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An Early Evaluation of Coral Disease Prevalence on Panjang Island, Java Sea, Indonesia

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ABSTRACT

Coral reef disease is one of the major causes of reef degradation and coral mortality in Panjang Island. The present study was carried out to assess inter-seasonal coral disease states present and the coral taxa affected on Panjang Island, Java Sea. Coral disease monitoring surveys were conducted in dry season (May) and rainy season (November) of 2013. The prevalence of coral disease on the reef building corals was calculated as the mean percentage of coral colonies affected by disease per 50 m^2 transect quadrats. Results of the present study showed that mean prevalence for all diseases observed was 74.37±5.29% SE. Four disease states detected were Pigmentation Response (58.68±4.81% SE), White Plague (17.76±8.60% SE), Ulcerative White Spot (6.59±0.08% SE) and Yellow Band Disease (2.88±0.05% SE). A total of 386 coral colonies observed, 287 colonies were affected by diseases. The prevalences of disease in the coral genus were found to be 59.15±6.77% SE in *Porites* sp., 6.85±1.52% SE in *Montipora* sp., 6.83±1.01% SE in *Favites* sp., 4.81±0.20% SE in *Acropora* sp., 4.71±1.21% SE in *Goniastrea* sp. and 1.02±0.02% SE in *Pocillopora* sp. There were no significant seasonal variation ($p>0.10$) between prevalence in dry season (74,68±3.61% SE) and rainy season (74.07±8,39% SE). To our knowledge, this is the first study of quantitatively coral disease on Panjang Island, Java Sea, Indonesia. Since a large number of corals in Panjang Island were affected by diseases, it represents an important area for future studies.

Key words: Coral disease, prevalence, seasonal variation

INTRODUCTION

Corals are animals that fall under the phylum Cnidaria and the class Anthozoa. These animals are colonies of made up of tiny animals called polyps that develop into reef building forms in pristine habitat with clear water, warm temperatures, constant salinities and adequate light levels (Veron, 1986). Indonesian coral reefs, 51,020 km^2 or 17.95% of the world's total coral reef areas, is the highest levels of biodiversity in all marine ecosystems. However, 82% of those coral reefs are facing detrimental effects due to variety of factors (UNEP-WCMC, 2013), such as, land-based pollution and destructive fishing (Edinger *et al*., 1998), heavy metals (Takarina *et al*., 2004; Sabdono, 2009; Sabdono *et al*., 2012) and pesticide pollutions (Sabdono *et al*., 2007a, b).

Panjang Island, a small island in the Java Sea, is situated 2.8 km from Jepara coast, surrounded by shallow waters and coral reefs. Those coral reef communities have experienced increasingly stressful conditions due to a combination of natural and anthropogenic factors (Edinger *et al*., 1998), such as port construction, shipyard, high density of coastal settlements, terrestrial runoff and dredging, wood industries and high intensity of mariculture activities (brakishwaters). Those envionmental factors cause physiological stress and influence the severity and dynamics of infectious coral disease by increasing host susceptibility and pathogen development and survival (Harvell *et al*., 2002, 2007; Muller *et al*., 2012). Thus, as corals become more stressed, diseases become more active and deadly.

Coral disease is often defined as an abnormal condition of a coral colony, which harms the coral's function and is often associated with specific signs/symptoms (ICRI/UNEP-WCMC, 2010). It was first described in the early 1970s and increased significantly with more than 36 syndromes discovered (Sussman *et al*., 2008). Recently, it has become an important research area since coral diseases were identified as a serious threat to coral reefs worldwide and a major cause of reef degradation and coral mortality (Weil *et al*., 2006). In this study, macroscopic observation of the presence and characteristics of lesion were used to identify coral disease (Aeby, 2005; Raymundo *et al*., 2008; Haapkyla *et al*., 2009).

Evidence from a variety studies of coral diseases within the last decade proved that coral disease outbreaks are being the most responsible for causing coral mortality and reduced growth and recruitment (Fabricius, 2005; Muller *et al*., 2012; De'ath *et al*., 2012). Global observations of coral disease prevalence between 2005-2007 showed the increasing rate of high levels in coral disease at several sites, but coral disease of Carribean was higher than that of in the Pasific (Ruiz Moreno *et al*., 2012). Current studies supports a relationship between increasing water temperature and damaging coral diseases (Bruno *et al*., 2007; Sato *et al*., 2009; Heron *et al*., 2010) and increasing nutrient runoff and outbreaks of coral disease (Patterson *et al*., 2002; Kaczmarsky, 2006).

