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Research Article

An Initial Assessment of Coral Disease Prevalence on Tourism Areas of Pasir Putih Beach, Java Sea

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Abstract

The increasing tourist industry along Java seashore might cause pollution and harm the coral reef ecosystems. The present study was carried out to quantify indicators of coral disease prevalence at sites inside and outside in the snorkeling tourism hotspot of Pasir Putih coastal waters, East Java, Indonesia. Coral disease rapid assessment was conducted in June, 2015. 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 total of 78 coral colonies observed, 33 colonies were affected by diseases. Mean prevalence for all diseases observed was 42.30±4.9% SE. The disease prevalence at site inside the snorkeling tourism hotspot (50.00%) was higher than that of outside (38.88 %). Six disease states detected were white syndrome (13.89±1.31% SE), white band (7.41±2.62% SE), yellow blotch (3.70±2.62% SE), dark spot syndrome (3.70%), white plague (1.85%) and growth anomaly (1.85%). The prevalences of disease in the coral genus were found to be 17.95% in *Acropora* sp., 12.82% in *Favia* sp., 1.28% in *Diploastrea* sp., 3.85±2.71% SE in *Porites* sp., 2.56% in *Favites* sp., 1.28% in *Goniastrea* sp. and 1.28% in *Montipora* sp. To our knowledge, this is the first study of quantitatively coral disease on Pasir Putih coastal waters, Java Sea. This early study revealed that tourism activity might be resulting in the decrease of the coral health in the coral tourism areas.

Key words: Coral disease, prevalence, tourism, coral health, coastal waters

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Pasir Putih Beach Situbondo is a maritime and nature tourism object in Java coastal waters. It has become an attractive tourism destination in recent years. The main tourist attractions are its sparkling white sand and magnificent coral reefs. In addition, as a marine tourism resort, Pasir Putih Beach is also the excellent place to practice snorkeling, swimming, wind surfing and diving. However, these tourist activities could adversely affect coral assemblages through physical injury (Hawkins *et al*., 2005), sediment deposition (Zakai and Chadwick-Furman, 2002) or presence of coral disease (Lamb and Willis, 2011). Coral reef communities have experienced increasingly stressful conditions because tourist activities could change environmental conditions, potentially weakening coral resistance to bacterial infections or increasing pathogen virulence (Harvell *et al*., 2007; Muller *et al*., 2012; Altizer *et al*., 2013).

Anthropogenic activity, such as terrestrial runoff of sediment and destructive fishing (Edinger *et al*., 1998), heavy metals pollution (Sabdono, 2009; Sabdono *et al*., 2012), agriculture herbicide (Sabdono *et al*., 2007a, b) and the presence of concentrated tourist activities (Diedrich, 2007; Lamb and Willis, 2011) implicated in coral disease outbreaks and rising prevalence levels (Lamb *et al*., 2014). No studies have attempted to relate between coral disease prevalence and the presence of concentrated tourist activities in Indonesia. However, several previous studies regarding of these correlations were reported from Caribbean coral (Hawkins *et al*., 1999), coral reefs of Aqaba, Red Sea (Winkler *et al*., 2004) and Great Barrier Reef Marine Park, Australia (Lamb *et al*., 2014). Most concluded that tourism could increase coral disease prevalence and reduce health in marine tourism regions. Lamb *et al*. (2014) reported that the prevalence of coral diseases at reefs with offshore tourism platforms were bigger than that of nearby reefs without platforms.

Several previous studies of coral disease prevalence and status has been carried out in Indonesia such as, Wakatobi Marine National Park (Haapkyla *et al*., 2007), Spermonde archipelago (Muller *et al*., 2012), Seribu islands (Johan *et al*., 2012) and Panjang island (Sabdono *et al*., 2014). To date, no study or survey of coral diseases has been carried out in Pasir Putih Beach Situbondo, a seashore in the Java Sea that has experienced a negative long term detrimental effects due to tourist-related damage. The objective of the survey was to quantify indicators of coral disease prevalence at sites inside and outside in the snorkeling tourism hot spot of Pasir Putih coastal waters. The study results will help to develop practical management strategies to mitigate the impacts of tourist activities on coral persistence and disease outbreaks in coastal regions.

