaving a bleached trail of coral colonies on its path.

The presence of BBD in the Thousand Islands concentrated only on one type of coral *Montipora* sp, different from those that found by several other studies which infect some species of corals and evenly distributed (Frias-Lopez et al., 2003). The BBD was also found on *Pachyseris* sp in Seribu Islands, and *Pavona* sp in Kendari (Johan, *in progress*).

The results of ANOVA showed the abundance of BBD was significantly different among sites. At the site of nearest vs middle distance, and of nearest vs farthest distance showed a significant difference on the abundance of BBD (respectively 0.030 and 0.025; confidence level 5%). However, the abundance between the middle and farthest distance showed no significant difference (Table 2).

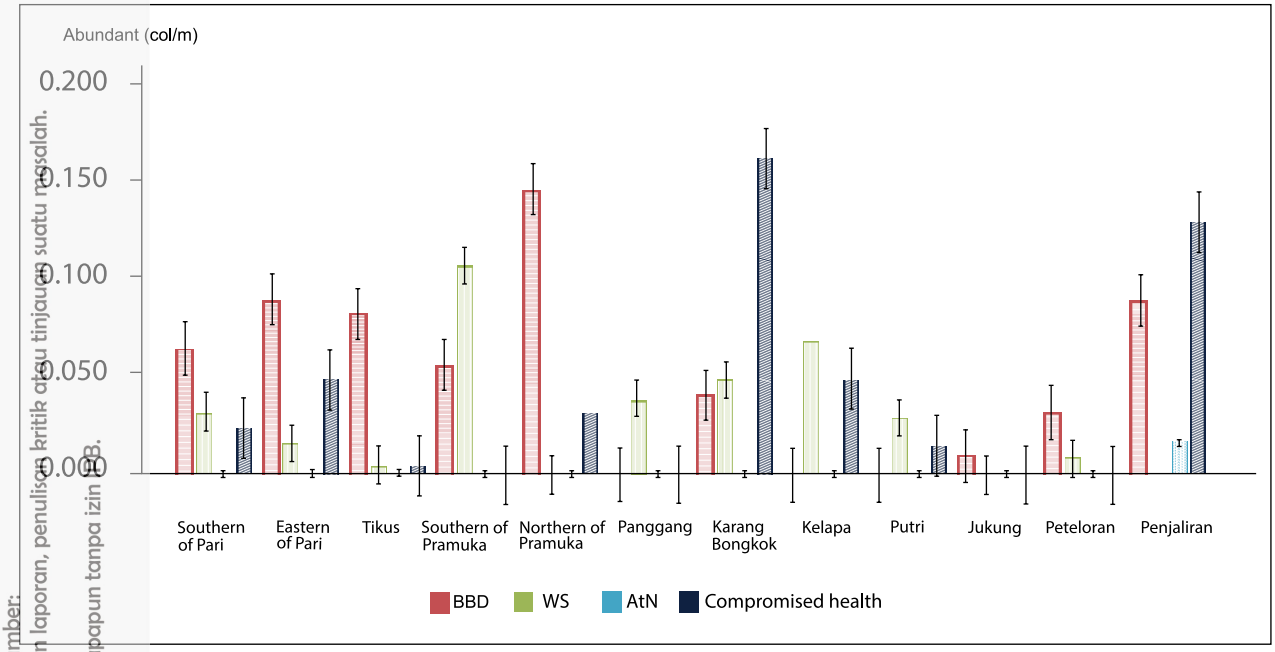

Fig 3. The comparation of BBD abundant (col/m) and others type of disease on several locations at Seribu Island.

Table 2. Statistic test of abundance.

Group Location	Amount of sites (N)	Average	SD	SE	Sig.
1 (nearest)	3	12	4.583	2.646	
2 (middle)	4	3	3.559	1.780	
3 (farthest)	3	2	2.000	1.155	
Locations 1*2		9		2.708	0.030*
Locations 1*3		10		2.895	0.025*
Locations 2*3		1		2.708	0.928

Based on the average of daily temperature during the last 11 years, it was recorded a maximum temperature of 32ºC, minimum 23ºC and a daily average of 28.54ºC (Fig. 4). The average temperature within this conducted research in 2011 was 28.44ºC in average, minimum of 23.2ºC and maximum of 35.4ºC. Based on the temperature chart (Fig. 4) showed an increase of temperature from March to July and from September and December on four years of data displayed. This condition can lead to coral disease in the Thousand Islands region.

Water Quality

Water quality measurement obtained in situ were temperature, salinity, DO, pH, and TDS. The temperature was in between 28.98–29.39ºC, and remained in quality standard (Table 3). Previous research on Pari Island obtained the temperature interval of 24.0–29.5ºC from September 1999 to June 2000 (Johan, 2001).