Very little study or survey of coral disease prevalence and status has been carried out in Indonesia. There were only few recent published reports of coral disease prevalence in Indonesia, such as, Wakatobi Marine National Park (Haapkyla *et al*., 2007) and Spermonde archipelago (Muller *et al*., 2012). To date, no study or survey of coral diseases has been carried out in Panjang Island, a small island in the Java Sea that has experienced a negative long term detrimental effects due to an over fishing, sedimentation, pollution, coral mining and even tourist-related damage. The objectives of the monitoring surveys were to provide baseline knowledge of coral health and disease prevalence in Panjang Island and to identify the disease states present and the coral taxa affected on dry and rainy season.

MATERIALS AND METHODS

Study area: The impact of coral disease was quantified on reefs adjacent to Panjang Island (S 06°34,745'/E 110°37.746') in the Jepara waters, Java Sea. Coral disease prevalence was determined at site located in the southern part of the Panjang Island (Fig. 1). Panjang Island was chosen as a study site due to the richness on different coral species. In reality, southern part of Panjang Island is the only area which is covered by hard corals. Coral damage is widespread consistently around this island. Two major impact types are high sedimentation due to discharge from nearby mainland rivers and over exploitation of marine resources (Edinger *et al*., 1998; Sabdono, 2009). This survey was carried out on May (dry season) and November (rainy season) 2013.