MATERIALS AND METHODS

Study area: The impact of coral disease was measured on reefs adjacent to Pasir Putih beach in the Situbondo waters, Java Sea. Coral disease prevalence was determined at site located in the inside (E113°49′278″ S07°41′442″) and outside (E113°49′453″S07°41′106″) in the snorkeling tourism hotspot (Fig. 1). This early assessment of coral disease prevalence was carried out on June, 2015.

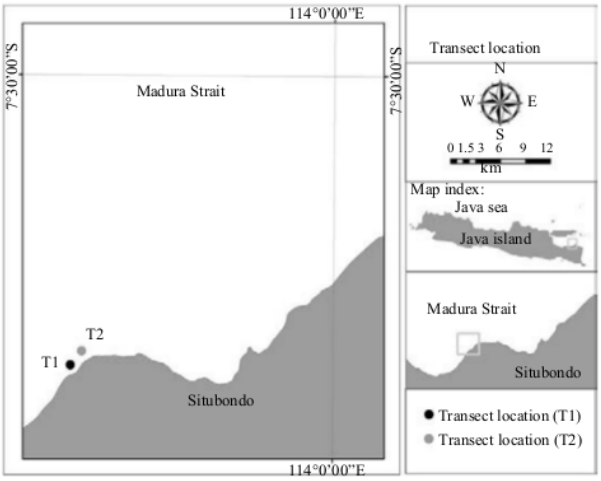

Fig. 1: Map of study area Pasir Putih, Situbondo

Survey method: Coral disease assesment was conducted using belt transects covering an area of 2×25 m (one meter on each side of the transect line) in May, 2015. While coral cover was estimated by using the line intercept transect method (English *et al*., 1997). Two replicate transects in each sites were laid in reef slope zone (1-4 m depth). Transects followed the depth contour of the reef in which sites inside and outside in the snorkeling tourism hotspot were located randomly 1000 and 3000 m in distance from seashore, respectively. Each coral colony within the belt was calculated to genus levels and recorded as healthy or diseased colonies. 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 2 transects of each site.

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. 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 prevalence for all diseases observed was 42.30±4.9% SE. The disease prevalence at site inside the snorkeling tourism hotspot (50.0 %) was higher than that of site outside (38.88 %). (Fig. 2). Six disease states, growth anomaly, white plague, white syndrome, yellow blotch, white band and dark spot syndrome were detected within transects and photographs of each disease presented in Fig. 3. The percentage of disease was different in each type of disease (Fig. 4). White syndrome showed the highest prevalence (13.89±1.31% SE), followed by white band (7.41±2.62% SE), yellow blotch (3.70±2.62% SE), yellow blotch disease (2.88±0.05% SE), dark spot syndrome (3.70%), white plague (1.85%) and growth anomaly (1.85%).

A total of 78 coral colonies observed, 33 colonies were affected by diseases in an area of 200 m^2 (four 2×25 m belt transects). Seven taxonomic groups of coral genera were found to be affected by diseases in Pasir Putih Beach Situbondo. Among these coral genera, *Acropora* sp. was the most common coral genus suffered very large from disease. It was affected by two diseases such as, white band and growth anomaly. While, *Favia* sp. was infected by three diseases, yellow blotch, growth anomaly and white syndrome. The other coral genera were affected by only one disease type. The disease prevalence for all diseases observed on coral genera were found to be 17.95% in *Acropora* sp., 12.82% in *Favia* sp., 1.28% in *Diploastrea* sp., 3.85% in *Porites* sp., 2.56% in *Favites* sp., 1.28% in *Goniastrea* sp. and 1.28% in *Montipora* sp. (Fig. 5). White band was the most prevalent in branching coral *Acropora* sp.