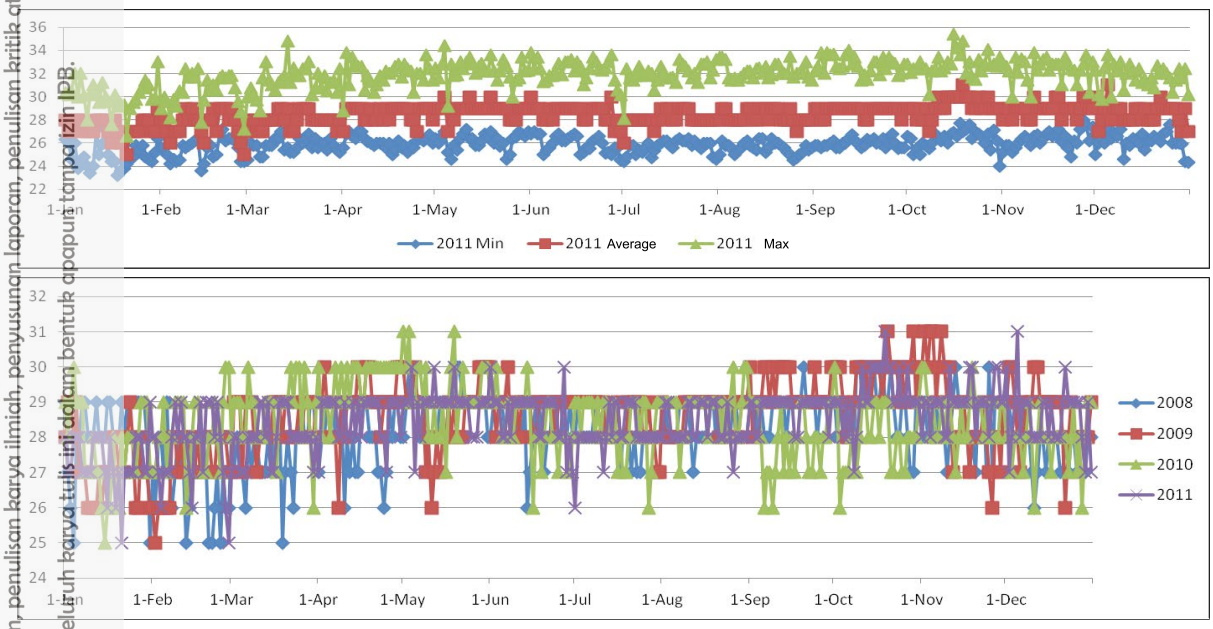

Fig 4. Fluctuation graphic of daily temperature (minimum, maximum and average) on Seribu Island in 2011 (above) and temperature graphic from 2001 to 2011 (Maritime Meteorology Station Tanjung Priok, 2011).

Table 3. Measurement result of in situ water qualities.

Parameter	Unit	Site			Standard Range
		Nearest	Middle	Fartherst	
Temperature	ºC	29.39 ± 0.70	28.98 ± 0.86	29.13 ± 0.79	28–30
Salinity	‰	32.02 ± 4.31	34.99 ± 0.55	34.79 ± 0.46	33–34
DO	mg/l	8.31 ± 1.60	7.28 ± 2.09	7.78 ± 1.86	>5
pH	-	7.53 ± 0.28	7.54 ± 0.23	7.28 ± 0.25	7.0–8.5
TDS	mg/l	31.93 ± 3.85	34.6 ± 0.48	34.43 ± 0.40	

Discriminant Analysis results on the difference between sites characterized by water quality variables, showed that the role and function of the first axis to the second respectively were 77.6% and 22.4%. The existence of two-axis function had been able to explain the difference between study sites, although the role of axis 1 and 2 functioned simultaneously or only the 2-axis function was not significantly different (P Value 0.590 and 0.648). Function of axis 1 was characterized by TDS and salinity, while the second axis function characterized by pH, DO and water temperature.

DISCUSSION

This study was carried out during dry season and showed the BBD occurance in location that closer to the mainland, though at the farthest location was also found coral diseases. The two types of coral disease oftenly found was BBD (Black Band Disease) and WS (White Syndrome). This answered one of the assumptions that coral disease was commonly found in locations that close to the mainland and considered as carriers of anthropogenic pollutants.

BBD is one of 4 types of known disease associated with changing in water temperature (Kuta and Richardson, 1996; Bruckner and Bruckner, 1997), other diseases plague (Dustan, 1977; Richardson, 1998), and a new type of disease known as dark spots disease (Gil-Agudelo and Garzon-Ferreira, 2001), where the disease generally occurs in summer when temperatures are above 28°C (Kuta and Richardson, 2002). Light intensity and temperature determined the presence of BBD and WS, because the locations were at the shallow reef flat. Then type of coral reefs were also dominated by foliose and encrusting growth forms of the same genus of coral. BBD has a bacterial disease associated with the sun so much found in the shallow reefs and on the wider of coral colonies surface, thus more effectively capture the light and into the host of the bacteria that ultimately cause disease.