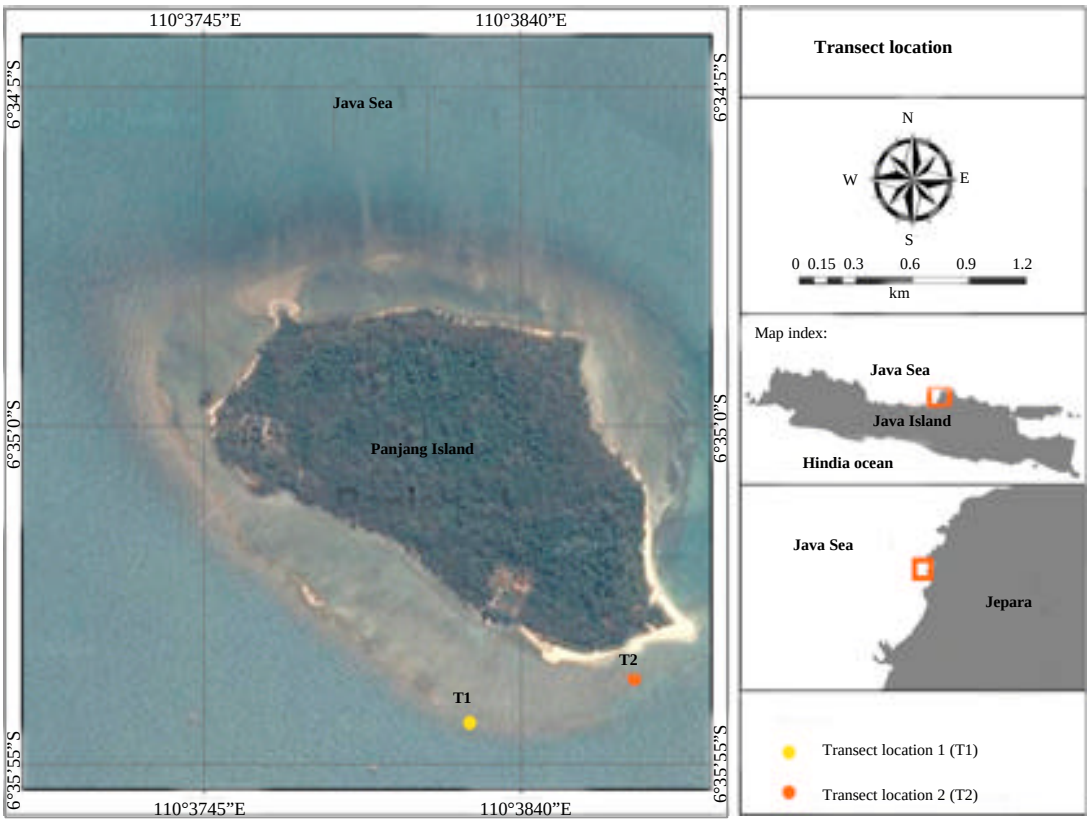

Fig. 1: Map of study area Panjang Island

Survey method: Coral disease monitoring surveys were conducted using belt transects covering an area of 2×25 m (1 m on each side of the transect line) in both dry and rainy season. While coral cover was estimated by using the line intercept transect method (English *et al*., 1997). Two replicate transects in each season were laid in reef crest zone (3-7 m depth) only, since in reef flat coral zone (1-3 m depth) had been completely destroyed, leaving only coral rubble behind. Transects followed the depth contour of the reef in which the first and second transects were located randomly with 30 m in distance. Each coral colony within the belt was calculated to genus levels and recorded as healthy or diseased corals. Prevalence of each disease was calculated by dividing the number of diseased colonies by the total number of coral colonies. This formula was used for individual populations and each particular disease. Means and Standard Errors (SE) were calculated from 4 transects, excepted when comparing seasonal variation.

In this study, coral disease identification was based on visual cues observed in the field and from photographs based on the presence and characteristics of lesions. Coral disease handbook guidelines (Raymundo *et al*., 2008) was used to identify lessions coral observed. Mean differences in the prevalence of disease among affected hard coral species were tested using one-way analyses of variance (ANOVA). Data were arcsine transformed before analysis and Tukey tests were used for post-hoc multiple comparisons using SPSS. A significance level of 0.05 was used for all tests.

Oceanographic parameters such as temperature, salinity, turbidity, conductivity, pH and dissolved oxygen concentration were measured by using water quality checker, produced by Horiba Co. Ltd, Japan. Wave recorder produced by Sountex, USA was used to measure current speed and orientation. Even both line transect and physical factors were recorded but were not presented in this study.

RESULTS

Results of the present study showed that mean total disease prevalence for all diseases observed on all reefs in the Panjang Island was 74.37±5.29% (Mean±SE). Variation in the prevalence of coral diseases observed on dry season (74,68±3.61% SE) and rainy season (74.07±8,39% SE) showed no significant difference ($F_{1, 2}$ = 0.09, p>0.10) (Fig. 2). Because there was no significant difference between dry season and rainy season, the data obtained were pooled for subsequent analyses.

Four disease states, pigmentation response, white plague, ulcerative white spot and yellow band, were detected within transects and description of each disease type was presented in Table 1. Photographs of each disease presented in Fig. 3. *Corallophyllia* predation and sedimentation damage were observed at low prevalence in regions away from transects. The percentage of disease was different in each type of disease (Fig. 4). Pigmentation response was having the highest prevalence (58.68±4.81% SE), followed by white plague (17.76±8.60% SE), ulcerative white spot (6.59±0.08% SE) and yellow band disease (2.88±0.05% SE). There was a

Table 1: Description of three conditions found on corals in the Panjang Island

Condition	Description
Pigmentation response	Got on the surface of massive Porites with along margins of dead or necrotic tissue, colonized by turf algae. Margins highly pigmented with pink and yellow, linear 1 to 3 mm wide, round
Ulcerative White Spot (UWS)	Small white lesion found in multifocal, annular. Algae colonized dead tissues. Most commonly found in massive porites
White plague	No band apparent between healthy tissue and bare skeleton. Linear tissue loss begins at the top or margin of a colony. Discrete band of bare skeleton separates live tissue from algal-colonized skeleton
Yellow band	Blotch followed by a circular ring pattern with a pale yellow to white margin, colonized by turf algae

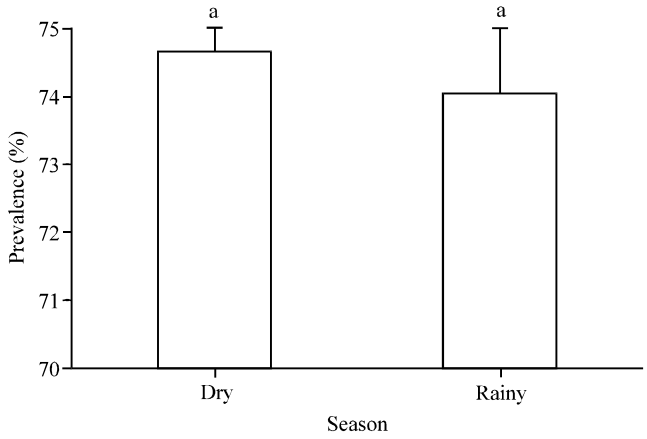

Fig. 2: Seasonal coral diseases prevalence in Panjang Island

Fig. 3(a-f): Diseases observed on 2013 Panjang Island surveys, (a) Pigmentation response, (b) Porites ulcerative white spot, (c) White plague, (d) Yellow band, (e) Sediment damage and (f) Coralliophylia predation