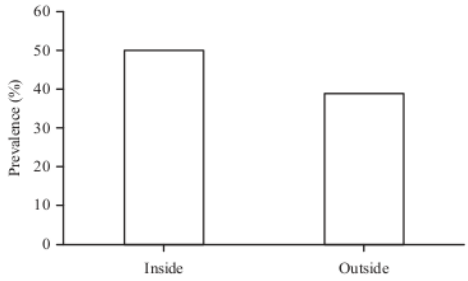

Fig. 2: Tourist location diseases prevalence in Pasir Putih, Situbondo

DISCUSSION

Several previous studies on anthropogenic impacts of coral reefs have been associated with the increased levels of coral disease (Zakai and Chadwick-Furman, 2002; Altizer *et al*., 2013). However, very little study on the effect of reef-based tourist facilities have been assessed. This study was conducted to examine the effectiveness of concentrating tourism activities on coral disease. In this early assessment showed that the mean prevalence for all coral disease in Pasir Putih beach was very high 42.30±4.9% SE (Mean±SE). The concentrating of tourism location affected on prevalence coral disease. The disease prevalence at site inside the snorkeling tourism hotspot (50.00%) was higher than that of outside (38.88%) (Fig. 2). Lamb and Willis (2011) reported that coral disease prevalence at reefs with offshore tourism platforms was bigger than at nearby reefs without platforms. Evidence from a variety studies of coral diseases within the last decade proved that tourism could increase coral disease prevalence and reduce health in marine tourism regions (Lamb *et al*., 2014).

Six disease states, growth anomaly, white plague, white spot, yellow blotch, white band and dark spot syndrome were documented in Pasir Putih beach (Fig. 3). The overall observed prevalence of coral diseases was high, with individual

Fig. 3(a-f): Diseases observed on 2015 Pasir Putih beach surveys. (a) Growth anomaly, (b) White plague, (c) White syndrome, (d) Yellow blotch, (e) White band and (f) Dark spot syndrome

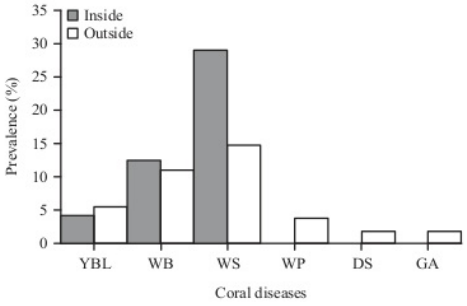

Fig. 4: Mean prevalence coral diseases of Pasir Putih coastal waters. GA: Growth anomaly, WP: White plague, WS: White syndrome, YBL: Yellow blotch, WB: White band, DS: Dark spot syndrome

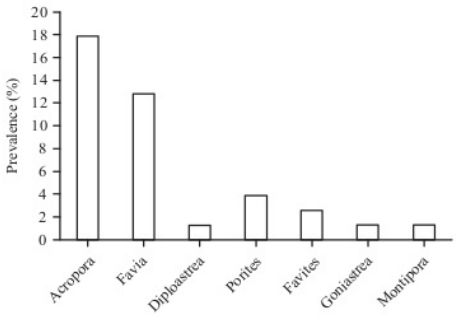

Fig. 5: Prevalence for all diseases observed on coral genera

prevalence ranging from 1.85% for white plague and growth anomaly to 13.89% for white syndrome (Fig. 4). White syndrome, causing tissue loss, has come out as a serious threat to coral reefs. This syndrome is characterized by lesions showing a sharp demarcation between apparently healthy coral tissue and the bare coral skeleton (Sussman *et al*., 2008; Roff *et al*., 2011). While white band disease affects a larger range of corals specifically certain Acropora like Elkhorn, Staghorn and other species of branching corals (Gignoux-Wolfsohn *et al*., 2012; Mayor *et al*., 2006).

Seven taxonomic groups of coral genera *Acropora* sp., *Favia* sp., *Diploastrea* sp., *Porites* sp., *Favites* sp., *Goniastrea* sp. and *Montipora* sp. found to be affected by diseases in Pasir Putih beach. *Acropora* sp. and *Favia* sp. were the common coral genus and suffered very large from disease (Fig. 5). In this study, Favia was the most susceptible genus that attacked by three diseases namely, yellow blotch, growth anomaly and white syndrome. This result was similar to the study reported from Spermonde and Wakatobi islands (Muller *et al*., 2012).

Not surprisingly, the coral disease prevalence in Pasir Putih Bach was very high, since coral reefs in this regions are subject to attractive tourist destination and human activities. Situbondo coastal waters are surrounded by shipyard, high density of coastal settlements and mountain forests. These environmental stressors are possible cause of declining water quality.

CONCLUSION

The result of the preliminary data from this study showed that the presence of concentrated tourist activities might increase coral disease prevalence and reduce health in marine tourism regions. These findings have important implications for the conservation and sustainable coral reef management, therefore it is important to continue coral disease monitoring attempts by expanding the number of monitored areas and tourism data.

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