Intake of nutrients from sewage sources, sedimentation, and water influx from the mainland is a potential factor that supports the emergence of new disease cases or coral disease incidence. Based on this study, five factors (temperature, depth, diversity of corals, and the concentration of ortho-phosphate and nitrite) was obtained statistically showed a very real relationship with the presence of BBD (Kuta and Richardson, 2002), as Bruckner and Bruckner (1997) reported that the increased occurrence of BBD on the coral reefs close to the sewage channel or regions and areas of high sediment intake.

Coral reefs are the most productive ecosystems biologically, but also most sensitive to any pressure (Birkeland, 1997). Thousand Islands are one example of coral reef ecosystems near to the state capital, hence affects on coral reefs. The closer to the coast of Jakarta or located in Jakarta Bay, the worse condition would have than coral reefs located farther sites, this mainly due to the impact of human activity Cleary et al., 2006). Similarly, the existence of coral species *Montipora* sp will be limited by the water conditions so that will not be found in the closer location to the Bay of Jakarta, because of very high sedimentation rate.

In the present study, it can be seen that the death of coral reefs due to disease will have an impact on the decline in diversity of coral species *Montipora* sp particularly in areas of high coral cover. All coral colonies infected with the disease were recorded to be death mainly in both Pari Island and Pramuka Island, and coral disease appeared again in a new colony. Another study conducted in several islands near with the mainland or the Bay of Jakarta in 2005 showed that in the Onrust Island is no longer found living reef ecosystem Giyanto et al., 2006). The decline of coral condition also already known from studies since 1994 that coral species diversity declined significantly on Onrust Island since 64 years, from 96 species were found in 1929 declined to 21 species in 1993. Other islands in the Bay of Jakarta are estimated to have the same problem. Thus one part of the Thousand Islands region in the Bay of Jakarta can no longer be expressed as the coral reef ecosystem, as some of the most important

components of the ecosystem is virtually no longer exist or have only a limited number. Commodities that are capable of living in this area have been replaced by another with the basic software comodity (Estradivari et al., 2009).

The impact of anthropogenic pollution on a coral reef deterioration factor is supported by the opinion of Cleary et al. (2006) which states that the factors which significantly affect the coral cover in the Thousand Islands is a major environmental gradients, the farther from the Bay of Jakarta, then the condition coral reefs will further increase because of the distance affects the levels of pollutants that enter to the waters. The outbreak of *Achantaster plancii* had been happened at the beginning of the 1990s, it was also one example of the environmental gradients that have led to a decline in coral cover from 23% in 1985 to 17% in 1995 (deVantier et al., 1998).

The presence of BBD has been found in many shallow waters (reef flat) in the Thousand Islands, and no longer been found at depths deeper than 6.6 m. Other studies supported that the BBD more existed on such shallow depths Antonius, 1981). Distribution patterns in these shallow waters due to BBD is dominated by a cyanobacterium that depend on sunlight (photosynthetic cyanobacterium) (Anthony, 1981; Richardson, 1998).

Although there was no comparison data on temperature between sites with existing BBD and non existing BBD, this study has managed to make measurements on temperature differences, where the water temperature at the existing sites of BBD differed markedly higher than sites without disease. In general, all existing sites of BBD has a temperature of between 29.0 to 30.0ºC, unless there is a site that has been found BBD temperature 26.0ºC.

Particularly the relationship between BBD abundance and the heat of water temperature has been reported by several previous investigators on the seasonal monitoring program (Anthony, 1981; Edmunds, 1991; Kuta and Richardson, 1996; Bruckner and Bruckner, 1997; Voss and Richardson, 2006; Rodriguez and Croquer, 2008; Zvuloni et al., 2009; Sato et al., 2010). Light intensity has also been suggested and a concern for environmental factors that play a role in determining the distribution pattern of BBD (Kuta and Richardson, 2002; Page and Willis, 2006; Croquer and Weil, 2009), and also changes in abundance of coral disease and progression of disease in coral colonies (Sato et al., 2011).

CONCLUSION

In this study we can conclude several things including the abundance of Black Band Disease (BBD) were higher in shallow than in deeper waters, where *Montipora* sp in foliouse form were more common. Another important characteristic of the reefs was categorized as good condition with live coral cover above 50%.

The highest abundance of coral disease was in northern of Pramuka Island (0.15 col/m), eastern of Pari Island (0.092 col/m), and Penjaliran Island (0.092 col/m); this high abundance was associated with an increase in water temperature.

Suggestion

1. More research on coral disease in Indonesia has been needed, some parts that have not been done in this research, including:
   - analysis of microbiological causes of coral disease
   - analysis of histopathology to see a part of colony attacked or damaged by disease
2. More research in other regions of Indonesia has also been needed, with assumptions or interim findings obtained from the Thousand Islands where coral disease was found at a depth of 0–1.5 m on *Montipora* sp. How about other locations in Indonesia?
3. The impact of coral disease management actions on the coral reef ecosystem as a whole in Indonesia has been needed to collect as much as data on how its widespread impact on Indonesian territory.

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