significant difference in disease prevalence among disease states ($F_{3,7} = 66.98$, $p<0.01$). A Tukey post-hoc test revealed that the only significant difference among coral diseases occurred between pigmentation response and other disease states.

A total of 386 coral colonies observed, 287 colonies were affected by diseases in an area of 200 m^2 (four 2×25 m belt transects). Six taxonomic groups of coral genera were found to be affected by diseases in Panjang Island. *Porites* sp. was the most common coral genus and suffered very large

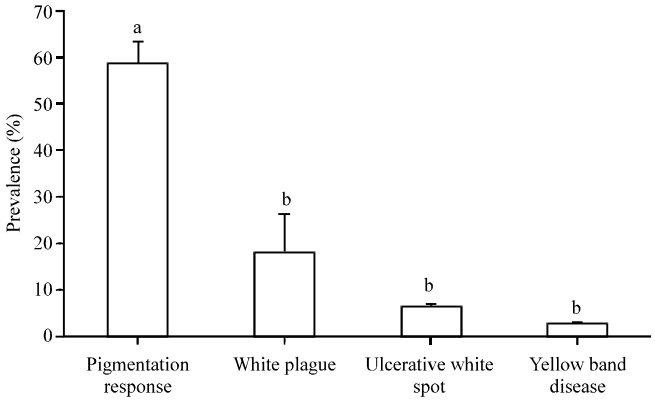

Fig. 4: Mean prevalence coral diseases of Panjang Island

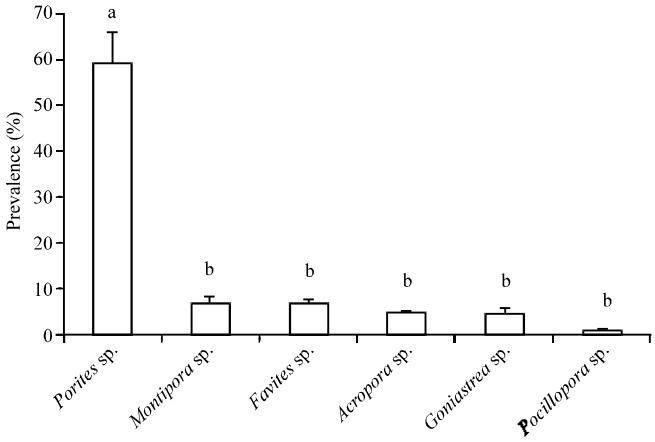

Fig. 5: Mean total disease prevalence for all diseases on coral genera

from disease. It was affected by 3 diseases such as, pigmentation response, white plague and ulcerative white spot. While, other coral genera were only affected by 1 disease type. The mean total disease prevalence for all diseases observed on coral genera were found to be 59.15±6.77% SE in *Porites* sp., 6.85±1.52% SE in *Montipora* sp., 6.83±1.01% SE in *Favites* sp., 4.81±0.20% SE in *Acropora* sp., 4.71±1.21% SE in *Goniastrea* sp. and 1.02±0.02% SE in *Pocillopora* sp. (Fig. 5). Pigmentation response was the most prevalent in massive *Porites* sp. Statitistical analyses showed that there was a significant difference in disease prevalence among affected coral taxa ($F_{5, 12} = 120.42$, $p<0.01$). A Tukey post-hoc test revealed that the only significant difference among species occurred between *Porites* sp. and other 5 coral genera affected.

DISCUSSION

In this very preliminary survey showed that the coral disease prevalence was very high in Panjang Island 74.37±5.29% (Mean±SE). However, there was no significant difference ($F_{1, 2} = 0.09$, $p>0.10$) in the effect of season on prevalence coral disease (Fig. 2). Compared to other studies in Indonesia, such as Wakatobi Marine National Park<1%; (Haapkyla *et al*., 2007) and Spermonde archipelago 1.5-4.6%, (Muller *et al*., 2012), the coral disease prevalence in Panjang Island is the

highest value. Even when compared to the number of locations in other countries at which disease has been observed, such as,, Carribean 60%; (Porter *et al*., 2001), Philippines 22%; (Raymundo *et al*., 2003), Great Barrier Reef, Australia 8.97%; (Willis *et al*., 2004), or Palk Bay, southeastern India 21%; (Thinesh *et al*., 2011) the coral disease prevalence in this study is still the highest value. Evidence from a variety studies of coral diseases within the last decade proved that the increasing rate of high levels in coral disease were highly correlated with the increasing of water temperature and nutrient runoff (Patterson *et al*., 2002; Willis *et al*., 2004; Kaczmarsky, 2006; Bruno *et al*., 2007; Heron *et al*., 2010).

Four disease states, pigmentation response, white plague, ulcerative white spot and yellow band, were documented in Panjang Island (Table 1 and Fig. 3), which are lower than the reported cases in Great Barier Reefs (Willis *et al*., 2004), Carribean (Weil, 2004), Philiphines (Raymundo *et al*., 2005) and India (Thinesh *et al*., 2011) with 8, 22, 5 and 6 disease types, respectively. However, this results was higher than the reported cases in Wakatobi (2 disease types; Haapkyla *et al*., 2007). In contrast with many studies of other reef systems, the overall observed prevalence of coral diseases was very high, with individual prevalence ranging from 2.88% for yellow band to 58.68% for pigmentation response (Fig. 4). Pigmentation response, causing tissue loss, has come out as a serious threat to coral reefs. This syndrome disease has been reported from several coastal regions in the world (Ravindran and Raghukumar, 2002; Raymundo *et al*., 2005; Haapkyla *et al*., 2007). However, there are continuing uncertainties about the cause of pigmentation response. There has been still controversy over whether pigment response is a disease (Ravindran and Raghukumar, 2002; Willis *et al*., 2004) or an immune response of the coral to a particular stress (Bongiorni and Rinkevich, 2005; Raymundo *et al*., 2005; Haapkyla *et al*., 2007; Palmer *et al*., 2009). Raymundo *et al*. (2005) suggested that unidentified chemical and/or microbial agent(s) may trigger this response or secondarily infect compromised tissue.

Six taxonomic groups of coral genera, *Porites* sp., *Montipora* sp., *Favites* sp., *Acropora* sp., *Goniastrea* sp. *Pocillopora* sp. were found to be affected by diseases in Panjang Island. *Porites* sp. was the most common coral genus and suffered very large from disease (Fig. 5). In this study, *Porites* sp. was the most susceptible genus that attacked by disease pigmentation response, white plague and ulcerative white spot. This result was similar to the study reported from Philippine (Raymundo *et al*., 2005) and southern India (Thinesh *et al*., 2011).

The finding of very high value of prevalence coral disease in Panjang Island above mentioned was not surprisingly, since coral reefs in Panjang Island are continuously being degraded by natural disturbances and human activities. Jepara coastal waters is surrounded by harbour, shipyard, high density of coastal settlements, coastal agriculture and wood industries. These environmental stressors are possible cause of declining water quality. Many studies reported that poor water quality caused increasing coral diseases on reefs worldwide (De'ath and Fabricius, 2010; Thinesh *et al*., 2011). Haapkyla *et al*. (2011) reported that rainfall and associated runoff could increase nutrients and organic matter in which caused increasing pathogen virulence. Indonesia experiences two seasons, namely dry and rainy season. Rainfall during the two seasons is usually distinctive, with the dry season having half as much as the rainy season. Rainfall is the most important cyclic phenomenon in Jepara as it brings about important changes in the physical and chemical characteristics of the Panjang Island coastal waters. This region generally experiences dry season between May to October. However, during this study there was a distinct dry season which receive substantial rainfall during the May-October. Hence, threre was no difference in seasonal variation due to their rainfall was equally distributed throughout the year.

CONCLUSION

The finding of the preliminary data from this study showed that the coral disease prevalence in Panjang Island was very high. This island could be an important area for future studies due to a large number of corals were affected by diseases. It is important to continue coral disease monitoring attempts by expanding the number of monitored areas in order to understand the processes of disease occurrence and distribution.

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